COMMUNITIES OF PLANTHOPPERS AND LEAFHOPPERS (HEMIPTERA: FULGOROMORPHA ET CICADOMORPHA) INHABITING SELECTED PLANT COMMUNITIES IN THE STOŁOWE MOUNTAINS NATIONAL PARK

The Monograph

ZGRUPOWANIA PIEWIKÓW (HEMIPTERA: FULGOROMORPHA ET CICADOMORPHA) WYBRANYCH ZBIOROWISK ROŚLINNYCH PARKU NARODOWEGO GÓR STOŁOWYCH

Monografia

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PRZYRODA NR 19

Daniel Gaj, Marcin Walczak, Wacław Wojciechowski

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Abstract.

The paper presents distributional data on the planthoppers and leafhoppers (Hemiptera: Fulgoromorpha et Cicadomorpha) occurring in the area of Stołowe Mountains National Park, abbreviated as SMNP (Polish: Park Narodowy Gór Stołowych) Syntaxonomical Subregion of the Western Sudetes, Syntaxonomical Region of the Sudetes, Sudetian Divide, SW Poland; UTM: [WR 99] and [XR 90]. The inventory of planthoppers and leafhoppers, their host plants, as well as ecological and chorological characteristic are given. The taxonomic structure, the chorological structure as well as ecological structure and trophic relationships of the planthoppers and leafhoppers of SMNP are given and discussed.

The study of the Fulgoromorpha and Cicadomorpha in the Stołowe Mountains National Park was conducted between 2003 and 2006. Over the Park's area there were selected 29 research areas (Fig. 1), from which samples were collected at 15 day intervals (i.e. at the beginning and in the middle of the month, with the accuracy of plus or minus three days), starting at the beginning of May and finishing in the middle of October (12 sample collections per one vegetation season). Altogether 1044 samples were collected, 36 from each research area (quantitative method). Moreover, bounties of planthoppers and leafhoppers were collected using a qualitative method. This insects were collected in the Stołowe Mountains National Park, there were selected 29 research areas situated within the patches of various types of plant communities, including: seminatural and anthropogenic meadow communities belonging to the *Molinio-Arrhenathereta* and *Nardo-Callunetea* classes, forest communities belonging to the *Vaccinio-Piceetea* class, secondary communities belonging to the *Querco-Fagetea* class, moss-sedge peat bogs and high bogs belonging to the *Scheuchzerio-Caricetea* class.

During the period of research conducted in the Stołowe Mountain National Park (Fig. 1) from 2003 to 2006, there were collected the representatives of 103 species of the Fulgoromorpha and Cicadomorpha (Tabs. 42, 43) out of about 520 species whose presence in Poland had been recorded up till then (Chudzicka, 2004). There were found 33 species which had never been recorded in the Sudetes range before (Tab. 42) (Nast, 1976a, Gaj & Dróżdż-Gaj, 2005, Pilarczyk & Szwedo, 2005), of which one species, namely *Eupteryx signatipennis* (Boheman, 1847) (Table 2, Fig. 31, 32, 33), had never been recorded in the area of Poland before. The chorological analysis of the collected material has shown that the Euro-Siberian and European elements were the most abundantly represented ones in the investigated area. The ecological analysis of the collected material has shown that the mezohygrophilous, mezoheliophilous, oligophagous and oligotopic species were the most abundantly represented ones in the investigated area. The voucher specimens are deposited in the entomological collections of the Department of Zoology, University of Silesia in Katowice.

Key words: Hemiptera, Fulgoromorpha, Cicadomorpha, Auchenorrhyncha, Park Narodowy Gór Stołowych, Stołowe Mountain National Park, faunistics, ecological relationships, host-plant relationships, chorology, origin of fauna

1. INTRODUCTION

The planthoppers and leafhoppers (Fulgoromorpha Evans, 1946 et Cicadomorpha Evans, 1946) are groups of hemipteran insects which can be found in almost all habitats of the contemporary world. Both groups had been considered to constitute a common group of Auchenorrhyncha Duméril, 1806, but recently conducted morphological and molecular studies showed that the Fulgomorpha and Cicadomorpha belonged to two separate suborders within the order Hemiptera (Bourgoi & Campbell, 2002; Szwedo *et al.*, 2004). However, it has to be highlighted that the study of the process of oogenesis and the structure of ovaries in the groups in question (Szklarzewicz *et al.*, 2007) definitely confirm the monophyletic origin of the Auchenorrhyncha.

The Fulgoromorpha and Cicadomorpha constitute an important part of the trophic network of land ecosystems, in which they form species communities characterized by complexity in both their structure and dynamics of number (Schiemenz, 1969; Andrzejewska, 1979; Waloff, 1980; Curry, 1994; Nickel *et al.*, 2002), at the same time being a sensitive indicator of the condition and changes of the environment (Skibińska & Chudzicka, 2000). A considerable number of the Fulgoromorpha and Cicadomorpha are believed to be trophically specialized monophagous and oligophagous species, mostly associated with seed plants, but also feeding on ferns and bryophytes (Wheeler, 2003).

Out of over 1700 species of the Fulgoromorpha and Cicadomorpha encountered in Europe (Nast, 1987), 520 species have been identified in Poland (Chudzicka, 2004), the number constituting 30% of the fauna.

A pioneer study of the Fulgoromorpha and Cicadomorpha fauna in the area of Poland was conducted 200 years ago (Weigel, 1806) and contained information that merely 19 species of the group in question were identified in Lower Silesia. In the middle of 19th century there followed other faunistic studies, conducted in southern Poland, mainly in Ojców National Park (Waga, 1854a, 1854b, 1857, 1860), Tatra Mountains and the surroundings of Kraków (Nowicki, 1868; Stobiecki, 1886), Galicia (Łomnicki, 1884), Upper Silesia (Waga, 1856, 1857; Letzner, 1871) and Lower Silesia (Wocke, 1874). In 20th century the studies of the Fulgoromorpha and Cicadomorpha fauna were conducted within the whole area of Poland (Smreczyński, 1906, 1910a, 1910b, 1954, 1955; Nast, 1976b).

The state of knowledge on the Fulgoromorpha and Cicadomorpha fauna in contemporary national parks is far from satisfactory (Pilarczyk *et al.*, 2004). Only a few parks situated in eastern and southern Poland have been extensively studied with respect to the group in question, namely Białowieża National Park (Szwedo, 1999, 2001a), Babia Góra National Park (Celary, 2003; Pilarczyk, 2007), Biebrza National Park (Gębicki *et al.*, 1982), Bieszczady National Park (Szwedo, 2001b), Ojców National Park (Szwedo, 1992), Pieniny National Park (Nast, 1976b) and Tatra National Park (Cichocki, 1993; Lauterer & Okali, 1974). Information on the Fulgoromorpha and Cicadomorpha population in other national parks is scarce, incomplete and

scattered over numerous faunistic, faunologic and taxonomic publications of the following researchers: Smreczyński (1910a, 1954, 1955), Nast (1936, 1938a, 1938b, 1955, 1958, 1966, 1973, 1976a, 1976b, 1979, 1981, 1986), Karpiński (1949, 1951, 1958), Gotkiewicz and Szafer (1950), Gajewski (1961), Dworakowska (1970), Pawłowski and Szeptycki (1977), Gębicki *et al.* (1982), Gębicki and Szwedo (1991), Szwedo *et al.* (1998), Chudzicka and Stroiński (2000), Bokłak *et al.* (2003).

The Sudety Mountains region is one of the areas in Poland where the studies on the Fulgoromorpha and Cicadomorpha fauna have been particularly scarce. The earliest mentions of Lower Silesia and Sudety Mountains can be found in the works of Weigel (1806), Wocke (1874), Dittrich (1906) and Pax (1921), which provide only a general picture of the Fulgoromorpha and Cicadomorpha fauna in this region. The studies conducted after the World War II by Dworakowska, Gajewski, Nast and others contributed to the identification of 127 species of the Fulgoromorpha and Cicadomorpha (Gaj & Drożdż-Gaj, 2005, Pilarczyk & Szwedo, 2005), among which only 4 were recorded in the area of contemporary Stołowe Mountains National Park abbreviated as SMNP (Polish: Park Narodowy Gór Stołowych, abbreviated as PNGS) (Nast, 1976a; Gaj & Drożdż-Gaj, 2005).

Faunistic knowledge of the Stołowe Mountains National Park and its buffer zone is fragmentary and unsatisfactory. There have been identified 167 species of vertebrates and 929 species of invertebrates, while 33 thousand have been identified in the whole area of Poland (Andrzejewski, *et al.* 1999). However, over 180 species of the identified invertebrates are rare, entered in the lists of species endangered with extinction, and therefore valuable from the faunistic point of view and from the point of view of environmental protection (Chudzicka *et al.*, 2001). Extensive studies of the invertebrate fauna in the SMNP mostly concern mollusks (*Mollusca*) (Wiktor, 1964), bark beetles *(Scolytidae)* (Michalski, 1996), spiders (*Aranei*) (Blady & Woźny, 1996), mites (*Acari*) (Skorupski & Gołojuch, 1996a, 1996b) and click beetles (*Elateridae*) (Janoszek & Tarnawski, 2001; Tarnawski & Janoszek, 2004). As for other groups of invertebrates, only random recordings or accidental information on individual species are available (Andrzejewski *et al.*, 1999).

The Stołowe Mountains National Park was established on 16th September 1993, being the nineteenth Polish national park (Jońca *et al.*, 1998). Total area of the park amounts to 6339.75 ha, and 5779.15 ha (i.e. 91.2% of the Park's area) is covered by forest communities (Jędryszczak & Miścicki, 2001), while state-owned and privately-owned non-forest areas cover slightly over 560 ha (Zgorzelski, 1999b). The Park was established especially for the sake of protecting rock formations, ecosystems, flora and fauna of the area (Zgorzelski, 1999a). Within the area covered by the Park there were identified 743 taxons of vascular flora (so far the presence of 613 has been confirmed) grouped in 90 families, and 560 taxons of spore plants and mosses (Solon & Świerkosz, 1999). In the Park's vegetation there prevail even-aged and single-layered spruce forests which take up over 85% of the forest areas, and in the remaining forest areas there prevail mixed stands with beeches, sycamores, larches, birches, and sporadically also firs (Jędryszczak, 1999).

The fragmentary and therefore unsatisfactory state of knowledge on the fauna of both vertebrates and invertebrates, especially the fauna of hemipteran insects, calls for an attempt at characterizing the Fulgoromorpha and Cicadomorpha communities inhabiting selected plant communities of the Stołowe Mountains National Park. The main aims of the study include:

- identifying the species composition of the Fulgoromorpha and Cicadomorpha in the Stołowe Mountains National Park;
- identifying the Fulgoromorpha and Cicadomorpha communities associated with selected plant communities of the SMNP, based on their dominance structure and degree of association with these communities;
- investigating the dynamics of seasonal changes of the Fulgoromorpha and Cicadomorpha, as exemplified by dominants and subdominants in the investigated plant communities of the SMNP;
- identifying the degree of association of the Fulgoromorpha and Cicadomorpha species and constancy of their occurrence in the investigated plant communities of the SMNP;
- identifying the species diversity and the similarities of insect communities in the investigated plant communities of the SMNP;
- distinguishing in the investigated community a group of species associated with the mosaic-like nature of ecosystem – discriminant analysis;
- conducting the ecological analysis of the investigated group of insects;
- conducting the chorological analysis of the investigated group of insects.

In this place the authors would like to thank warmly dr Edyta Sierka for her help in marking plant communities in the SMNP and dr Jacek Szwedo for checking the description of some Fulgoromorpha and Cicadomorpha species and providing information on their distribution and occurrence in Poland, as well as the Colleagues from the Department of Zoology of the University of Silesia for their valuable remarks while discussing the results of this study.

2. PHYSIOGRAPHY OF THE STOŁOWE MOUNTAINS

The Stołowe Mountains, running evenly with the parallel of latitude, are situated in the central part of the Intra-Sudetic Basin (Kondracki, 2000). They stretch across the adjacent territory of Czech Republic (where they are called Bromowskie Ściany) and Poland, where their northwest and southeast parts are situated, the latter being 18 km long and about 5 km wide (Zgorzelski, 1999c).

The Stołowe Mountains neighbor with Radków Depression (Obniżenie Radkowskie) encompassing Ścinawskie Hills (Wzgórza Ścinawskie) in the north, and Kłodzka Basin (Kotlina Kłodzka) in the east, while in the south they neighbor with Duszniki Depression (Obniżenie Dusznickie) and Lewińskie Hills (Wzgórza Lewińskie) (Zgorzelski, 1999c). The highest, and also the most spectacularly exposed fragment of the Cretaceous sandstones in the Stołowe Mountains is the Szczeliniec Wielki Massif (Masyw Szczelińca Wielkiego), reaching the height of 919 m a.s.l. (Košťák, 2001).

According to geobotanical division, the Stołowe Mountains constitute an independent Landscape Subregion in the Landscape Region of the Inner Mountain Ranges of the Central Sudetes, which forms part of the Syntaxonomical Subregion of the Western Sudetes, Syntaxonomical Region of the Sudetes, Sudetian Divide, Hercynian and Bohemian Subprovince, Subatlantic Montane Province (Matuszkiewicz, 2001, Solon, 1999). In accordance with the Universal Transverse Mercator (UTM) system applied in the analysis of faunistic data and utilized by the Faunistic Documentation Center of the Polish Academy of Sciences Museum and Institute of Zoology (Centrum Dokumentacji Faunistycznej Muzeum i Instytutu Zoologii PAN) the research area is situated in the squares [WR 99] and [XR 90]

2.1. GEOLOGICAL STRUCTURE

The Stołowe Mountains Massif, stretching across the Intra-Sudetic Basin, was shaped from Upper Cretaceous rocks that had been formed in shallow epicontinental sea, under warm climactic conditions. The sediments took form of cracked sandstones and Plänermergel (Niemczyk, 1999). These rocks are situated in a basin, but placed horizontally, and thus from a distance their plateaus resemble a table (Kondracki, 2000).

Within the boundaries of the region, on the lower plate of the cracked sandstone reaching up to 300 meters above the ground level, there are situated Turonic marls and slates, slightly water-pervious, but subject to weathering, reaching up to 700–750 m (Kondracki, 2000).

The highest layer of the Stołowe Mountains, including the mesas of Mały Szczeliniec (895 m) and Wielki Szczeliniec (919 m), Skalniak (915 m), Narożnik (851 m) and the Błędne Skały plateau (850 m) consists of the rocks that are most impervious to weathering, which are called cracked sandstones due to their origin and properties. They are characterized by numerous cracks facilitating the formation of cuboidal blocks under the influence of destructive chemical and physical factors such as

precipitation water and meltwater. The process of weathering has resulted in the formation of numerous rock labyrinths, column and mushroom rocks, or cudgel-shaped rocks (Zgorzelski, 1999c).

The forming of the Stołowe Mountains region has recently been influenced also by Quaternary tectonics, resulting, among others, in the increased water erosion directly responsible for the cutting of very deep gorges stretching downwards from the surroundings of Pasterka in the northwestern direction (Zgorzelski, 1999c).

2.2. SOILS OF THE STOŁOWE MOUNTAINS NATIONAL PARK

There can be distinguished four major lithological soil units in the area of the Stołowe Mountains National Park. The first of these includes the granite surfaces situated in the southwestern part of the Park. They are mostly covered with forest soils of the montane acid brown soil variety. The other two soil units cover the sandstones, i.e. most of the upland areas of the SMNP. The fourth unit covers marl surfaces composed of calcareous, loamy siltstones and silty, siliceous marls, known as slate dust or siltstone (Wicik, 1999a).

Soils of the Stołowe Mountains National Park have been classified as belonging to the following typological units (according to the Typology of Polish Soils 1989 after (Szerszeń & Kabała, 1999):

1. Phytogenic soils – including lithosols and rankers.
2. Autogenic soils – including typical brown soils, acid brown soils and podsols.
3. Semi-hydrologic soils – including surface-water gley (pseudogley) soils and ground-water gley soils.
4. Hydrologic soils – including silt soils, peat soils and boggy soils.
5. Colluvial soils – including river muds and deluvial soils.

2.3. CLIMATE OF THE STOŁOWE MOUNTAINS NATIONAL PARK

The Sudetes are situated in the temperate continental climate zone. However, the climate of the Sudetes and the Stołowe Mountains region is strongly influenced by both the relative height and the height above sea level, and the general direction of major mountain ranges, resulting in large disparities concerning the availability of sunlight, temperature, humidity and rainfall (Kicińska *et al.*, 1999).

A characteristic feature of mountain regions is fall in temperature with increasing height, which is connected with the development of a vertical thermal gradient, whose value depends, among other things, on the time of day, season of the year and the terrain formation, being the highest in summer and the lowest in winter. Significant diversity of temperature between the summits and the foot of the mountain or between the higher situated areas and nearby crevices is influenced by the phenomenon of thermal inversion, resulting in the locally occurring ground frost, which under specific conditions may appear in the spring and autumn period (Kicińska *et al.*, 1999).

Annual average rainfall in the hilltop area (over 700 m a.s.l.) of the Stołowe Mountains amounts to about 850 mm (Pasterka measurement station), decreasing to 710–730 mm in the lower situated areas (Wicik, 1999b). The largest rainfall intensity is recorded in summer (July), and the smallest late in winter (February or March), while in the summit areas of the mountains the most intensive rainfalls are recorded in the autumn period. Similarly, with increasing height there also increases the frequency and volume of snowfall, as well as the thickness of snow cover and the length of its flushing period. Usually the number of days when it snows does not exceed 100, but in narrow valleys and crevices the snow may remain for up to 200 days (Kicińska *et al.*, 1999).

2.4. HYDROLOGICAL CONDITIONS

The Stołowe Mountains region belongs to two large hydrographic units:

- Baltic Sea Watershed – the Oder catchment area
- North Sea Watershed – the Elbe catchment area.

These two units are separated by a water divide running from north to south. From the area of the Stołowe Mountains National Park east off the water divide (Baltic Sea Watershed) there flow the rivers Pośna, Kamienny Potok (with Czerwona Woda) and Cicha, and west off the water divide (North Sea Watershed) there flow the rivers Żidovka, Czernica, Kudowski Potok and Dańczówka (Nowicka, 1999).

The area of the Stołowe Mountains National Park is characterized by a well developed network of natural watercourses, with average drainage density of 2.7 km/km^2, which facilitates quick and efficient water collection from the Park's area, in all directions.

The said network includes 23 watercourses with total length of 174.5 km. The largest of these is Czerwona Woda, collecting water from 23% of the Park's area (Nowicka, 1999).

Apart from the network of natural watercourses the Park's area is covered with numerous ditches and various "constructions" of anthropogenic origin, which increase the density of drainage structure more than twice, up to 5.7 km/km^2 (Nowicka, 1998).

2.5. FLORA OF THE STOŁOWE MOUNTAINS NATIONAL PARK

In the area of the Stołowe Mountains National Park and its immediate surroundings there have been recorded 743 species of vascular plants, currently including the actually present (or present with large degree of probability) 613 taxons belonging to 90 families, of which the prevailing number are represented by just several taxons. Currently, the families represented by the most species in the Park's area include: Asteraceae (72 taxons), Poaceae (55 taxons) and Rosaceae (43 taxons), while the most numerously represented genera include *Carex* (26 species), *Galium* (12 species) and the genus *Salix* represented by as many as 11 species and hybrids (Solon & Świerkosz, 1999).

In the area of the SMNP and its buffer zone there have been recorded 44 protected species, including 35 totally protected and 9 partly protected species. Furthermore,

up till now, in the same area, there have been recorded 13 taxons included in the Red List of Threatened Species listing endangered species in the area of Poland (Solon & Świerkosz, 1999).

Contemporary flora of the SMNP, together with spore plants and lichens, includes 608 species, among which there are 214 species of lichens, 122 species of hepatics and 272 species of moss (the latter group including 25 species whose presence has not been confirmed and 23 species encountered only in the buffer zone). The representatives of this kind of vegetation mostly include such species which are highly characteristic of the zone in question, i.e. especially montane and ocean taxons, as well as organisms characteristic of sandstone substratum (Solon & Świerkosz, 1999).

Plant communities and associations of the SMNP belong to 15 phytosociological classes, out of which 6 are represented in the Park only by single associations limited to comparatively small areas. Better developed communities, which possess characteristic species and spatial structures, include forest associations of the *Querco-Fagetea* class, lowland peat-bog associations of the *Scheuzerio-Caricetea* class, and meadow associations of the *Nardo-Callunetea* and *Molinio-Arrhenatheretea* classes (Kozłowska & Solon, 1999).

From the point of view of geobotanical regionalization, the Stołowe Mountains differ from neighboring subregions due to the absence of broadleaved forest (*Galio sylvatici-Carpinetum*), riparian forest (*Astrantio-Fraxinetum*), acidophilous oak forest (*Luzulo-Quercetum petreae*) and well developed mountain forest (*Plagiothecio-Piceetum hercynicum*), and the presence of pine forest (*Betulo-Pinetum*) and beech forest (*Dentario enneaphylidis- Fagetum*) (Solon, 1999).

2.6. THE STOŁOWE MOUNTAINS NATIONAL PARK AND ENVIRONMENTAL PROTECTION

The most important reason for establishing the SMNP was the necessity to protect unique rock formations encountered in the area, and thus the most important tasks included rebuilding the water circulation system, eliminating the activities and structures accelerating water erosion and drainage, reconstructing tree stands, protecting endangered species of flora and fauna, and carefully protecting the most valuable ecosystems and ecosystem associations (Zgorzelski, 1999a), such as Szczeliniec, Białe Ściany or the reserves "Wrota Pośny", "Łężyckie Skałki" and "Wielkie Torfowisko Batorowskie" (Zgorzelski, 1999c).

3. CHARACTERISTICS OF THE RESEARCH PLOTS

In order to conduct quantitative research in the Stołowe Mountains National Park, there were selected 29 research plots situated within the patches of various types of plant communities, including: seminatural and anthropogenic meadow communities belonging to the *Molinio-Arrhenathereta* and *Nardo-Callunetea* classes, forest communities belonging to the *Vaccinio-Piceetea* class, secondary communities belonging to the *Querco-Fagetea* class, moss-sedge peat bogs and high bogs belonging to the *Scheuchzerio-Caricetea* class.

The class *Molinio-Arrhenathereta* R. TX. 1937 includes seminatural and anthropogenic turf meadow and pasture communities growing on non-boggy mesotrophic and eutrophic mineral soils, organic-mineral soils and mineralized and dried moorsh soils that developed from lowland peat bog (Matuszkiewicz, 2001).

The class *Nardo-Callunetea* Prsg., 1949 includes seminatural and anthropogenic communities which originally took up little area but spontaneously expanded as a result of human activity and developed to achieve their present shape (Matuszkiewicz, 2001).

The class *Vaccinio-Piceetea* Br.-Bl., 1939 includes holarctic boreal, oligotrophic and mesotrophic communities in which there prevail coniferous trees, shrubs and bryophytes. In Europe this class includes lowland and montane spruce, pine and fir forests, and partly also mixed forests (Matuszkiewicz, 2001).

The class *Scheuchzerio-Caricetea* (Nordh., 1937) R. Tx. 1937 includes low-sedge communities of bog meadows rich in bryophytes, and also the communities of turf secondary peat bogs and lowland peat bogs (Matuszkiewicz, 2001).

The class *Querco-Fagetea* Br.-Bl. et Vlieg., 1937 includes the areas covered with mesotrophic and eutrophic deciduous forests which lose leaves in winter, growing on mineral soils characterized by different degrees of humidity, constituting an ecological climax of the lowlands and lower mountain regions of the prevailing part of the European continent (Matuszkiewicz, 2001).

A detailed ecological and syntaxonomical characteristics of the 29 research plots situated in the Stołowe Mountains National Park is presented in Table 1 and their geographical distribution is presented in Figure 1 (Fig. 1).

Table 1. Characteristics of the research plots established for the purpose of quantitative research in the years 2004–2006 in the Stołowe Mountain National Park.

Plots	Location of the plots	Ecological characteristics	Syntaxonomical characteristics after Matuszkiewicz (2001)	Plant community	Dominating plant species (herbal cover after Braun-Blanquet 1963)
1	2	3	4	5	6
1	West of the Batorów village; 100 m from the border of the SMNP	Altitude [m]: 610 m Slope: 15° Exposure: NE Percentage of plant cover: 100%	CLASS: *Molinio-Arrhenatheretea* ORDER: *Molinietalia caeruleae* ALLIANCE: *Caltion palustris*	***Cirsietum rivularis***	*Cirsium rivulare* (4.4) *Dactylis glomerata* (3.3) *Cirsium oleraceum* (2.2) *Juncus articulatus* (2.2) *Phalaris arundinacea* (2.2)
2	South-West of the Batorów village; 600 m from the border of the SMNP	Altitude [m]: 630 m Slope: 20° Exposure: NE Percentage of plant cover: 100%	CLASS: *Molinio-Arrhenatheretea* ORDER: *Molinietalia caeruleae* ALLIANCE: *Caltion palustris*	***Cirsietum rivularis***	*Cirsium rivulare* (4.4) *Juncus articulatus* (2.2) *Molinia coerulea* (2.2) *Phalaris arundinacea* (1.1)
3	the "Małe Torfowisko Batorowskie" in the vicinity of the road: Karłów–Batorów villages	Altitude [m]: 680 m Slope: 5° Exposure: SE Percentage of plant cover: 100%	CLASS: *Molinio-Arrhenatheretea* ORDER: *Molinietalia caeruleae* ALLIANCE: *Filipendulion ulmariae*	***Lysimachio-Filipenduletum***	*Filipendula ulmaria* (5.5) *Deschampsia caespitosa* (2.2) *Juncus effusus* (1.1) *Stachys palustris* (1.1)
4	the "Małe Torfowisko Batorowskie" in the vicinity of the road: Karłów–Batorów villages	Altitude [m]: 690 m Slope: 5° Exposure: SE Percentage of plant cover: 100%	CLASS: *Molinio-Arrhenatheretea* ORDER: *Molinietalia caeruleae* ALLIANCE: *Caltion palustris*	***Cirsietum rivularis***	*Cirsium rivulare* (4.4) *Juncus articulatus* (2.2) *Molinia coerulea* (2.2) *Juncus effusus* (1.1)
5	East of the Karłów village in the vicinity of the road: Karłów-Batorów villages	Altitude [m]: 720 m Slope: 1° Exposure: S Percentage of plant cover: 100%	CLASS: *Nardo-Callunetea* ORDER: *Nardetalia* ALLIANCE: *Nardion*	***Nardus stricta***	*Nardus stricta* (5.5) *Hypericum maculatum* r
6	East of the Karłów village between the roads: Karłów–Batorów and Karłów–Radków villages	Altitude [m]: 730 m Slope: 30° Exposure: S Percentage of plant cover: 100%	CLASS: *Nardo-Callunetea* ORDER: *Nardetalia* ALLIANCE: *Nardion*	***Nardus stricta***	*Nardus stricta* (5.5) *Dactylis glomerata* (2.2) *Ranunculus acer* (1.1) *Carlina acaulis* r
7	East of the "Pośna" stream in the vicinity of the "Mały Karłów"	Altitude [m]: 740 m Slope: 15° Exposure: W Percentage of plant cover: 100%	CLASS: *Molinio-Arrhenatheretea* ORDER: *Arrhenatheretalia* ALLIANCE: *Arrhenatherion elatioris*	***Cirsium heterophyllum***	*Cirsium heterophyllum* (5.5) *Arrhenatherum elatius* (2.2) *Festuca rubra* (2.2) *Dactylis glomerata* (1.1)

1	2	3	4	5	6
8	West of the "Pośna" stream in the vicinity of the "Mały Karłów"	Altitude [m]: 740 m Slope: 30° Exposure: SW Percentage of plant cover: 100%	CLASS: *Molinio-Arrhenatheretea* ORDER: *Arrhenatheretalia* ALLIANCE: *Arrhenatherion elatioris*	***Arrhenatherum elatius***	*Arrhenatherum elatius* (5.5) *Achillea millefolium* (2.2) *Cirsium heterophyllum* (1.1) *Festuca rubra* (2.2)
9	West of the "Kozi Potok" stream in the vicinity of the road: Karłów–Pasterka villages	Altitude [m]: 750 m Slope: 3° Exposure: SW Percentage of plant cover: 100%	CLASS: *Molinio-Arrhenatheretea* ORDER: *Arrhenatheretalia* ALLIANCE: *Arrhenatherion elatioris*	***Cirsium heterophyllum – Dactlis glomerata***	*Cirsium heterophyllum* (4.4) *Dactylis glomerata* (4.4) *Galium mollugo* (2.2) *Knautia arvensis* (1.1)
10	West of the "Kozi Potok" stream in the vicinity of the road: Karłów–Pasterka villages	Altitude [m]: 760 m Slope: 10° Exposure: SW P Percentage of plant cover: 100%	CLASS: *Molinio-Arrhenatheretea* ORDER: *Arrhenatheretalia* ALLIANCE: *Arrhenatherion elatioris*	***Holcus lanatus – Cirsium heterophyllum***	*Holcus lanatus* (4.4) *Cirsium heterophyllum* (3.3) *Arrhenatherum elatius* (1.1) *Festuca rubra* (1.1)
11	West of the "Wrota Pośny" nature reserve	Altitude [m]: 690 m Slope: 10° Exposure: W P Percentage of plant cover: 100%	CLASS: *Molinio-Arrhenatheretea* ORDER: *Molinietalia caeruleae* ALLIANCE: *Caltion palustris*	***Deschampsia caespitosa***	*Deschampsia caespitosa* (4.4) *Solidago gigantea* (2.2) *Polygonum bistorta* (1.1) *Scirpus silvaticus* (1.1)
12	West of the "Wrota Pośny" nature reserve	Altitude [m]: 720 m Slope: 5° Exposure: W Percentage of plant cover: 100%	CLASS: *Molinio-Arrhenatheretea* ORDER: *Molinietalia caeruleae* ALLIANCE: *Caltion palustris*	***Deschampsia caespitosa***	*Deschampsia caespitosa* (5.5) *Molinia coerulea* (2.2) *Sanguisorba officinalis* (1.1) *Scirpus silvaticus* r
13	North-West of the Pasterka village	Altitude [m]: 680 m Slope: 10° Exposure: W Percentage of plant cover: 100%	CLASS: *Molinio-Arrhenatheretea* ORDER: *Molinietalia caeruleae* ALLIANCE: *Alopecurion pratensis*	***Alopecurus pratensis***	*Alopecurus pratensis* (5.5) *Symphylum officinale* (2.2) *Glechoma hederacea* (1.1) *Lychnis flos-cuculi* r
14	North of the Pasterka village	Altitude [m]: 700 m Slope: 15° Exposure: E Percentage of plant cover: 100%	CLASS: *Molinio-Arrhenatheretea* ORDER: *Molinietalia caeruleae* ALLIANCE: *Alopecurion pratensis*	***Alopecurus pratensis***	*Alopecurus pratensis* (4.4) *Glechoma hederacea* (2.2) *Molinia coerulea* (1.1) *Scirpus silvaticus* (1.1)
15	Eastern part of the "Łężyckie Skałki" nature reserve	Altitude [m]: 770 m Slope: 20° Exposure: SW Percentage of plant cover: 100%	CLASS: *Molinio-Arrhenatheretea* ORDER: *Molinietalia caeruleae* ALLIANCE: *Caltion palustris*	***Cirsietum rivularis***	*Cirsium rivulare* (4.4) *Juncus acutiformis* (3.3) *Geum rivale* (1.1) *Trollius europaeus* r

1	2	3	4	5	6
16	Western part of the "Łężyckie Skałki" nature reserve	Altitude [m]: 760 m Slope: 5° Exposure: SW Percentage of plant cover: 100%	CLASS: *Molinio-Arrhenatheretea* ORDER: *Molinietalia caeruleae* ALLIANCE: *Caltion palustris*	***Cirsietum rivularis***	*Cirsium rivulare* (5.5) *Cirsium oleraceum* (3.3) *Caltha palustris* (1.1) *Juncus effusus* (1.1)
17	West of the Karłów village; the vicinity of the route: from the Karłów–Pasterka villages	Altitude [m]: 750 m Slope: 20° Exposure: SW Percentage of plant cover: 100%	CLASS: *Molinio-Arrhenatheretea* ORDER: *Arrhenatheretalia* ALLIANCE: *Arrhenatherion elatioris*	***Cirsium heterophyllum***	*Cirsium heterophyllum* (4.4) *Knautia arvensis* (2.2) *Arrhenatherum elatius* (1.1) *Daucus carota* (1.1)
18	East of the Pasterka village; the vicinity of the route: from the Karłów–Pasterka villages	Altitude [m]: 770 m Slope: 3° Exposure: S Percentage of plant cover: 100%	CLASS: *Molinio-Arrhenatheretea* ORDER: *Arrhenatheretalia* ALLIANCE: *Arrhenatherion elatioris*	***Cirsium heterophyllum***	*Cirsium heterophyllum* (4.4) *Arrhenatherum elatius* (2.2) *Campanula patula* (1.1) *Knautia arvensis* (1.1)
19	Western part of the "Łężyckie Skałki" nature reserve in the vicinity of the "Kłodowisko"	Altitude [m]: 620 m Slope: 25° Exposure: SE Percentage of plant cover: 100%	CLASS: *Molinio-Arrhenatheretea* ORDER: *Arrhenatheretalia*	***Holcus lanatus***	*Holcus lanatus* (3.3) *Arrhenatherum elatius* (2.2) *Festuca rubra* (2.2) *Geranium pratense* (2.2)
20	Western part of the "Łężyckie Skałki" nature reserve (East of the plot 19) in the vicinity of the "Kłodowisko"	Altitude [m]: 630 m Slope: 20° Exposure: SE Percentage of plant cover: 100%	CLASS: *Molinio-Arrhenatheretea* ORDER: *Arrhenatheretalia*	***Holcus lanatus***	*Holcus lanatus* (4.4) *Arrhenatherum elatius* (3.3) *Alopecurus pratensis* (2.2) *Lotus corniculatus* (2.2)
21	Southern part of the "Łężyckie Skałki" nature reserve	Altitude [m]: 730 m Slope: 3° Exposure: W Percentage of plant cover: 90%	CLASS: *Querco-Fagetea* ORDER: *Fagetalia sylvaticae* ALLIANCE: *Alno-Ulmion*	***Betula pendula – Molinia caerulea***	*Betula pendula* (3.3) *Molinia coerulea* (3.3) *Festuca gigantea* (2.2) *Lysimachia vulgaris* (2.2)
22	Southern part of the "Łężyckie Skałki" nature reserve	Altitude [m]: 740 m Slope: 1° Exposure: W Percentage of plant cover: 80%	CLASS: *Querco-Fagetea* ORDER: *Fagetalia sylvaticae* ALLIANCE: *Alno-Ulmion*	***Betula pendula – Carex remota***	*Betula pendula* (4.4) *Molinia coerulea* (3.3) *Oxalis acetosella* (2.2) *Carex remota* (2.2)
23	Eastern part of the SMNP in the vicinity of the "Niknąca Łąka"	Altitude [m]: 710 m Slope: 3° Exposure: S Percentage of plant cover: 100%	CLASS: *Scheuchzerio-Caricetea* ORDER: *Caricetalia davalianae* ALLIANCE: *Caricion davalianae*	***Eriophorum latifolium***	*Eriophorum latifolium* (4.4) *Sphagnum sp.* (3.3) *Polytrichum formosum* (2.2) *Carex flava* (1.1)

1	2	3	4	5	6
24	Eastern part of the SMNP in the vicinity of the "Wąska Łąka"	Altitude [m]: 710 m Slope: 1° Exposure: S Percentage of plant cover: 100%	CLASS: *Scheuchzerio-Caricetea* ORDER: *Caricetalia davalianae* ALLIANCE: *Caricion davalianae*	***Carex flava – Eriophorum latifolium***	*Eriophorum latifolium* (4.4) *Oxycoccus quadripetalus* (3.3) *Vaccinium myrtilus* (3.3) *Juncus articulatus* (2.2)
25	Central part of the SMNP; south of the Karłów village, between "Lisia Przełęcz" and "Lisi Grzbiet"	Altitude [m]: 810 m Slope: 10° Exposure: W Percentage of plant cover: 70%	CLASS: *Vaccinio-Piceetea* ORDER: *Vaccinio-Piceetalia* ALLIANCE: *Vaccinio-Piceeion*	***Picea excelsa – Calamagrosyis epigejos***	*Picea excelsa* (3.3) *Calamagrosyis epigejos* (3.3) *Deschampsia flexuosa* (2.2) *Vaccinium myrtilus* (2.2)
26	East of the Karłów village; in the vicinity of the road: Karłów–Batorów villages	Altitude [m]: 710 m Slope: 15° Exposure: SE Percentage of plant cover: 100%	CLASS: *Vaccinio-Piceetea* ORDER: *Vaccinio-Piceetalia* ALLIANCE: *Vaccinio-Piceeion*	***Picea excelsa – Vaccinium myrtilus***	*Picea excelsa* (4.4) *Vaccinium myrtilus* (3.3) *Deschampsia flexuosa* (2.2) *Pteridium aquilinum* (1.2)
27	Eastern part of the PNGS in the vicinity of the "Wąska Łąka"	Altitude [m]: 700 m Slope: 3° Exposure: E Percentage of plant cover: 90%	CLASS: *Vaccinio-Piceetea* ORDER: *Vaccinio-Piceetalia* ALLIANCE: *Vaccinio-Piceeion*	***Picea excelsa – Deschhampsia flexuosa***	*Deschampsia flexuosa* (4.4) *Picea excelsa* (3.3) *Polytrichum formosum* (2.2) *Vaccinium myrtilus* (2.2)
28	West of the Pasterka village	Altitude [m]: 6900 m Slope: 20° Exposure: S Percentage of plant cover: 90%	CLASS: *Vaccinio-Piceetea* ORDER: *Vaccinio-Piceetalia* ALLIANCE: *Vaccinio-Piceeion*	***Picea excelsa – Trientalis europaea***	*Picea excelsa* (4.4) *Trientalis europaea* (3.3) *Pteridium aquilinum* (2.2) *Vaccinium myrtilus* (2.2)
29	At the foothill of the "Szczeliniec Mały" Mountain; between Karłów and Pasterka villages	Altitude [m]: 770 m Slope: 3° Exposure: NE Percentage of plant cover: 90%	CLASS: *Vaccinio-Piceetea* ORDER: *Vaccinio-Piceetalia* ALLIANCE: *Vaccinio-Piceeion*	***Betula pendula – Pteridium aquilinum***	*Betula pendula* (4.4) *Oxalis acetosella* (3.3) *Vaccinium myrtilus* (3.3) *Pteridium aquilinum* (2.2)

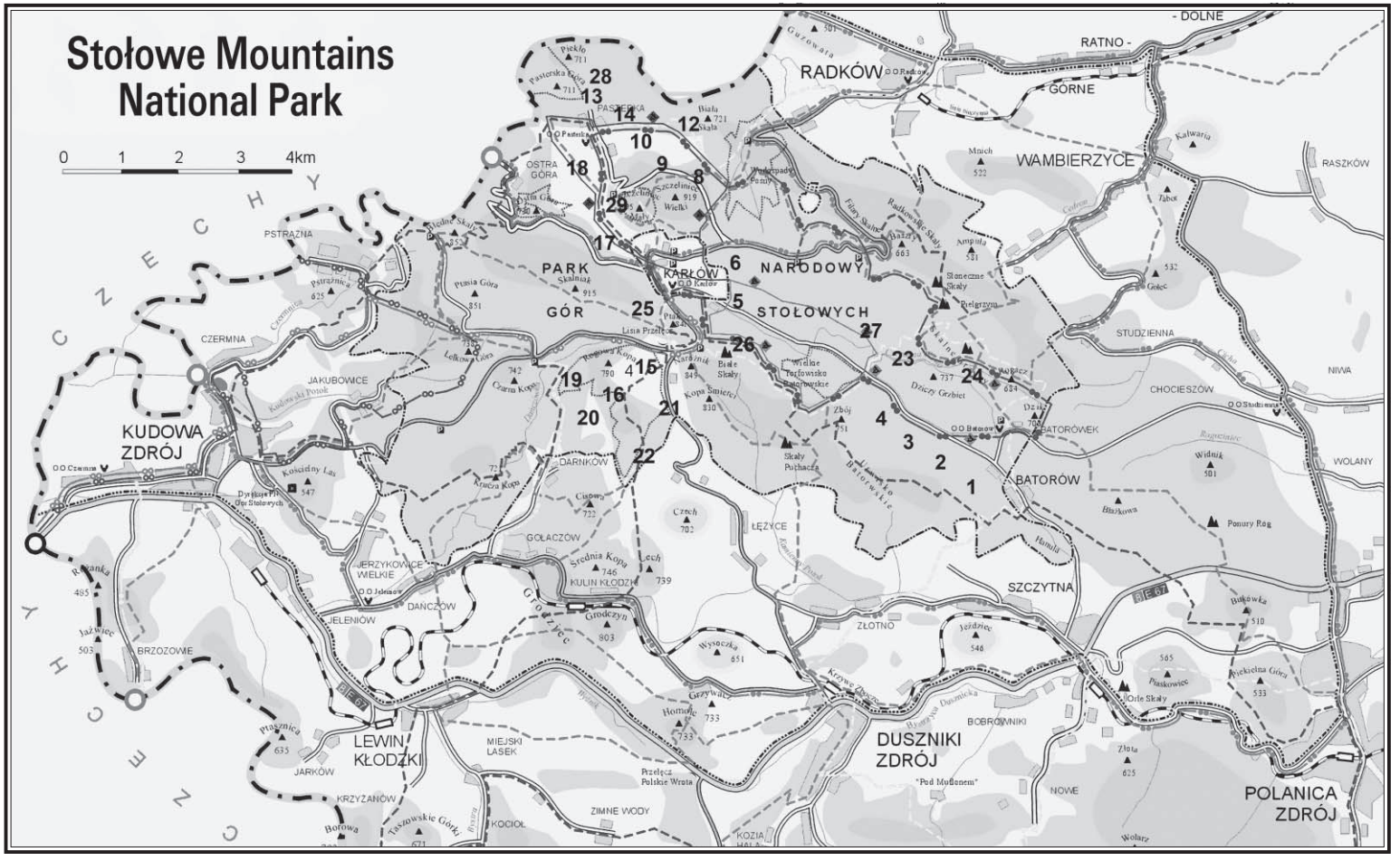


Fig. 1. Location of research plots in the Stołowe Mountains National Park.

