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# Diversification of communities of *Ichneumoninae* (*Hymenoptera: Ichneumonidae*) of canopies of pines during secondary succession of the pine forest of Puszcza Białowieska*

**Abstract.** *Ichneumoninae* communities occurring in pine cultures and canopies of pines (*Pinus silvestris*) are described in the consecutive stages of secondary succession of subcontinental (*Peucedano-Pinetum*) pine forests in Puszcza Białowieska. The parameters analysed include species composition (136 species), structure of dominance as well as indices of species diversity, species composition similarity and dominance structure similarity. The following communities were identified: the *Ichneumoninae* community of the culture stage, which was markedly distinct from the others, a transitional-type community of the young stand and communities specific to older stands, where the community's core (parasitoids of the *Microlepidoptera* of pine) becomes stabilized – in the pole wood.

## INTRODUCTION

Silvicultural practices in forests are usually aimed at maximizing timber output. As a result, pine forests are cultivated according to well-defined methods that include clear felling as a means for clearing forests. Artificial methods of stand renewal and silvicultural practices lead to transformation of the developing stands into even-aged pine monocultures with specific features and properties. In certain regions of Poland, the forests are particularly prone to pest gradation. The clear felling is extensive and particularly destructive to forest ecosystems. Cultures of pine planted on a felling site trigger the process of secondary succession, which is, to a certain extent, directed and controlled by foresters. Thus, following a clear felling of a mature stand of pine, the first stage of secondary succession is a pine culture characterized by a high density of several-year-old pines and a plant cover that comprises open area species

* The material was collected within the framework of the research problem CPBP 04.10.07.

(species of sandy greens), while plants characteristic of older stands are eradicated. Pine-choking species, including birch, are removed during silvicultural practices. The young stand and the pole wood are the subsequent stages of succession. As pine canopies are very dense, the abundance of open area plant species is reduced significantly in the herb layer and ground cover composed of mosses or dead plants is formed. As the stand grows older (as early as the pole wood stage), canopy density decreases as a result of tree separation and thinning, and vegetation similar to a typical phytocoenosis of a mature stand of pine starts to form gradually in the lower layer.

Comprehensive studies of *Ichneumonidae* communities of canopies of pines in consecutive developmental stages of pine stands in coniferous forests have not been carried out so far. However GARBARCZYK and SAWONIEWICZ (1990) have presented some quantitative information referring to parasidoids of pine forest in Poland. *Ichneumonidae* communities have only been described at certain stages of secondary succession in different regions of Poland: pine cultures *Ichneumonidae* communities frequenting flowers have been described in forests near Białystok (SAWONIEWICZ 1974), a pole wood community has been investigated in the Warsaw area (SAWONIEWICZ 1981) and young stand communities near Kraśnik and in Puszcza Kampinoska (SAWONIEWICZ 1979).

The larvae of the representatives of the subfamily *Ichneumoninae* are parasitic to butterflies of various families, including all primary forest pests. The species of the tribe *Phaeogenini* affect only *Microlepidoptera*, while the other tribes prefer mostly *Macrolepidoptera*. The females attack larvae and chrysalises of butterflies, while imagines always leave the host pupae. The parasitoids are therefore an important factor of environmental resistance, limiting and so regulating butterfly abundance.

The main objective of this paper is to investigate and assess the changes occurring in *Ichneumoninae* communities at the consecutive stages of secondary succession in a developing pine forest. Quantitative changes, species composition and the structure of dominance of the *Ichneumoninae* communities under study are described on the background of the feeding relations of the more important parasitoids; species diversity in the communities is then analysed as well as species composition and dominance structure similarity.

## STUDY AREAS, MATERIAL AND METHODS

The communities were monitored in the years 1986 and 1987 in Puszcza Białowieska in a subcontinental (*Peucedano-Pinetum*) fresh pine forest (MATUSZKIEWICZ et al. 1993).

Four developmental stages of pine forests were selected (resulting in 12 areas altogether – 3 for each stage): cultures of pine (0) with 2–4-year-old pine planted in trenches, 15–22-year-old young stands and thickets (1), 40–60-year-old pole wood (2) and 90–130-year-old mature stands of pine (3) (BAŃKOWSKA 1993). Some of the older stands were situated within the Sitki partial reserve.

*Ichneumoninae* were captured into Moericke's pitfall traps (yellow bowls), placed on the ground or in the litter in cultures, and hung in canopies of pines in the other stages. The total number of *Ichneumoninae* individuals caught in 2 vegetational season (6 months each) was 1572, representing 136 species (Tab. I and III). Average abundance (n'), i.e. the number of individuals caught into 1 trap during a 24-hour period – differed markedly between the age classes of pine stands under investigation, varying from 0.02 to 0.15 (Tab. I), with a maximum in young stands and a minimum in cultures.