4. MATERIALS AND RESEARCH METHODS

4.1. ANALYSIS OF DATA IN QUANTITATIVE AND QUALITATIVE RESEARCH

The study of the Fulgoromorpha and Cicadomorpha in the Stołowe Mountains National Park was conducted between 2003 and 2006. Over the Park's area there were selected 29 research areas (Fig. 1), from which samples were collected at 15 day intervals (i.e. at the beginning and in the middle of the month, with the accuracy of plus or minus three days), starting at the beginning of May and finishing in the middle of October (12 sample collections per one vegetation season). Altogether 1044 samples were collected, 36 from each research area. The material was collected with the help of a standard sweeping net (Ø = 30 cm), every sampling consisting of 25 sweeping movements in four one meter wide transects (4 x 25 = 100) over an area of about 500 m^2 (20 x 25 m). Sweep netting is a method which allows for the collection of a large number of insects and species (Gromadzka & Trojan, 1967), at the same time being easy to apply and facilitating the collection of samples from many locations in various plant communities in a comparatively short time (Andrzejewska & Kajak, 1966). Insects were extracted from the sweeping net with the help of an exhauster or poured out into test tubes with a soporific agent, and then carefully segregated in the laboratory. Qualitative research conducted in the Stołowe Mountain National Park between 2003 and 2006 was also conducted with the help of the standard sweeping net. Additionally, some species were collected by shaking branches of trees and shrubs, as well as by hand. Moreover, samples were also acquired from vegetation growing in the areas in which the quantitative research was not conducted, randomly scattered over the Park's area. In total, during four vegetation seasons within the Park's area there were collected the representatives of 103 species of the Fulgoromorpha and Cicadomorpha imagines and numerous larvae, which in most cases were omitted during the analysis of the quantitative and qualitative samplings as it was impossible to classify them according to their species.

The research material collected between 2003 and 2006 was labeled with respect to species using patterns developed by the following authors: Dlabola, 1954; Logvinenko, 1975; Ossiannilsson, 1978, 1981, 1983; Holzinger *et al*. 2003; Biedermann and Niedringhaus, 2004. Furthermore, there were also utilized numerous detailed studies on such genera as: *Muellerianella* (Booij, 1981), *Ribautodelphax* (Bieman, 1987), *Utecha* (Gębicki, 2002), *Aphrodes* (Tišečkin, 1998), *Forcipata* (Gnezdilov, 2000), *Eupteryx* (Le Quesne, 1974), *Balclutha* (Wagner, 1950) *Macrosteles* (Gajewski, 1961), *Doratura* (Dworakowska, 1968a), *Rhopalopyx* (Dmitriev, 1999), *Elymana* (Dworakowska, 1968b), *Arthaldeus* (Remane, 1960) and *Streptanus* (Chudzicka, 1980). The detailed structure of systematic division and scientific names of insects were adopted from Nast, 1986 and "Checklist of animals of Poland" ("Wykaz zwierząt Polski") (Nast & Chudzicka, 1990).

While labeling some species of the Fulgoromorpha and Cicadomorpha, the genital segments of males were dissected in accordance with the procedure developed by KNIGHT (1965), in order to carefully analyze particular elements of the copulatory apparatus. In a few cases, while labeling male insects, also the elements of the acoustic apparatus were dissected, i.e. the first, second and third abdominal sterna.

The collected representatives of the Fulgoromorpha and Cicadomorpha are stored as part of the scientific collection of the Department of Zoology, Faculty of Biology and Environmental Protection of the University of Silesia.

All research areas were described with respect to their flora, specifying such details as phytosociological affinity, habitat parameters (height above sea level, gradient, exposure), characteristics of vegetation (green vegetation cover, bryophyte and lichen cover, dominant species together with the cover abundance values according to BRAUN-BLANQUET, 1963 scale after SCAMONI, 1967). The systematics of plant communities and typology of phytosociological units was based on MATUSZKIEWICZ (2001), and the names of vascular plants were based on MIREK *et al*. (2002).

While analyzing the collected material, commonly utilized analytical and synthetic indices were applied. Furthermore, there also was conducted an analysis of indices necessary for drawing conclusions about the species diversity of the investigated Fulgoromorpha and Cicadomorpha communities.

4.1.1. DOMINATION INDEX (*D*)

Domination index (*D*) specifies the percentage of particular insect species among all individuals collected over a specific area. Domination index is expressed by the following equation (KASPRZAK & NIEDBAŁA, 1981):

$$D = \frac{n}{N} \times 100\%$$

where:

n – number of individuals belonging to a given species collected over a given area

N – number of all individuals collected over a given area

Based on the values received by applying the domination index equation the following five classes of domination have been distinguished:

1. **eudominants** – less than 30%
2. **dominants** – from 20.01% to 30.00%
3. **subdominants** – from10.01% to 20.00%
4. **recedents** – from 5% to 10.00%
5. **subrecedents** – less than 5%.

4.1.2. CONSTANCY OF OCCURRENCE (*C*)

Constancy of occurrence (*C*) specifies the ratio of a number of samplings in which a given species occurred to the number of samplings collected from a given area, expressed by the following equation (Kasprzak & Niedbała, 1981):

$$C = \frac{N_a}{N} \times 100\%$$

where:

N_a – number of samplings containing a given species, where *a* indicates the species

N – number of all samplings collected from a given area

Based on the values received by applying the above equation the following five classes of constancy of occurrence have been distinguished:

1. **I Class** – from 75.01% to 100%
2. **II Class** – from 50.01% to 75.00%
3. **III Class** – from 25% to 50.00%
4. **IV Class** – less than 25%

4.1.3. SYNTHETIC INDEX (*Q*)

In order to facilitate the interpretation of the domination structure, there was also calculated the synthetic index denoted by *Q*. It combined the indices denoted by *C* (constancy of occurrence) and *D* (domination) into one index being their geometric mean (Kasprzak & Niedbała, 1981):

$$Q = \sqrt{C \times D}$$

4.1.4. FIDELITY COEFFICIENT (*W*)

In order to analyze the degree of association of various species of the Fulgoromorpha and Cicadomorpha with investigated plant communities and to identify the species typical for particular communities, the fidelity coefficient (*W*) was utilized, calculated by the following equation (Kasprzak & Niedbała, 1981):

$$W = \frac{a}{b} \times 100\%$$

where:

a – number of individuals belonging to a particular species recorded in a given plant community

b – number of individuals belonging to a particular species recorded in the whole investigation area

Four fidelity classes were distinguished:

1. **differential species** – (*W* from 95.01% to 100.00%) – species encountered in only one type of plant community, strongly associated with their habitat and usually trophically associated with characteristic or differential plant species;
2. **characteristic species** – (*W* from 50.01% to 95.00%) – species usually, but not necessarily encountered in a given type of plant community, whose representatives can also be encountered, even in large numbers and regularly, in other phytocenoses, but at the same time showing a clear association with a group of similar communities;
3. **companions** – (*W* below 50%) – species which can be encountered in various types of plant communities, usually not in large numbers, showing no strong association with specific types of habitats. Most frequently they are either polyphagous species or species associated with plants widely distributed across ecological spectrum;
4. **accidental species** – species only accidentally encountered in a given plant community, showing no strong association with this community.

4.1.5. SPECIES DIVERSITY

In order to specify the biological species diversity the following indices were utilized:

- **Shannon–Weaver species diversity index** denoted by H' (Shannon & Weaver 1949 after Trojan, 1992):

$$H' = -\sum_{i=1}^{S} p_i \log p_i$$

where:

p_i – the proportion of individuals of a given species "*i*" (n_i) to the total number of individuals in a given community (N), where S is the number of species in the community

- **Pielou evenness index** denoted by J' (Pielou 1969 after Trojan, 1994):

$$J' = \frac{100H'}{H_{\max}} \ [\%]$$

where:

H' – actual species diversity $\left(H' = -\sum_{i=1}^{S} p_i \log p_i\right)$

pi – the proportion of individuals of a given species *"i"* (n_i) to the total number of individuals in a given community (N), where S is the number of species in the community

H_{max} – maximum species diversity ($H_{max} = \log_2 S$)

- **Brillouin species diversity index** denoted by $\hat{H}$ (Brillouin 1962 after Trojan, 1992):

$$\hat{H} = \frac{1}{N}\log\left(\frac{N!}{n_1!n_2!n_3!...n_S!}\right)$$

where:

N – number of individuals in the investigated sample

n_S – number of individuals of a given species in the investigated sample

- **Simpson species diversity index** denoted by I (Simpson 1949 after Trojan, 1992):

In order to calculate the Simpson diversity index there was employed the sampling-related Pielou diversity index (Pielou 1975 after Trojan, 1992):

$$I' = 1 - \sum_{i=1}^{S}\left[\frac{n_i(n_i - 1)}{N(N-1)}\right]$$

where:

n_i – number of individuals of the i-th species in the sample

N – total number of individuals in the sample

In order to estimate the maximum species diversity in a sample (i.e. potential diversity) in a given community the following equation was employed (Trojan, 1992):

$$I_p = 1 - \frac{S\left\{\overline{n_i}\left(\overline{n_i} - 1\right)\right\}}{N(N-1)} \approx 1 - \frac{1}{S}$$

where:

n_i – number of individuals of the i-th species in the sample

N – total number of individuals in the sample

In order to calculate the disparity between the actual and potential species diversity in a given community, the following equation was employed: (Trojan, 1992):

$$dI = \frac{I'}{I_p}100\%$$

where:

I' – sampling-related diversity index

I_p – potential diversity index

Thus, the percent value of disparity between the actual and potential species diversity in a given community was calculated.

4.1.6. COMMUNITY SIMILARITIES

Agglomeration

Agglomerative algorithm is utilized for progressive merging of entities into clusters, and its application is connected with a similarity or distance measurement. Such merging results in creating a hierarchical clustering dendrogram.

The clustering process necessitates the selection of a distance measure between individual entities. In this particular case the Euclidean distance was applied, which denotes the actual geometric distance between the location of two entities in the multidimensional space. Euclidean distance is calculated in the following way:

distance

$$(x,y) = \left\{\sum i\ (x_i - y_i)^2\right\}^1$$

Ward's method was applied for estimating the distance between individual clusters. The method in question looks at cluster analysis as an analysis of variance problem, and aims at minimizing the total sum of square deviations in any two clusters that can be formed at any stage of the analysis.

- **Principal Components Analysis (PCA)**

The general aim of Principal Components Analysis (PCA) is to transform the original variables into a smaller number of uncorrelated variables, called principal components. In this way a set of lower dimensional vectors in created, upon which the original points are projected in such a way that the structure in question can be detected. This method mainly consists in finding straight lines (i.e. component axes) which are the best fit to clouds of data points in vector dimension, in accordance with the criterion of the least squares. The graphic representation of the analysis is a component plane generated by a chosen pair of axes, upon which the points from the vector dimension are projected.

4.1.7. DISCRIMINANT ANALYSIS

Habitat mosaicity indices

In order to describe the diversity of communities encountered in heterogeneous habitats, composed of species that are mutually related by trophic associations, Trojan (1997) proposed a method based on the broken stick model (MacArthur, 1957 after Trojan & Smoleński, 2002). This model assumes that two categories of species are present in every natural community. The first category includes the species associated with a particular type of habitat, which can be encountered in the whole spectrum of ecosystems developing in this habitat; they are the species building up the community. The second category includes species which are not abundant, and associated with

secondary habitat diversity expressed by its mosaicity. With the help of a discriminant procedure (Fischer, 1954 after Trojan & Smoleński, 2002) the two categories of species can be separated, while the analysis of the abundance distribution of species characterized by narrow ecological tolerance is conducted with the help of broken stick distribution model, which results in obtaining a distribution tail whose length is characteristic of a given habitat (being the longest for natural habitats) (Trojan & Smoleński, 2002).

The two categories of species are separated by cutting the empirical distribution in the point (p), in which there takes place the probability jump of the goodness of fit of the empirical distribution. In the analysis conducted for the purposes of this study it was assumed that $p > 0.5$.

Estimation of the number of individuals belonging to particular species is expressed by the following equation:

$$n_j = \frac{N}{S} \times \sum_{j=1}^{j=1} \frac{1}{S + 1 - j}$$

where:

n_j – estimated number of individuals belonging to the species denoted by "j"
j – species rank from the least abundant to the most abundant
N – total number of individuals in a sample
S – number of species in a sample

Knowledge of the number of species in a community and their abundance allows for developing two diversity measures.

1. **numerical index of habitat mosaicity,** which specifies the abundance of species in the distribution tail and is expressed by the following equation:

$$Dn = \frac{\sum_{r=s}^{r=sl} ni}{N}$$

where:

Dn – specific diversity:
ni – the i-th species abundance in accordance with distribution
N – total community abundance
sl – first species in accordance with distribution
s – last species in the community

2. **species index of habitat mosaicity,** which specifies the proportion of tail species in the community and is expressed by the equation:

$$Ds = \frac{s'}{S}$$

where:

Ds – species index of habitat mosaicity
s' – number of species in accordance with broken stick distribution
S – total number of species in the community

Variability in the case of habitat mosaicity indices ranges from 0 to 1.0.

4.2. CHOROLOGICAL ANALYSIS

The chorological analysis was conducted in order to identify the percentage of particular zoogeographical elements in the Fulgoromorpha and Cicadomorpha fauna within the investigated area. The typology of zoogeographical elements proposed by Nickel and Remane (2002) was applied, as one reflecting the association of the Fulgoromorpha and Cicadomorpha with particular plant formations. The species range was understood here as the area encompassing the center of the species dispersion, where the species was most frequently encountered, this being conditioned by its ecological requirements. The localities situated far from the center of species dispersion were considered less important. Each species was classified as belonging to one of the following chorological elements:

1. **Euro-Siberian** – includes species inhabiting coniferous and deciduous forests of Europe and Siberia;
2. **European** – includes species inhabiting European deciduous forests;
3. **Transpalearctic** – includes species inhabiting the prevailing part of Palearctics;
4. **Siberian** – includes species inhabiting the Siberian taiga; in Central Europe these species are associated with shady (i.e. not very warm) habitats;
5. **Western Palearctic** – includes species inhabiting the western and southwestern parts of Palearctics (Europe and the western part of Asia, in the east extending towards Central Siberia and Mongolia);
6. **Holarctic** – includes species encountered in the cold and temperate climate zones of the northern hemisphere, extending off the Tropic of Cancer;
7. **Northern European** – includes species inhabiting the areas of tundra and boglands in Northern Europe;
8. **Western European** – includes species inhabiting the heaths and coastal region;
9. **Mediterranean** – includes species encountered in the areas situated around the Mediterranean Sea Basin;
10. **Euroalpine** – includes species inhabiting the mountainous regions of Europe;
11. **Kazakh** – includes species inhabiting the steppes of Central Asia; in Central Europe these species are encountered in dry and very sunny habitats.

4.3. ECOLOGICAL ANALYSIS

Ecological analysis was conducted in order to define the percentage share of ecological elements in the Fulgoromorpha and Cicadomorpha fauna inhabiting the investigated plant communities.

There were specified the preferences of the species in question connected with such environmental factors as humidity and sunshine intensity, trophic associations and life strategy. This was achieved with the help of data on the Fulgoromorpha and Cicadomorpha ecology available in Polish studies, and also, as some necessary information could not be found in these, with the help of the monograph on the Fulgoromorpha and Cicadomorpha of Germany (Nickel, 2003). In conducting the ecological analysis with respect to habitat humidity and sunshine intensity, the criteria proposed by Czechowski and Mikołajczyk (1981) were applied, while in conducting the analysis with respect to trophic associations there were applied the criteria proposed by Nickel and Remane (2002).

With respect of the preferences concerning habitat humidity the following ecological elements were distinguished:

1. **hygrophilous** – species which prefer damp and boggy habitats, where they are most abundant;
2. **mezohygrophilous** – species which are comparatively abundant in habitats with diversified humidity levels;
3. **xerophilous** – species associated with dry and very sunny biotopes, where they are most abundant.

With respect of the preferences concerning sunshine intensity the following ecological elements were distinguished:

1. **heliophilous** – associated with open, sunny areas, where they usually inhabit higher vegetation layers;
2. **mezoheliophilous** – encountered in both sunny areas and in the areas which are shaded to a certain extent;
3. **skiophilous** – the shade-loving species, preferring the areas which are shaded to a large extent and often characterized by a high level of humidity as well.

With respect to their trophic associations the following ecological elements were distinguished:

1. **polyphags** – living on a wide spectrum of host plants;
2. **oligophags** – living on plant species belonging to one or two families;
3. **monophags** – living on plants belonging to one genus or species.

While distinguishing ecological elements with respect to their life strategies, there were utilized the criteria proposed by Achtziger and Nickel (1997), as well as those proposed by Nickel and Hildebrandt (2003).

The following ecological elements were distinguished with respect to associations with their habitats:

1. **eurytopic** – the element including species inhabiting various types of both open and forest communities, showing no distinct preferences with respect to any biotope (usually oligophags, mostly double-generation species);
2. **oligotopic** – including species inhabiting grassland communities, but preferring strictly specified abiotic conditions such as humidity, food supply or the height of the herb layer (mainly single-generation species with weak capacity for flying);
3. **stenotopic** – including species tightly associated with a specific biotope and, in addition, trophically associated with a single plant species or genus (mainly short-winged and single-generation species);

as well as:

4. **pioneering** – including species inhabiting the habitats in early stages of succession, always long-winged with strong capacity for flying, the polyphagous and multi-generation ones (accidental element in homeostatic communities);
5. **dendrophilous** – including species that show tighter associations with specific tree and shrub species being their host plants, than with other biotopes (accidental element in non-forest communities).

All necessary calculations were made with the help of such software as MS EXCEL, STATISTICA and MVSP w in the Department of Zoology, Faculty of Biology and Environmental Protection of the University of Silesia.

5. RESULTS

During the period of research conducted in the Stołowe Mountain National Park (Fig. 1) from 2003 to 2006, there were collected the representatives of 103 species of the Fulgoromorpha and Cicadomorpha (Tabs. 2, 3) out of about 520 species whose presence in Poland had been recorded up till then (Chudzicka, 2004).

There were found 32 species which had never been recorded in the Sudetes range before (Tab. 2) (Pilarczyk & Szwedo, 2005), of which one species, namely *Eupteryx signatipennis* (Boheman, 1847) (Table 2, Fig. 31, 32, 33), had never been recorded in the area of Poland before.

Table 2. Characteristics of the Fulgoromorpha and Cicadomorpha species collected in the Stołowe Mountains National Park in the years 2003–2006.

Species	Chorological elements	ECOLOGICAL ANALYSIS					
		Habitat humidity	Insolation	Trophic relationships	Food plant	Number of generation per year	Life strategies
1	2	3	4	5	6	7	8
Cixius nervosus	Euro-Siberian	mezohygrophilous	mezoheliophilous	polyphagous	Decioduous woody plants	1	dendrophilous
*Kelisia guttula**	Euro-Siberian	mezohygrophilous	heliophilous	monophagous	*Carex flacca*	1	stenotopic
*Kelisia pallidula**	Euro-Siberian	hygrophilous	heliophilous	monophagous	*Carex panicea*	1	oligotopic
*Anakelisia perspicillata**	Euro-Siberian	mezohygrophilous	heliophilous	monophagous	*Carex flacca, C. pilulifera*	1	stenotopic
*Stenocranus minutus**	Western Palearctic	mezohygrophilous	heliophilous	monophagous	*Dactylis glomerata*	1	oligotopic
Stenocranus major	Western Palearctic	hygrophilous	heliophilous	monophagous	*Phalaris arundinacea*	1	eurytopic
Megamelus notula	Euro-Siberian	hygrophilous	mezoheliophilous	monophagous	*Carex* spp.	1 – 2	eurytopic
Conomelus anceps	Western European	hygrophilous	mezoheliophilous	monophagous	*Juncus* spp.	1	oligotopic
Eurybregma nigrolineata	Euro-Siberian	mezohygrophilous	heliophilous	oligophagous	*Holcus lanatus, Elymus repens*	1	eurytopic
Stiroma affinis	Euro-Siberian	mezohygrophilous	mezoheliophilous	oligophagous	Poaceae	1	oligotopic
*Stiroma bicarinata**	Euro-Siberian	mezohygrophilous	mezoheliophilous	oligophagous	Poaceae	1	oligotopic
Laodelphax striatella	Transpalearctic	mezohygrophilous	mezoheliophilous	polyphagous	Poaceae (Cyperaceae, Juncaceae?)	2	pioneering
Hyledelphax elegantula	Euro-Siberian	mezohygrophilous	heliophilous	oligophagous	Poaceae	2	eurytopic
*Muellerianella brevipennis**	Euro-Siberian	hygrophilous	mezoheliophilous	monophagous	*Deschampsia. caespitosa*	1 – 2	stenotopic
Muellerianella extrusa	Euro-Siberian	hygrophilous	heliophilous	monophagous	*Molinia caerulea*	1	stenotopic
*Acanthodelphax denticauda**	European	mezohygrophilous	heliophilous	monophagous	*Deschampsia. caespitosa*	2	eurytopic
Acanthodelphax spinosa	European	mezohygrophilous	heliophilous	monophagous	*Festuca ovina, F. rubra*	(1 –?)2	stenotopic
Nothodelphax distincta	Northern European	hygrophilous	heliophilous	monophagous	*Eriophorum vaginatum*	1 – 2	stenotopic
*Dicranotropis hamata**	Transpalearctic	mezohygrophilous	mezoheliophilous	oligophagous	Poaceae	1 – 2	eurytopic
*Florodelphax leptosoma**	European	hygrophilous	mezoheliophilous	monophagous	*Juncus articulatus*	2	stenotopic
*Xanthodelphax flaveola**	Siberian	mezohygrophilous	mezoheliophilous	monophagous	*Poa pratensis*	1	stenotopic
Criomorphus albomarginatus	European	hygrophilous	mezoheliophilous	oligophagous	Poaceae	1	oligotopic
Javesella discolor	Euro-Siberian	hygrophilous	skiophilous	polyphagous	Poaceae, Cyperaceae?	1	oligotopic

1	2	3	4	5	6	7	8
Javesella dubia	Transpalearctic	hygrophilous	mezoheliophilous	oligophagous	*Agrostis capillaris, A. stolonifera*	2	oligotopic
*Javesella forcipata**	Siberian	hygrophilous	mezoheliophilous	oligophagous	*Deschampsia caespitosa, Holcus mollis*	1	stenotopic
Javesella pellucida	Transpalearctic	mezohygrophilous	mezoheliophilous	polyphagous	Poaceae, Cyperaceae?, Juncaceae?	2	pioneering
Ribautodelphax albostriatus	Western Palearctic	mezohygrophilous	heliophilous	monophagous	*Poa pratensis*	2	stenotopic
*Ribautodelphax angulosus**	European	xerophilous	heliophilous	monophagous	*Anthoxanthum odoratum*	2	stenotopic
*Ribautodelphax collinus**	European	xerophilous	heliophilous	monophagous	*Agrostis capillaris*	2	stenotopic
*Cercopis sanguinolenta**	Mediterranean	xerophilous	heliophilous	polyphagous	Mainly dicotyledonous herbs	1	oligotopic
Cercopis vulnerata	European	mezohygrophilous	heliophilous	polyphagous	Mainly dicotyledonous herbs	1	oligotopic
Neophilaenus lineatus	Transpalearctic	mezohygrophilous	mezoheliophilous	polyphagous	Poaceae, Cyperaceae, Juncaceae	1	eurytopic
Aphrophora alni	Transpalearctic	hygrophilous	mezoheliophilous	polyphagous	Adult: woody plants, Nymph: Dicotyledones	1	dendrophilous
*Aphrophora salicina**	Euro-Siberian	hygrophilous	mezoheliophilous	monophagous	*Salix alba, S. purpurea*	1	dendrophilous
Philaenus spumarius	Transpalearctic	mezohygrophilous	mezoheliophilous	polyphagous	Mainly dicotyledonous herbs	1	eurytopic
Centrotus cornutus	Euro-Siberian	mezohygrophilous	mezoheliophilous	polyphagous	Herbs, shrubs	1 / 2	eurytopic
Ulopa reticulata	European	mezohygrophilous	mezoheliophilous	monophagous	*Calluna vulgaris*	1 / 2	eurytopic
Megophthalmus scanicus	Mediterranean	mezohygrophilous	heliophilous	oligophagous	Fabaceae	1	oligotopic
Oncopsis flavicollis	Transpalearctic	mezohygrophilous	mezoheliophilous	monophagous	*Betula pendula, B. pubescens*	1	dendrophilous
Oncopsis tristis	Euro-Siberian	mezohygrophilous	heliophilous	monophagous	*Betula pendula, B. pubescens*	1	dendrophilous
*Pediopsis tiliae**	European	mezohygrophilous	mezoheliophilous	monophagous	*Tilia cordata, T. platyphyllos*	1	dendrophilous
*Agallia brachyptera**	Western Palearctic	hygrophilous	mezoheliophilous	oligophagous	Asteraceae, Fabaceae	1	oligotopic
*Anaceratagallia ribauti**	Western Palearctic	mezohygrophilous	heliophilous	oligophagous	*Plantago* spp., Fabaceae?, Lamiaceae?	1	oligotopic
Populicerus populi	Transpalearctic	hygrophilous	mezoheliophilous	monophagous	*Populus tremula*	1	eurytopic
Eupelix cuspidata	Transpalearctic	xerophilous	heliophilous	monophagous	*Festuca ovina, F. rubra*	1 / 2	stenotopic
*Aphrodes makarovi**	European	mezohygrophilous	mezoheliophilous	polyphagous	*Urtica dioica, Taraxacum* spp., *Cirsium* ssp.	1	oligotopic
Planaphrodes nigrita	European	mezohygrophilous	mezoheliophilous	oligophagous	*Poaceae*	1	eurytopic
*Anoscopus flavostriatus**	Euro-Siberian	hygrophilous	mezoheliophilous	oligophagous	*Poaceae*	1	oligotopic
*Evacanthus acuminatus**	Transpalearctic	hygrophilous	skiophilous	polyphagous	*Lamiaceae*	1	stenotopic

1	2	3	4	5	6	7	8
Evacanthus interruptus	Transpalearctic	mezohygrophilous	mezoheliophilous	polyphagous	*Urtica, Epilobium*	1	eurytopic
Cicadella viridis	Transpalearctic	hygrophilous	mezoheliophilous	polyphagous	*Carex* spp., *Juncus* spp.	1	oligotopic
Erythria manderstjernii	Euroalpine	mezohygrophilous	mezoheliophilous	polyphagous	Lamiaceae, Asteraceae	1	oligotopic
Dikraneura variata	Holarctic	mezohygrophilous	mezoheliophilous	oligophagous	*Deschampsia flexuosa, Festuca* spp.	2	oligotopic
Forcipata citrinella	Siberian	hygrophilous	mezoheliophilous	monophagous	*Carex* spp.	(1 –?)2	stenotopic
Forcipata forcipata	Siberian	mezohygrophilous	mezoheliophilous	polyphagous	*Carex* spp., *Luzula* spp.	(1 –?)2	oligotopic
Notus flavipennis	Euro-Siberian	hygrophilous	heliophilous	oligophagous	*Carex* ssp.	(1 –?)2	oligotopic
Kybos smaragdulus	Euro-Siberian	mezohygrophilous	heliophilous	monophagous	*Alnus incana, A. glutinosa*	2	dendrophilous
Chlorita paolii	Kazakh	mezohygrophilous	heliophilous	oligophagous	*Artemisia campestris, Achillea millefolium*	2(– 3?)	oligotopic
*Fagocyba cruenta**	European	mezohygrophilous	mezoheliophilous	polyphagous	Decioduous woody plants	(1 –?)2	dendrophilous
Eupteryx atropunctata	European	mezohygrophilous	heliophilous	polyphagous	Dicotyledonous herbs	2(– 3?)	oligotopic
Eupteryx aurata	European	hygrophilous	mezoheliophilous	polyphagous	Dicotyledonous herbs	(1 –?)2	oligotopic
Eupteryx cyclops	Euro-Siberian	mezohygrophilous	mezoheliophilous	monophagous	*Urtica dioica*	2	stenotopic
*Eupteryx signatipennis***	Northern European	hygrophilous	skiophilous	monophagous	*Filipendula ulmaria*	2	stenotopic
Eupteryx vittata	European	mezohygrophilous	mezoheliophilous	oligophagous	*Glechoma hederacea, Ranunculus repens*	2	oligotopic
*Balclutha calamagrostis**	Northern European	xerophilous	heliophilous	monophagous	*Calamagrostis epigejos*	1	stenotopic
Balclutha rhenana	Euro-Siberian	hygrophilous	mezoheliophilous	monophagous	*Phalaris arundinacea*	1	stenotopic
Balclutha punctata	Holarctic	mezohygrophilous	mezoheliophilous	oligophagous	Poaceae	1	oligotopic
Macrosteles laevis	Holarctic	xerophilous	heliophilous	polyphagous	Poaceae	(1 –?)2	pioneering
Macrosteles ossiannilssoni	Northern European	mezohygrophilous	mezoheliophilous	polyphagous	*Carex* spp., *Juncus* spp.	1 – 2	stenotopic
*Macrosteles septemnotatus**	Euro-Siberian	hygrophilous	heliophilous	monophagous	*Filipendula ulmaria*	2	stenotopic
Deltocephalus pulicaris	Holarctic	mezohygrophilous	mezoheliophilous	oligophagous	Poaceae	1 – 2	eurytopic
Doratura stylata	Transpalearctic	mezohygrophilous	mezoheliophilous	oligophagous	*Festuca rubra, Agrostis capillaris*	1 (– 2?)	oligotopic
Allygus mixtus	European	mezohygrophilous	mezoheliophilous	polyphagous	Nym.: Poaceae?; Adult: Decioduous woody plants	1	dendrophilous
Graphocraerus ventralis	Euro-Siberian	mezohygrophilous	heliophilous	oligophagous	Poaceae	1	oligotopic
Paluda flaveola	Siberian	mezohygrophilous	mezoheliophilous	oligophagous	*Calamagrostis* spp., *Molinia* spp.	1	oligotopic
Rhopalopyx adumbratus	Euro-Siberian	mezohygrophilous	mezoheliophilous	monophagous	*Festuca rubra, F. ovina*	1	stenotopic

1	2	3	4	5	6	7	8
Rhopalopyx preyssleri	Euro-Siberian	mezohygrophilous	heliophilous	monophagous	*Poa pratensis*	1	stenotopic
*Elymana kozhevnikovi**	Siberian	mezohygrophilous	heliophilous	monophagous	*Calamagrostis arundinacea, C. varia, C. canescens*	1	stenotopic
Elymana sulphurella	Transpalearctic	mezohygrophilous	mezoheliophilous	oligophagous	Poaceae	1	eurytopic
*Cicadula albingensis**	Siberian	hygrophilous	heliophilous	oligophagous	*Scirpus silvaticus, Carex* spp.	1	stenotopic
*Cicadula rubroflava**	Siberian	hygrophilous	heliophilous	monophagous	*Carex brizoides*	2 ?	stenotopic
Cicadula persimilis	Euro-Siberian	mezohygrophilous	mezoheliophilous	monophagous	*Dactylis glomerata*	1 – 2	stenotopic
Cicadula quadrinotata	Euro-Siberian	hygrophilous	mezoheliophilous	monophagous	*Carex* spp.	1 – 2	oligotopic
Speudotettix subfusculus	Transpalearctic	mezohygrophilous	mezoheliophilous	polyphagous	Decioduous woody plants	1	eurytopic
Hesium domino	European	xerophilous	mezoheliophilous	oligophagous	Adult: *Betula* ssp., Nymph: Poaceae	1	dendrophilous
Macustus grisescens	Euro-Siberian	hygrophilous	mezoheliophilous	oligophagous	Poaceae, *Carex* ssp.	1	oligotopic
*Doliotettix lunulatus**	Siberian	mezohygrophilous	mezoheliophilous	monophagous	*Agrostis stolonifera*	1	stenotopic
Athysanus argentarius	Euro-Siberian	mezohygrophilous	mezoheliophilous	oligophagous	Poaceae	1	oligotopic
Streptanus aemulans	Holarctic	mezohygrophilous	mezoheliophilous	oligophagous	Poaceae	2	oligotopic
Streptanus marginatus	Siberian	mezohygrophilous	mezoheliophilous	oligophagous	*D. flexuosa, F. ovina*	1	oligotopic
Streptanus sordidus	European	hygrophilous	mezoheliophilous	oligophagous	*Agrostis stolonifera, A. capillaris*	2	oligotopic
Arocephalus longiceps	European	mezohygrophilous	heliophilous	oligophagous	*Bromus erectus, Holcus mollis*	(1 –?)2	oligotopic
*Psammotettix alienus**	Holarctic	mezohygrophilous	mezoheliophilous	oligophagous	Poaceae	2	pioneering
Psammotettix cephalotes	European	xerophilous	heliophilous	monophagous	*Briza media*	1 – 2	stenotopic
Psammotettix confinis	Holarctic	mezohygrophilous	mezoheliophilous	oligophagous	Poaceae	2	pioneering
Errastunus ocellaris	Transpalearctic	mezohygrophilous	mezoheliophilous	oligophagous	Poaceae	2	eurytopic
Jassargus alpinus neglectus	Euro-Siberian	hygrophilous	mezoheliophilous	oligophagous	Poaceae	1	oligotopic
Jassargus distinguendus	Northern European	mezohygrophilous	mezoheliophilous	oligophagous	*Festuca rubra, Agrostis capillaris*	2	eurytopic
*Diplocolenus bohemani**	Euro-Siberian	xerophilous	heliophilous	oligophagous	Poaceae	1	eurytopic
Diplocolenus sudeticus	Euroalpine	xerophilous	mezoheliophilous	oligophagous	Poaceae	1	stenotopic
Verdanus abdominalis	Western Palearctic	mezohygrophilous	mezoheliophilous	oligophagous	Poaceae	1	oligotopic
Arthaldeus pascuellus	Euro-Siberian	mezohygrophilous	heliophilous	oligophagous	Poaceae	2	eurytopic
*Sorhoanus xanthoneurus**	Siberian	hygrophilous	heliophilous	monophagous	*Eriophorum vaginatum*	1	stenotopic

* – species never recorded in the Sudetes before; ** – species never recorded in Poland before

Table 3. Species composition of the Fulgoromorpha and Cicadomorpha collected in the years 2003–2006 in particular research areas and the total area of the Stołowe Mountains National Park (J – qualitative research)

Species	Plots																													J
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
FULGOROMORPHA Evans, 1946																														
Cixiidae Spinola, 1839																														
Cixius nervosus (Linnaeus, 1758)																														■
Delphacidae Leach, 1815																														
Kelisia guttula (Germar, 1818)																			■	■										
Kelisia pallidula (Boheman, 1847)																														■
Anakelisia perspicillata (Boheman, 1845)																														■
Stenocranus major (Kirschbaum, 1868)	■	■		■			■	■		■			■	■	■		■		■						■					■
Stencranus minutes (Fabricius, 1787)																														■
Megamelus notula (Germar, 1830)																														■
Conomelus anceps (Germar, 1821)			■		■	■			■	■																				■
Eurybregma nigrolineata (Scott, 1875)																						■			■					■
Stiroma affinis (Fieber, 1866)																														■
Stiroma bicarinata (Herrich-Schaffer, 1835)				■						■	■	■					■					■								■
Laodelphax striatella (Fallen, 1826)	■		■		■		■		■	■			■						■	■	■	■	■	■	■					■
Hyledelphax elegantula (Boheman, 1847)																					■	■			■	■	■	■	■	■
Muellerianella brevipennis (Boheman, 1847)			■	■	■				■		■	■	■	■						■					■				■	■
Muellerianella extrusa (Scott, 1871)																														■
Acanthodelphax denticauda (Boheman, 1847)										■								■		■										
Acanthodelphax spinosa (Fieber, 1866)	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■		■	■	■										■
Nothodelphax distincta (Flor, 1861)																							■	■						
Dicranotropis hamata (Boheman, 1847)		■									■	■							■											■
Florodelphax leptosoma (Flor, 1861)	■																			■										
Xanthodelphax flaveola (Flor, 1861)																														■
Criomorphus albomarginatu (Curtis, 1833)				■		■											■													■
Javesella discolor (Boheman, 1847)																									■		■	■		■

Species	Plots																													J
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
Javesella dubia (Kirschbaum, 1868)														■						■										■
Javesella forcipata (Boheman, 1847)																														■
Javesella pellucida (Fabricius, 1794)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■			■	■		■	■	■
Ribautodelphax albostriata (Fieber, 1866)								■														■								■
Ribautodelphax angulosus (Ribaut, 1953)																														■
Ribautodelphax collina (Boheman, 1847)						■													■	■										■
CICADOMORPHA Evans, 1946																														
Cercopidae Leach, 1815																														
Cercopis sanguinolenta (Scopoli, 1763)			■																											
Cercopis vulnerata Illiger in Rossi, 1807				■					■			■		■											■					■
Neophilaenus lineatus (Linnaeus, 1758)			■	■												■					■	■	■	■	■	■	■	■	■	■
Aphrophora alni (Fallen, 1805)		■	■	■			■	■	■	■	■	■	■	■			■		■	■	■	■								■
Aphrophora salicina (Goeze, 1778)																														■
Philaenus spumarius (Linnaeus, 1758)	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■					■			■		■
Membracidae Rafinesque, 1815																														
Centrotus cornutus (Linnaeus, 1758)																														■
Ulopidae Le Peletier et Serville, 1843																														
Ulopa reticulata (Fabricius, 1794)																														■
Cicadellidae Lateille, 1825																														
Megophthalmus scanicus (Fallen, 1806)					■								■						■											■
Oncopsis flavicollis (Linnaeus, 1761)																									■			■		■
Oncopsis tristis (Zetterstedt, 1840)																					■	■							■	■
Pediopsis tiliae (Germar, 1831)																														■
Agallia brachyptera (Boheman, 1847)			■	■	■	■	■		■				■								■				■				■	■
Anaceratagallia ribauti (Ossiannilsson, 1938)																														■
Populicerus populi (Linnaeus, 1761)																														■
Eupelix cuspidata (Fabricius, 1775)					■	■	■						■		■															■
Aphrodes makarovi (Zachvatkin, 1948)			■																											■
Planaphrodes nigrita (Kirschbaum, 1868)																					■									

Species	Plots																												J
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
Anoscopus flavostriatus (Donovan, 1799)					■																									■
Evacanthus acuminatus (Fabricius, 1794)																														■
Evacanthus interruptus (Linnaeus, 1758)								■		■		■					■		■											■
Cicadella viridis (Linnaeus, 1758)	■		■		■				■	■				■					■	■				■	■		■		■
Erythria manderstjernii (Kirschbaum, 1868)																														■
Dikraneura variata (Hardy, 1850)																												■	■	
Forcipata citrinella (Zetterstedt, 1828)	■	■	■		■	■													■	■										■
Forcipata forcipata (Flor, 1861)																														■
Notus flavipennis (Zetterstedt, 1828)																				■										■
Kybos smaragdulus (Fallen, 1806)																													■	
Chlorita paolii (Ossiannilsson, 1939)															■															■
Fagocyba cruenta (Herrich-Schàffer,1838)			■																											
Eupteryx atropunctata (Goeze, 1778)											■																			■
Eupteryx aurata (Linnaeus, 1758)									■	■	■																			■
*Eupteryx cyclops (*Matsumura, 1906)																														■
Eupteryx signatipennis (Boheman, 1847)										■	■	■																		■
Eupteryx vittata (Linnaeus, 1758)																			■	■										
Balclutha calamagrostis (Ossiannilsson 1961)																														■
Balclutha punctata (Fabricius, 1775)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■
Balclutha rhenana Wagner, 1939																														■
Macrosteles laevis (Ribaut, 1927)		■			■	■	■	■		■	■		■	■	■	■			■	■								■		■
*Macrosteles ossiannilssoni (*Lindberg, 1954)																				■										
Macrosteles septemnotatus (Fallen, 1806)																														■
Deltocephalus pulicaris (Fallen, 1806)					■	■			■	■								■	■	■	■	■								■
Doratura stylata (Boheman, 1847)	■		■		■	■	■		■	■		■	■	■				■	■								■		■
Allygus mixtus (Fabricius, 1794)										■				■					■								■		■
Graphocraerus ventralis (Fallen, 1806)					■	■	■			■			■	■	■	■		■	■	■										■
Paluda flaveola (Boheman, 1845)		■		■		■	■		■	■	■	■	■	■	■		■	■							■				■	■

Species	Plots																												J
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
Rhopalopyx adumbratus (C.Sahlberg, 1842)																														■
Rhopalopyx preyssleri (Herrich-Schäffer, 1838)					■	■			■			■																		■
Elymana kozhevnikovi (Zachvatkin, 1938)																												■	■	■
Elymana sulphurella (Zetterstedt, 1828)	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■			■	■	■			■		■
Cicadula albingensis (Wagner, 1940)																														■
Cicadula rubroflava Linnavuori, 1952																														■
Cicadula persimilis (Edwards, 1920)	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■	■		■	■										■
Cicadula quadrinotata (Fabricius, 1794)																				■										■
Speudotettix subfusculus (Fallen, 1806)																			■	■	■	■			■					■
Hesium domino (Reuter, 1880)	■		■			■	■	■	■	■	■	■				■	■		■	■										■
Macustus grisescens (Zetterstedt, 1828)	■	■	■	■			■			■	■	■		■					■	■				■						■
Doliotettix lunulatus (Zetterstedt, 1840)	■		■	■			■	■			■	■						■		■										■
*Athysanus argentarius (*Metcalf, 1955)		■	■	■	■	■	■	■	■	■	■	■	■	■			■		■	■					■					■
Streptanus aemulans (Kirschbaum, 1868)						■																								■
Streptanus marginatus (Kirschbaum, 1858)			■		■	■			■									■	■									■	■	■
Streptanus sordidus (Zetterstedt, 1828)								■		■		■		■					■	■										■
Arocephalus longiceps (Kirschbaum, 1868)								■					■	■	■			■							■				■	■
Psammotettix alienus (Dahlbom, 1850)			■		■	■	■			■			■		■	■		■	■	■	■	■			■			■	■	■
Psammotettix cephalotes (Herrich-Schäffer, 1834)	■	■				■								■			■	■	■	■										■
Psammotettix confinis (Dahlbom, 1850)		■				■	■	■	■	■																				■
Errastunus ocellaris (Fallen, 1806)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■					■
Jassargus alpinus neglectus (Then, 1896)				■																					■			■	■	■
Jassargus distinguendus (Flor, 1861)	■	■	■		■	■	■		■	■	■	■	■	■	■	■	■	■	■	■			■	■	■		■	■	■	■
Diplocolenus bohemani (Zetterstedt, 1840)																												■		
Diplocolenus sudeticus (Kolenati, 1860)				■																					■			■	■	■
Verdanus abdominalis (Fabricius, 1803)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				■	■
Arthaldeus pascuellus (Fallen, 1826)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■					■
Sorhoanus xanthoneurus (Fieber, 1869)																							■	■						

5.1. COMMUNITIES OF THE FULGOROMORPHA AND CICADOMORPHA ON THE RESEARCH PLOTS

Within the 29 research plots in the Stołowe Mountains National Park (Fig. 1), between 2004 and 2006, there were collected 20431 representatives of the Fulgoromorpha and Cicadomorpha which belonged to 77 species.

Plot 1 (*Cirsietum rivularis*)

On the plot 1 from 2004 to 2006 there were collected 623 representatives of the Fulgoromorpha and Cicadomorpha belonging to 20 species.

Dominant species in the years 2005 and 2006 were the species *Verdanus abdominalis* (22.22%; 20.95%) and *Arthaldeus pascuellus* (24.53%; 24.26%). The species *Balclutha punctata* was a subdominant in 2004 (17.77%) and 2006 (12.86%), while in 2004 the subdominants additionally included such species as *Javesella pellucida* (11.85%), *Philaenus spumarius* (14.81%), *Verdanus abdominalis* (11.85%) and *Arthaldeus pascuellus* (18.51%) (Tab. 4).

In all three research seasons, with respect to the constancy of occurrence, to the second class there belonged the species *Balclutha punctata*, while in the years 2005 and 2006 to the same class there also belonged such species as *Elymana sulphurella*, *Errastunus ocellaris* and *Arthaldeus pascuellus*, and additionally in 2006 also the species *Verdanus abdominalis* and *Jassargus distinguendus* (Tab. 4).

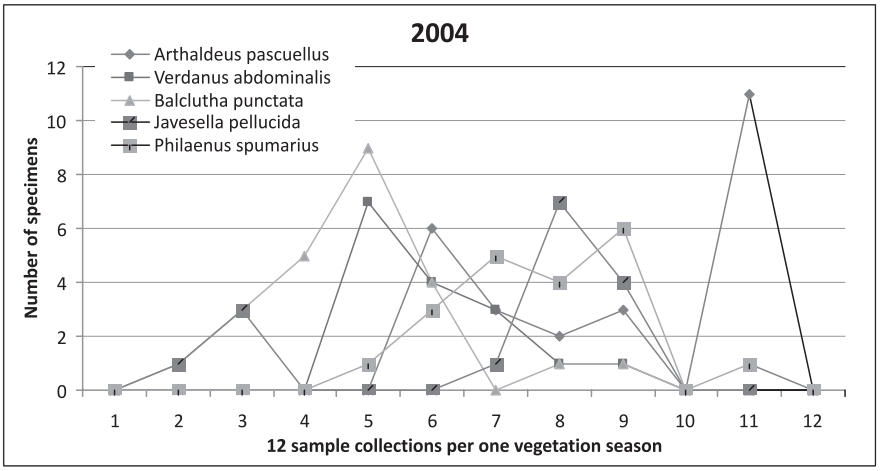
The highest value of the *Q* index in all research seasons was achieved by the species *Arthaldeus pascuellus* (27.76, 40.43 and 40.21 respectively) (Tab. 4).

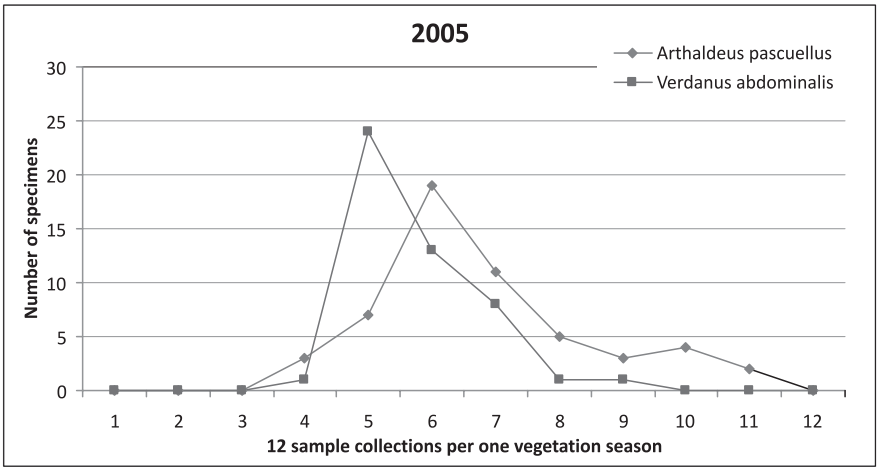
The dynamics of species abundance among the species dominating on the plot 1 was the following: the species *Verdanus abdominalis* was most abundant at the beginning of July, *Arthaldeus pascuellus* had two maxima of appearance, in the middle of July and in the middle of September, while the maximum of appearance of the species *Balclutha punctata* took place in the second half of June (Fig. 2).

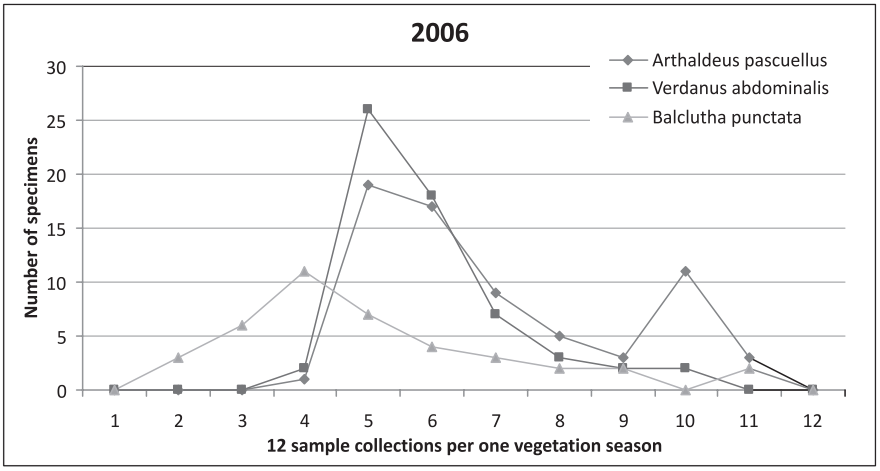
Table 4. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 1 – *Cirsietum rivularis*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Stenocranus major (Kbm.)	8.88	16.66	IV	12.16	0.46	8.33	IV	1.95	–	–		–
Laodelphax striatella (Fall.)	–	–		–	1.85	25	IV	6.80	–	–		–
Acanthodelphax spinosa (Fieb.)	2.96	25	IV	8.60	9.25	41.66	III	19.63	2.2	33.33	III	8.56
Florodelphax leptosoma (Fl.)	–	–		–	–	–		–	0.36	8.33	IV	1.73
Javesella pellucida (F.)	11.85	41.66	III	22.21	5.09	41.66	III	14.56	2.57	33.33	III	9.25
Philaenus spumarius (L.)	14.81	50	III	27.21	4.62	41.66	III	13.87	–	–		–
Cicadella viridis (L.)	1.48	16.66	IV	4.96	–	–		–	–	–		–
Forcipata citrinella (Zett.)	–	–		–	1.38	16.66	IV	4.79	6.98	33.33	III	15.25
Balclutha punctata (F.)	17.77	58.33	II	32.19	7.4	66.66	II	22.26	12.86	75	II	31.05
Doratura stylata (Boh.)	–	–		–	–	–		–	0.73	16.66	IV	3.48
Elymana sulphurella (Zett.)	–	–		–	8.33	58.33	II	22.04	6.61	58.33	II	19.63
Cicadula persimilis (Edw.)	–	–		–	–	–		–	1.1	16.66	IV	4.28
Hesium domino (Reut.)	2.22	25	IV	7.44	0.92	16.66	IV	3.91	0.36	8.33	IV	1.73
Macustus grisescens (Zett.)	2.22	16.66	IV	6.08	0.92	16.66	IV	3.91	1.1	16.66	IV	4.28
Doliotettix lunulatus (Zett.)	–	–		–	1.85	25	IV	6.80	1.83	25	IV	6.76
Psammotettix cephalotes (H.-S.)	–	–		–	1.38	16.66	IV	4.79	2.94	41.66	III	11.06
Errastunus ocellaris (Fall.)	7.4	33.33	III	15.70	7.87	58.33	II	21.42	6.98	66.66	II	21.57
Jassargus distinguendus (Fl.)	–	–		–	1.85	25	IV	6.80	8.08	58.33	II	21.70
Verdanus abdominalis (F.)	11.85	41.66	III	22.21	22.22	50	III	33.33	20.95	58.33	II	34.95
Arthaldeus pascuellus (Fall.)	18.51	41.66	III	27.76	24.53	66.66	II	40.43	24.26	66.66	II	40.21

Fig. 2. The dynamics of species abundance among the species dominating on the plot 1.







Plot 2 (*Cirsietum rivularis*)

On the plot 2 from 2004 to 2006 there were collected 515 representatives of the Fulgoromorpha and Cicadomorpha belonging to 20 species.

Balclutha punctata was the dominant species in the years 2004–2005 in this area (30%, 28.87% and 28.63% respectively). Furthermore, in 2004 the status of the dominant species was also achieved by *Verdanus abdominalis* (20.62%), which was slightly less abundant in the years 2005 and 2006 and therefore was classified as the subdominant (19.01% and 16.9% respectively). In 2004 *Stenocranus major* was the subdominating species (16.87%), replaced by *Philaenus spumarius* in 2005 (11.26%), and *Arthaldeus pascuellus* in 2006 (12.67%). Furthermore, in the seasons 2005 and 2006 the group of subdominants included also *Errastunus ocellaris* (15.49% and 15.02% respectively) (Tab. 5).

In the seasons 2005 and 2006, with respect to the constancy of occurrence, the species *Balclutha punctata* belonged to the first class, while the species *Errastunus ocellaris* and *Arthaldeus pascuellus* belonged to the second class (Tab. 5).

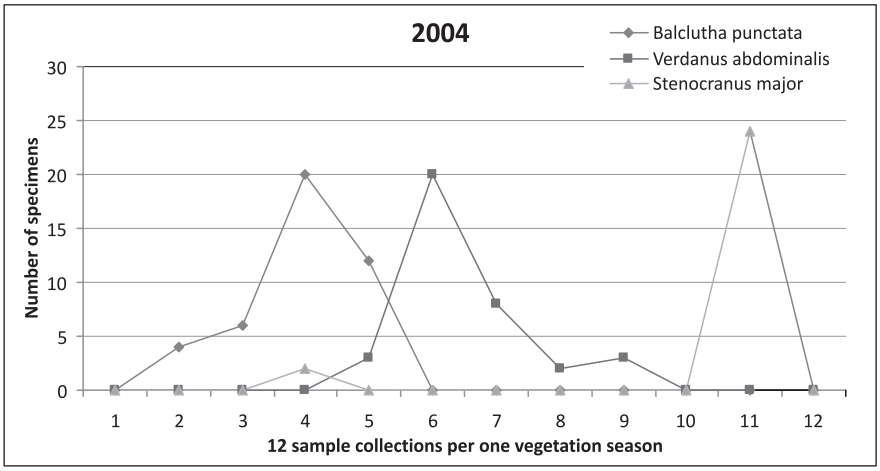
The highest value of the *Q* index from 2004 to 2006 was achieved by two species, namely *Balclutha punctata* (38.72, 49.04 and 51.22 respectively) and *Errastunus ocellaris* (9.12, 30.05 and 31.64 respectively) (Tab. 5).

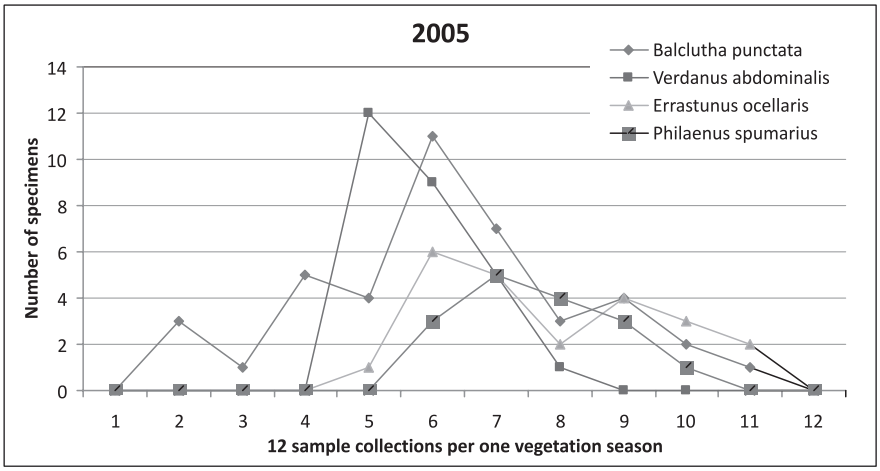
The dynamics of species abundance among the species dominating on the plot 2 was the following: the species *Verdanus abdominalis* achieved its maximum of appearance at the beginning of July in 2005 and 2006, and in the middle of July in 2004, while the species *Balclutha punctata* achieved its maximum in the middle of July (Fig. 3). The species *Errastunus ocellaris* achieved two maxima of appearance, i.e. one in the middle of July and the other in the middle of September. In 2004 the species *Stenocranus major* achieved its maximum of appearance at the beginning of November (Fig. 3).

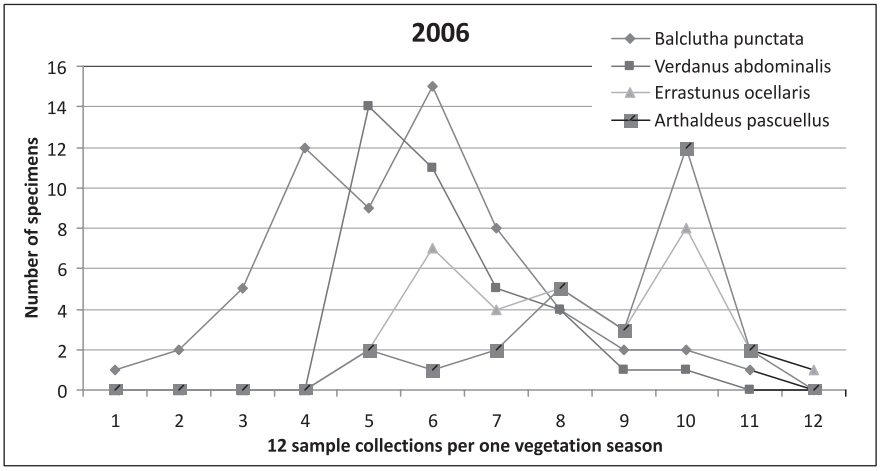
Table 5. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 2 – *Cirsietum rivularis*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Stenocranus major (Kbm.)	16.87	33.33	III	23.71	1.4	8.33	IV	3.41	–	–	–	–
Acanthodelphax spinosa (Fieb.)	0.62	8.33	IV	2.27	4.22	33.33	III	11.85	3.28	33.33	III	10.45
Dicranotropis hamata (Boh.)	–	–	–	–	–	–	–	–	0.46	8.33	IV	1.95
Javesella pellucida (F.)	5.62	33.33	III	13.68	5.66	33.33	III	13.73	2.34	25	IV	7.64
Aphrophora alni (Fall.)	1.25	16.66	IV	4.56	–	–	–	–	–	–	–	–
Philaenus spumarius (L.)	8.75	41.66	III	19.09	11.26	41.66	III	21.65	5.63	50	III	16.77
Forcipata citrinella (Zett.)	–	–	–	–	–	–	–	–	1.87	25	IV	6.83
Balclutha punctata (F.)	30	50	III	38.72	28.87	83.33	I	49.04	28.63	91.66	I	51.22
Macrosteles laevis (Rib.)	1.87	16.66	IV	5.58	–	–	–	–	3.28	41.66	III	11.68
Paluda flaveola (Boh.)	2.5	25	IV	7.9	0.7	8.33	IV	2.41	1.4	16.66	IV	4.82
Elymana sulphurella (Zett.)	–	–	–	–	–	–	–	–	3.75	33.33	III	11.17
Cicadula persimilis (Edw.)	–	–	–	–	–	–	–	–	2.34	25	IV	7.64
Macustus grisescens (Zett.)	0.62	8.33	IV	2.27	3.52	33.33	III	10.83	2.34	25	IV	7.64
Athysanus argentarius Metc.	2.5	25	IV	7.9	0.7	8.33	IV	2.41	–	–	–	–
Psammotettix cephalotes (H.-S.)	–	–	–	–	0.7	8.33	IV	2.41	–	–	–	–
Psammotettix confinis (Dalb.)	1.25	8.33	IV	3.22	–	–	–	–	–	–	–	–
Errastunus ocellaris (Fall.)	5	16.66	IV	9.12	15.49	58.33	II	30.05	15.02	66.66	II	31.64
Jassargus distinguendus (Fl.)	2.5	25	IV	7.9	–	–	–	–	–	–	–	–
Verdanus abdominalis (F.)	20.62	41.66	III	29.3	19.01	33.33	III	25.17	16.9	50	III	29.06
Arthaldeus pascuellus (Fall.)	–	–	–	–	8.45	58.33	II	22.2	12.67	58.33	II	27.18

Fig. 3. The dynamics of species abundance among the species dominating on the plot 2.







Plot 3 (*Lysimachio-Filipenduletum*)

On the plot 3 from 2004 to 2006 there were collected 843 representatives of the Fulgoromorpha and Cicadomorpha belonging to 27 species.

On the plot 3, during all research seasons (2004–2006), the status of the eudominant species was achieved by *Verdanus abdominalis* (38.4%, 40.27% and 38.79% respectively).

In 2004 the status of the subdominant species was achieved by the species *Balclutha punctata* (13.6%) and *Streptanus marginatus* (10,4%), and in the years 2005-2006 by the species *Doratura stylata* (12.43% and 15.22% respectively) and *Arthaldeus pascuellus* (12.43% and 13.79% respectively) (Tab. 6).

As for the constancy of occurrence, in the years 2005 and 2006 to the first class there belonged the species *Balclutha punctata*, and to the second class such species as *Elymana sulphurella*, *Verdanus abdominalis* and *Arthaldeus pascuellus*. Moreover, in 2005 to the second class there also belonged the species *Doratura stylata* (Tab. 6).

The highest value of the *Q* index in all research seasons was achieved by the species *Verdanus abdominalis* (39.99, 48.46 and 47.56 respectively) (Tab. 6).

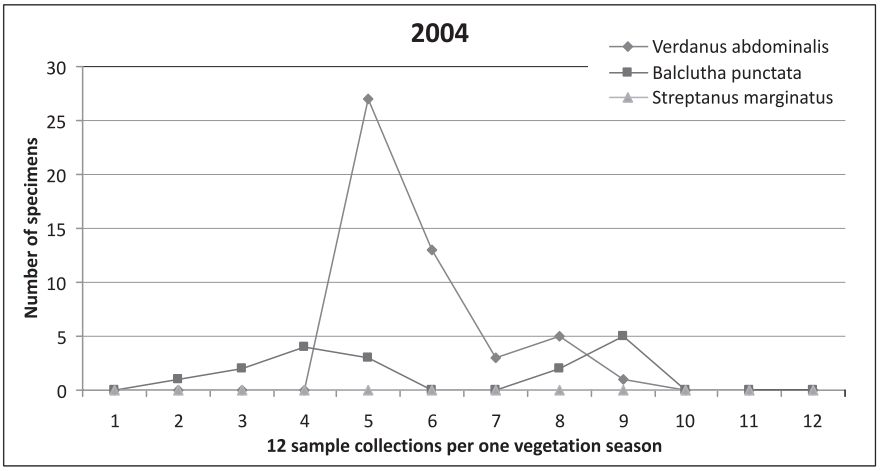
There were distinguished three differential species on the plot 3, namely *Cercopis sanguinolenta* (100%), *Aphrodes makarovi* (100%) and *Fagocyba cruenta* (100%) (Annex 1).

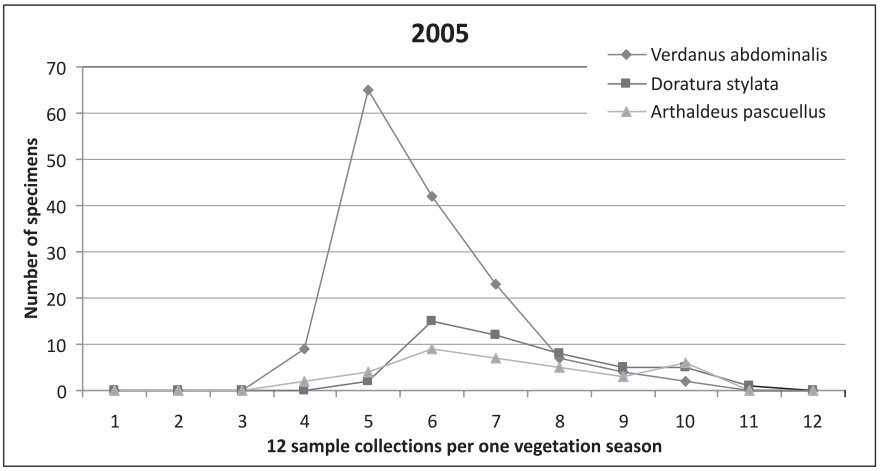
The dynamics of species abundance among the species dominating on the plot 3 was the following: the species *Verdanus abdominalis* achieved its single maximum of appearance at the beginning of July in all research seasons. In the years 2005 and 2006 the species *Doratura stylata* was the most abundant one in the middle of July, while the species *Arthaldeus pascuellus* achieved its maximum of appearance twice, i.e. in the middle of July and towards the end of September (Fig. 4).

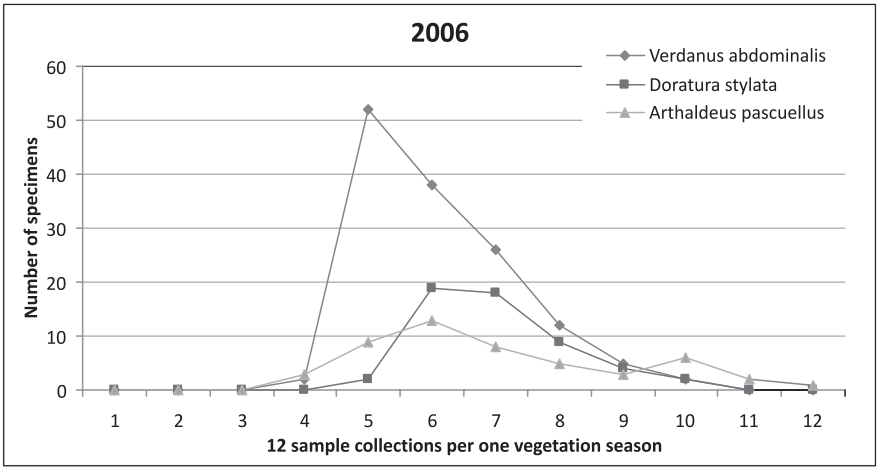
Table 6. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 3 – *Lysimachio-Filipenduletum*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Conomelus anceps (Germ.)	-	-	-	-	-	-	-	-	1.14	16.66	IV	4.35
Laodelphax striatella (Fall.)	-	-	-	-	1.89	25	IV	6.87	-	-	-	-
Muellerianella brevipennis (Boh.)	-	-	-	-	0.27	8.33	IV	1.49	-	-	-	-
Acanthodelphax spinosa (Fieb.)	1.6	8.33	IV	3.65	2.97	33.33	III	9.94	1.72	33.33	III	7.57
Javesella pellucida (F.)	3.2	25	IV	8.94	2.16	33.33	III	8.48	2.29	41.66	III	9.76
Cercopis sanguinolenta (Scop.)	1.6	16.66	IV	5.16	0.27	8.33	IV	1.49	0.86	16.66	IV	3.78
Neophilaenus lineatus (L.)	0.8	8.33	IV	2.58	-	-	-	-	-	-	-	-
Aphrophora alni (Fall.)	-	-	-	-	0.27	8.33	IV	1.49	0.57	16.66	IV	3.08
Agallia brachyptera (Boh.)	1.6	16.66	IV	5.16	0.81	16.66	IV	3.67	1.14	25	IV	5.33
Aphrodes makarowi Zachv.	1.6	8.33	IV	3.65	-	-	-	-	-	-	-	-
Cicadella viridis (L.)	4	25	IV	10	0.27	8.33	IV	1.49	0.86	16.66	IV	3.78
Forcipata citrinella (Zett.)	-	-	-	-	1.35	25	IV	5.8	1.72	25	IV	6.55
Fagocyba cruenta (H-S.)	-	-	-	-	0.27	8.33	IV	1.49	-	-	-	-
Balclutha punctata (F.)	13.6	50	III	26.07	8.1	83.33	I	25.98	7.18	83.33	I	24.46
Doratura stylata (Boh.)	2.4	8.33	IV	4.47	12.43	58.33	II	26.92	15.22	50	III	27.58
Elymana sulphurella (Zett.)	-	-	-	-	8.64	58.33	II	22.44	8.04	58.33	II	21.65
Cicadula persimilis (Edw.)	-	-	-	-	0.54	16.66	IV	2.99	-	-	-	-
Hesium domino (Reut.)	-	-	-	-	0.27	8.33	IV	1.49	-	-	-	-
Macustus grisescens (Zett.)	3.2	16.66	IV	7.3	1.62	25	IV	6.36	1.14	25	IV	5.33
Doliotettix lunulatus (Zett.)	6.4	25	IV	12.64	-	-	-	-	-	-	-	-
Athysanus argentarius Metc.	2.4	16.66	IV	6.32	1.62	25	IV	6.36	0.86	16.66	IV	3.78
Streptanus marginatus (Kbm.)	10.4	16.66	IV	13.16	1.89	16.66	IV	5.61	1.43	16.66	IV	4.88
Psammotettix alienus (Dhlb.)	-	-	-	-	0.27	8.33	IV	1.49	-	-	-	-
Errastunus ocellaris (Fall.)	4	16.66	IV	8.16	-	-	-	-	1.43	25	IV	5.97
Jassargus distinguendus (Fl.)	-	-	-	-	1.35	16.66	IV	4.74	1.72	25	IV	6.55
Verdanus abdominalis (F.)	38.4	41.66	III	39.99	40.27	58.33	II	48.46	38.79	58.33	II	47.56
Arthaldeus pascuellus (Fall.)	4.8	25	IV	10.95	12.43	75	II	30.53	13.79	75	II	32.15

Fig. 4. The dynamics of species abundance among the species dominating on the plot 3.