Table I. Number of individuals (n), average abundance (n') and number of species of *Ichneumoninae* caught into Moericke's pitfall traps in pine cultures and in canopies of pines in a pine forest habitat in Puszcza Białowieska: 0 – pine cultures, 1 – young stands, 2 – pole wood, 3 – mature stands.

| Stands / Years | 0 | | 1 | | 2 | | 3 | |
|---|---|---|---|---|---|---|---|---|
| | n | n' | n | n' | n | n' | n | n' |
| 1986 | 56 | 0.022 | 378 | 0.150 | 270 | 0.105 | 217 | 0.086 |
| 1987 | 84 | 0.050 | 210 | 0.075 | 166 | 0.060 | 191 | 0.069 |
| Number of specimens | 140 | 0.036 | 588 | 0.113 | 436 | 0.083 | 408 | 0.078 |
| Number of species | 54 | – | 98 | – | 57 | – | 43 | – |

The indices employed in the analysis of the *Ichneumoninae* communities under study include: an index of species diversity (H'), the "percentage" modification of Pielou's index of evenness (J) (Tab. II), Soerensen's index of species composition similarity (So) and Renkonen's index of dominance structure similarity (Re) (SZUJECKI 1987, TROJAN et al. 1994). The values of the above similarity indices obtained for the communities studied are presented as a Czekanowski's diagram (Figs 2 and 3).

Table II. Index of species diversity (H') and evenness (J) of communities of *Ichneumoninae* of various age classes of pine forests in Puszcza Białowieska: 0 – pine cultures, 1 – young stands, 2 – pole wood, 3 – mature stands.

| Stands | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| H' | 4.95 | 5.26 | 4.50 | 3.94 |
| $H_{max}$ | 5.75 | 6.61 | 5.78 | 5.43 |
| J | 86.03% | 79.48% | 77.86% | 72.56% |

## SURVEY OF COMMUNITIES OF *ICHNEUMONINAE*

Consecutive stages of secondary succession of the pine forest bring about noticeable changes in the species composition and structure of dominance of the communities under study (Fig. 1).

The culture stage community (0): 54 species were recorded, approximately half of which are associated with open areas; the structure of dominance was rather unique (Fig. 1) with one strong dominant (D = 28.6%): *Vulgichneumon*

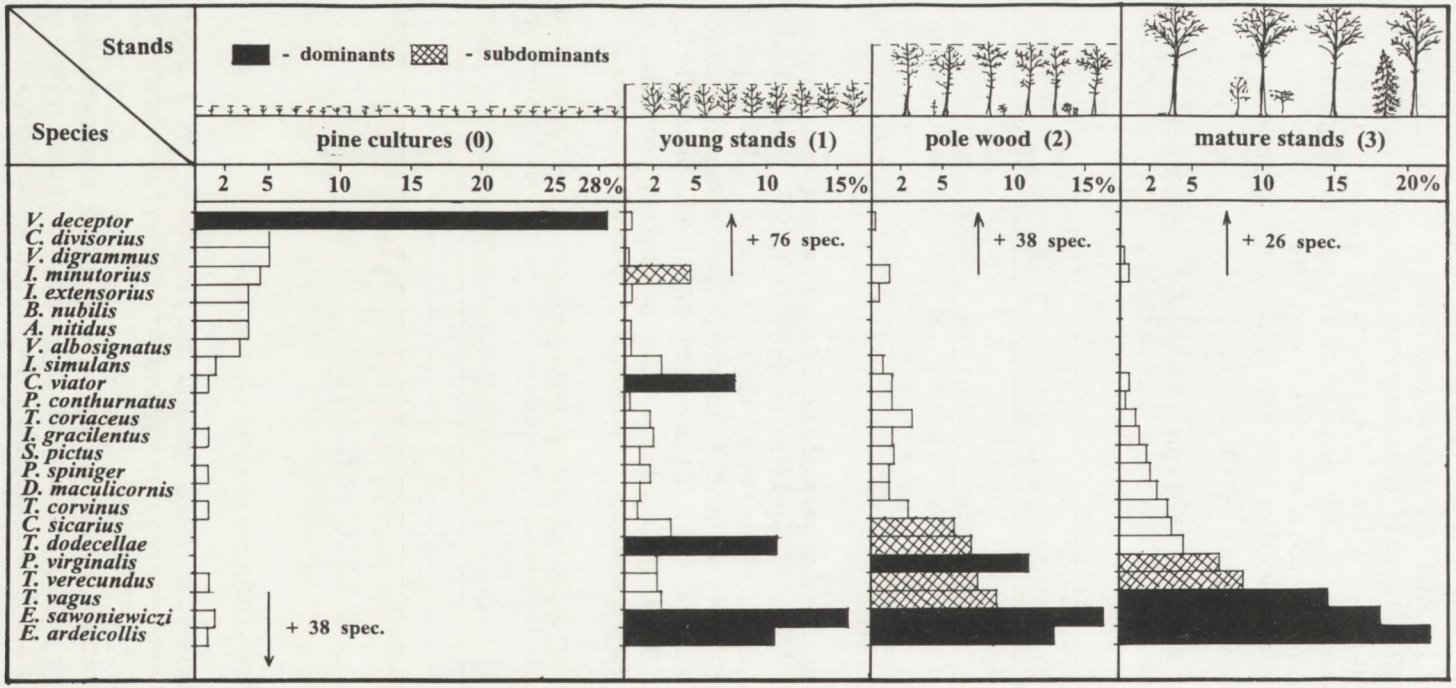


Fig. 1. Structure of dominance of *Ichneumoninae* communities of various developmental stages of pine forests in Puszcza Białowieska: 0 – pine cultures, 1 – young stands, 2 – pole wood, 3 – mature stands.

*deceptor*, which is parasitic to chrysalises of *Noctuidae*; other more numerous species (D = 3–5%) are also associated with *Noctuidae* and with open areas and bushes.

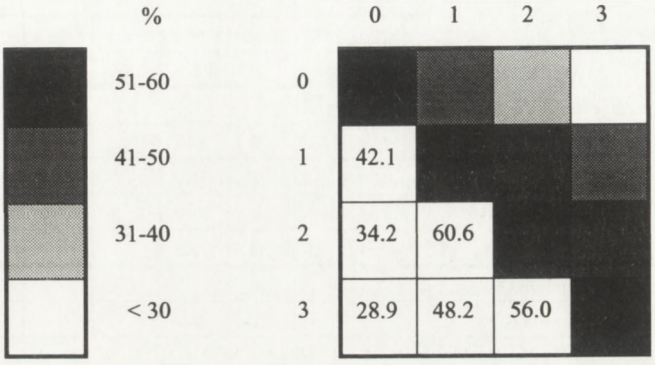


Fig. 2. Diagram of species composition similarity (So) of *Ichneumoninae* communities of the developmental stages of pine forests studied in Puszcza Białowieska: 0 – pine cultures, 1 – young stands, 2 – pole wood, 3 – mature stands.

Young stand and pine thicket community (1): 98 species found; 4 dominants (D = 8–16%) are associated with pests of pine: *Eriplatys ardeicollis* (possibly also *Eriplatys sawoniewiczi*) are parasites of *Ocnerostoma piniarellum* (ZELL.) (*Yponomeutidae*); *Tycherus dodecellae* is a parasitoid of *Exoteleia dodecella* (L.) (*Gelechidae*) and *Cratichneumon viator* searches the litter for chrysalises of *Panolis flammea* (SCHIFF.) (*Noctuidae*) and *Bupalus piniarius* (L.) (*Geometridae*) and others.

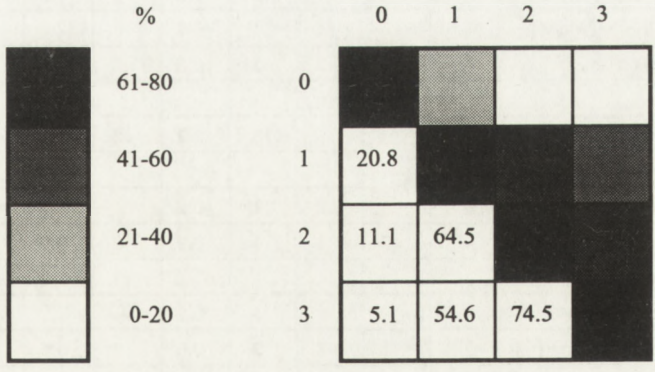


Fig. 3. Diagram of dominance structure similarity (Re) of *Ichneumoninae* communities of the developmental stages of pine forests studied in Puszcza Białowieska: 0 – pine cultures, 1 – young stands, 2 – pole wood, 3 – mature stands.

Table III. List of *Ichneumoninae* species occurring in various age classes of pine forests in Puszcza Białowieska: 0 – pine cultures, 1 – young stands, 2 – pole wood, 3 – mature stands (n – number of individuals)