Plot 4 (*Cirsietum rivularis*)

On the plot 4 from 2004 to 2006 there were collected 537 representatives of the Fulgoromorpha and Cicadomorpha belonging to 23 species.

The species *Balclutha punctata* achieved the status of the eudominant species in 2004 (34.93%), the status of the dominant species in 2005 (22.22%), and the status of the subdominant species in 2006 (16.22%). In the years 2004–2006 *Verdanus abdominalis* was the subdominant species (12.32%, 14.28% and 15.47% respectively), while *Doliotettix lunulatus* achieved the same status in the years 2004–2005 (13.69% and 14.28% respectively), and *Arthaldeus pascuellus* achieved it in the years 2005–2006 (19.04% and 15.09% respectively). To the group of subdominant species which achieved this status in only one research season there belonged the species *Philaenus spumarius* (15.07% in 2005) and *Muellerianella brevipennis* (14.71% in 2006) (Tab. 7).

In 2006 the species *Balclutha punctata* belonged to the first class with reference to the constancy of occurrence, and in the remaining seasons it belonged to the second class. Furthermore, in 2005 to the second class there belonged the species *Philaenus spumarius* and *Arthaldeus pascuellus*, and in 2006 the species *Javesella pellucida* and *Arthaldeus pascuellus* (Tab. 7).

The highest value of the *Q* index was achieved by the species *Balclutha punctata* (45.13, 40.82 and 38.55 respectively) and *Arthaldeus pascuellus* (13.5, 33.32 and 31.71 respectively) (Tab. 7).

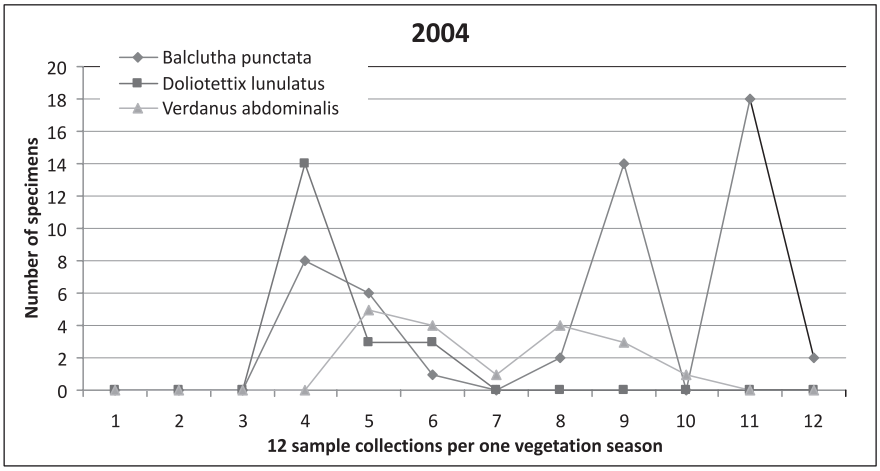
The characteristic species on the plot 4 was *Doliotettix lunulatus* (53.63%) (Annex 1).

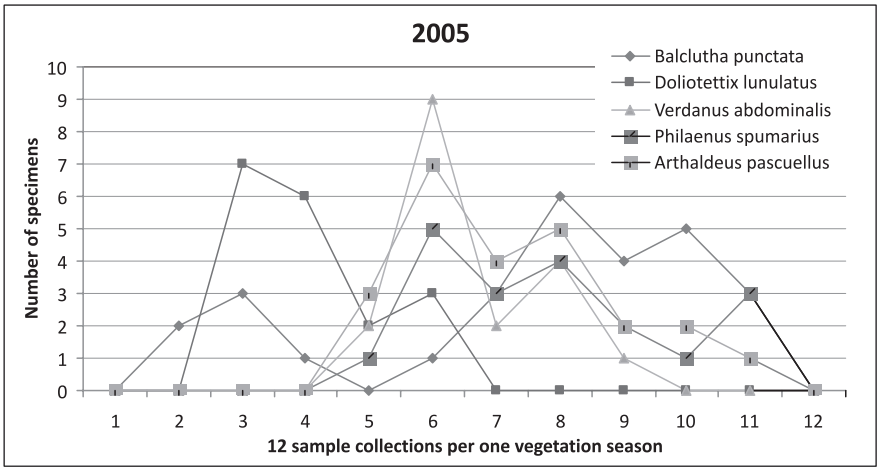
The dynamics of species abundance among the species dominating on the plot 4 was the following: the species *Doliotettix lunulatus* had its maximum of appearance at the beginning of June (2005, 2006) and in the middle of June (2004), and the species *Verdanus abdominalis* had its maximum in the middle of July. As for the species *Balclutha punctata*, it achieved two maxima of appearance, one in June and the other in September (Fig. 5).

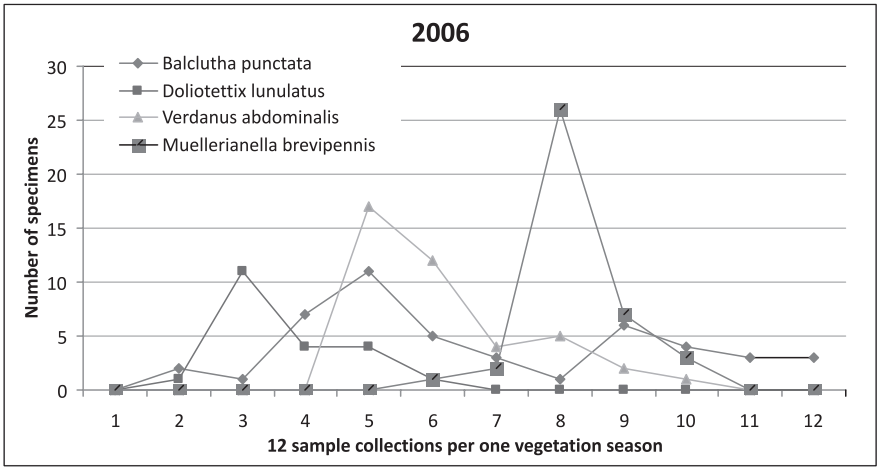
Table 7. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 4 – *Cirsietum rivularis*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Stenocranus major (Kbm.)	4.79	33.33	III	12.63	–	–	–	–	–	–	–	–
Stiroma bicarinata (H.-S.)	–	–	–	–	1.58	8.33	IV	3.62	–	–	–	–
Muellerianella brevipennis (Boh.)	–	–	–	–	–	–	–	–	14.71	41.66	III	24.75
Acanthodelphax spinosa (Fieb.)	0.68	8.33	IV	2.38	–	–	–	–	0.75	16.66	IV	3.53
Criomorphus albomarginatus Curt.	–	–	–	–	1.58	16.66	IV	5.13	–	–	–	–
Javesella pellucida (F.)	2.05	16.66	IV	5.84	4.76	33.33	III	12.59	5.66	58.33	II	18.16
Cercopis vulnerata Rossi	0.68	8.33	IV	2.38	–	–	–	–	–	–	–	–
Neophilaenus lineatus (L.)	1.36	8.33	IV	3.36	–	–	–	–	–	–	–	–
Aphrophora alni (Fall.)	2.05	25	IV	7.15	1.58	16.66	IV	5.13	0.37	8.33	IV	1.75
Philaenus spumarius (L.)	9.58	41.66	III	19.97	15.07	58.33	II	29.64	4.52	50	III	15.03
Agallia brachyptera (Boh.)	1.36	16.66	IV	4.76	–	–	–	–	1.5	25	IV	6.12
Balclutha punctata (F.)	34.93	58.33	II	45.13	22.22	75	II	40.82	16.22	91.66	I	38.55
Paluda flaveola (Boh.)	2.73	25	IV	8.26	–	–	–	–	–	–	–	–
Elymana sulphurella (Zett.)	–	–	–	–	–	–	–	–	13.2	41.66	III	23.45
Cicadula persimilis (Edw.)	–	–	–	–	0.79	8.33	IV	2.56	3.01	33.33	III	10.01
Macustus grisescens (Zett.)	1.36	16.66	IV	4.76	–	–	–	–	–	–	–	–
Doliotettix lunulatus (Zett.)	13.69	25	IV	18.5	14.28	33.33	III	21.81	7.92	41.66	III	18.16
Athysanus argentarius Metc	2.05	16.66	IV	5.84	–	–	–	–	–	–	–	–
Errastunus ocellaris (Fall.)	3.42	33.33	III	10.67	1.58	16.66	IV	5.13	–	–	–	–
Jassargus alpinus neglectus (Then)	–	–	–	–	–	–	–	–	0.37	8.33	IV	1.75
Diplocolenus sudeticus (Kol.)	1.36	16.66	IV	4.76	3.17	25	IV	8.9	1.13	16.66	IV	4.33
Verdanus abdominalis (F.)	12.32	50	III	24.81	14.28	41.66	III	24.39	15.47	50	III	27.81
Arthaldeus pascuellus (Fall.)	5.47	33.33	III	13.5	19.04	58.33	II	33.32	15.09	66.66	II	31.71

Fig. 5. The dynamics of species abundance among the species dominating on the plot 4.







Plot 5 (*Nardus stricta*)

On the plot 5 from 2004 to 2006 there were collected 730 representatives of the Fulgoromorpha and Cicadomorpha belonging to 26 species.

In 2004, the most abundant, i.e. the eudominant species was *Verdanus abdominalis* (45.91%), which achieved the status of the dominant species in the remaining seasons (23% and 28.41% respectively). The species *Doratura stylata* achieved the status of the dominant species in 2004 (21.38%) and 2006 (24.35%), and the status of the subdominant species in 2005 (18.33%). The species *Acanthodelphax spinosa* achieved the dominant status only in 2005 (17%) (Tab. 8).

As for the constancy of occurrence, to the second class there belonged the species *Verdanus abdominalis* and *Arthaldeus pascuellus* (2006), *Doratura stylata*, *Acanthodelphax spinosa* and *Javesella pellucida* (2005, 2006) (Tab. 8).

The highest value of the *Q* index was achieved by the species *Verdanus abdominalis* (47.91, 30.95 and 40.7 respectively) and *Doratura stylata* (32.69, 32.69 and 37.68 respectively) (Tab. 8).

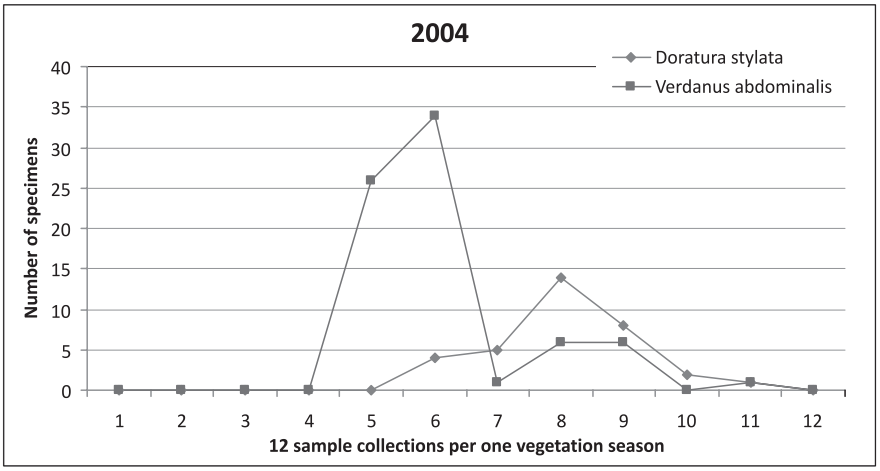
The differential species on the plot 5 was *Anoscopus flavostriatus* (100%) (Annex 1).

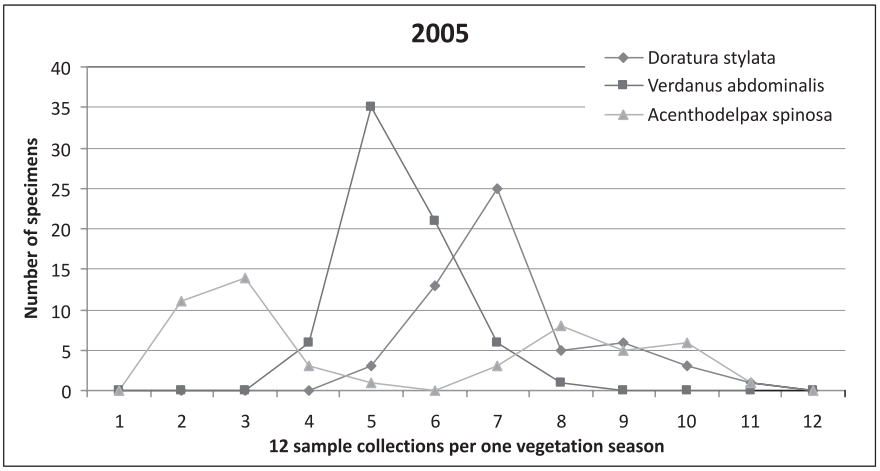
The dynamics of species abundance among the species dominating in the Research Plot 5 was the following: in the years 2004–2006 the species *Verdanus abdominalis* had one maximum of appearance in the first half of July, similarly to the species *Doratura stylata*, which also had just one maximum of appearance, falling on the first half of August (Fig. 6).

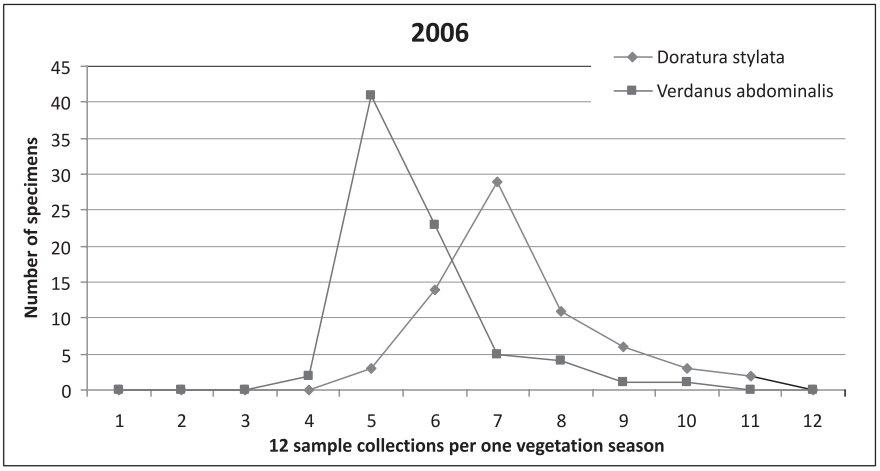
Table 8. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 5 – *Nardus stricta*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Conomelus anceps (Germ.)	–	–	–	–	1.33	16.66	IV	4.7	0.36	8.33	IV	1.73
Laodelphax striatella (Fall.)	–	–	–	–	2	25	IV	7.07	–	–	–	–
Muellerianella brevipennis (Boh.)	–	–	–	–	0.33	8.33	IV	1.65	5.53	41.66	III	15.17
Acanthodelphax spinosa (Fieb.)	5.03	41.66	III	14.47	17	75	II	35.7	6.27	58.33	II	19.12
Javesella pellucida (F.)	5.03	33.33	III	12.94	8.66	66.66	II	24.02	6.27	58.33	II	19.12
Philaenus spumarius (L.)	3.14	25	IV	8.86	–	–	–	–	–	–	–	–
Megophthalmus scanicus (Fall.)	–	–	–	–	0.33	8.33	IV	1.65	–	–	–	–
Agallia brachyptera (Boh.)	–	–	–	–	0.66	16.66	IV	3.31	–	–	–	–
Eupelix cuspidata (F.)	1.25	8.33	IV	3.22	–	–	–	–	0.73	16.66	IV	3.48
Anoscopus flavostriatus (Don.)	–	–	–	–	–	–	–	–	0.36	8.33	IV	1.73
Cicadella viridis (L.)	1.25	16.66	IV	4.56	–	–	–	–	–	–	–	–
Forcipata citrinella (Zett.)	–	–	–	–	0.33	8.33	IV	1.65	0.36	8.33	IV	1.73
Balclutha punctata (F.)	3.14	33.33	III	10.23	–	–	–	–	5.9	66.66	II	19.83
Macrosteles laevis (Rib.)	–	–	–	–	2.66	25	IV	8.15	–	–	–	–
Deltocephalus pulicaris (Fall.)	3.77	25	IV	9.7	0.33	8.33	IV	1.65	–	–	–	–
Doratura stylata (Boh.)	21.38	50	III	32.69	18.33	58.33	II	32.69	24.35	58.33	II	37.68
Graphocraerus ventralis (Fall.)	0.62	8.33	IV	2.27	–	–	–	–	–	–	–	–
Rhopalopyx preyssleri (H-S.)	–	–	–	–	2.33	33.33	III	8.81	0.73	16.66	IV	3.48
Elymana sulphurella (Zett.)	–	–	–	–	8	66.66	II	23.09	5.9	50	III	17.17
Athysanus argentarius Metc.	1.88	16.66	IV	5.59	0.66	16.66	IV	3.31	0.73	16.66	IV	3.48
Streptanus marginatus (Kbm.)	0.62	8.33	IV	2.27	–	–	–	–	–	–	–	–
Psammotettix alienus (Dhlb.)	–	–	–	–	4.33	25	IV	10.4	4.05	33.33	III	11.61
Errastunus ocellaris (Fall.)	0.62	8.33	IV	2.27	1.33	25	IV	5.76	1.84	25	IV	6.78
Jassargus distinguendus (Fl.)	3.77	16.66	IV	7.92	3.66	58.33	II	14.61	3.32	50	III	12.88
Verdanus abdominalis (F.)	45.91	50	III	47.91	23	41.66	III	30.95	28.41	58.33	II	40.7
Arthaldeus pascuellus (Fall.)	2.51	25	IV	7.92	4.66	50	III	15.26	4.79	58.33	II	16.71

Fig. 6. The dynamics of species abundance among the species dominating on the plot 5.







Plot 6 (*Nardus stricta*)

On the plot 6 from 2004 to 2006 there were collected 1715 representatives of the Fulgoromorpha and Cicadomorpha belonging to 29 species.

In all research seasons the status of the eudominant species was achieved by *Verdanus abdominalis* (40.82%, 31.39% and 35.04%), while the species *Doratura stylata* achieved the same status in the years 2005–2006 (30.65% and 32.99% respectively), and the subdominant status in 2004 (17.03%) (Tab. 9).

With respect to the constancy of occurrence only one species, namely *Balclutha punctata*, belonged to the first class in 2006 (Tab. 9).

The highest value of the *Q* index was achieved by the species *Verdanus abdominalis* (48.79, 39.61 and 45.2 respectively) and *Doratura stylata* (29.18, 42.28 and 43.86 respectively) (Tab. 9).

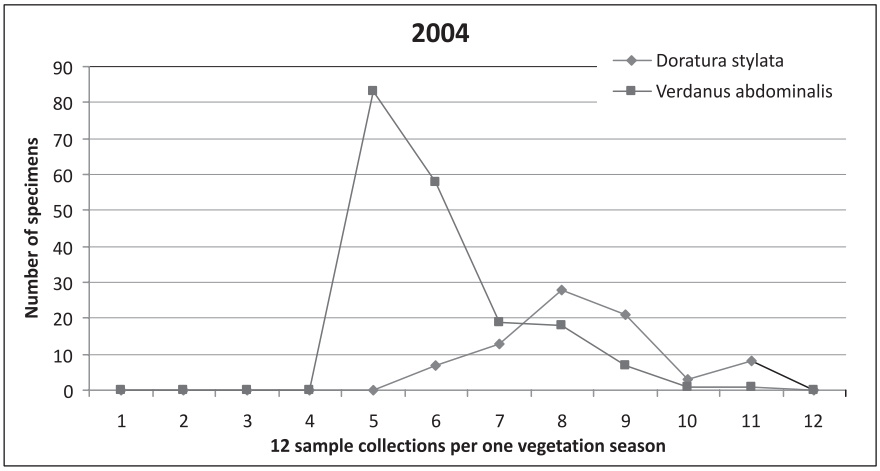
The differential species on the plot 6 was *Streptanus aemulans* (100%), and the characteristic species included: *Eupelix cuspidata* (72.41%), *Deltocephalus pulicaris* (62.5%), *Doratura stylata* (53.41%), *Psammotettix cephalotes* (51.31%) and *Rhopalopyx preyssleri* (66.66%) (Annex 1).

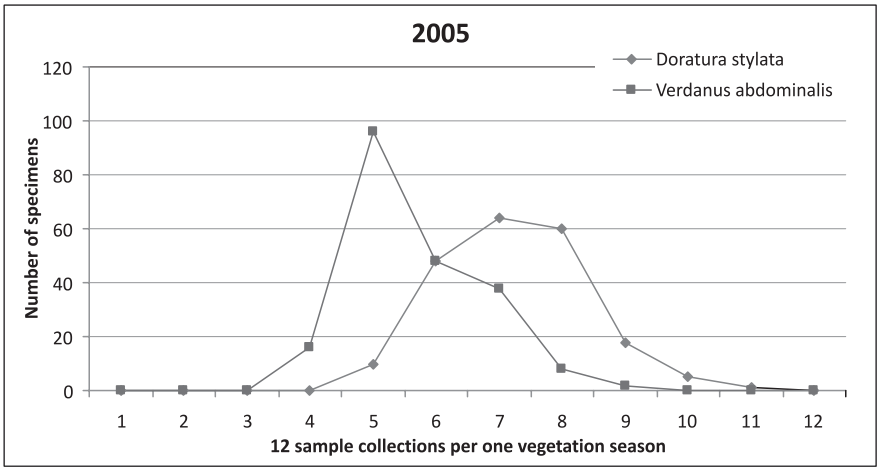
The dynamics of species abundance among the species dominating on the plot 6 was as follows: *Verdanus abdominalis* achieved its single maximum of appearance at the beginning of July, while *Doratura stylata* achieved its maximum in the first half of August (Fig. 7).

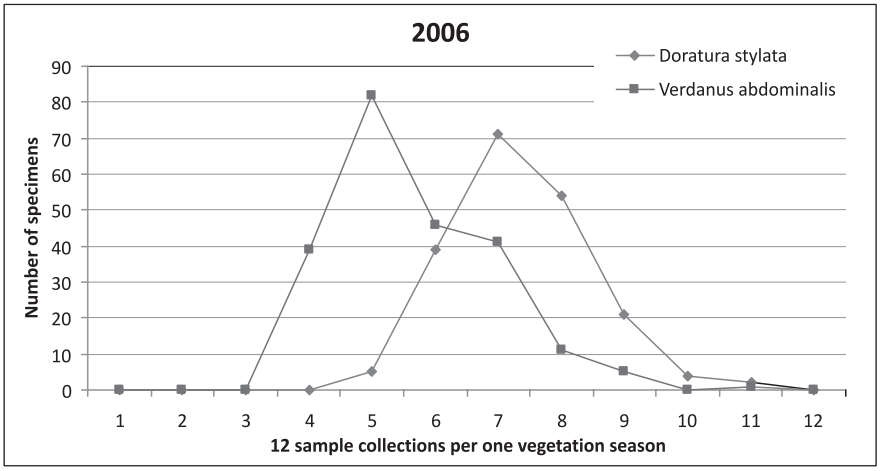
Table 9. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 6 – *Nardus stricta*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Conomelus anceps (Germ.)	–	–	–	–	–	–	–	–	0.17	8.33	IV	1.19
Acanthodelphax spinosa (Fieb.)	4.8	41.66	III	14.14	3.86	58.33	II	15	2.56	58.33	II	12.21
Criomorphus albomarginatus Curt.	–	–	–	–	0.14	8.33	IV	1.07	–	–	–	–
Javesella pellucida (F.)	–	–	–	–	1.93	41.66	III	8.96	–	–	–	–
Ribautodelphax collina (Boh.)	0.43	16.66	IV	2.67	–	–	–	–	–	–	–	–
Philaenus spumarius (L.)	–	–	–	–	–	–	–	–	0.17	8.33	IV	1.19
Agallia brachyptera (Boh.)	2.62	25	IV	8.09	0.44	16.66	IV	2.7	0.51	16.66	IV	2.91
Eupelix cuspidata (F.)	3.27	33.33	III	10.43	2.67	25	IV	8.17	1.53	33.33	III	7.14
Forcipata citrinella (Zett.)	–	–	–	–	–	–	–	–	0.34	8.33	IV	1.68
Balclutha punctata (F.)	1.31	33.33	III	6.6	0.29	16.66	IV	2.19	4.1	83.33	I	18.48
Macrosteles laevis (Rib.)	0.21	8.33	IV	1.32	0.59	16.66	IV	3.13	1.02	33.33	III	5.83
Deltocephalus pulicaris (Fall.)	–	–	–	–	0.44	25	IV	3.31	0.34	16.66	IV	2.38
Doratura stylata (Boh.)	17.03	50	III	29.18	30.65	58.33	II	42.28	32.99	58.33	II	43.86
Graphocraerus ventralis (Fall.)	0.43	8.33	IV	1.89	–	–	–	–	–	–	–	–
Paluda flaveola (Boh.)	3.93	41.66	III	12.79	–	–	–	–	–	–	–	–
Rhopalopyx preyssleri (H-S.)	–	–	–	–	2.23	50	III	10.55	1.53	41.66	III	7.98
Elymana sulphurella (Zett.)	–	–	–	–	9.07	66.66	II	24.58	5.12	58.33	II	17.28
Cicadula persimilis (Edw.)	2.18	33.33	III	8.52	–	–	–	–	–	–	–	–
Hesium domino (Reut.)	0.43	16.66	IV	2.67	–	–	–	–	–	–	–	–
Athysanus argentarius Metc.	2.18	41.66	III	9.52	1.04	25	IV	5.09	0.85	33.33	III	5.32
Streptanus aemulans (Kbm.)	0.43	16.66	IV	2.67	–	–	–	–	–	–	–	–
Streptanus marginatus (Kbm.)	5.45	33.33	III	13.47	1.78	25	IV	6.67	2.05	25	IV	7.15
Psammotettix alienus (Dhlb.)	–	–	–	–	–	–	–	–	0.68	16.66	IV	3.36
Psammotettix cephalotes (H.-S.)	1.74	25	IV	6.59	2.23	50	III	10.55	2.73	50	III	11.68
Psammotettix confinis (Dalb.)	–	–	–	–	0.44	16.66	IV	2.7	–	–	–	–
Errastunus ocellaris (Fall.)	0.43	16.66	IV	2.67	–	–	–	–	–	–	–	–
Jassargus distinguendus (Fl.)	9.17	41.66	III	19.54	6.84	66.66	II	21.35	4.27	66.66	II	16.87
Verdanus abdominalis (F.)	40.82	58.33	II	48.79	31.39	50	III	39.61	35.04	58.33	II	45.2
Arthaldeus pascuellus (Fall.)	3.05	33.33	III	10.08	3.86	50	III	13.89	3.93	58.33	II	15.14

Fig. 7. The dynamics of species abundance among the species dominating on the plot 6.







Plot 7 (*Cirsium heterophyllum*)

On the plot 7 from 2004 to 2006 there were collected 626 representatives of the Fulgoromorpha and Cicadomorpha belonging to 25 species.

In 2006 the dominant species was *Balclutha punctata* (20.34%), while in the years 2004 and 2005 it had the subdominant status (11.25% and 11.48% respectively). The species *Arthaldeus pascuellus* had the subdominant status in all research seasons (10.62%, 17.02% and 15.15% respectively). Additionally, the subdominant status was also achieved by the species *Verdanus abdominalis* (11.87%) in 2004, by the species *Acanthodelphax spinosa* (14.89%), *Javesella pellucida* (11.91%) and *Cicadula persimilis* (11.91%) in 2005, and by the species *Javesella pellucida* in 2006 (14.71%) (Tab. 10).

As for the constancy of occurrence, in 2006 there were two species which belonged to the first class: *Balclutha punctata* and *Javesella pellucida* (Tab. 10).

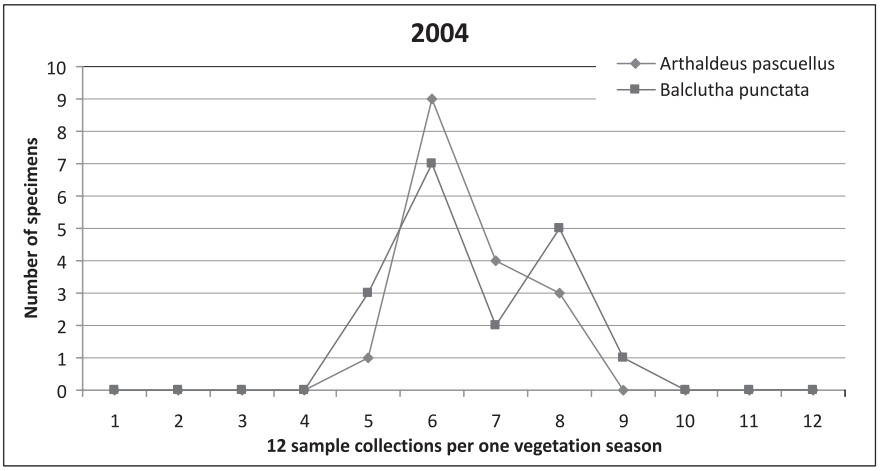
The highest value of the *Q* index on the plot 7 was achieved by the species *Balclutha punctata* (21.64, 29.34 and 41.16 respectively) and *Arthaldeus pascuellus* (18.81, 33.68 and 31.77 respectively) (Tab. 10).

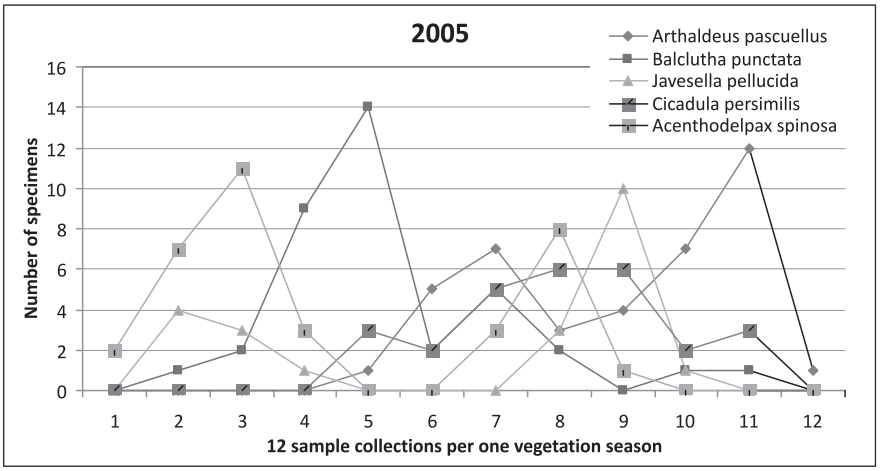
The dynamics of species abundance among the species dominating on the plot 7 was as follows: the species *Balclutha punctata* had two maxima of appearance, one at the beginning of July (2005–2006) and in the middle of July (2004), and the other at the beginning of August (2005–2006) and in the middle of August (2004) (Fig. 8).

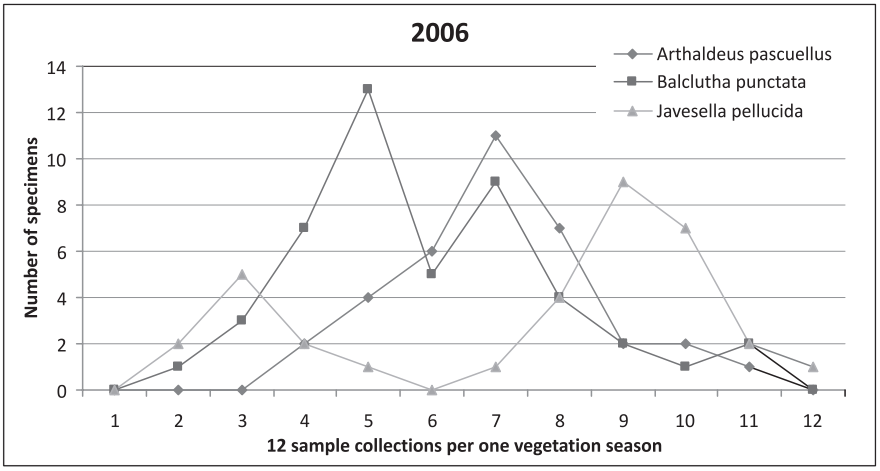
Table 10. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 7 – *Cirsium heterophyllum*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Stenocranus major (Kbm.)	1.25	16.66	IV	4.56	–	–	–	–	–	–	–	–
Laodelphax striatella (Fall.)	–	–	–	–	1.27	16.66	IV	4.59	–	–	–	–
Acanthodelphax spinosa (Fieb.)	8.12	16.66	IV	11.63	14.89	58.33	II	29.47	7.79	58.33	II	21.31
Javesella pellucida (F.)	9.37	33.33	III	17.67	11.91	58.33	II	26.35	14.71	83.33	I	35.01
Aphrophora alni (Fall.)	5.62	33.33	III	13.68	1.27	16.66	IV	4.59	0.86	16.66	IV	3.78
Philaenus spumarius (L.)	5.62	33.33	III	13.68	2.97	41.66	III	11.12	4.76	41.66	III	14.08
Agallia brachyptera (Boh.)	–	–	–	–	0.85	16.66	IV	3.76	0.43	8.33	IV	1.89
Eupelix cuspidata (F.)	–	–	–	–	1.27	16.66	IV	4.59	–	–	–	–
Balclutha punctata (F.)	11.25	41.66	III	21.64	11.48	75	II	29.34	20.34	83.33	I	41.16
Macrosteles laevis (Rib.)	–	–	–	–	1.27	16.66	IV	4.59	2.16	25	IV	7.34
Doratura stylata (Boh.)	–	–	–	–	0.42	8.33	IV	1.87	0.86	16.66	IV	3.78
Graphocraerus ventralis (Fall.)	–	–	–	–	0.85	16.66	IV	3.76	–	–	–	–
Paluda flaveola (Boh.)	5	25	IV	11.18	1.7	25	IV	6.51	–	–	–	–
Elymana sulphurella (Zett.)	–	–	–	–	8.93	58.33	II	22.82	9.52	50	III	21.81
Cicadula persimilis (Edw.)	6.87	33.33	III	15.13	11.91	58.33	II	26.35	7.79	58.33	II	21.31
Hesium domino (Reut.)	5.62	33.33	III	13.68	0.85	16.66	IV	3.76	1.29	16.66	IV	4.63
Macustus grisescens (Zett.)	4.37	25	IV	10.45	–	–	–	–	–	–	–	–
Doliotettix lunulatus (Zett.)	5.62	16.66	IV	9.67	–	–	–	–	–	–	–	–
Athysanus argentarius Metc.	2.5	25	IV	7.9	–	–	–	–	–	–	–	–
Psammotettix alienus (Dhlb.)	–	–	–	–	–	–	–	–	1.29	8.33	IV	3.27
Psammotettix confinis (Dalb.)	–	–	–	–	2.12	25	IV	7.28	–	–	–	–
Errastunus ocellaris (Fall.)	3.12	33.33	III	10.19	3.4	41.66	III	11.9	4.76	58.33	II	16.66
Jassargus distinguendus (Fl.)	3.12	25	IV	8.83	0.42	8.33	IV	1.87	1.29	25	IV	5.67
Verdanus abdominalis (F.)	11.87	33.33	III	19.89	5.1	33.33	III	13.03	6.92	33.33	III	15.18
Arthaldeus pascuellus (Fall.)	10.62	33.33	III	18.81	17.02	66.66	II	33.68	15.15	66.66	II	31.77

Fig. 8. The dynamics of species abundance among the species dominating on the plot 7.







Plot 8 (*Arrhenatherum elatius*)

On the plot 8 from 2004 to 2006 there were collected 538 representatives of the Fulgoromorpha and Cicadomorpha belonging to 20 species.

The species *Cicadula persimilis* achieved the eudominant status (35.55%) in 2005, the dominant status (24.01%) in 2006 and the subdominant status (13.17%) in 2004. Furthermore, the species *Verdanus abdominalis* (23.25%) had the dominant status in 2004, and the species *Balclutha punctata* (22.7%) had the dominant status in 2006. Other subdominant species included *Philaenus spumarius* (13.17%) in 2004, *Balclutha punctata* (12.77%), *Elymana sulphurella* (13.88%) and *Arthaldeus pascuellus* (12.77%) in 2005, and *Elymana sulphurella* (15.28%) in 2006 (Tab. 11).

As for the constancy of occurrence, in the seasons 2005 and 2006 to the first class there belonged the species *Balclutha punctata*, while to the second class there belonged the species *Cicadula persimilis* and *Arthaldeus pascuellus* (Tab. 11).

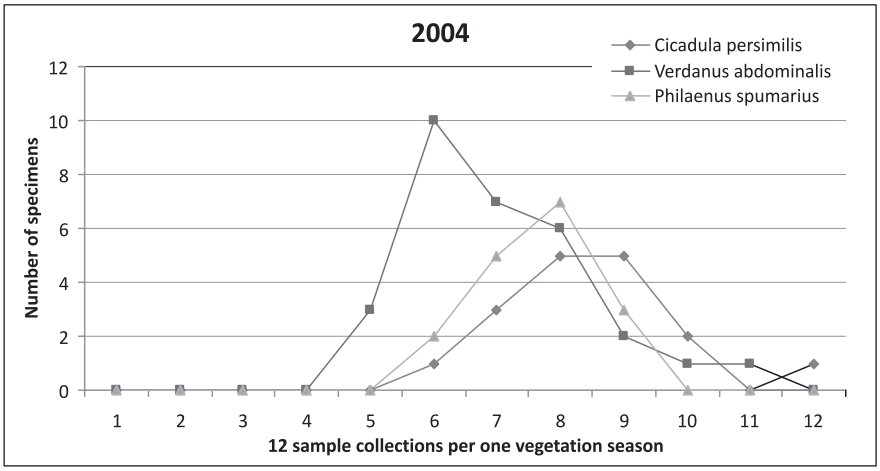
The highest value of the *Q* index was achieved by the species *Balclutha punctata* (19.68, 32.62 and 45.61 respectively) and *Cicadula persimilis* (25.66, 48.68 and 40 respectively) (Tab. 11).

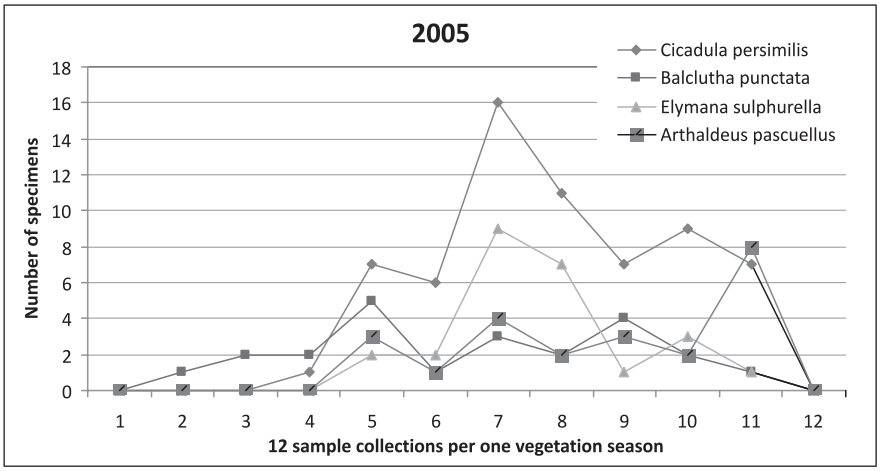
The dynamics of species abundance among the species dominating on the plot 8 was as follows: in 2005 the species *Cicadula persimilis* achieved its maximum of appearance at the break of July and August, and in the years 2004 and 2006 in the middle of August. The species *Verdanus abdominalis* achieved its maximum of appearance in the middle of July, and the species *Balclutha punctata* achieved its maximum in the second half of June and the first half of August (Fig. 9).

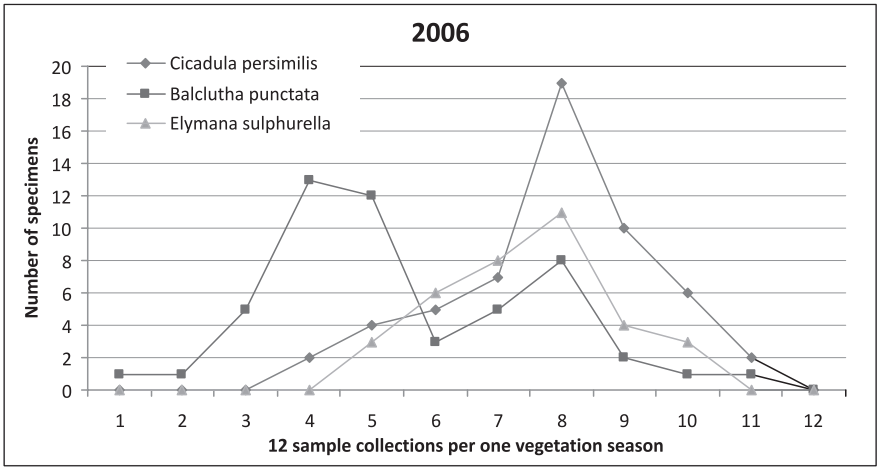
Table 11. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 8 – *Arrhenatherum elatius*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Stenocranus major (Kbm.)	–	–	–	–	0.55	8.33	IV	2.14	–	–	–	–
Acanthodelphax spinosa (Fieb.)	4.65	25	IV	10.78	–	–	–	–	2.18	33.33	III	8.52
Javesella pellucida (F.)	3.87	25	IV	9.83	6.11	50	III	17.47	9.6	58.33	II	23.66
Ribautodelphax albostriata (Fieb.)	–	–	–	–	–	–	–	–	0.43	8.33	IV	1.89
Aphrophora alni (Fall.)	8.52	41.66	III	18.83	0.55	8.33	IV	2.14	0.87	16.66	IV	3.8
Philaenus spumarius (L.)	13.17	33.33	III	20.95	–	–	–	–	3.05	41.66	III	11.27
Evacanthus interruptus (L.)	–	–	–	–	1.11	16.66	IV	4.3	–	–	–	–
Balclutha punctata (F.)	9.3	41.66	III	19.68	12.77	83.33	I	32.62	22.7	91.66	I	45.61
Macrosteles laevis (Rib.)	–	–	–	–	0.55	8.33	IV	2.14	2.18	33.33	III	8.52
Elymana sulphurella (Zett.)	–	–	–	–	13.88	58.33	II	28.45	15.28	50	III	27.64
Cicadula persimilis (Edw.)	13.17	50	III	25.66	35.55	66.66	II	48.68	24.01	66.66	II	40
Hesium domino (Reut.)	6.97	41.66	III	17.04	2.77	25	IV	8.32	2.18	33.33	III	8.52
Doliotettix lunulatus (Zett.)	1.55	8.33	IV	3.59	–	–	–	–	–	–	–	–
Athysanus argentarius Metc.	3.1	25	IV	8.8	2.77	25	IV	8.32	1.74	25	IV	6.59
Streptanus sordidus (Zett.)	–	–	–	–	0.55	8.33	IV	2.14	–	–	–	–
Arocephalus longiceps (Kbm.)	–	–	–	–	0.55	8.33	IV	2.14	–	–	–	–
Psammotettix confinis (Dalb.)	–	–	–	–	2.77	25	IV	8.32	–	–	–	–
Errastunus ocellaris (Fall.)	6.2	41.66	III	16.07	1.66	25	IV	6.44	3.93	50	III	14.01
Verdanus abdominalis (F.)	23.25	58.33	II	36.82	5	33.33	III	12.9	5.24	33.33	III	13.21
Arthaldeus pascuellus (Fall.)	6.2	33.33	III	14.37	12.77	58.33	II	27.29	6.55	58.33	II	19.54

Fig. 9. The dynamics of species abundance among the species dominating on the plot 8.







Plot 9 (*Cirsium heterophyllum – Dactylis glomerata*)

On the plot 9 from 2004 to 2006 there were collected 691 representatives of the Fulgoromorpha and Cicadomorpha belonging to 26 species.

The species *Verdanus abdominalis* had the largest share in the collected material, and achieved the eudominant status (36.53%) in 2004, and the dominant status in the remaining seasons (26.49% and 29.58% respectively). In all research seasons *Arthaldeus pascuellus* had the status of the subdominant species (11.53%, 17.53% and 14.6% respectively). Furthermore, the status of subdominants was achieved by the species *Doratura stylata* (16.02%) and *Jassargus distinguendus* (10.25%) in 2004, *Errastunus ocellaris* in 2005 (11.94%) and *Balclutha punctata* in 2006 (12.73%) (Tab. 12).

As for the constancy of occurrence, the only species which belonged to the first class in 2005 and 2006 was *Balclutha punctata*. In the same years to the second class there belonged the species: *Arthaldeus pascuellus*, *Jassargus distinguendus*, *Errastunus ocellaris* and *Javesella pellucida*. In 2004 to the second class there belonged only the species *Verdanus abdominalis* (Tab. 12).

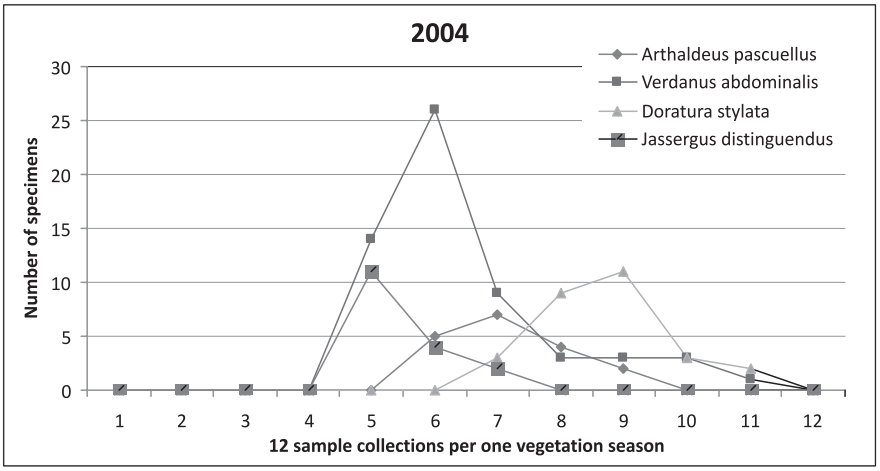
The highest value of the *Q* index was achieved by the species *Verdanus abdominalis* (46.16, 36.39 and 41.53 respectively) (Tab. 12).

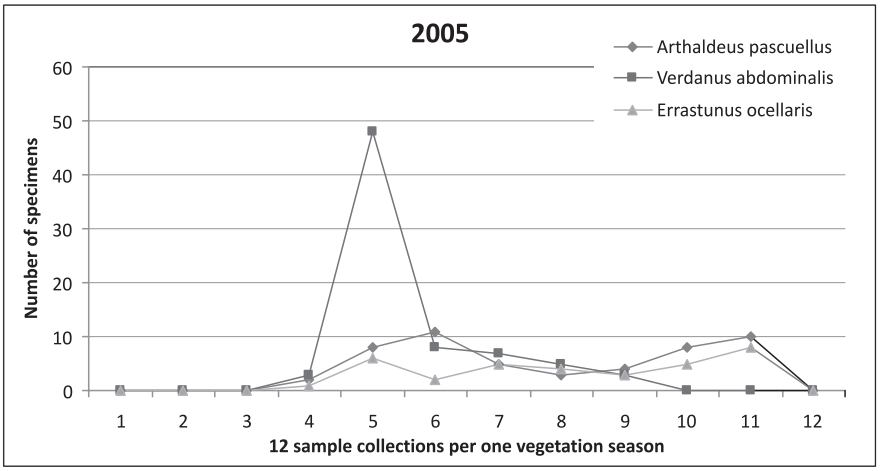
The dynamics of species abundance among the species dominating on the plot 9 was as follows: the species *Verdanus abdominalis* had its maximum of appearance at the break of June and July in the years 2005–2006, and in the middle of July in 2004 (Fig. 10).

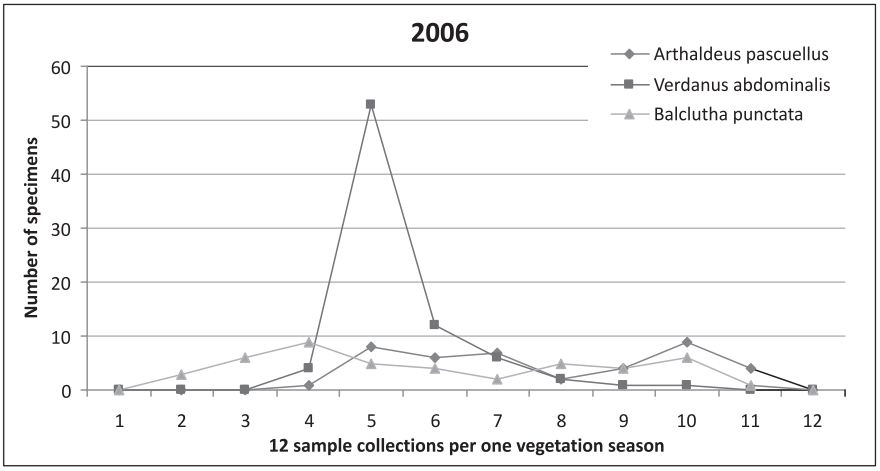
Table 12. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 9 – *Cirsium heterophyllum – Dactylis glomerata*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Conomelus anceps (Germ.)	–	–	–	–	–	–	–	–	1.49	25	IV	6.1
Laodelphax striatella (Fall.)	–	–	–	–	–	–	–	–	0.74	16.66	IV	3.51
Muellerianella brevipennis (Boh.)	–	–	–	–	0.74	16.66	IV	3.51	2.99	33.33	III	9.98
Acanthodelphax spinosa (Fieb.)	–	–	–	–	1.86	25	IV	6.81	–	–	–	–
Javesella pellucida (F.)	–	–	–	–	4.1	58.33	II	15.46	5.61	58.33	II	18.08
Cercopis vulnerata Rossi	1.88	16.66	IV	5.59	–	–	–	–	–	–	–	–
Aphrophora alni (Fall.)	1.28	16.66	IV	4.61	0.37	8.33	IV	1.75	0.74	16.66	IV	3.51
Philaenus spumarius (L.)	–	–	–	–	1.49	25	IV	6.1	4.49	50	III	14.98
Agallia brachyptera (Boh.)	–	–	–	–	0.37	8.33	IV	1.75	–	–	–	–
Cicadella viridis (L.)	–	–	–	–	–	–	–	–	0.74	16.66	IV	3.51
Eupteryx aurata (L.)	–	–	–	–	0.37	8.33	IV	1.75	–	–	–	–
Balclutha punctata (F.)	6.41	33.33	III	14.61	8.95	83.33	I	27.3	12.73	83.33	I	32.56
Deltocephalus pulicaris (Fall.)	–	–	–	–	0.74	16.66	IV	3.51	–	–	–	–
Doratura stylata (Boh.)	16.02	41.66	III	25.83	3.73	41.66	III	12.46	1.49	33.33	III	7.04
Paluda flaveola (Boh.)	5.76	25	IV	12	1.11	16.66	IV	4.3	2.24	33.33	III	8.64
Rhopalopyx preyssleri (H-S.)	–	–	–	–	–	–	–	–	0.37	8.33	IV	1.75
Elymana sulphurella (Zett.)	–	–	–	–	3.35	41.66	III	11.81	4.86	50	III	15.58
Cicadula persimilis (Edw.)	–	–	–	–	6.71	58.33	II	19.78	–	–	–	–
Hesium domino (Reut.)	6.41	33.33	III	14.61	4.1	33.33	III	11.68	2.62	33.33	III	9.34
Athysanus argentarius Metc.	1.28	16.66	IV	4.61	–	–	–	–	–	–	–	–
Streptanus marginatus (Kbm.)	0.64	8.33	IV	2.3	–	–	–	–	–	–	–	–
Psammotettix confinis (Dalb.)	–	–	–	–	0.37	8.33	IV	1.75	–	–	–	–
Errastunus ocellaris (Fall.)	1.88	16.66	IV	5.59	11.94	66.66	II	28.21	8.61	66.66	II	23.95
Jassargus distinguendus (Fl.)	10.25	25	IV	16	5.59	58.33	II	18.05	5.99	66.66	II	19.98
Verdanus abdominalis (F.)	36.53	58.33	II	46.16	26.49	50	III	36.39	29.58	58.33	II	41.53
Arthaldeus pascuellus (Fall.)	11.53	33.33	III	19.6	17.53	66.66	II	34.18	14.6	66.66	II	31.19

Fig. 10. The dynamics of species abundance among the species dominating on the plot 9.







Plot 10 (*Holcus lanatus – Cirsium heterophyllum*)

On the plot 10 from 2004 to 2006 there were collected 959 representatives of the Fulgoromorpha and Cicadomorpha belonging to 32 species.

In the years 2004–2006 the eudominant species on the plot 10 was *Verdanus abdominalis* (40.21%, 30.6% and 32.77% respectively). In 2005 the subdominant status was achieved by the species *Acanthodelphax spinosa* (10.12%), *Jassargus distinguendus* (16.62%) and *Arthaldeus pascuellus* (10.84%), while in 2006 such a status was achieved by the species *Jassargus distinguendus* (11.66%) (Tab. 13).

As for the constancy of occurrence, in 2005 and 2006 to the second class there belonged the following species: *Acanthodelphax spinosa*, *Javesella pellucida*, *Errastunus ocellaris*, *Jassargus distinguendus* and *Arthaldeus pascuellus*. Furthermore, in 2006 to the second group there also belonged the species *Balclutha punctata*, *Macrosteles laevis* and *Verdanus abdominalis* (Tab. 13).

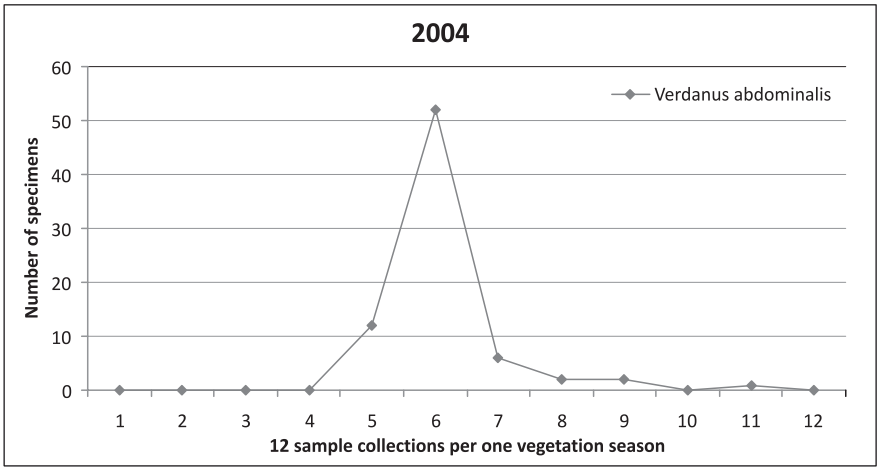
The highest value of the *Q* index in all three research seasons on the plot 10 was achieved by the species *Verdanus abdominalis* (44.83, 35.7 and 43.72 respectively) (Tab. 13).

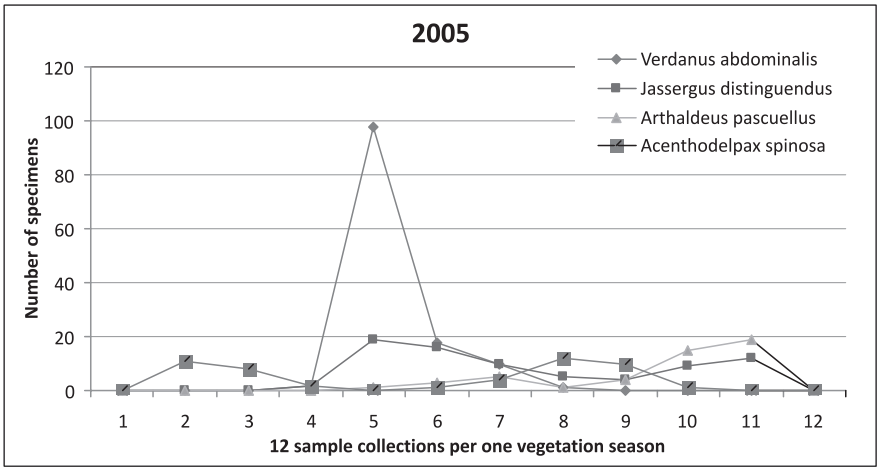
The dynamics of species abundance among the species dominating in the Research Plot 10 was as follows: in the years 2005 and 2006, the species *Verdanus abdominalis* achieved its maximum of appearance at the beginning of July, and in 2004 in the middle of July, the same as it did on the plot 9 (Fig. 11).

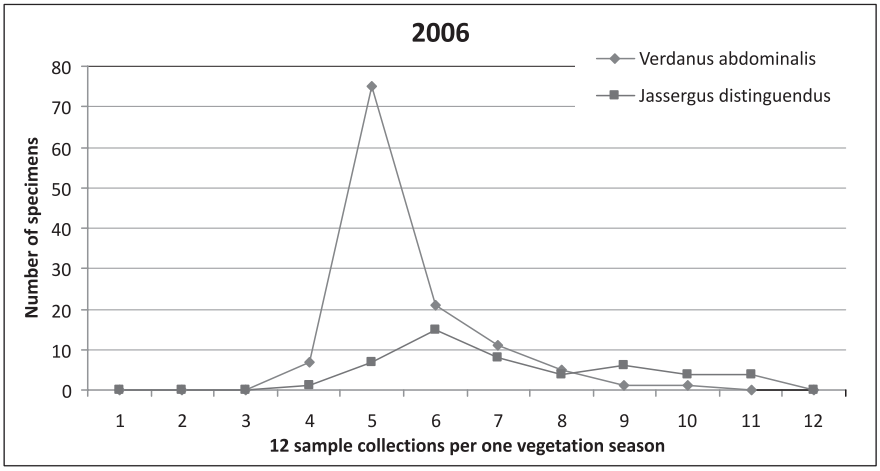
Table 13. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 10 – *Holcus lanatus* – *Cirsium heterophyllum*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Stenocranus major (Kbm.)	–	–	–	–	0.96	25	IV	4.89	–	–	–	–
Conomelus anceps (Germ.)	–	–	–	–	–	–	–	–	2.22	33.33	III	8.6
Stiroma bicarinata (H.-S.)	–	–	–	–	–	–	–	–	1.11	25	IV	5.26
Laodelphax striatella (Fall.)	–	–	–	–	–	–	–	–	0.55	16.66	IV	3.02
Acanthodelphax denticauda (Boh.)	–	–	–	–	0.72	16.66	IV	3.46	–	–	–	–
Acanthodelphax spinosa (Fieb.)	2.71	25	IV	8.23	10.12	75	II	27.54	5.55	66.66	II	19.23
Javesella pellucida (F.)	3.8	25	IV	9.74	7.22	66.66	II	21.93	6.38	75	II	21.87
Aphrophora alni (Fall.)	–	–	–	–	0.72	16.66	IV	3.46	–	–	–	–
Philaenus spumarius (L.)	5.97	41.66	III	15.77	–	–	–	–	4.16	41.66	III	13.16
Evacanthus interruptus (L.)	–	–	–	–	–	–	–	–	0.27	8.33	IV	1.49
Cicadella viridis (L.)	–	–	–	–	–	–	–	–	0.83	16.66	IV	3.71
Eupteryx aurata (L.)	–	–	–	–	0.24	8.33	IV	1.41	–	–	–	–
Eupteryx signatipennis (Boh.)	1.63	25	IV	6.38	–	–	–	–	–	–	–	–
Balclutha punctata (F.)	–	–	–	–	1.92	41.66	III	8.94	4.16	66.66	II	16.65
Macrosteles laevis (Rib.)	–	–	–	–	–	–	–	–	2.77	58.33	II	12.71
Deltocephalus pulicaris (Fall.)	–	–	–	–	1.2	25	IV	5.47	–	–	–	–
Doratura stylata (Boh.)	9.78	41.66	III	20.18	4.09	41.66	III	13.05	3.88	41.66	III	12.71
Allygus mixtus (F.)	–	–	–	–	–	–	–	–	0.55	16.66	IV	3.02
Graphocraerus ventralis (Fall.)	0.54	8.33	IV	2.12	–	–	–	–	–	–	–	–
Paluda flaveola (Boh.)	5.43	25	IV	11.65	0.48	16.66	IV	2.82	0.55	16.66	IV	3.02
Elymana sulphurella (Zett.)	–	–	–	–	0.96	25	IV	4.89	3.33	50	III	12.9
Cicadula persimilis (Edw.)	–	–	–	–	1.44	25	IV	6	–	–	–	–
Hesium domino (Reut.)	2.17	25	IV	7.36	1.2	25	IV	5.47	1.66	25	IV	6.44
Macustus grisescens (Zett.)	0.54	8.33	IV	2.12	–	–	–	–	–	–	–	–
Athysanus argentarius Metc.	5.43	41.66	III	15.04	0.24	8.33	IV	1.41	1.11	25	IV	5.26
Streptanus sordidus (Zett.)	1.63	16.66	IV	5.21	–	–	–	–	–	–	–	–
Psammotettix alienus (Dhlb.)	–	–	–	–	1.68	33.33	III	7.48	–	–	–	–
Psammotettix confinis (Dalb.)	–	–	–	–	–	–	–	–	1.94	33.33	III	8.04
Errastunus ocellaris (Fall.)	6.52	41.66	III	16.48	8.67	66.66	II	24.04	5.83	66.66	II	19.71
Jassargus distinguendus (Fl.)	7.06	33.33	III	15.33	16.62	66.66	II	33.28	11.66	66.66	II	27.87
Verdanus abdominalis (F.)	40.21	50	III	44.83	30.6	41.66	III	35.7	32.77	58.33	II	43.72
Arthaldeus pascuellus (Fall.)	6.52	25	IV	12.76	10.84	58.33	II	25.14	8.61	58.33	II	22.41

Fig. 11. The dynamics of species abundance among the species dominating on the plot 10.







Plot 11 (*Deschampsia caespitosa*)

On the plot 11 from 2004 to 2006 there were collected 442 representatives of the Fulgoromorpha and Cicadomorpha belonging to 23 species.

The most abundant species on the plot 11 was the species *Balclutha punctata*, which achieved the subdominant status (18.18% in 2004), and the eudominant status in the following years (30.76% and 38.76% respectively). In the years 2005 and 2006 *Cicadula persimilis* was the dominant species (23.07% and 22.47% respectively), while in 2004 the species *Verdanus abdominalis* achieved the subdominant status (12.39%) (Tab. 14).

In 2005 and 2006 the eudominant species *Balclutha punctata* belonged to the first class with respect to the constancy of occurrence, while the species *Cicadula persimilis* and *Arthaldeus pascuellus* belonged to the second class (Tab. 14).

The highest value of the *Q* index in all three research seasons was achieved by the species *Balclutha rhenana* (30.14, 50.62 and 62.25 respectively) (Tab. 14).

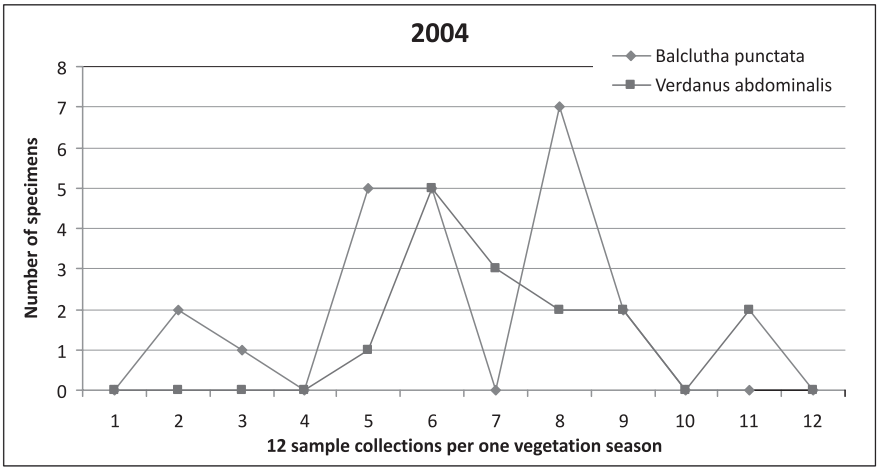
The differential species on the plot 11 was *Eupteryx atropunctata* (100%) (Annex 1).

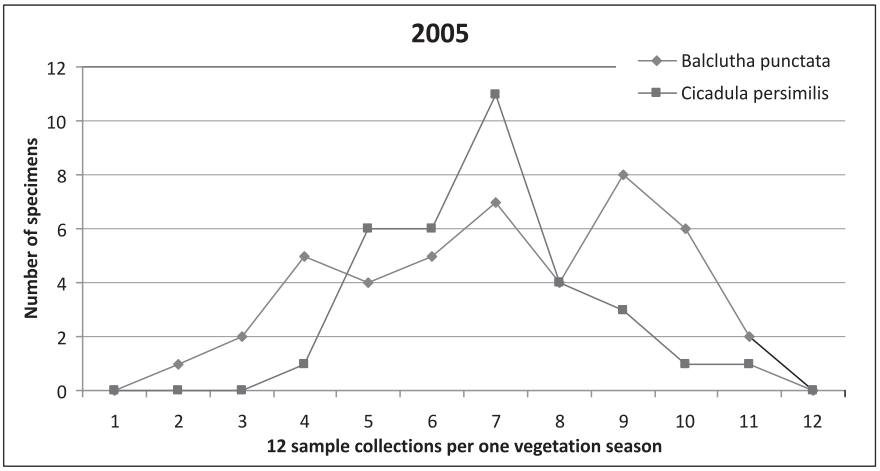
The dynamics of species abundance among the species dominating on the plot 11 was as follows: the species *Balclutha punctata* achieved two maxima of abundance, one in the middle of June and the other in the second half of August. The species *Cicadula persimilis* achieved its maximum of appearance at the beginning of August (Fig. 12).

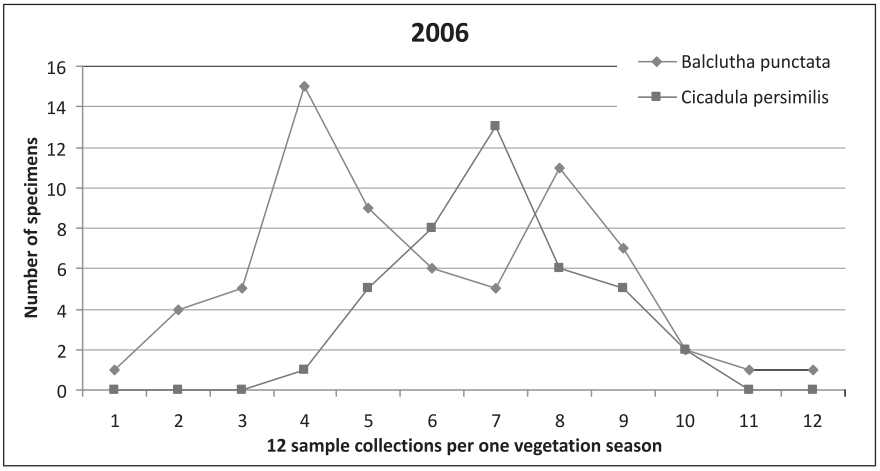
Table 14. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 11 – *Deschampsia caespitosa*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Stiroma bicarinata (H.-S.)	–	–	–	–	4.89	25	IV	11.05	–	–	–	–
Muellerianella brevipennis (Boh.)	–	–	–	–	1.39	16.66	IV	4.81	2.24	25	IV	7.48
Acanthodelphax spinosa (Fieb.)	2.47	16.66	IV	6.41	–	–	–	–	–	–	–	–
Dicranotropis hamata (Boh.)	0.82	8.33	IV	2.61	–	–	–	–	–	–	–	–
Javesella pellucida (F.)	–	–	–	–	–	–	–	–	0.56	8.33	IV	2.15
Aphrophora alni (Fall.)	4.95	33.33	III	12.84	1.39	16.66	IV	4.81	0.56	8.33	IV	2.15
Philaenus spumarius (L.)	9.09	33.33	III	17.4	3.49	33.33	III	10.78	4.49	41.66	III	13.67
Eupteryx atropunctata (Goeze)	–	–	–	–	1.39	16.66	IV	4.81	1.68	16.66	IV	5.29
Eupteryx aurata (L.)	–	–	–	–	–	–	–	–	1.12	16.66	IV	4.31
Eupteryx signatipennis (Boh.)	2.47	16.66	IV	6.41	–	–	–	–	–	–	–	–
Balclutha punctata (F.)	18.18	50	III	30.14	30.76	83.33	I	50.62	38.76	100	I	62.25
Macrosteles laevis (Rib.)	–	–	–	–	–	–	–	–	1.12	16.66	IV	4.31
Paluda flaveola (Boh.)	8.26	25	IV	14.37	–	–	–	–	–	–	–	–
Elymana sulphurella (Zett.)	–	–	–	–	8.39	50	III	20.48	–	–	–	–
Cicadula persimilis (Edw.)	8.26	33.33	III	16.59	23.07	66.66	II	39.21	22.47	58.33	II	36.2
Hesium domino (Reut.)	8.26	25	IV	14.37	4.89	33.33	III	12.76	5.05	41.66	III	14.5
Macustus grisescens (Zett.)	0.82	8.33	IV	2.61	5.59	33.33	III	13.64	2.8	25	IV	8.36
Doliotettix lunulatus (Zett.)	4.13	16.66	IV	8.29	–	–	–	–	5.05	25	IV	11.23
Athysanus argentarius Metc.	6.61	25	IV	12.85	–	–	–	–	–	–	–	–
Errastunus ocellaris (Fall.)	2.47	8.33	IV	4.53	–	–	–	–	–	–	–	–
Jassargus distinguendus (Fl.)	4.13	16.66	IV	8.29	–	–	–	–	–	–	–	–
Verdanus abdominalis (F.)	12.39	50	III	24.88	6.29	33.33	III	14.47	5.05	33.33	III	12.97
Arthaldeus pascuellus (Fall.)	6.61	33.33	III	14.84	8.39	58.33	II	22.12	8.98	58.33	II	22.88

Fig. 12. The dynamics of species abundance among the species dominating on the plot 11.







Plot 12 (*Deschampsia caespitosa*)

On the plot 12 from 2004 to 2006 there were collected 565 representatives of the Fulgoromorpha and Cicadomorpha belonging to 25 species.

The most abundant species was *Balclutha punctata*, which achieved the dominant status (22.33%) in 2004, and the eudominant status in the years 2005–2006 (34.46% and 37.5% respectively). The sudominant species in 2005 and 2006 was *Cicadula persimilis* (19.9% and 18.75% respectively). In 2005 the following species achieved the subdominant status: *Philaenus spumarius* (14.56%), *Hesium domino* (12.62%) and *Athysanus argentarius* (10.67%) (Tab. 15).

As for the constancy of occurrence, in 2006 the species *Balclutha punctata* belonged to the first class (Tab. 15).

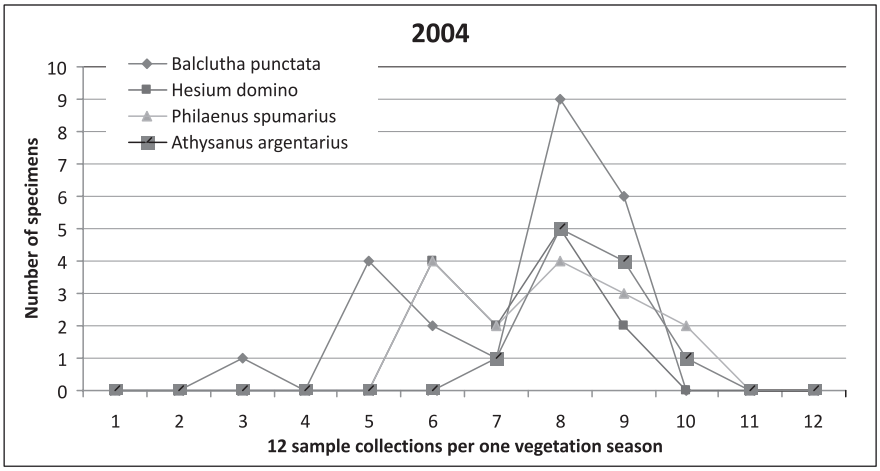
The highest value of the *Q* index in all research seasons was achieved by the species *Balclutha punctata* (33.41, 50.83 and 61.23 respectively) (Tab. 15).

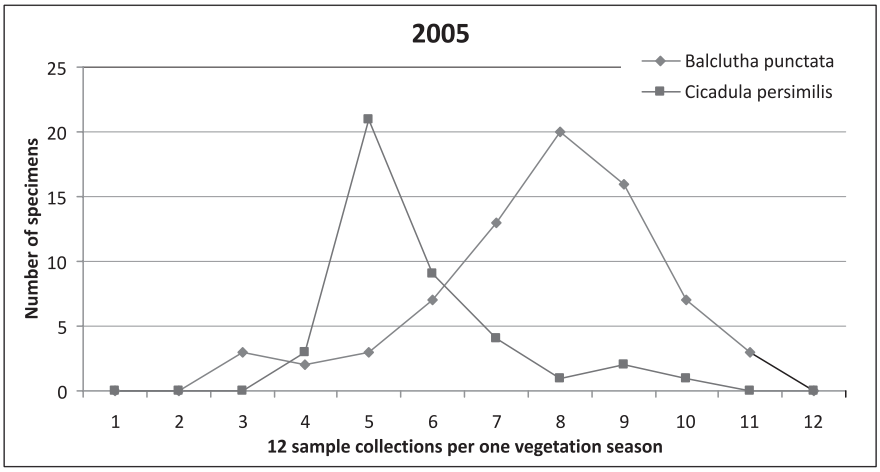
The dynamics of species abundance among the species dominating on the plot 12 was as follows: the species *Balclutha punctata* had two maxima of appearance, one in the second half of June and the other in the second half of August (Fig. 13).