| No | Stand / *Ichneumoninae* | 0 | | 1 | | 2 | | 3 | | Σ |
|---|---|---|---|---|---|---|---|---|---|---|
| | | n | % | n | % | n | % | n | % | n |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| | *Protichneumonini* | | | | | | | | | |
| 1 | *Coelichneumon deliratorius* (L.) | 1 | 0.7 | 3 | 0.5 | | | | | 4 |
| 2 | *Coelichneumon desinatorius* (THUNB.) | | | 1 | 0.2 | | | | | 1 |
| 3 | *Coelichneumon falsificus* (WESM.) | | | 4 | 0.7 | 3 | 0.7 | 1 | 0.2 | 8 |
| 4 | *Coelichneumon fasciatus* (GMEL.) | | | 3 | 0.5 | | | | | 3 |
| 5 | *Coelichneumon pumilionobilis* HEINR. | | | | | | | 1 | 0.2 | 1 |
| 6 | *Coelichneumon sugillatorius* (L.) | | | 1 | 0.2 | | | | | 1 |
| | *Heresiarchini* | | | | | | | | | |
| 7 | *Heresiarches eudoxius* (WESM.) | | | 1 | 0.2 | | | 1 | 0.2 | 2 |
| | *Listrodromini* | | | | | | | | | |
| 8 | *Anisobas platystylus* THOMS. | | | 1 | 0.2 | | | | | 1 |
| | *Acanthojoppini* | | | | | | | | | |
| 9 | *Pseudoplatylabus uniguttatus* (GRAV.) | 1 | 0.7 | 1 | 0.2 | | | | | 2 |
| 10 | *Pseudoplatylabus violentus* (GRAV.) | 2 | 1.4 | | | | | | | 2 |
| | *Ichneumonini* | | | | | | | | | |
| 11 | *Stenichneumon culpator* (SCHRANK) | | | 1 | 0.2 | 1 | 0.2 | | | 2 |
| 12 | *Syspasis alboguttatus* (GRAV.) | | | 2 | 0.3 | | | | | 2 |
| 13 | *Syspasis eburnifrons* (WESM.) | | | | | 1 | 0.2 | | | 1 |
| 14 | *Sysaspis scutellator* (GRAV.) | 1 | 0.7 | 1 | 0.2 | | | 1 | 0.2 | 3 |
| 15 | *Stenoaoplus pictus* (GRAV.) | | | 5 | 0.9 | 7 | 1.6 | 7 | 1.7 | 19 |
| 16 | *Aoplus defraudator* (WESM.) | | | 1 | 0.2 | | | | | 1 |
| 17 | *Aoplus ochropis* (GMEL.) | 1 | 0.7 | 2 | 0.3 | | | | | 3 |
| 18 | *Aoplus* sp. | | | | | | | 1 | 0.2 | 1 |
| 19 | *Platylabops virginalis* (WESM.) | | | 13 | 2.2 | 48 | 11.1 | 28 | 6.9 | 89 |
| 20 | *Stenobarichneumon basalis* (PERK.) | 1 | 0.7 | | | | | | | 1 |
| 21 | *Stenobarichneumon citator* (THUNB.) | 1 | 0.7 | 1 | 0.2 | | | | | 2 |
| 22 | *Baronisobas ridibundus* (GRAV.) | 2 | 1.4 | 4 | 0.7 | 2 | 0.5 | | | 8 |
| 23 | *Lymantrichneumon dispar* (PODA) | | | | | 1 | 0.2 | | | 1 |
| 24 | *Cratichneumon culex* (MÜLL.) | | | 1 | 0.2 | | | 1 | 0.2 | 2 |
| 25 | *Cratichneumon fabricator* (F.) | 1 | 0.7 | 3 | 0.5 | 2 | 0.5 | | | 6 |
| 26 | *Cratichneumon palliditarsus* (THOMS.) | | | 1 | 0.2 | | | | | 1 |
| 27 | *Cratichneumon punctifrons* (GRAV.) | | | 2 | 0.3 | 1 | 0.2 | 1 | 0.2 | 4 |
| 28 | *Cratichneumon rufifrons* (GRAV.) | | | 2 | 0.3 | 1 | 0.2 | 2 | 0.5 | 5 |
| 29 | *Cratichneumon sicarius* (GRAV.) | | | 19 | 3.2 | 25 | 5.8 | 14 | 3.4 | 58 |
| 30 | *Cratichneumon versator* (THUNB.) | | | 4 | 0.7 | 5 | 1.2 | | | 9 |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| 31 | *Cratichneumon viator* (Scop.) | 1 | 0.7 | 46 | 7.8 | 6 | 1.4 | 2 | 0.5 | 55 |
| 32 | *Eupalamus lacteator* (Grav.) | | | 1 | 0.2 | 2 | 0.5 | 1 | 0.2 | 4 |
| 33 | *Eupalamus oscillator* Wesm. | | | 1 | 0.2 | | | | | 1 |
| 34 | *Eupalamus wesmaeli* Thoms. | | | 2 | 0.3 | | | | | 2 |
| 35 | *Crypteffigies lanius* (Grav.) | | | | | | | 1 | 0.2 | 1 |
| 36 | *Homotherus locutor* (Thunb.) | | | 2 | 0.3 | 2 | 0.5 | 1 | 0.2 | 5 |
| 37 | *Homotherus varipes* (Grav.) | | | 2 | 0.3 | 3 | 0.7 | 3 | 0.7 | 8 |
| 38 | *Eristicus clarigator* (Wesm.) | 1 | 0.7 | 6 | 1.0 | 5 | 1.2 | 3 | 0.7 | 15 |
| 39 | *Eristicus clericus* (Grav.) | | | | | | | 1 | 0.2 | 1 |
| 40 | *Vulgichneumon bimaculatus* (Schrank) | | | 1 | 0.2 | | | | | 1 |