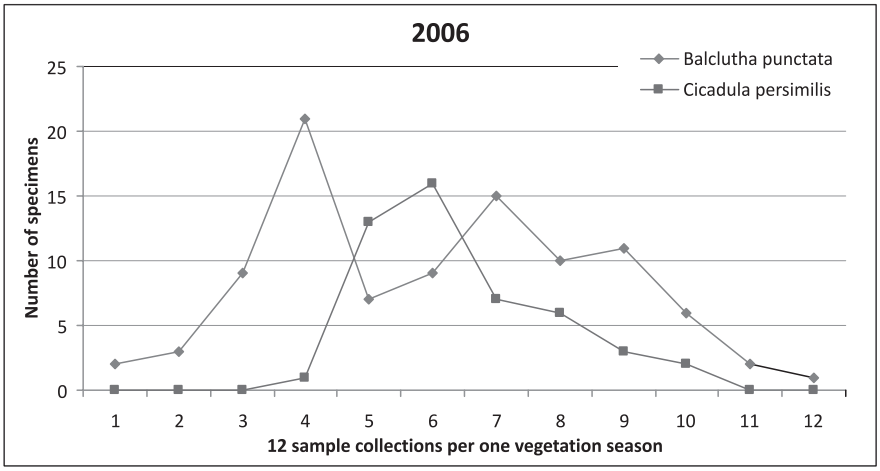
Table 15. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 12 – *Deschampsia caespitosa*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Stiroma bicarinata (H.-S.)	1.94	8.33	IV	4.01	–	–	–	–	–	–	–	–
Muellerianella brevipennis (Boh.)	–	–	–	–	2.42	33.33	III	8.98	2.73	33.33	III	9.53
Acanthodelphax spinosa (Fieb.)	–	–	–	–	1.94	25	IV	6.96	1.56	25	IV	6.24
Dicranotropis hamata (Boh.)	1.94	8.33	IV	4.01	–	–	–	–	–	–	–	–
Javesella pellucida (F.)	2.91	16.66	IV	6.96	–	–	–	–	1.95	25	IV	6.98
Cercopis vulnerata Rossi	–	–	–	–	–	–	–	–	0.39	8.33	IV	1.8
Aphrophora alni (Fall.)	–	–	–	–	–	–	–	–	0.39	8.33	IV	1.8
Philaenus spumarius (L.)	14.56	41.66	III	24.62	4.85	41.66	III	14.21	5.85	50	III	17.1
Evacanthus interruptus (L.)	3.88	25	IV	9.84	2.91	41.66	III	11.01	–	–	–	–
Eupteryx signatipennis (Boh.)	2.91	25	IV	8.52	–	–	–	–	–	–	–	–
Balclutha punctata (F.)	22.33	50	III	33.41	34.46	75	II	50.83	37.5	100	I	61.23
Doratura stylata (Boh.)	–	–	–	–	2.42	33.33	III	8.98	1.95	25	IV	6.98
Paluda flaveola (Boh.)	1.94	16.66	IV	5.68	5.33	41.66	III	14.9	3.12	33.33	III	10.19
Rhopalopyx preyssleri (H-S.)	–	–	–	–	0.97	16.66	IV	4.01	–	–	–	–
Elymana sulphurella (Zett.)	–	–	–	–	1.45	25	IV	6.02	1.56	25	IV	6.24
Cicadula persimilis (Edw.)	4.85	25	IV	11.01	19.9	58.33	II	34.07	18.75	58.33	II	33.07
Hesium domino (Reut.)	12.62	33.33	III	20.5	2.91	25	IV	8.52	9.76	41.66	III	20.16
Macustus grisescens (Zett.)	3.88	25	IV	9.84	–	–	–	–	–	–	–	–
Doliotettix lunulatus (Zett.)	0.97	8.33	IV	2.84	–	–	–	–	1.56	16.66	IV	5.09
Athysanus argentarius Metc.	10.67	33.33	III	18.85	3.39	25	IV	9.2	1.56	25	IV	6.24
Streptanus sordidus (Zett.)	–	–	–	–	0.97	16.66	IV	4.01	–	–	–	–
Errastunus ocellaris (Fall.)	0.97	8.33	IV	2.84	–	–	–	–	–	–	–	–
Jassargus distinguendus (Fl.)	0.97	8.33	IV	2.84	0.48	8.33	IV	1.99	–	–	–	–
Verdanus abdominalis (F.)	7.76	41.66	III	17.98	7.28	33.33	III	15.57	3.9	33.33	III	11.4
Arthaldeus pascuellus (Fall.)	4.85	25	IV	11.01	8.25	66.66	II	23.45	7.42	66.66	II	22.23

Fig. 13. The dynamics of species abundance among the species dominating on the plot 12.







Plot 13 (*Alopecurus pratensis*)

On the plot 13 from 2004 to 2006 there were collected 912 representatives of the Fulgoromorpha and Cicadomorpha belonging to 23 species.

During the three-year research period on the plot 13 the dominant species was *Errastunus ocellaris* (22.95%, 27.73% and 27.7% respectively). Furthermore, in 2004 the dominant status was also achieved by the species *Verdanus abdominalis* (24.59%). The subdominant species was *Philaenus spumarius* (14.57%) in 2004, *Cicadula persimilis* (17.51%) and *Arthaldeus pascuellus* (10.46%) in 2005, and *Cicadula persimilis* (18.2%) in 2006 (Tab. 16).

As for the constancy of occurrence, to the first class in 2005 and 2006 there belonged the species *Balclutha punctata*. To the second class in the same years there belonged the following species: *Elymana sulphurella*, *Cicadula persimilis*, *Errastunus ocellaris* and *Arthaldeus pascuellus* (Tab. 16).

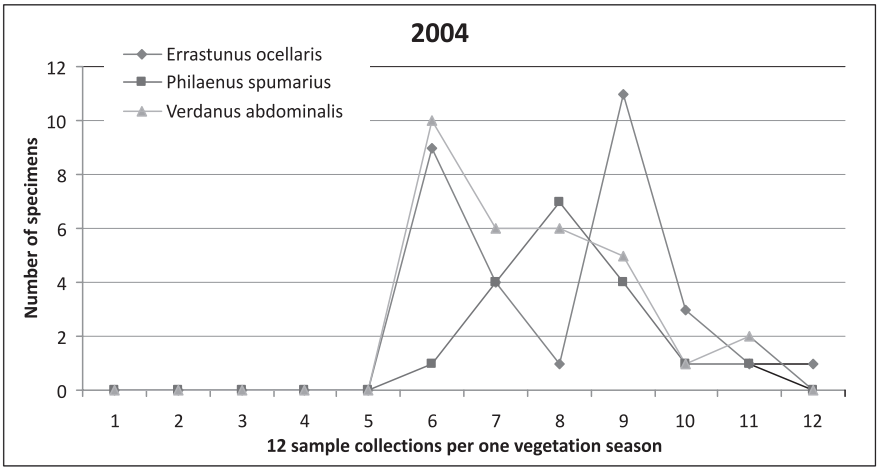
The highest value of the *Q* index in the years 2004–2006 was achieved by the species *Errastunus ocellaris* (36.58, 42.99 and 45.57 respectively) (Tab. 16).

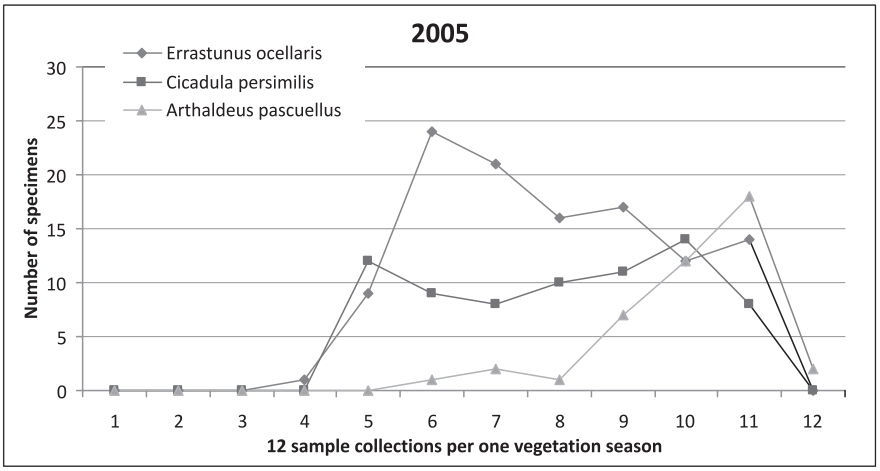
The dynamics of species abundance among the species dominating on the plot 13 was as follows: in 2004 the species *Errastunus ocellaris* achieved two maxima of appearance, one in the middle of July and the other at the beginning of September. In the years 2005–2006 this species achieved its maximum in the second half of July. The species *Verdanus abdominalis* achieved its maximum of appearance in the middle of July (Fig. 14).

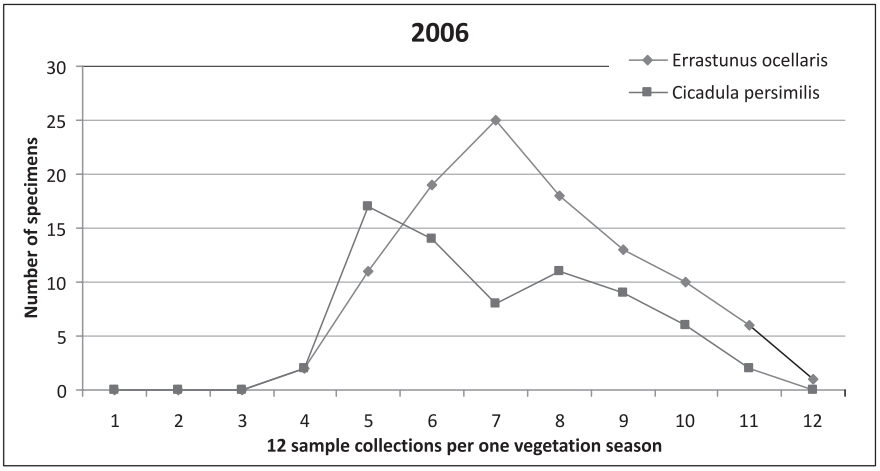
Table 16. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 13 – *Alopecurus pratensis*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Stenocranus major (Kbm.)	0.81	8.33	IV	2.59	–	–	–	–	–	–	–	–
Laodelphax striatella (Fall.)	–	–	–	–	–	–	–	–	1.58	33.33	III	7.25
Muellerianella brevipennis (Boh.)	–	–	–	–	–	–	–	–	1.31	33.33	III	6.6
Javesella pellucida (F.)	–	–	–	–	3.89	58.33	II	15.06	2.11	50	III	10.27
Aphrophora alni (Fall.)	–	–	–	–	0.48	8.33	IV	1.99	–	–	–	–
Philaenus spumarius (L.)	14.75	50	III	27.15	4.37	41.66	III	13.49	3.95	58.33	II	15.17
Megophthalmus scanicus (Fall.)	–	–	–	–	0.48	16.66	IV	2.82	–	–	–	–
Agallia brachyptera (Boh.)	–	–	–	–	0.48	16.66	IV	2.82	0.52	16.66	IV	2.94
Eupelix cuspidata (F.)	–	–	–	–	0.72	16.66	IV	3.46	–	–	–	–
Balclutha punctata (F.)	9.83	50	III	22.16	3.89	83.33	I	18	5.27	83.33	I	20.95
Macrosteles laevis (Rib.)	–	–	–	–	1.7	25	IV	6.51	3.43	58.33	II	14.14
Doratura stylata (Boh.)	–	–	–	–	4.37	41.66	III	13.49	2.63	41.66	III	10.46
Graphocraerus ventralis (Fall.)	0.81	8.33	IV	2.59	–	–	–	–	–	–	–	–
Paluda flaveola (Boh.)	7.37	33.33	III	15.67	2.43	33.33	III	8.99	2.11	33.33	III	8.38
Elymana sulphurella (Zett.)	7.37	25	IV	13.57	8.27	58.33	II	21.96	4.48	58.33	II	16.16
Cicadula persimilis (Edw.)	–	–	–	–	17.51	58.33	II	31.95	18.2	66.66	II	34.83
Athysanus argentarius Metc.	8.19	41.66	III	18.47	1.7	33.33	III	7.52	1.84	33.33	III	7.83
Arocephalus longiceps (Kbm.)	–	–	–	–	0.72	16.66	IV	3.46	–	–	–	–
Psammotettix alienus (Dhlb.)	–	–	–	–	0.24	8.33	IV	1.41	6.06	50	III	17.4
Errastunus ocellaris (Fall.)	22.95	58.33	II	36.58	27.73	66.66	II	42.99	27.7	75	II	45.57
Jassargus distinguendus (Fl.)	3.27	16.66	IV	7.38	0.97	25	IV	4.92	2.11	33.33	III	8.38
Verdanus abdominalis (F.)	24.59	50	III	35.06	9.48	41.66	III	19.87	7.12	50	III	18.86
Arthaldeus pascuellus (Fall.)	–	–	–	–	10.46	58.33	II	24.7	9.49	66.66	II	25.15

Fig. 14. The dynamics of species abundance among the species dominating on the plot 13.







Plot 14 (*Alopecurus pratensis*)

On the plot 14 from 2004 to 2006 there were collected 850 representatives of the Fulgoromorpha and Cicadomorpha belonging to 26 species.

In 2005, in the Research Plot 14, the eudominant status was achieved by the species *Cicadula persimilis* (30.32%), which had the subdominant status (10.07%) in the previous year. As for the remaining species, in the years 2005–2006 the subdominant status was achieved by *Errastunus ocellaris* (16.93% and 20% respectively), in the years 2004–2006 by *Arthaldeus pascuellus* (12.23%, 14.48% and 11.88% respectively) and in 2006 by *Verdanus abdominalis* (14.78%). In 2004 the latter species achieved the dominant status (24.46%) (Tab. 17).

With respect to the constancy of occurrence, in the years 2005–2006 there were three species which belonged to the second class, namely *Cicadula persimilis*, *Errastunus ocellaris* and *Arthaldeus pascuellus*. Additionally, in 2006 to the second group there also belonged the species *Javesella pellucida* and *Verdanus abdominalis* (Tab. 17).

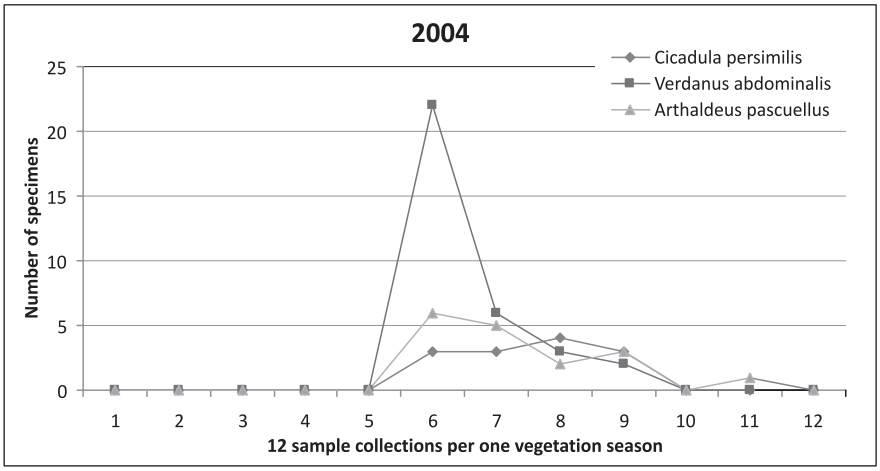
The highest value of the *Q* index (i.e. 47.68) was achieved by the species *Cicadula persimilis* in 2005 (Tab. 17).

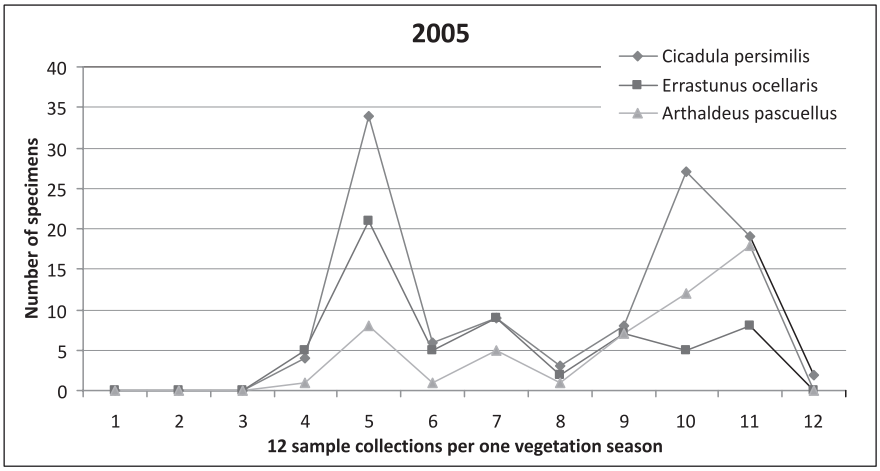
The dynamics of species abundance among the species dominating on the plot 14 was as follows: the species *Cicadula persimilis* achieved two maxima of appearance, one at the beginning of July, and the other in the middle of September. The species *Verdanus abdominalis* had its single maximum of appearance in the middle of July in 2004, and at the beginning of July in 2006 (Fig. 15).

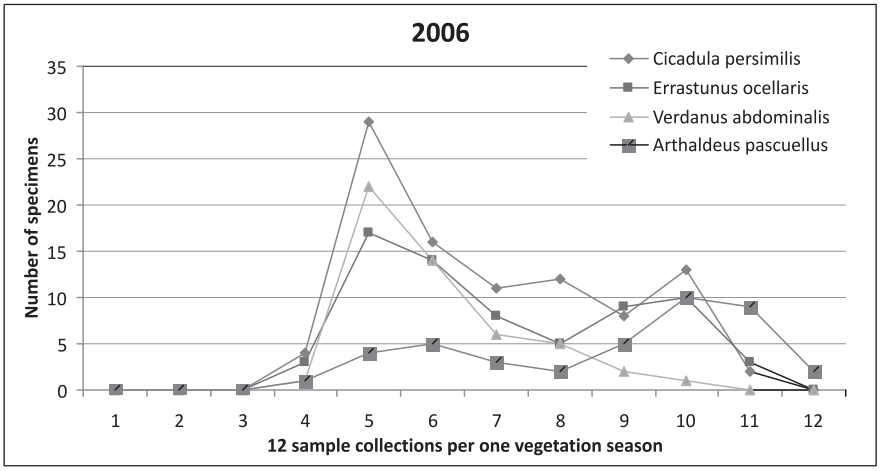
Table 17. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 14 – *Alopecurus pratensis*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Stenocranus major (Kbm.)	0.71	8.33	IV	2.43	–	–	–	–	–	–	–	–
Muellerianella brevipennis (Boh.)	–	–	–	–	–	–	–	–	1.44	33.33	III	6.92
Acanthodelphax spinosa (Fieb.)	2.15	16.66	IV	5.98	–	–	–	–	1.73	33.33	III	7.59
Javesella dubia (Kbm.)	–	–	–	–	–	–	–	–	0.28	8.33	IV	1.52
Javesella pellucida (F.)	2.15	16.66	IV	5.98	4.09	41.66	III	13.05	4.92	66.66	II	18.1
Cercopis vulnerata Rossi	–	–	–	–	–	–	–	–	1.15	16.66	IV	4.37
Aphrophora alni (Fall.)	0.71	8.33	IV	2.43	–	–	–	–	–	–	–	–
Philaenus spumarius (L.)	7.19	33.33	III	15.48	1.91	41.66	III	8.92	2.89	41.66	III	10.97
Cicadella viridis (L.)	–	–	–	–	–	–	–	–	1.73	25	IV	6.57
Balclutha punctata (F.)	2.15	16.66	IV	5.98	1.91	41.66	III	8.92	3.47	50	III	13.17
Macrosteles laevis (Rib.)	–	–	–	–	4.09	25	IV	10.11	1.15	33.33	III	6.19
Doratura stylata (Boh.)	–	–	–	–	2.18	25	IV	7.38	1.44	25	IV	6
Allygus mixtus (F.)	–	–	–	–	0.54	16.66	IV	2.99	–	–	–	–
Graphocraerus ventralis (Fall.)	–	–	–	–	1.36	16.66	IV	4.76	–	–	–	–
Paluda flaveola (Boh.)	8.63	33.33	III	16.95	4.09	33.33	III	11.67	2.6	33.33	III	9.3
Elymana sulphurella (Zett.)	–	–	–	–	5.46	58.33	II	17.84	–	–	–	–
Cicadula persimilis (Edw.)	10.07	41.66	III	20.48	30.32	75	II	47.68	7.53	66.66	II	22.4
Macustus grisescens (Zett.)	–	–	–	–	–	–	–	–	0.86	16.66	IV	3.78
Athysanus argentarius Metc.	5.75	33.33	III	13.84	2.45	33.33	III	9.03	2.02	33.33	III	8.2
Streptanus sordidus (Zett.)	–	–	–	–	0.27	8.33	IV	1.49	–	–	–	–
Arocephalus longiceps (Kbm.)	3.59	25	IV	9.47	–	–	–	–	–	–	–	–
Psammotettix cephalotes (H.-S.)	2.87	25	IV	8.47	–	–	–	–	–	–	–	–
Errastunus ocellaris (Fall.)	7.91	33.33	III	16.23	16.93	66.66	II	33.59	20	66.66	II	36.51
Jassargus distinguendus (Fl.)	9.35	33.33	III	17.65	–	–	–	–	–	–	–	–
Verdanus abdominalis (F.)	24.46	41.66	III	31.92	9.83	33.33	III	18.1	14.78	58.33	II	29.36
Arthaldeus pascuellus (Fall.)	12.23	41.66	III	22.57	14.48	66.66	II	31.06	11.88	75	II	29.84

Fig. 15. The dynamics of species abundance among the species dominating on the plot 14.







Plot 15 (*Cirsietum rivularis*)

On the plot 15 from 2004 to 2006 there were collected 810 representatives of the Fulgoromorpha and Cicadomorpha belonging to 17 species.

In the years 2004 and 2005 the eudominant status was achieved by the species *Errastunus ocellaris* (40.3% and 30.54% respectively). In 2005 the same species achieved the dominant status (27.11%). Furthermore, *Philaenus spumarius* (23.15%) was the dominant species in 2006, while in the previous years it had been the subdominant species (19.77% and 14.4% respectively). The species which achieved the subdominant status in all three research seasons was *Verdanus abdominalis* (18.25%, 17.79% and 16.72% respectively). Additionally, the species *Jassargus distinguendus* (13.98%) achieved the subdominant status in 2005 (Tab. 18).

As for the constancy of occurrence, to the second class in all research seasons there belonged the species *Errastunus ocellaris*, in the years 2005–2006 the species *Jassargus distinguendus* and *Arthaldeus pascuellus*, and in 2006 also the species *Acanthodelphax spinosa*, *Philaenus spumarius* and *Verdanus abdominalis* (Tab. 18).

The highest value of the *Q* index in all research seasons was achieved by the species *Errastunus ocellaris* (51.83, 42.51 and 47.85 respectively) (Tab. 18).

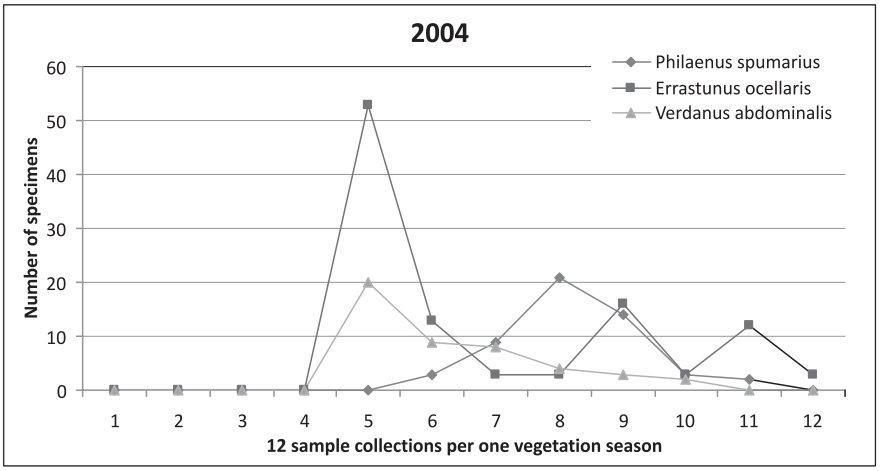
The differential species for the plot 15 was *Chlorita paolii* (100%) (Annex 1).

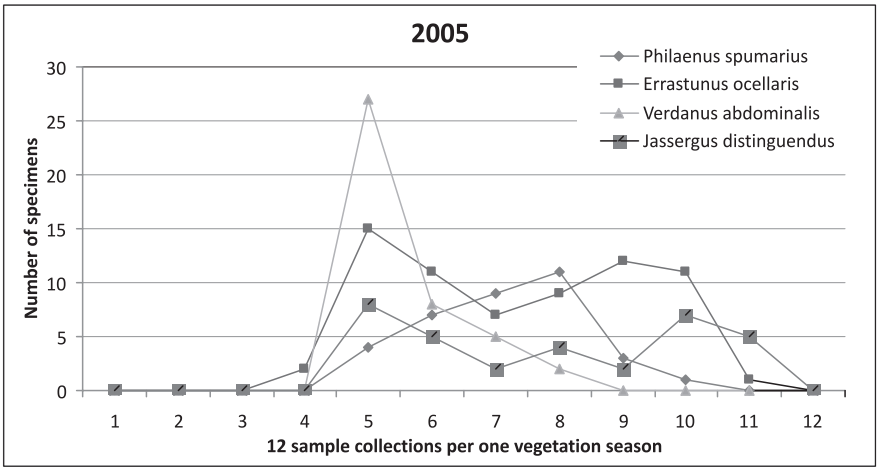
The dynamics of species abundance among the species dominating on the plot 15 was as follows: the species *Errastunus ocellaris* achieved two maxima of occurrence, one at the beginning of July and the other at the beginning of September. The species *Philaenus spumarius* had its maximum of appearance in the first half of August (Fig. 16).

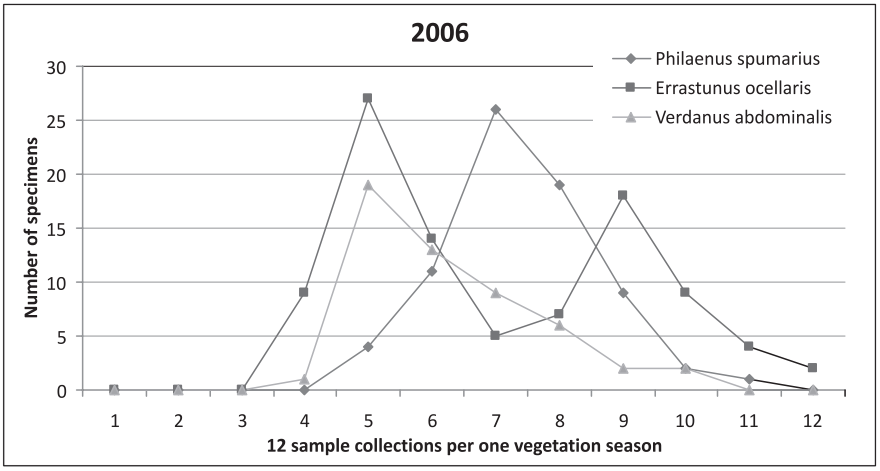
Table 18. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 15 – *Cirsietum rivularis*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Stenocranus major (Kbm.)	0.38	8.33	IV	1.77	–	–	–	–	–	–	–	–
Acanthodelphax spinosa (Fieb.)	1.14	16.66	IV	4.35	6.77	41.66	III	16.79	5.78	58.33	II	18.36
Javesella pellucida (F.)	0.76	8.33	IV	2.51	2.96	25	IV	8.6	2.89	25	IV	8.5
Philaenus spumarius (L.)	19.77	50	III	31.44	14.4	50	III	26.83	23.15	58.33	II	36.74
Eupelix cuspidata (F.)	0.76	16.66	IV	3.55	–	–	–	–	1.28	25	IV	5.65
Chlorita paolii (Oss.)	0.38	8.33	IV	1.77	–	–	–	–	–	–	–	–
Balclutha Punctata (F.)	4.56	33.33	III	12.32	2.11	25	IV	7.26	3.21	50	III	12.66
Macrosteles laevis (Rib.)	–	–	–	–	2.11	25	IV	7.26	0.96	25	IV	4.89
Graphocraerus ventralis (Fall.)	4.18	16.66	IV	8.34	2.54	25	IV	7.96	1.28	25	IV	5.65
Paluda flaveola (Boh.)	–	–	–	–	0.42	8.33	IV	1.87	0.32	8.33	IV	1.63
Cicadula persimilis (Edw.)	1.9	33.33	III	7.95	–	–	–	–	–	–	–	–
Arocephalus longiceps (Kbm.)	0.38	8.33	IV	1.77	–	–	–	–	–	–	–	–
Psammotettix alienus (Dhlb.)	–	–	–	–	1.69	25	IV	6.5	0.96	16.66	IV	3.99
Errastunus ocellaris (Fall.)	40.3	66.66	II	51.83	27.11	66.66	II	42.51	30.54	75	II	47.85
Jassargus distinguendus (Fl.)	–	–	–	–	13.98	58.33	II	28.55	6.43	58.33	II	19.36
Verdanus abdominalis (F.)	18.25	50	III	30.2	17.79	33.33	III	24.35	16.72	58.33	II	31.22
Arthaldeus pascuellus (Fall.)	7.6	50	III	19.49	8.05	58.33	II	21.66	6.43	58.33	II	19.36

Fig. 16. The dynamics of species abundance among the species dominating on the plot 15.







Plot 16 (*Cirsietum rivularis*)

On the plot 16 from 2004 to 2006 there were collected 541 representatives of the Fulgoromorpha and Cicadomorpha belonging to 15 species.

The species *Errastunus ocellaris* had the dominant status in 2004, and the subdominant status in the following years (17.32% and 19.21% respectively). The species *Verdanus abdominalis* had the dominant status in 2004 and 2006 (26.47% and 20.68% respectively), and the subdominant status (15.34%) in 2005. Furthermore, the dominant status in 2005 and 2006 was achieved by the species *Arthaldeus pascuellus* (27.22% and 24.13%), which in 2004 was the subdominant species (11.02%) together with *Balclutha punctata* (15.44%) (Tab. 19).

The only species which belonged to the second class with respect of constancy of occurrence in all research seasons was *Errastunus ocellaris*. Furthermore, to the second class there also belonged the species *Balclutha punctata* (2005–2006), *Arthaldeus pascuellus* (2005–2006), *Acanthodelphax spinosa* (2006) and *Elymana sulphurella* (2005) (Tab. 19).

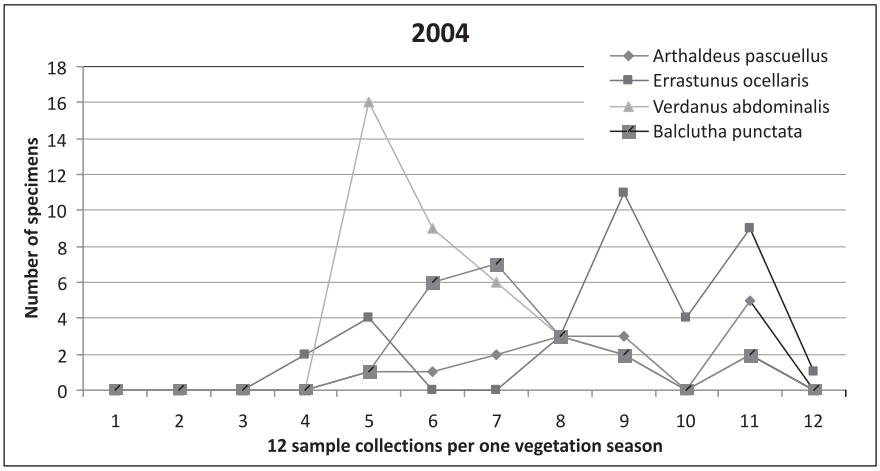
The highest value of the *Q* index was achieved by the species *Errastunus ocellaris* (38.18, 33.97 and 35.78 respectively) and *Arthaldeus pascuellus* (23.47, 42.59 and 40.1 respectively) (Tab. 19).

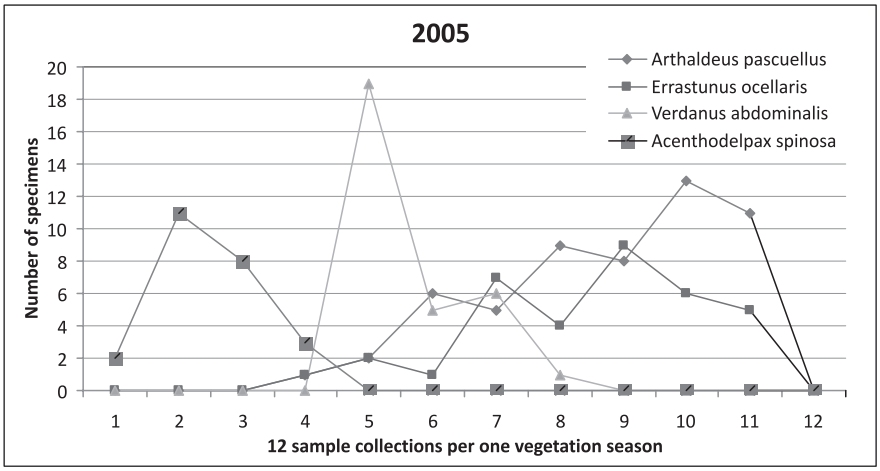
The dynamics of species abundance among the species dominating on the plot 16 was as follows: the species *Errastunus ocellaris* had its maximum of appearance at the break of August and September, and the species *Verdanus abdominalis* had its maximum at the beginning of July. The species *Arthaldeus pascuellus* had its maximum of appearance towards the end of September in 2004 and 2005, and in the second half of August in 2006 (Fig. 17).

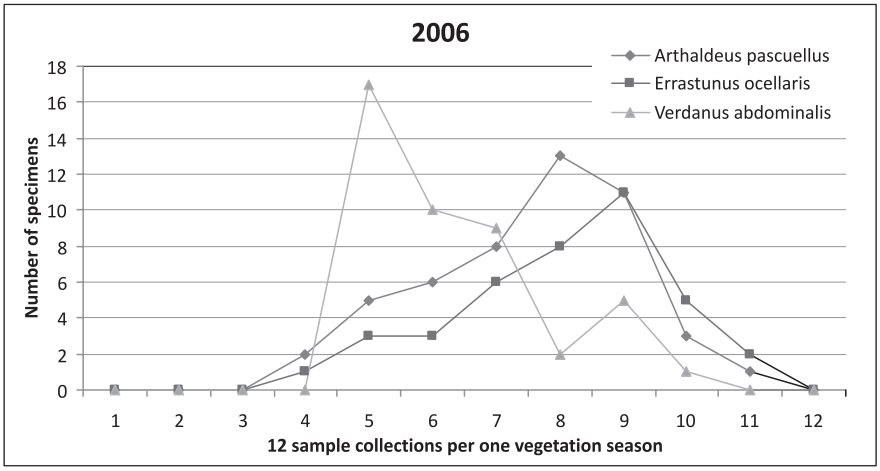
Table 19. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 16 – *Cirsietum rivularis*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Acanthodelphax spinosa (Fieb.)	2.2	16.66	IV	6.05	11.88	33.33	III	19.89	9.85	66.66	II	25.62
Javesella pellucida (F.)	0.73	8.33	IV	2.46	–	–	–	–	–	–	–	–
Neophilaenus lineatus (L.)	0.73	8.33	IV	2.46	–	–	–	–	–	–	–	–
Philaenus spumarius (L.)	7.35	33.33	III	15.65	3.96	41.66	III	12.84	3.94	41.66	III	12.81
Balclutha Punctata (F.)	15.44	50	III	27.78	5.94	58.33	II	18.61	7.88	66.66	II	22.91
Macrosteles laevis (Rib.)	–	–	–	–	2.97	25	IV	8.61	–	–	–	–
Graphocraerus ventralis (Fall.)	3.67	25	IV	9.57	–	–	–	–	0.98	16.66	IV	4.04
Elymana sulphurella (Zett.)	–	–	–	–	6.93	58.33	II	20.1	6.89	50	III	18.56
Cicadula persimilis (Edw.)	2.94	16.66	IV	6.99	4.45	33.33	III	12.17	5.91	41.66	III	15.69
Hesium domino (Reut.)	–	–	–	–	–	–	–	–	0.49	8.33	IV	2.02
Psammotettix alienus (Dhlb.)	–	–	–	–	3.96	33.33	III	11.48	–	–	–	–
Errastunus ocellaris (Fall.)	25	58.33	II	38.18	17.32	66.66	II	33.97	19.21	66.66	II	35.78
Jassargus distinguendus (Fl.)	4.41	25	IV	10.5	–	–	–	–	–	–	–	–
Verdanus abdominalis (F.)	26.47	41.66	III	33.2	15.34	33.33	III	22.61	20.68	50	III	32.15
Arthaldeus pascuellus (Fall.)	11.02	50	III	23.47	27.22	66.66	II	42.59	24.13	66.66	II	40.1

Fig. 17. The dynamics of species abundance among the species dominating on the plot 16.







Plot 17 (*Cirsium heterophyllum*)

On the plot 17 from 2004 to 2006 there were collected 678 representatives of the Fulgoromorpha and Cicadomorpha belonging to 18 species.