| 41 | *Vulgichneumon deceptor* (Scop.) | 40 | 28.6 | 3 | 0.5 | 1 | 0.2 | | | 44 |
| 42 | *Vulgichneumon saturatorius* (L.) | | | 3 | 0.5 | 1 | 0.2 | | | 4 |
| 43 | *Virgichneumon albosignatus* (Grav.) | 4 | 2.9 | 2 | 0.3 | | | | | 6 |
| 44 | *Virgichneumon digrammus* (Grav.) | 7 | 5.0 | 1 | 0.2 | | | 1 | 0.2 | 9 |
| 45 | *Virgichneumon dumeticola* (Grav.) | | | 7 | 1.2 | | | | | 7 |
| 46 | *Virgichneumon extremator* (Thunb.) | 1 | 0.7 | 1 | 0.2 | | | | | 2 |
| 47 | *Virgichneumon callicerus* (Grav.) | 1 | 0.7 | | | | | | | 1 |
| 48 | *Virgichneumon faunus* (Grav.) | | | 1 | 0.2 | | | 1 | 0.2 | 2 |
| 49 | *Virgichneumon maculicauda* Perk. | 1 | 0.7 | | | | | | | 1 |
| 50 | *Virgichneumon monostagon* (Grav.) | | | 1 | 0.2 | | | | | 1 |
| 51 | *Virgichneumon tergenus* (Grav.) | 1 | 0.7 | 1 | 0.2 | | | | | 2 |
| 52 | *Barichneumon heraclianus* (Bridgm.) | | | 1 | 0.2 | 1 | 0.2 | | | 2 |
| 53 | *Barichneumon nubilis* (Brischke) | 5 | 3.6 | | | | | | | 5 |
| 54 | *Barichneumon ? perversus* (Kriechb.) | 4 | 2.9 | | | 1 | 0.2 | | | 5 |
| 55 | *Barichneumon praeceptor* (Thunb.) | 1 | 0.7 | | | | | | | 1 |
| 56 | *Hoplismenus terrificus* Wesm. | | | 1 | 0.2 | | | | | 1 |
| 57 | *Exephanes amabilis* (Kriechb.) | | | 1 | 0.2 | | | | | 1 |
| 58 | *Chasmias lugens* (Grav.) | | | | | 1 | 0.2 | | | 1 |
| 59 | *Chasmias motatorius* (F.) | | | 1 | 0.2 | | | | | 1 |
| 60 | *Ichneumon albicollis* Wesm. | 1 | 0.7 | 1 | 0.2 | | | | | 2 |
| 61 | *Ichneumon albiger* Wesm. | | | | | 1 | 0.2 | | | 1 |
| 62 | *Ichneumon cessator* Müll. | | | 1 | 0.2 | | | | | 1 |
| 63 | *Ichneumon extensorius* L. | 5 | 3.6 | 3 | 0.5 | 2 | 0.5 | | | 10 |
| 64 | *Ichneumon gracilentus* Wesm. | 1 | 0.7 | 12 | 2.0 | 6 | 1.4 | 5 | 1.2 | 24 |
| 65 | *Ichneumon insidiosus* Wesm. | 3 | 2.1 | 5 | 0.9 | | | | | 8 |
| 66 | *Ichneumon latrator* F. | 2 | 1.4 | 13 | 2.2 | 1 | 0.2 | | | 16 |
| 67 | *Ichneumon melanotis* Holmgr. | | | 3 | 0.5 | | | | | 3 |
| 68 | *Ichneumon memorator* Wesm. | | | 1 | 0.2 | | | | | 1 |
| 69 | *Ichneumon minutorius* Desv. | 6 | 4.3 | 27 | 4.6 | 6 | 1.4 | 2 | 0.5 | 41 |
| 70 | *Ichneumon nereni* Thoms. | 1 | 0.7 | | | | | | | 1 |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| 71 | *Ichneumon sarcitorius* L. | 1 | 0.7 | | | | | 1 | 0.2 | 2 |
| 72 | *Ichneumon simulans* TISCHB. | 2 | 1.4 | 15 | 2.6 | 3 | 0.7 | | | 20 |
| 73 | *Ichneumon* sp.1 | | | 1 | 0.2 | | | | | 1 |
| 74 | *Ichneumon* sp.2 | 1 | 0.7 | | | | | | | 1 |
| 75 | *Ichneumon* sp.3 | | | 1 | 0.2 | | | | | 1 |
| 76 | *Ichneumon* sp.4 | | | 1 | 0.2 | | | | | 1 |
| 77 | *Ichneumon* sp.5 | | | 1 | 0.2 | | | | | 1 |
| 78 | *Ichneumon* sp.6 | | | 1 | 0.2 | | | 1 | 0.2 | 2 |
| 79 | *Rhadinodonta rufidens* (WESM.) | 1 | 0.7 | 1 | 0.2 | 1 | 0.2 | | | 3 |
| 80 | *Limerodops elongatus* (BRISCHKE) | | | 7 | 1.2 | 1 | 0.2 | 2 | 0.5 | 10 |
| 81 | *Ctenichneumon funereus* (GEOFF.) | | | | | | | 1 | 0.2 | 1 |
| 82 | *Ctenichneumon divisorius* (GRAV.) | 7 | 5.0 | | | | | | | 7 |
| 83 | *Ctenichneumon* sp. | 1 | 0.7 | | | | | | | 1 |
| 84 | *Diphyus amatorius* (MÜLL.) | 1 | 0.7 | 3 | 0.5 | 1 | 0.2 | 2 | 0.5 | 7 |
| 85 | *Diphyus luctatorius* (L.) | 2 | 1.4 | | | | | | | 2 |
| 86 | *Diphyus* sp.1 | | | 1 | 0.2 | | | | | 1 |
| 87 | *Diphyus* sp.2 | | | 1 | 0.2 | | | | | 1 |
| 88 | *Spilothyrateles punctus* (GRAV.) | | | 1 | 0.2 | | | | | 1 |
| 89 | *Spilichneumon ammonius* (GRAV.) | | | 1 | 0.2 | 1 | 0.2 | | | 2 |
| 90 | *Spilichneumon* sp. | 1 | 0.7 | | | | | | | 1 |
| | *Platylabini* | | | | | | | | | |
| 91 | *Platylabus nigrocyaneus* (GRAV.) | | | 1 | 0.2 | | | | | 1 |
| 92 | *Platylabus concinnus* THOMS. | | | 1 | 0.2 | | | | | 1 |
| 93 | *Platylabus tricingulatus* (GRAV.) | | | 4 | 0.7 | 1 | 0.2 | | | 5 |
| 94 | *Poecilostictus conthurnatus* (GRAV.) | | | 2 | 0.3 | 6 | 1.4 | 1 | 0.2 | 9 |
| 95 | *Cyclolabus nigricollis* (WESM.) | | | 1 | 0.2 | 3 | 0.7 | | | 4 |
| 96 | *Linycus exhortator* (F.) | | | 1 | 0.2 | | | | | 1 |
| | *Phaeogenini* | | | | | | | | | |
| 97 | *Eriplatys ardeicollis* (WESM.) | 1 | 0.7 | 62 | 10.5 | 55 | 12.7 | 88 | 21.6 | 206 |
| 98 | *Eriplatys sawoniewiczi* DILLER | 2 | 1.4 | 93 | 15.8 | 71 | 16.4 | 74 | 18.1 | 240 |
| 99 | *Hemichneumon elongatus* (RATZ.) | | | | | 2 | 0.5 | | | 2 |
| 100 | *Trachyarus corvinus* THOMS. | 1 | 0.7 | 5 | 0.9 | 11 | 2.5 | 13 | 3.2 | 30 |
| 101 | *Stenodontus marginellus* (GRAV.) | | | | | 1 | 0.2 | | | 1 |
| 102 | *Dicaelotus crassifemur* THOMS. | | | 2 | 0.3 | | | | | 2 |
| 103 | *Dicaelotus inflexus* THOMS. | 2 | 1.4 | | | | | | | 2 |
| 104 | *Dicaelotus pumilus* (GRAV.) | | | 1 | 0.2 | 1 | 0.2 | | | 2 |
| 105 | *Dicaelotus rufilimbatus* (GRAV.) | | | | | 1 | 0.2 | | | 1 |
| 106 | *Deloglyptus pictus* SCHMIEDEKN. | | | 2 | 0.3 | 2 | 0.5 | 4 | 1.0 | 8 |
| 107 | *Diadromus subtilicornis* (GRAV.) | | | 1 | 0.2 | 1 | 0.2 | | | 2 |
| 108 | *Diadromus troglodytes* (GRAV.) | | | 5 | 0.9 | 1 | 0.2 | 1 | 0.2 | 7 |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| 109 | *Diadromus* sp. | | | | | | | 1 | 0.2 | 1 |
| 110 | *Colpognathus celerator* (GRAV.) | 1 | 0.7 | | | | | | | 1 |
| 111 | *Colpognathus* sp. | 1 | 0.7 | | | | | | | 1 |
| 112 | *Centeterus* sp. | 1 | 0.7 | | | | | | | 1 |
| 113 | *Aethecerus discolor* WESM. | 1 | 0.7 | 1 | 0.2 | 1 | 0.2 | | | 3 |
| 114 | *Aethecerus nitidus* WESM. | 5 | 3.6 | 2 | 0.3 | | | | | 7 |
| 115 | *Aethecerus* sp. | 1 | 0.7 | | | | | 1 | 0.2 | 2 |
| 116 | *Phaeogenes melanogonos* (GMEL.) | 1 | 0.7 | | | | | | | 1 |
| 117 | *Phaeogenes spiniger* (GRAV.) | 1 | 0.7 | 10 | 1.7 | 5 | 1.2 | 8 | 2.0 | 24 |
| 118 | *Dirophanes callopus* (WESM.) | | | 3 | 0.5 | 5 | 1.2 | | | 8 |
| 119 | *Dirophanes maculicornis* (STEPH.) | | | 6 | 1.0 | 5 | 1.2 | 10 | 2.5 | 21 |
| 120 | *Dirophanes fulvitarsis* (WESM.) | | | 3 | 0.5 | | | | | 3 |
| 121 | *Dirophanes* sp. | | | 1 | 0.2 | | | | | 1 |
| 122 | *Tycherus amoenus* (WESM.) | 1 | 0.7 | 2 | 0.3 | | | | | 3 |
| 123 | *Tycherus clypearis* (BRISCHKE) | | | 10 | 1.7 | 4 | 0.9 | 4 | 1.0 | 18 |
| 124 | *Tycherus coriaceus* (PERK.) | | | 10 | 1.7 | 12 | 2.8 | 4 | 1.0 | 26 |
| 125 | *Tycherus dodecellae* RANIN | | | 63 | 10.7 | 31 | 7.1 | 18 | 4.4 | 112 |
| 126 | *Tycherus ? jucundus* (WESM.) | 4 | 2.9 | | | | | | | 4 |
| 127 | *Tycherus ophthalmicus* (WESM.) | | | | | | | 1 | 0.2 | 1 |
| 128 | *Tycherus osculator* (THUNB.) | | | 1 | 0.2 | | | | | 1 |
| 129 | *Tycherus vagus* (BERTH.) | | | 15 | 2.6 | 38 | 8.8 | 59 | 14.5 | 112 |
| 130 | *Tycherus verecundus* RANIN | 1 | 0.7 | 13 | 2.2 | 33 | 7.6 | 35 | 8.6 | 82 |
| 131 | *Tycherus* sp.1 | | | | | 1 | 0.2 | | | 1 |
| 132 | *Tycherus* sp.2 | | | 1 | 0.2 | | | | | 1 |
| 133 | *Tycherus* sp.3 | | | | | 1 | 0.2 | | | 1 |
| 134 | *Tycherus* sp.4 | 1 | 0.7 | | | | | | | 1 |
| 135 | *Epitomus infuscatus* (GRAV.) | 1 | 0.7 | 2 | 0.3 | | | | | 3 |
| 136 | *Misetus oculatus* (WESM.) | | | 1 | 0.2 | 1 | 0.2 | | | 2 |
| | Total | 140 | | 588 | | 436 | | 408 | | 1572 |