In the years 2004–2006 on the plot 17, the species *Verdanus abdominalis* had the eudominant status (47.4%, 32.41% and 37.58% respectively). In the years 2005 and 2006 the subdominant species was *Elymana sulphurella* (16.6% and 15.86% respectively) (Tab. 20).

With respect to the constancy of occurrence to the first class there belonged only one species, namely *Balclutha punctata* – in 2006 (Tab. 20).

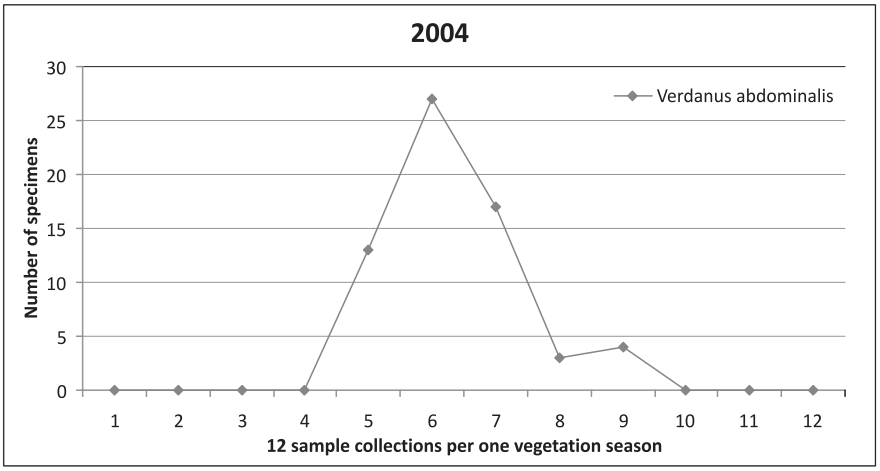
The highest value of the *Q* index was achieved by the species *Verdanus abdominalis* (44.43, 36.74 and 46.81% respectively) (Tab. 20).

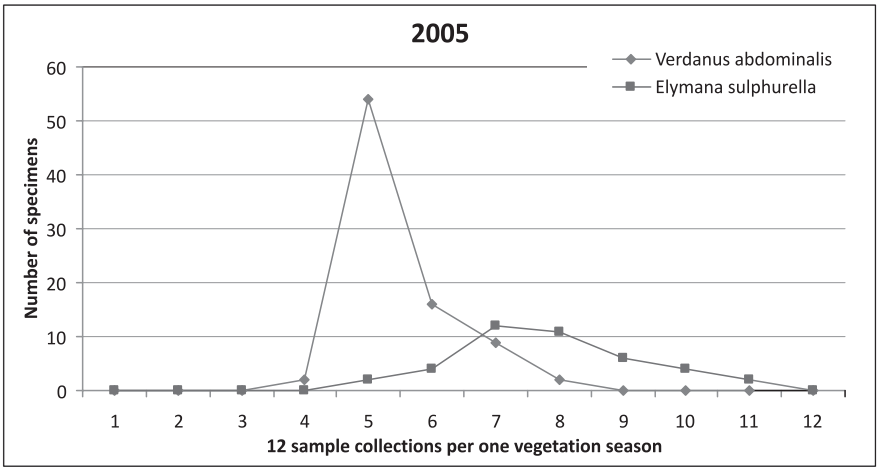
The dynamics of species abundance among the species dominating on the plot 17 was as follows: the species *Verdanus abdominalis* had one maximum of appearance in the middle of July in 2004 and at the beginning of July in 2005 and 2006 (Fig. 18).

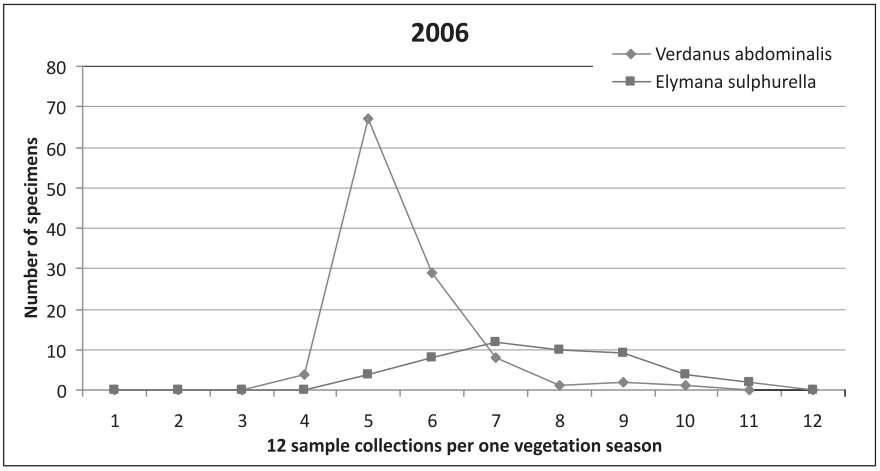
Table 20. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 17 – *Cirsium heterophyllum*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Stenocranus major (Kbm.)	–	–	–	–	0.79	16.66	IV	3.62	–	–	–	–
Stiroma bicarinata (H.-S.)	0.74	8.33	IV	2.48	–	–	–	–	–	–	–	–
Criomorphus albomarginatus Curt.	–	–	–	–	–	–	–	–	0.34	8.33	IV	1.68
Javesella pellucida (F.)	–	–	–	–	1.58	25	IV	6.28	2.75	41.66	III	10.7
Aphrophora alni (Fall.)	0.74	8.33	IV	2.48	–	–	–	–	–	–	–	–
Philaenus spumarius (L.)	7.4	41.66	III	17.55	7.11	41.66	III	17.21	4.48	50	III	14.96
Evacanthus interruptus (L.)	7.4	33.33	III	15.7	–	–	–	–	–	–	–	–
Balclutha Punctata (F.)	0.74	8.33	IV	2.48	8.3	75	II	24.94	8.62	83.33	I	26.8
Paluda flaveola (Boh.)	2.96	25	IV	8.6	6.32	33.33	III	14.51	3.79	33.33	III	11.23
Elymana sulphurella (Zett.)	0.74	8.33	IV	2.48	16.6	58.33	II	31.11	15.86	58.33	II	30.41
Cicadula persimilis (Edw.)	2.96	25	IV	8.6	3.16	41.66	III	11.47	3.1	41.66	III	11.36
Hesium domino (Reut.)	–	–	–	–	0.39	8.33	IV	1.8	–	–	–	–
Athysanus argentarius Metc.	4.44	25	IV	10.53	3.95	33.33	III	11.47	3.44	33.33	III	10.7
Psammotettix cephalotes (H.-S.)	–	–	–	–	0.39	8.33	IV	1.8	–	–	–	–
Errastunus ocellaris (Fall.)	6.66	41.66	III	16.65	5.13	58.33	II	17.29	8.62	66.66	II	23.97
Jassargus distinguendus (Fl.)	9.62	25	IV	15.5	9.09	58.33	II	23.02	5.86	58.33	II	18.48
Verdanus abdominalis (F.)	47.4	41.66	III	44.43	32.41	41.66	III	36.74	37.58	58.33	II	46.81
Arthaldeus pascuellus (Fall.)	8.14	33.33	III	16.47	4.74	58.33	II	16.62	5.51	66.66	II	19.16

Fig. 18. The dynamics of species abundance among the species dominating on the plot 17.







Plot 18 (*Cirsium heterophyllum*)

On the plot 18 from 2004 to 2006 there were collected 1131 representatives of the Fulgoromorpha and Cicadomorpha belonging to 19 species.

In all research seasons the eudominant species was *Verdanus abdominalis* (42.26%, 32.58% and 34.03% respectively), while the subdominant species included *Errastunus ocellaris* (11.9%, 17.69% and 17.37%) and *Jassargus distinguendus* (16.07%, 16.57% and 16.66% respectively). In 2005 and 2006 the subdominant status was achieved also by the species *Arthaldeus pascuellus* (15.64% and 10.79% respectively) (Tab. 21).

With respect to the constancy of occurrence, to the second class in the years 2004–2006 there belonged the species *Errastunus ocellaris*. Furthermore, in the years 2005 and 2006 to the second class there also belonged such species as *Balclutha punctata*, *Jassargus distinguendus* and *Arthaldeus pascuellus*. The species *Verdanus abdominalis* belonged to the second class in the years 2004 and 2006, while the species *Javesella pellucida* belonged to the same class only in 2006 (Tab. 21).

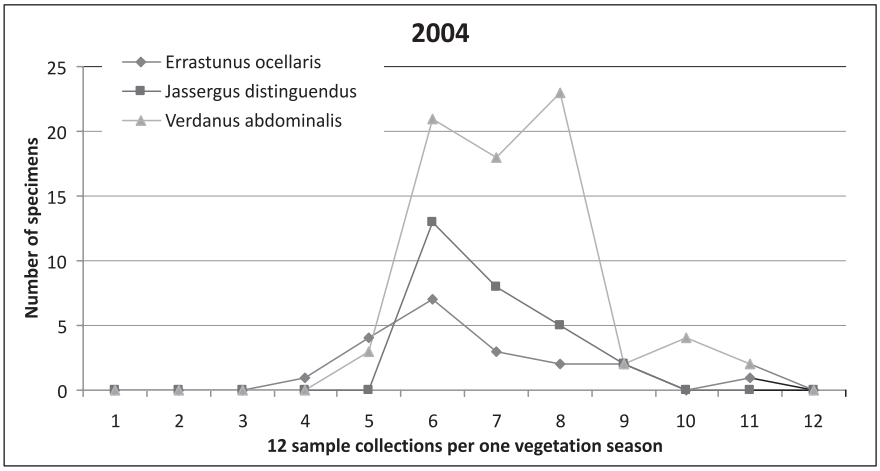
The highest value of the *Q* index in all research seasons was achieved by the species *Verdanus abdominalis* (49.64, 40.36 and 44.55 respectively) (Tab. 21).

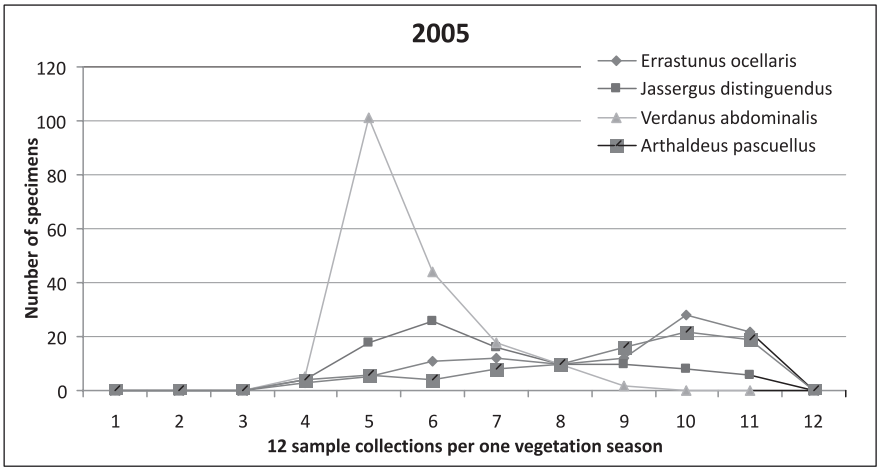
The dynamics of species abundance among the species dominating on the plot 18 was as follows: the species *Verdanus abdominalis* had its maximum of appearance once, between the middle of July and the middle of August in 2004, and at the beginning of July in 2005 and 2006 (Fig. 19).

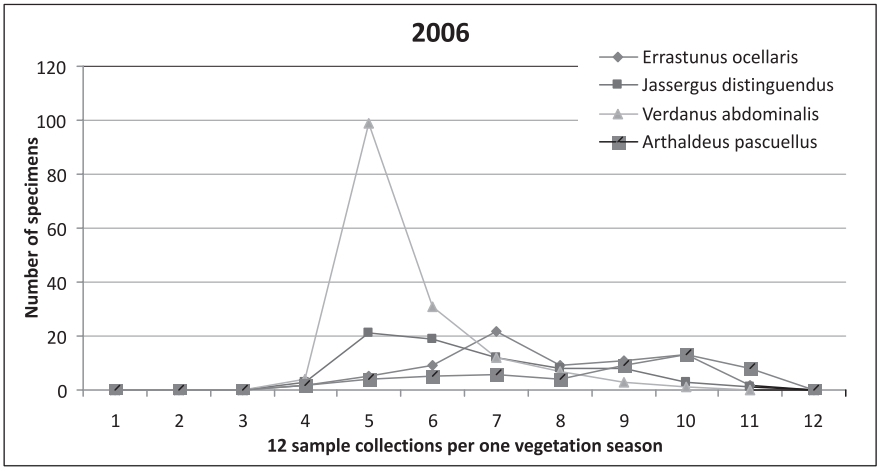
Table 21. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 18 – *Cirsium heterophyllum*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Acanthodelphax denticauda (Boh.)	–	–	–	–	–	–	–	–	0.46	16.66	IV	2.76
Acanthodelphax spinosa (Fieb.)	–	–	–	–	1.3	41.66	III	7.35	1.87	41.66	III	8.82
Javesella pellucida (F.)	0.59	8.33	IV	2.21	1.3	33.33	III	6.58	3.75	58.33	II	14.78
Philaenus spumarius (L.)	9.52	33.33	III	17.81	–	–	–	–	2.58	41.66	III	10.36
Balclutha punctata (F.)	1.19	16.66	IV	4.45	2.04	58.33	II	10.9	3.28	66.66	II	14.78
Deltocephalus pulicaris (Fall.)	–	–	–	–	0.74	25	IV	4.3	–	–	–	–
Doratura stylata (Boh.)	–	–	–	–	–	–	–	–	0.23	8.33	IV	1.38
Graphocraerus ventralis (Fall.)	–	–	–	–	0.37	16.66	IV	2.48	0.23	8.33	IV	1.38
Paluda flaveola (Boh.)	–	–	–	–	0.55	16.66	IV	3.02	–	–	–	–
Elymana sulphurella (Zett.)	4.76	25	IV	10.9	4.84	50	III	15.55	4.46	50	III	14.93
Doliotettix lunulatus (Zett.)	0.59	8.33	IV	2.21	–	–	–	–	–	–	–	–
Streptanus marginatus (Kbm.)	3.57	16.66	IV	7.71	0.74	16.66	IV	3.51	3.28	25	IV	9.05
Arocephalus longiceps (Kbm.)	1.19	16.66	IV	4.45	0.93	25	IV	4.82	–	–	–	–
Psammotettix alienus (Dhlb.)	–	–	–	–	4.28	33.33	III	11.94	–	–	–	–
Psammotettix cephalotes (H.-S.)	2.97	25	IV	8.61	0.37	16.66	IV	2.48	0.93	25	IV	4.82
Errastunus ocellaris (Fall.)	11.9	58.33	II	26.34	17.69	66.66	II	34.33	17.37	66.66	II	34.02
Jassargus distinguendus (Fl.)	16.07	33.33	III	23.14	16.57	66.66	II	33.23	16.66	66.66	II	33.32
Verdanus abdominalis (F.)	42.26	58.33	II	49.64	32.58	50	III	40.36	34.03	58.33	II	44.55
Arthaldeus pascuellus (Fall.)	5.35	33.33	III	13.35	15.64	75	II	34.24	10.79	75	II	28.44

Fig. 19. The dynamics of species abundance among the species dominating on the plot 18.







Plot 19 (*Holcus lanatus*)

On the plot 19 from 2004 to 2006 there were collected 1444 representatives of the Fulgoromorpha and Cicadomorpha belonging to 34 species.

The species *Verdanus abdominalis* (29.26%) had the dominant status in 2004, and the subdominant status in the years 2005–2006 (11.86% and 12.22% respectively). Furthermore, in 2005 and 2006 the subdominant status was also achieved by such species as *Arthaldeus pascuellus* (10.99% and 12.42% respectively) and *Macrosteles laevis* (12.73% and 10.84% respectively). The subdominant species included also *Philaenus spumarius* (11.38%) in 2004, *Acanthodelphax spinosa* (14.61%) in 2005, and *Cicadula persimilis* (10.25%) in 2006 (Tab. 22).

As for the constancy of occurrence, on the plot 19 only one species belonged to the first class, namely *Balclutha punctata* (2006), which belonged to the second class in the two previous years (Tab. 22).

The highest value of the *Q* index was achieved by the species *Verdanus abdominalis* (38.24) in 2004 (Tab. 22).

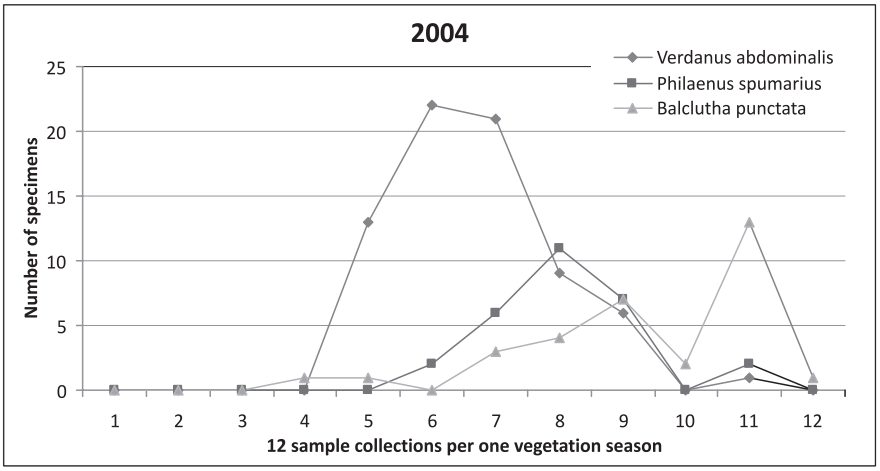
The characteristic species for the plot 19 included: *Ribautodelphax collina* (81.25%) and *Eupteryx vittata* (66.66%) (Annex 1).

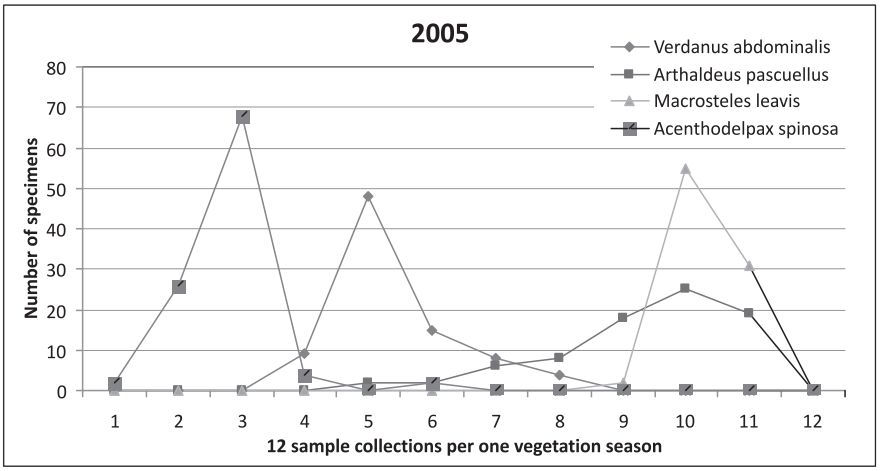
The dynamics of species abundance among the species dominating on the plot 19 was as follows: the species *Verdanus abdominalis* had one maximum of occurrence, in the second half of July in 2004, and at the beginning of July in 2005 and 2006 (Fig. 20).

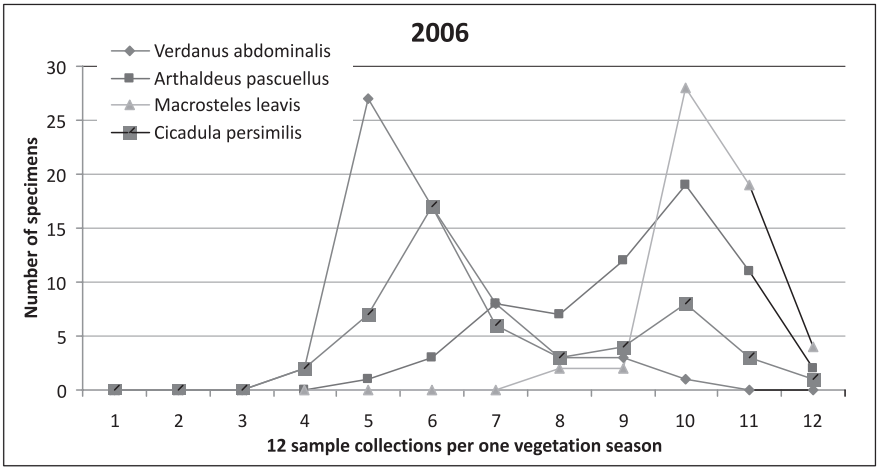
Table 22. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 19 – *Holcus lanatus*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Kelisia guttula (Germ.)	–	–	–	–	1.3	33.33	III	6.58	0.98	25	IV	4.94
Stenocranus major (Kbm.)	0.81	16.66	IV	3.67	0.28	16.66	IV	2.15	–	–	–	–
Laodelphax striatella (Fall.)	–	–	–	–	0.28	16.66	IV	2.15	–	–	–	–
Acanthodelphax spinosa (Fieb.)	6.09	25	IV	12.33	14.61	41.66	III	24.67	6.11	50	III	17.47
Dicranotropis hamata (Boh.)	0.81	8.33	IV	2.59	–	–	–	–	–	–	–	–
Javesella pellucida (F.)	4.47	25	IV	10.57	1.44	25	IV	6	4.14	66.66	II	16.61
Ribautodelphax collina (Boh.)	3.65	16.66	IV	7.79	3.03	25	IV	8.7	1.77	25	IV	6.65
Aphrophora alni (Fall.)	1.62	25	IV	6.36	0.43	16.66	IV	2.67	1.38	25	IV	5.87
Philaenus spumarius (L.)	11.38	41.66	III	21.77	1.15	33.33	III	6.19	7.69	58.33	II	21.17
Megophthalmus scanicus (Fall.)	–	–	–	–	–	–	–	–	0.59	16.66	IV	3.13
Evacanthus interruptus (L.)	–	–	–	–	–	–	–	–	0.39	16.66	IV	2.54
Cicadella viridis (L.)	–	–	–	–	–	–	–	–	0.98	25	IV	4.94
Forcipata citrinella (Zett.)	6.09	58.33	II	18.84	7.95	66.66	II	23.02	2.76	41.66	III	10.72
Eupteryx vittata (L.)	–	–	–	–	0.8	16.66	IV	3.65	–	–	–	–
Balclutha punctata (F.)	13	66.66	II	29.43	2.46	66.66	II	12.8	9.07	83.33	I	27.49
Macrosteles laevis (Rib.)	–	–	–	–	12.73	33.33	III	20.59	10.84	41.66	III	21.25
Deltocephalus pulicaris (Fall.)	–	–	–	–	0.28	16.66	IV	2.15	–	–	–	–
Doratura stylata (Boh.)	–	–	–	–	0.72	25	IV	4.24	0.98	25	IV	4.94
Allygus mixtus (F.)	–	–	–	–	0.28	16.66	IV	2.15	0.19	8.33	IV	1.25
Graphocraerus ventralis (Fall.)	1.62	16.66	IV	5.19	2.46	25	IV	7.84	1.38	25	IV	5.87
Elymana sulphurella (Zett.)	–	–	–	–	4.05	58.33	II	15.36	4.73	58.33	II	16.61
Cicadula persimilis (Edw.)	7.31	41.66	III	17.45	6.94	58.33	II	20.11	10.25	75	II	27.72
Speudotettix subfusculus (Fall.)	1.21	16.66	IV	4.48	0.72	25	IV	4.24	0.78	25	IV	4.41
Hesium domino (Reut.)	2.84	25	IV	8.42	0.57	25	IV	3.77	0.39	16.66	IV	2.54
Macustus grisescens (Zett.)	1.21	16.66	IV	4.48	–	–	–	–	–	–	–	–
Athysanus argentarius Metc.	–	–	–	–	0.28	16.66	IV	2.15	–	–	–	–
Streptanus marginatus (Kbm.)	0.4	8.33	IV	1.82	–	–	–	–	–	–	–	–
Streptanus sordidus (Zett.)	–	–	–	–	0.28	16.66	IV	2.15	–	–	–	–
Psammotettix alienus (Dhlb.)	–	–	–	–	4.77	33.33	III	12.6	–	–	–	–
Psammotettix cephalotes (H.-S.)	–	–	–	–	0.28	16.66	IV	2.15	0.98	33.33	III	5.71
Errastunus ocellaris (Fall.)	–	–	–	–	0.57	25	IV	3.77	–	–	–	–
Jassargus distinguendus (Fl.)	8.13	41.66	III	18.4	8.82	58.33	II	22.68	8.87	75	II	25.79
Verdanus abdominalis (F.)	29.26	50	III	38.24	11.86	41.66	III	22.22	12.22	58.33	II	26.69
Arthaldeus pascuellus (Fall.)	–	–	–	–	10.99	58.33	II	25.31	12.42	66.66	II	28.77

Fig. 20. The dynamics of species abundance among the species dominating on the plot 19.







Plot 20 (*Holcus lanatus*)

On the plot 20 from 2004 to 2006 there were collected 1910 representatives of the Fulgoromorpha and Cicadomorpha belonging to 35 species.

In 2004 *Verdanus abdominalis* (38.8%) was the eudominant species, and in 2006 it was the subdominant species (11.63%). Other species which achieved the subdominant status included *Philaenus spumarius* (15.29%) in 2004; *Acanthodelphax spinosa* (12.14%), *Macrosteles laevis* (13.97%), *Psammotettix alienus* (11.02%) in 2005; *Macrosteles laevis* (14.5%) and *Arthaldeus pascuellus* (10.87%) in 2006 (Tab. 23).

With respect to the constancy of occurrence, to the first class there belonged only one species, namely *Javesella pellucida* in 2006 (Tab. 23).

The highest value of the *Q* index was achieved by the species *Verdanus abdominalis* (47.57) in 2004 (Tab. 23).

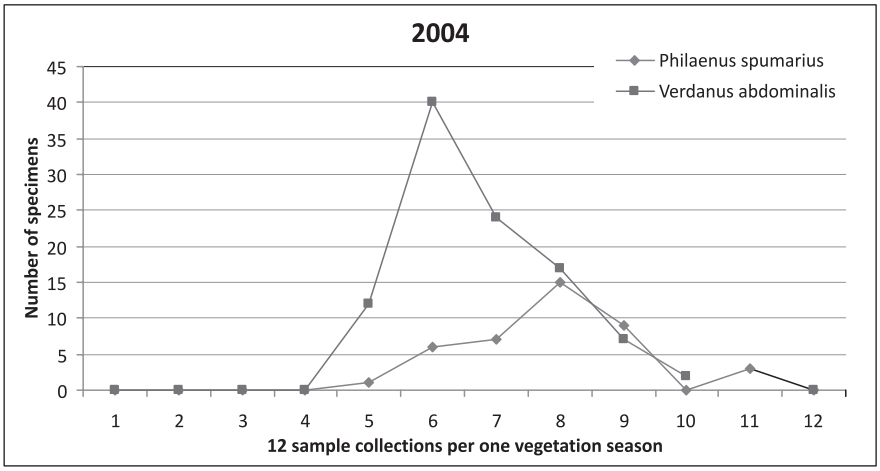
Differential species on the plot 20 included: *Notus flavipennis* (100%), *Macrosteles ossiannilssoni* (100%) and *Cicadula quadrinotata* (100%), while the characteristic species for this research area was *Forcipata citrinella* (51.36%) (Annex 1).

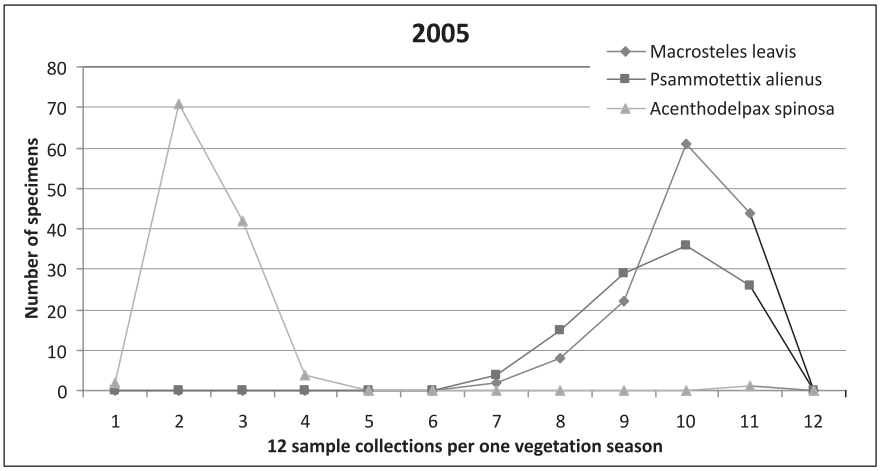
The dynamics of species abundance among the species dominating on the plot 20 was as follows: the species *Verdanus abdominalis* had one maximum of appearance, in the middle of July in 2004, and at the beginning of July in 2006 (Fig. 21).

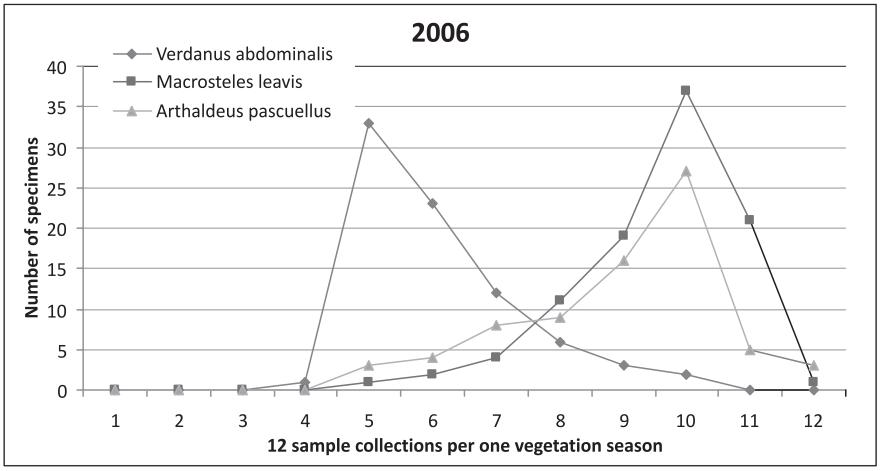
Table 23. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 20 – *Holcus lanatus*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Kelisia guttula (Germ.)	–	–	–	–	0.81	33.33	III	5.19	0.9	25	IV	4.74
Laodelphax striatella (Fall.)	–	–	–	–	0.3	16.66	IV	2.23	–	–	–	–
Muellerianella brevipennis (Boh.)	–	–	–	–	1.42	25	IV	5.95	–	–	–	–
Acanthodelphax denticauda (Boh.)	0.37	8.33	IV	1.75	0.1	8.33	IV	0.91	0.3	16.66	IV	2.23
Acanthodelphax spinosa (Fieb.)	1.86	16.66	IV	5.56	12.14	41.66	III	22.48	4.53	58.33	II	16.25
Florodelphax leptosoma (Fl.)	–	–	–	–	0.1	8.33	IV	0.91	–	–	–	–
Javesella dubia (Kbm.)	–	–	–	–	0.2	16.66	IV	1.82	–	–	–	–
Javesella pellucida (F.)	4.1	25	IV	10.12	5.4	66.66	II	18.97	4.68	83.33	I	19.74
Ribautodelphax collina (Boh.)	1.49	16.66	IV	4.98	–	–	–	–	0.45	16.66	IV	2.73
Aphrophora alni (Fall.)	1.49	25	IV	6.1	0.1	8.33	IV	0.91	0.15	8.33	IV	1.11
Philaenus spumarius (L.)	15.29	50	III	27.64	4.28	50	III	14.62	6.79	58.33	II	19.9
Cicadella viridis (L.)	–	–	–	–	0.1	8.33	IV	0.91	–	–	–	–
Forcipata citrinella (Zett.)	4.85	50	III	15.57	8.36	75	II	25.03	5.58	58.33	II	18.04
Notus flavipennis (Zett.)	–	–	–	–	1.42	25	IV	5.95	0.9	25	IV	4.74
Eupteryx vittata (L.)	–	–	–	–	0.1	8.33	IV	0.91	–	–	–	–
Balclutha punctata (F.)	–	–	–	–	0.91	50	III	6.74	3.32	75	II	15.77
Macrosteles laevis (Rib.)	–	–	–	–	13.97	50	III	26.42	14.5	66.66	II	31.08
Macrosteles ossiannilssoni Ldb.	–	–	–	–	6.73	33.33	III	14.97	6.19	41.66	III	16.05
Deltocephalus pulicaris (Fall.)	–	–	–	–	0.2	16.66	IV	1.82	0.15	8.33	IV	1.11
Graphocraerus ventralis (Fall.)	1.11	8.33	IV	3.04	0.71	16.66	IV	3.43	0.6	25	IV	3.87
Elymana sulphurella (Zett.)	–	–	–	–	2.34	33.33	III	8.83	2.71	50	III	11.64
Cicadula quadrinotata (F.)	–	–	–	–	1.73	33.33	III	7.59	1.51	41.66	III	7.93
Cicadula persimilis (Edw.)	5.22	41.66	III	14.74	9.18	75	II	26.23	9.96	75	II	27.33
Speudotettix subfusculus (Fall.)	0.37	8.33	IV	1.75	–	–	–	–	–	–	–	–
Hesium domino (Reut.)	–	–	–	–	0.3	16.66	IV	2.23	0.3	16.66	IV	2.23
Macustus grisescens (Zett.)	1.86	16.66	IV	5.56	–	–	–	–	–	–	–	–
Doliotettix lunulatus (Zett.)	1.11	16.66	IV	4.3	–	–	–	–	–	–	–	–
Athysanus argentarius Metc.	6.34	50	III	17.8	0.81	33.33	III	5.19	0.75	25	IV	4.33
Streptanus sordidus (Zett.)	–	–	–	–	0.3	16.66	IV	2.23	0.15	8.33	IV	1.11
Psammotettix alienus (Dhlb.)	–	–	–	–	11.02	50	III	23.47	7.85	50	III	19.81
Psammotettix cephalotes (H.-S.)	–	–	–	–	0.4	16.66	IV	2.58	–	–	–	–
Errastunus ocellaris (Fall.)	–	–	–	–	1.12	25	IV	5.29	2.11	41.66	III	9.37
Jassargus distinguendus (Fl.)	9.32	50	III	21.58	2.55	58.33	II	12.19	3.02	58.33	II	13.27
Verdanus abdominalis (F.)	38.8	58.33	II	47.57	4.18	41.66	III	13.19	11.63	58.33	II	26.04
Arthaldeus pascuellus (Fall.)	6.34	41.66	III	16.25	8.57	66.66	II	23.9	10.87	66.66	II	26.91

Fig. 21. The dynamics of species abundance among the species dominating on the plot 20.







Plot 21 (*Betula pendula – Molinia caerulea*)

On the plot 21 from 2004 to 2006 there were collected 363 representatives of the Fulgoromorpha and Cicadomorpha belonging to 14 species.

On the plot 21 the species *Neophilaenus lineatus* had the eudominant status in the years 2004–2006 (42.46%, 31.72% and 36.55% respectively). Moreover, in 2005 the eudominant status was also achieved by the species *Balclutha punctata*, which in 2006 became the dominant species (24.82%), and in 2004 had been the subdominant species (12,32%). Additionally, the subdominant status was achieved by the species *Psammotettix alienus* (14.48%) in 2005 and by the species *Hyledelphax elegantula* (10.34%) in 2006 (Tab. 24).

As for the constancy of occurrence, the species *Balclutha punctata* belonged to the first class in 2006, and to the second class in 2005. In 2006, to the second class there also belonged the species *Hyledelphax elegantula* and *Neophilaenus lineatus* (Tab. 24).

The highest value of the *Q* index in the years 2004–2006 was achieved by the species *Neophilaenus lineatus* (46.07, 39.82 and 49.36 respectively) (Tab. 24).

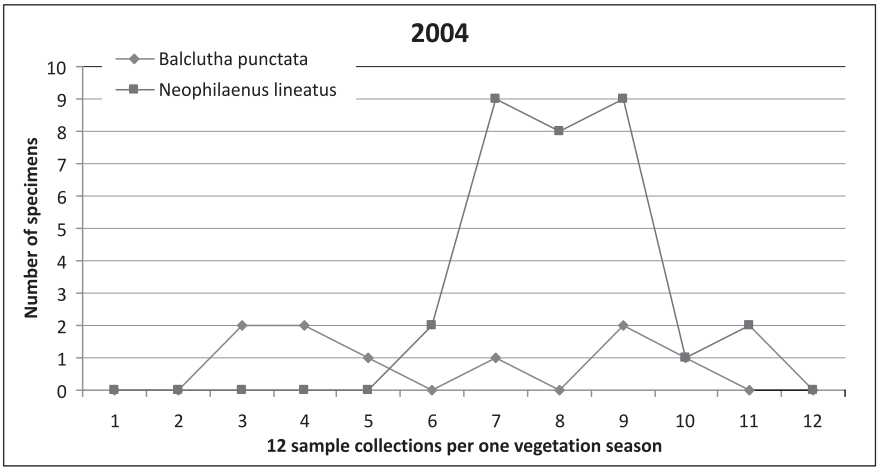
The differential species for the Research Area 21 was *Planaphrodes nigrita* (100%) (Annex 1).