Communities of the pole wood (2) and mature stands of pine (3): 57 and 43 species registered respectively; the share of dominants and subdominants ranged from 22%–6%; the structures of dominance of these two communities were very similar, with only slight shifts of the more important species. Apart from species which were abundant in young stands, *Tycherus vagus* and *T. verecundus* (parasitoids of *Torticidae* of pines) and *Platylabops virginalis* associated with *Geometridae*, also occurred in large numbers. *Cratichneumon sicarius*, a parasitoid of various *Macrolepidoptera*, was also quite abundant in the pole wood.

## ECOLOGICAL ANALYSIS

Shannon and Weaver's index of species diversity reached its highest value (H' = 5.3) in the *Ichneumoninae* community from young stands of pine (Tab. II). Samples from this habitat yielded the greatest number of species, including both species penetrating the litter in pine stands (e.g. *Cratichneumon vicator*) and open area species. Hence, young stands may be said to represent some features of an ecotone between the culture stage and older stands. A relatively high value of the index in the cultures (H' = 5) may be attributed to the fact that some of the species caught in this habitat, besides numerous open area species, occur in adjacent older stands. In the pole wood and mature stands, canopies of pines are a relatively uniform habitat at a height of 15–25 m, with a specific entomofauna closely related to that habitat. Due to that, the value of H' decreases as the stand grows older, from 5.3 through 4.5 to reach 4 in the mature stand. This is, however, accompanied by the formation of the core of the *Ichneumoninae* community, peculiar to that forest layer. Potential species diversity ($H_{max}$) follows a similar pattern in the consecutive developmental stages of secondary succession i.e. with a maximum in the young stand and a minimum in the mature stand (Tab. II). Pielou's index of evenness (J), reflecting the degree of approximation of the actual diversity (H') to potential diversity ($H_{max}$), also decreases throughout the forest sere, the values falling from 86% in the culture stage to 73% in the mature stand (Tab. II). This indicates that the development of internal relations within the community consists in an increase in internal organisation of the communities at the expense of reduction of species diversity and formation of a structure of dominance represented by a less flattened distribution curve (interpretation given by Prof. P. Trojan – TROJAN et al. 1994).

Analysis of Czekanowski's diagrams (Figs 2 and 3) illustrating the degree of similarity of species composition (So) and of the structure of dominance (Re) in the *Ichneumoninae* communities of the stages of secondary succession under investigation shows that the culture stage *Ichneumoninae* community clearly differs in species composition and structure of dominance from the communities inhabiting the consecutive developmental stages of the sere under study. The differences are particularly sharp when the community is compared to the communities living in older stands (the pole wood and mature stand), as is suggested by low values of the "So" index of similarity, 34% and 20% respectively, and exceptionally low values of the "Re" index – 11% and 5% respectively.

## SUMMARY

The greatest number of species in pine canopy *Ichneumoninae* communities inhabiting the consecutive stages of secondary succession of a pine forest in Puszcza Białowieska was noted in young stands, while the lowest number of species was recorded in mature stands. The more-than-double decrease in the number of species in the mature stand, as compared with the young stand, stems from the characteristic features (evenness) of the specific habitat forming

in canopies of high trees. As the stand grows older, the number of species increases and so does the proportion of parasitoids of *Microlepidoptera* of pine – the core of the *Ichneumoninae* community is formed. It consists of *Eriplatys ardeicollis, E. sawoniewiczi, Tycherus vagus, T. dodecellae* and others. These species account for about 70% of the community. The young stand-thicket community is transitional between open areas and the fauna typical of older coniferous forests. In the culture stage *Ichneumoninae* community, about 50% of the species content and 70% of individuals are open area species e.g. *Vulgichneumon deceptor, Ctenichneumon divisorius, Virgichneumon digrammus*, most of which are parasitoids of *Noctuidae*. None of the species recorded was abundant in every stage of secondary succession. The uniqueness of the culture stage community and the formation of a unique community of *Ichneumoninae* in the canopies of older pine stands is confirmed by the values of the species similarity and dominance structure indices. In the *Ichneumoninae* community of pine canopies noticeable stabilisation begins in the pole wood stage (age class III). The communities of *Ichneumoninae* of the secondary succession stages studies in the pine forests of Puszcza Białowieska are similar to respective communities inhabiting pine forest stands in other regions of Poland.

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STRESZCZENIE

[Tytuł: Zróżnicowanie zgrupowań *Ichneumoninae* (*Hymenoptera, Ichneumonidae*) koron sosen w sukcesji wtórnej boru świeżego w Puszczy Białowieskiej]

Obserwacje prowadzono na terenie Puszczy Białowieskiej w czterech fazach rozwojowych sukcesji wtórnej boru świeżego (zespół *Peucedano-Pinetum*): uprawa (0), młodnik i tyczkowina (1), drągowina (2) i starodrzew (3). Przy pomocy pułapek Moercke'go w uprawach i koronach sosen łącznie odłowiono 1.572 osobniki *Ichneumoninae* reprezentowane przez 136 gatunków (Tab. I i III).

W zgrupowaniach *Ichneumoninae*, w kolejnych fazach rozwojowych boru świeżego, najwyższą liczbę gatunków odnotowano w młodniku, natomiast najniższą w starodrzewie; ponad dwukrotny spadek liczby gatunków w starodrzewie w porównaniu z młodnikiem wynika ze specyfiki (jednorodności) środowiska jakim są korony wysokich drzew. W miarę wzrostu drzewostanu zwiększa się liczba gatunków i udział parazytoidów *Microlepidoptera* sosny – formuje się podstawowy trzon gatunków *Ichneumoninae*, w skład którego wchodzą m.in. *Eriplatys ardeicollis*, *E. sawoniewiczi*, *Tycherus vagus*, *T. dodecellae*. W koronach starodrzewów stanowią one około 70% osobników zgrupowania. Zgrupowanie z młodnika-tyczkowiny wykazuje charakter przejściowy między fauną terenów otwartych a typową dla starszych borów. W zgrupowaniu z uprawy sosnowej 50% gatunków i blisko 70% osobników stanowią gatunki terenów otwartych, np. *Vulgichneumon deceptor*, *Ctenichneumon divisorius*, *Virgichneumon digrammus*, które są zwykle parazytoidami *Noctuidae*. Nie stwierdzono gatunków, które występowałyby licznie we wszystkich badanych stadiach sukcesji wtórnej. Odrębność zgrupowania uprawy i formowanie się specyficznego zespołu *Ichneumoninae* w koronach starszych drzewostanów potwierdzają zarówno wartości wskaźników różnorodności gatunkowej i równomierności, jak i wartości współczynników podobieństwa składu gatunkowego i struktury dominacji. Wyraźne początki w stabilizacji zgrupowania *Ichneumoninae* koron sosen obserwujemy na etapie drągowiny (III klasa wieku). Zgrupowania *Ichneumoninae* badanych stadiów sukcesji borów świeżych Puszczy Białowieskiej są podobne do odpowiednich zgrupowań drzewostanów sosnowych w innych rejonach Polski.

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