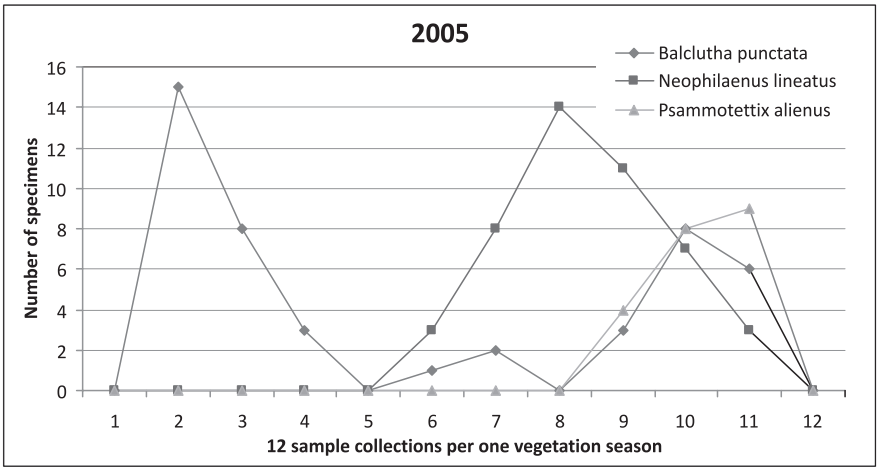
The dynamics of species abundance among the species dominating on the plot 21 was as follows: the species *Neophilaenus lineatus* had two maxima of appearance in 2004, one at the beginning of August and the other towards the end of August; in the other years its maximum of appearance was recorded in the middle of August. The species *Balclutha punctata* had two maxima of appearance, one at the break of May and June, and the other at the break of August and September (Fig. 22).

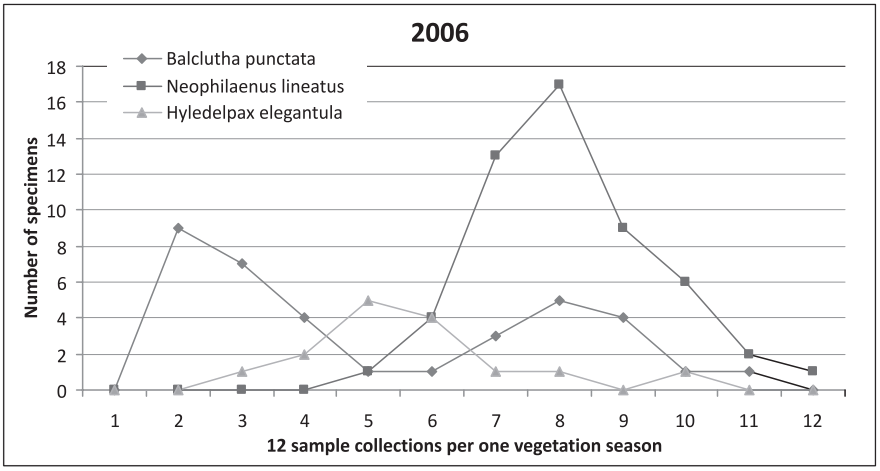
Table 24. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 21 – *Betula pendula – Molinia caerulea*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Laodelphax striatella (Fall.)	1.36	8.33	IV	3.36	5.51	41.66	III	15.15	3.44	33.33	III	10.70
Hyledelphax elegantula (Boh.)	4.1	16.66	IV	8.26	–	–	–	–	10.34	58.33	II	24.55
Neophilaenus lineatus (L.)	42.46	50	III	46.07	31.72	50	III	39.82	36.55	66.66	II	49.36
Aphrophora alni (Fall.)	2.73	16.66	IV	6.74	2.75	25	IV	8.29	2.06	25	IV	7.17
Oncopsis tristis (Zett.)	–	–	–	–	2.75	16.66	IV	6.76	1.37	16.66	IV	4.77
Agallia brachyptera (Boh.)	5.47	25	IV	11.69	0.68	8.33	IV	2.38	–	–	–	–
Planaphrodes nigrita (Kbm.)	1.36	8.33	IV	3.36	1.37	16.66	IV	4.77	0.68	8.33	IV	2.38
Balclutha punctata (F.)	12.32	50	III	24.81	31.72	66.66	II	45.98	24.82	83.33	I	45.47
Deltocephalus pulicaris (Fall.)	4.1	16.66	IV	8.26	–	–	–	–	0.68	8.33	IV	2.38
Speudotettix subfusculus (Fall.)	8.21	25	IV	14.32	2.06	16.66	IV	5.85	2.06	16.66	IV	5.85
Psammotettix alienus (Dhlb.)	–	–	–	–	14.48	25	IV	19.02	7.58	41.66	III	17.77
Errastunus ocellaris (Fall.)	8.21	33.33	III	16.54	4.13	33.33	III	11.73	4.13	41.66	III	13.11
Verdanus abdominalis (F.)	9.58	33.33	III	17.86	–	–	–	–	–	–	–	–
Arthaldeus pascuellus (Fall.)	–	–	–	–	2.75	25	IV	8.29	6.20	50	III	17.60

Fig. 22. The dynamics of species abundance among the species dominating on the plot 21.







Plot 22 (*Betula pendula – Carex remota*)

On the plot 22 from 2004 to 2006 there were collected 390 representatives of the Fulgoromorpha and Cicadomorpha belonging to 16 species.

In all research seasons the eudominant status was achieved by the species *Neophilaenus lineatus* (36.98%, 38.56% and 32.92% respectively). The dominant species were: *Speudotettix subfusculus* (20.54%) in 2004; *Hyledelphax elegantula* (20.26%) in 2005; *Balclutha punctata* (29.26%) in 2006. In the years 2004 and 2005 the subdominant species was *Balclutha rhenana* (10.95% and 18.95% respectively), and in 2006 *Hyledelphax elegantula* (10.36%) (Tab. 25).

As for the constancy of appearance, to the first class there belonged the species *Balclutha punctata* (2006), while to the second class there belonged the species *Hyledelphax elegantula* (2005–2006) and *Balclutha punctata* (2005) (Tab. 25).

The highest value of the *Q* index was achieved by the species *Balclutha punctata* (49.37) in 2006 (Tab. 25).

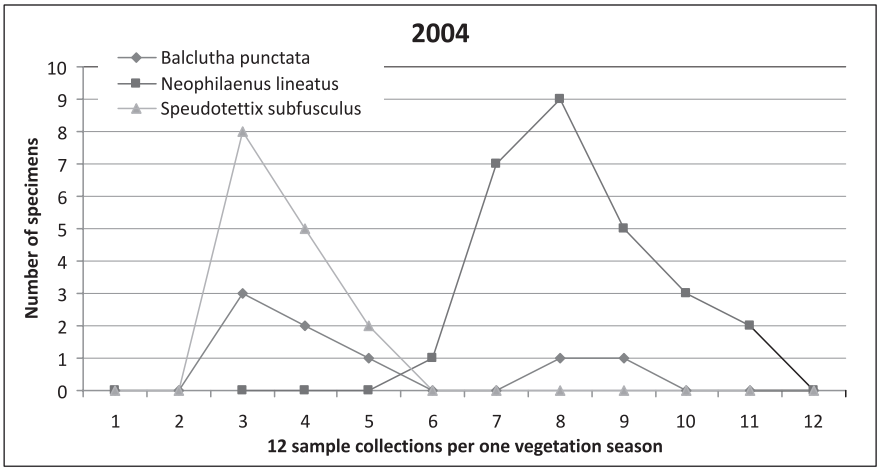
The characteristic species for the plot 22 was the *Ribautodelphax albostriata* (75%) (Annex 1).

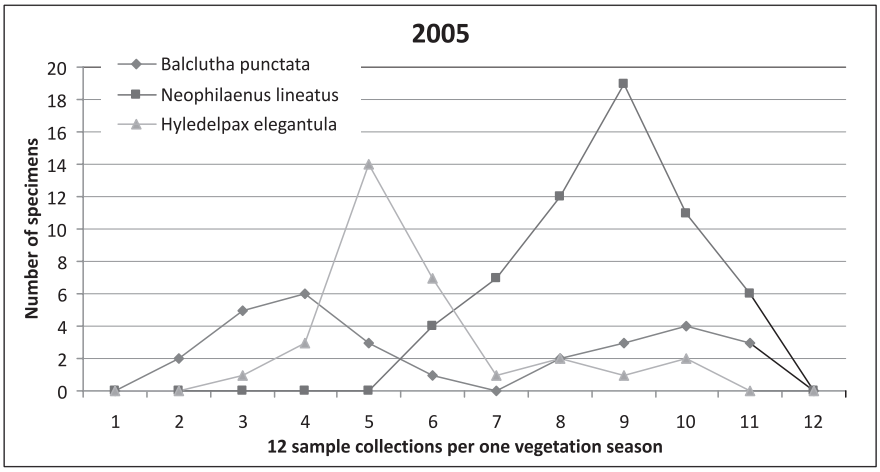
The dynamics of species abundance among the species dominating on the plot 22 was as follows: the species *Neophilaenus lineatus* had its maximum of appearance in the second half of August, and in 2004 the species *Speudotettix subfusculus* had its maximum at the beginning of June. The species *Balclutha punctata* achieved two maxima of appearance, one in the middle of June, the other at the break of August and September (Fig. 23).

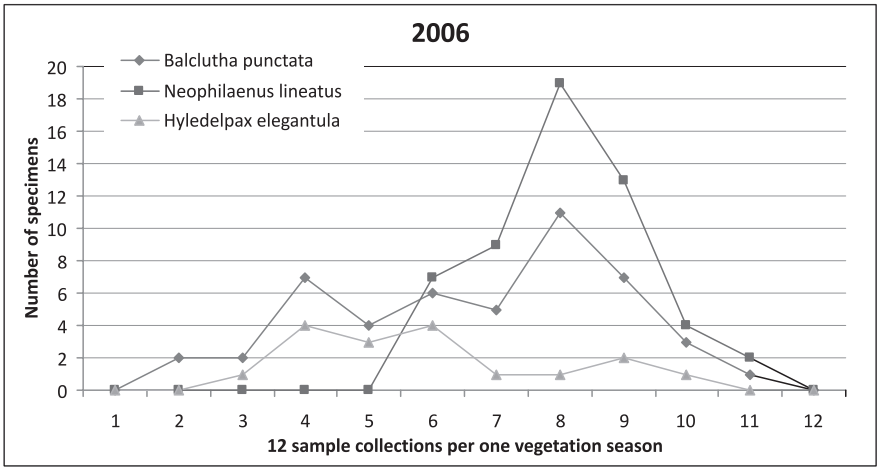
Table 25. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 22 – *Betula pendula – Carex remota*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Eurybregma nigrolineata Scott	1.36	8.33	IV	3.36	–	–	–	–	–	–	–	–
Stiroma bicarinata (H.-S.)	–	–	–	–	1.96	16.66	IV	5.71	–	–	–	–
Laodelphax striatella (Fall.)	–	–	–	–	–	–	–	–	2.43	25	IV	7.79
Hyledelphax elegantula (Boh.)	2.73	16.66	IV	6.74	20.26	66.66	II	36.74	10.36	66.66	II	26.27
Javesella pellucida (F.)	–	–	–	–	5.88	16.66	IV	9.89	4.26	25	IV	10.31
Ribautodelphax albostriata (Fieb.)	4.1	16.66	IV	8.26	–	–	–	–	–	–	–	–
Neophilaenus lineatus (L.)	36.98	50	III	43	38.56	50	III	43.9	32.92	50	III	40.57
Aphrophora alni (Fall.)	5.47	25	IV	11.69	–	–	–	–	–	–	–	–
Oncopsis tristis (Zett.)	–	–	–	–	3.26	25	IV	9.02	2.43	25	IV	7.79
Balclutha punctata (F.)	10.95	41.66	III	21.35	18.95	75	II	37.69	29.26	83.33	I	49.37
Deltocephalus pulicaris (Fall.)	1.36	8.33	IV	3.36	0.65	8.33	IV	2.32	1.82	16.66	IV	5.5
Speudotettix subfusculus (Fall.)	20.54	25	IV	22.66	5.22	33.33	III	13.19	3.04	25	IV	8.71
Psammotettix alienus (Dhlb.)	–	–	–	–	2.61	16.66	IV	6.59	5.48	33.33	III	13.51
Errastunus ocellaris (Fall.)	6.84	25	IV	13.07	1.96	25	IV	7	6.7	50	III	18.3
Verdanus abdominalis (F.)	5.47	25	IV	11.69	0.65	8.33	IV	2.32	–	–	–	–
Arthaldeus pascuellus (Fall.)	4.1	25	IV	10.12	–	–	–	–	1.21	16.66	IV	4.48

Fig. 23. The dynamics of species abundance among the species dominating on the plot 22.







Plot 23 (*Eriophorum latifolium*)

On the plot 23 from 2004 to 2006 there were collected 331 representatives of the Fulgoromorpha and Cicadomorpha belonging to 10 species.

The most abundant species on the plot 23 was *Nothodelphax distincta*, which achieved the eudominant status in 2005 and 2006 (50.74% and 32.41% respectively). The subdominant species *Neophilaenus lineatus* (19.23%;), *Jassargus distinguendus* (11.53%), *Verdanus abdominalis* (19.23%) and *Arthaldeus pascuellus* (13.46%) in 2004, and *Arthaldeus pascuellus* (12.41%) in 2006 (Tab. 26).

As for the constancy of occurrence, in 2006 to the second class there belonged the species *Balclutha punctata* and *Arthaldeus pascuellus* (Tab. 26).

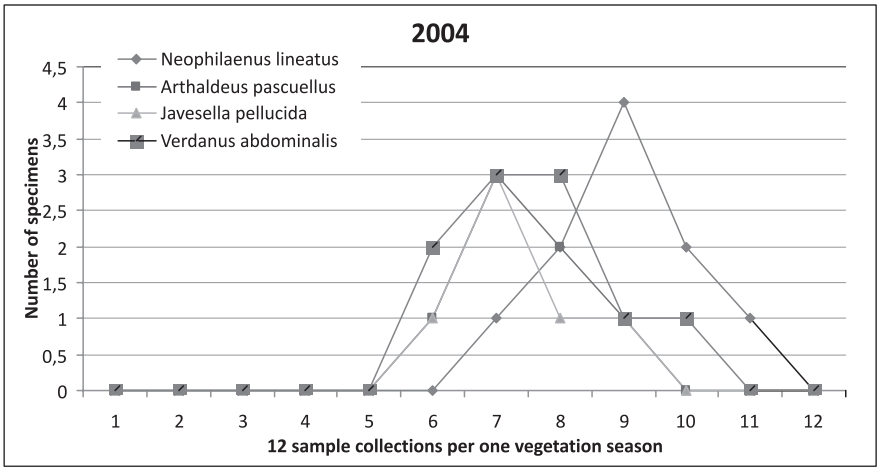
The highest value of the *Q* index was achieved in 2006 by the species *Nothodelphax distincta* (35.61) (Tab. 26).

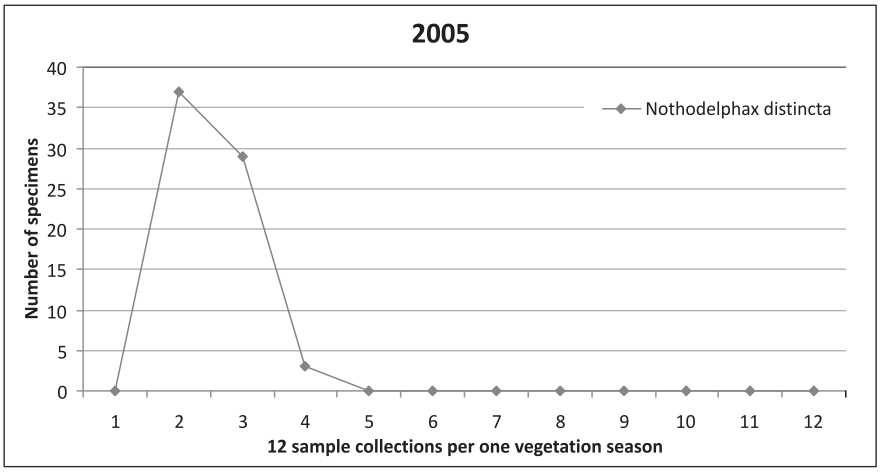
The dynamics of species abundance among the species dominating on the plot 23 was as follows: the species *Nothodelphax distincta* had its single maximum of appearance in the middle of May (Fig. 24).

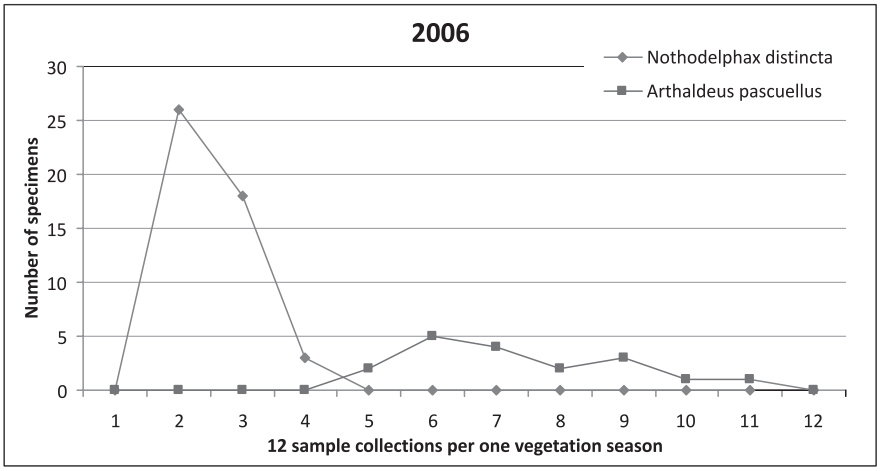
Table 26. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 23 – *Eriophorum latifolium*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Laodelphax striatella (Fall.)	–	–	–	–	6.71	41.66	III	16.71	6.89	41.66	III	16.94
Nothodelphax distincta (Fl.)	7.69	16.66	IV	11.31	50.74	25	IV	35.61	32.41	25	IV	28.46
Neophilaenus lineatus (L.)	19.23	41.66	III	28.3	–	–	–	–	6.89	41.66	III	16.94
Balclutha punctata (F.)	7.69	25	IV	13.86	5.97	50	III	17.27	8.96	66.66	II	24.43
Elymana sulphurella (Zett.)	7.69	16.66	IV	11.31	7.46	50	III	19.31	6.2	50	III	17.6
Errastunus ocellaris (Fall.)	9.61	33.33	III	17.89	8.2	50	III	20.24	7.58	50	III	19.46
Jassargus distinguendus (Fl.)	11.53	33.33	III	19.6	5.22	41.66	III	14.76	6.2	41.66	III	16.07
Verdanus abdominalis (F.)	19.23	41.66	III	28.3	2.98	25	IV	8.63	3.44	25	IV	9.27
Arthaldeus pascuellus (Fall.)	13.46	33.33	III	21.18	2.98	25	IV	8.63	12.41	58.33	II	26.9
Sorhoanus xanthoneurus (Fieb.)	3.84	16.66	IV	7.99	9.7	33.33	III	17.98	8.96	33.33	III	17.28

Fig. 24. The dynamics of species abundance among the species dominating on the plot 23.







Plot 24 (*Carex flava – Eriophorum latifolium*)

On the plot 24 from 2004 to 2006 there were collected 333 representatives of the Fulgoromorpha and Cicadomorpha belonging to 10 species.

In the years 2005–2006 the eudominant species was *Nothodelphax distincta* (58.74% and 43.06% respectively), while *Nothodelphax distincta* (26.41%) and *Neophilaenus lineatus* (24.52%) were the dominant species in 2004. The subdominant species included: *Jassargus distinguendus* (16.98%) and *Arthaldeus pascuellus* (16.98%) in 2004; *Arthaldeus pascuellus* (10.48%) in 2005; *Neophilaenus lineatus* (10.94%) and *Sorhoanus xanthoneurus* (10.94%) in 2006 (Tab. 27).

With respect to the constancy of occurrence, in 2005 and 2006 to the second class there belonged the species *Laodelphax striatella*. Moreover, to the second class there also belonged the species *Arthaldeus pascuellus* in 2005, and *Elymana sulphurella* in 2006 (Tab. 27).

In 2005–2006, the highest value of the *Q* index on the plot 24 was achieved by the species *Nothodelphax distincta* (38.32 and 32.81 respectively) (Tab. 27).

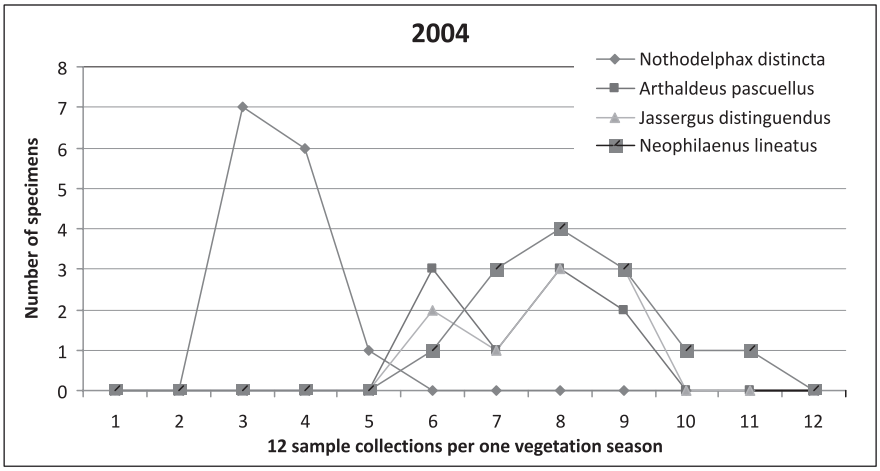
The characteristic species for the plot 24 included *Nothodelphax distincta* (56.88%) and *Sorhoanus xanthoneurus* (51.72%) (Annex 1).

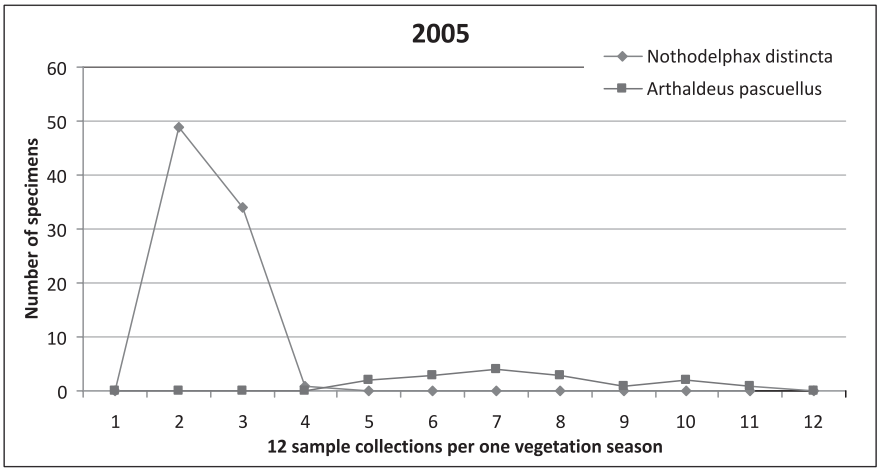
The dynamics of species abundance among the species dominating on the plot 24 was as follows: the species *Nothodelphax distincta* had its single maximum of appearance at the beginning of June in 2004, and in the middle of May in the years 2005–2006. The species *Neophilaenus lineatus* had its maximum of appearance in the middle of August, in the years 2004 and 2006 (Fig. 25).

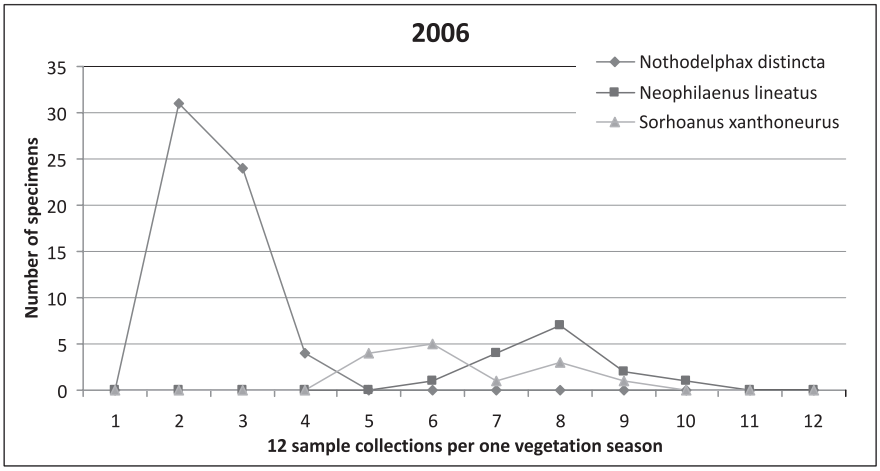
Table 27. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 24 – *Carex flava – Eriophorum latifolium*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Laodelphax striatella (Fall.)	–	–	–	–	7.69	58.33	II	21.17	8.75	58.33	II	22.59
Nothodelphax distincta (Fl.)	26.41	25	IV	25.69	58.74	25	IV	38.32	43.06	25	IV	32.81
Neophilaenus lineatus (L.)	24.52	50	III	35.01	2.79	25	IV	8.35	10.94	41.66	III	21.34
Cicadella viridis (L.)	3.77	16.66	IV	7.92	–	–	–	–	1.45	8.33	IV	3.47
Elymana sulphurella (Zett.)	–	–	–	–	3.49	33.33	III	10.78	8.75	58.33	II	22.59
Macustus grisescens (Zett.)	3.77	16.66	IV	7.92	2.09	16.66	IV	5.9	0.72	8.33	IV	2.44
Jassargus distinguendus (Fl.)	16.98	33.33	III	23.78	6.99	50	III	18.69	6.56	50	III	18.11
Verdanus abdominalis (F.)	–	–	–	–	–	–	–	–	4.37	33.33	III	12.06
Arthaldeus pascuellus (Fall.)	16.98	33.33	III	23.78	10.48	58.33	II	24.72	4.37	41.66	III	13.49
Sorhoanus xanthoneurus (Fieb.)	7.54	25	IV	13.72	7.69	41.66	III	17.89	10.94	41.66	III	21.34

Fig. 25. The dynamics of species abundance among the species dominating on the plot 24.







Plot 25 (*Picea excelsa – Calamagrostis epigejos*)

On the plot 25 from 2004 to 2006 there were collected 596 representatives of the Fulgoromorpha and Cicadomorpha belonging to 26 species.

The species *Neophilaenus lineatus* achieved the eudominant status in 2004, and the dominant status in 2005 and 2006 (34.5%, 20.51% and 26.81% respectively). As for the subdominant status, it was achieved by *Arthaldeus pascuellus* (10.56%) in 2004; *Laodelphax striatella* (13.67%) and *Balclutha punctata* (19.23%) in 2005; *Javesella pellucida* (12.27%) in 2006. Additionally, in all research seasons the subdominant status was achieved by the species *Diplocolenus sudeticus* (15.49%, 11.11% and 12.27% respectively) (Tab. 28).

As for the constancy of occurrence, in the years 2005 and 2006 the species *Balclutha punctata* belonged to the first class (Tab. 28).

The highest value of the *Q* index on the plot 25 during the three research seasons was achieved by the following species: *Balclutha punctata* (20.25, 40.03 and 37.07 respectively) and *Neophilaenus lineatus* (33.9, 32.02 and 39.54 respectively) (Tab. 28).

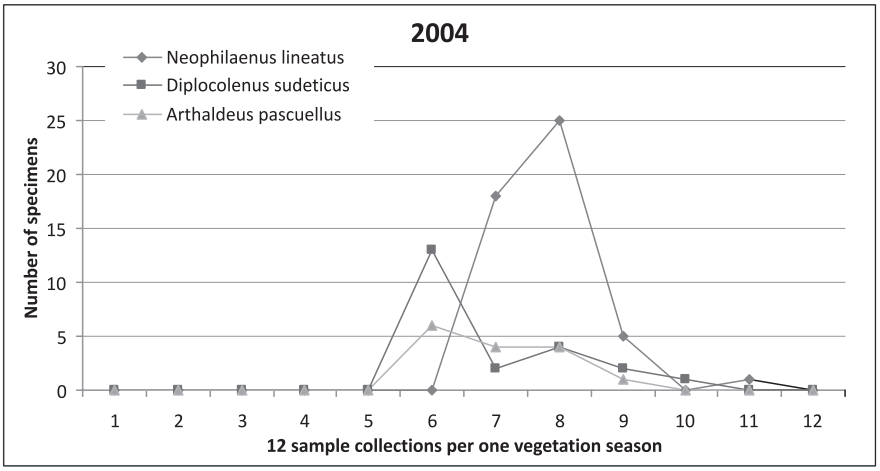
The characteristic species for the plot 25 included *Cercopis vulnerata* (52.63%) and *Diplocolenus sudeticus* (55.14%) (Annex 1).

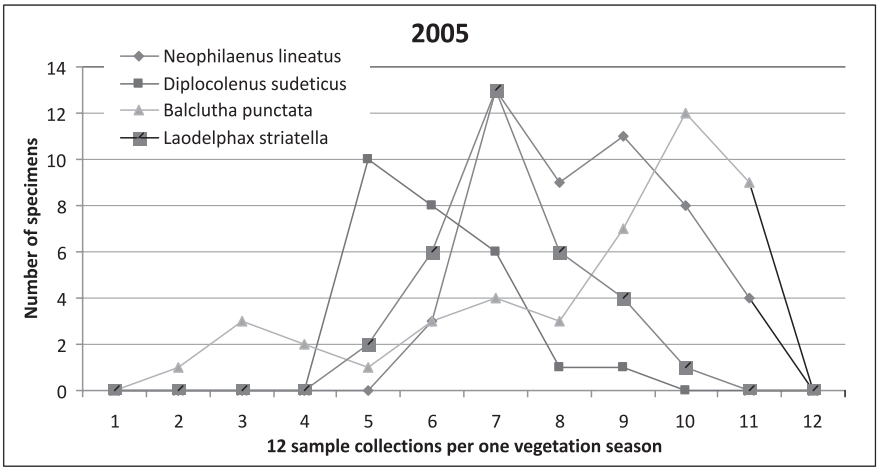
The dynamics of species abundance among the species dominating on the plot 25 was as follows: in the years 2004–2006 the species *Neophilaenus lineatus* achieved its maximum of appearance in the first half of August (Fig. 26).

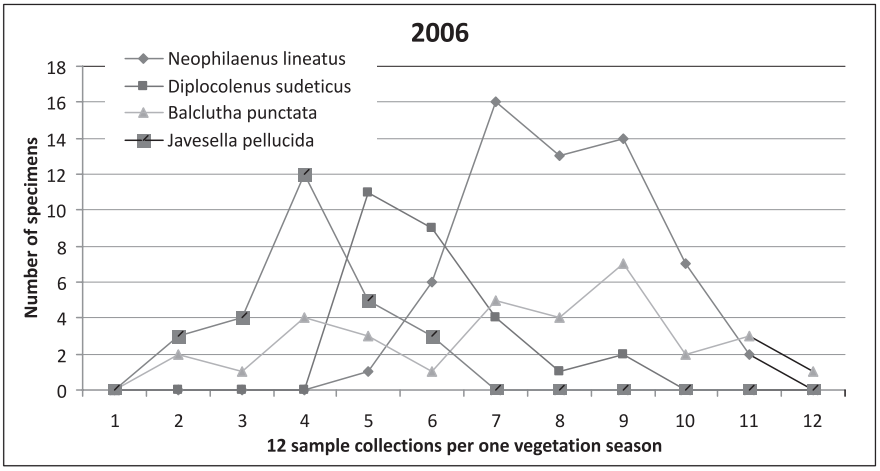
Table 28. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 25 – *Picea excelsa – Calamagrostis epigejos*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Stenocranus major (Kbm.)	–	–	–	–	0.85	8.33	IV	2.66	–	–	–	–
Eurybregma nigrolineata Scott	0.7	8.33	IV	2.41	–	–	–	–	–	–	–	–
Laodelphax striatella (Fall.)	–	–	–	–	13.67	50	III	26.14	5.45	41.66	III	15.06
Hyledelphax elegantula (Boh.)	6.33	25	IV	12.57	6.41	66.66	II	20.67	5.45	58.33	II	17.82
Muellerianella brevipennis (Boh.)	–	–	–	–	1.7	25	IV	6.51	5.9	41.66	III	15.67
Javesella discolor (Boh.)	–	–	–	–	0.42	8.33	IV	1.87	–	–	–	–
Javesella pellucida (F.)	0.7	8.33	IV	2.41	1.7	25	IV	6.51	12.27	41.66	III	22.6
Cercopis vulnerata Rossi	1.4	16.66	IV	4.82	1.7	25	IV	6.51	1.1	16.66	IV	4.28
Neophilaenus lineatus (L.)	34.5	33.33	III	33.9	20.51	50	III	32.02	26.81	58.33	II	39.54
Philaenus spumarius (L.)	–	–	–	–	2.13	25	IV	7.29	1.36	25	IV	5.83
Oncopsis flavicollis (L.)	–	–	–	–	–	–	–	–	0.45	8.33	IV	1.93
Agallia brachyptera (Boh.)	2.11	16.66	IV	5.92	–	–	–	–	–	–	–	–
Cicadella viridis (L.)	2.11	25	IV	7.26	–	–	–	–	–	–	–	–
Balclutha punctcta (F.)	9.85	41.66	III	20.25	19.23	83.33	I	40.03	15	91.66	I	37.07
Paluda flaveola (Boh.)	3.52	25	IV	9.38	5.12	33.33	III	13.06	3.18	33.33	III	10.29
Elymana sulphurella (Zett.)	–	–	–	–	4.27	50	III	14.61	–	–	–	–
Speudotettix subfusculus (Fall.)	2.81	25	IV	8.38	–	–	–	–	–	–	–	–
Athysanus argentarius Metc.	–	–	–	–	–	–	–	–	0.45	8.33	IV	1.93
Arocephalus longiceps (Kbm.)	–	–	–	–	1.7	16.66	IV	5.32	–	–	–	–
Psammotettix alienus (Dhlb.)	–	–	–	–	3.84	33.33	III	11.31	–	–	–	–
Errastunus ocellaris (Fall.)	–	–	–	–	2.99	41.66	III	11.16	5.45	58.33	II	17.82
Jassargus alpinus neglectus (Then)	–	–	–	–	1.7	16.66	IV	5.32	3.18	25	IV	8.91
Jassargus distinguendus (Fl.)	7.04	25	IV	13.26	–	–	–	–	–	–	–	–
Diplocolenus sudeticus (Kol.)	15.49	41.66	III	25.4	11.11	41.66	III	21.51	12.27	41.66	III	22.6
Verdanus abdominalis (F.)	2.81	25	IV	8.38	0.85	16.66	IV	3.76	–	–	–	–
Arthaldeus pascuellus (Fall.)	10.56	33.33	III	18.76	–	–	–	–	0.9	16.66	IV	3.87

Fig. 26. The dynamics of species abundance among the species dominating on the plot 25.







Plot 26 (*Picea excelsa – Vaccinium myrtilus*)

On the plot 26 from 2004 to 2006 there were collected 233 representatives of the Fulgoromorpha and Cicadomorpha belonging to 4 species.

In the years 2004–2006 the eudominant species was *Neophilaenus lineatus* (72.41%, 61.85% and 61.53% respectively), while the dominant species was *Balclutha punctata* (20.68%, 24.74% and 28.2% respectively). Moreover, in 2005 the subdominant status was achieved by the species *Hyledelphax elegantula* (13.4%) (Tab. 29).

As for the constancy of occurrence, in 2005 and 2006 to the first class there belonged the species *Balclutha punctata* (Tab. 29).

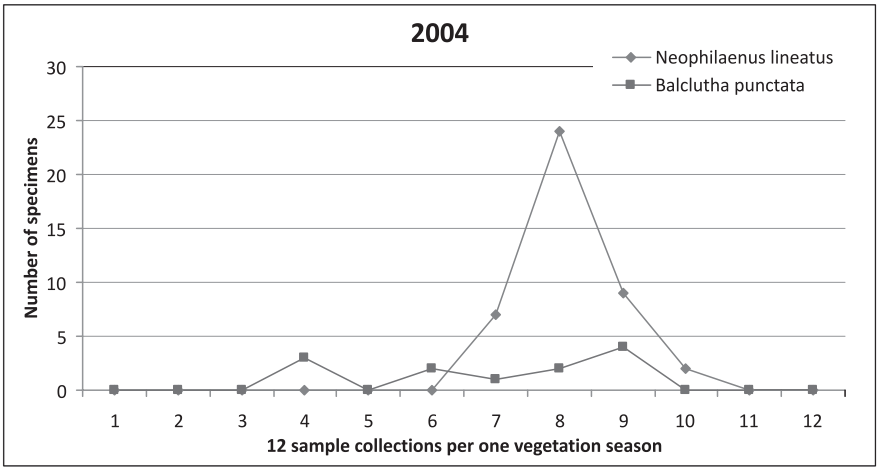
The highest value of the *Q* index in the years 2004–2006 was achieved by the species *Neophilaenus lineatus* (49.12, 55.61 and 55.46) (Tab. 29).

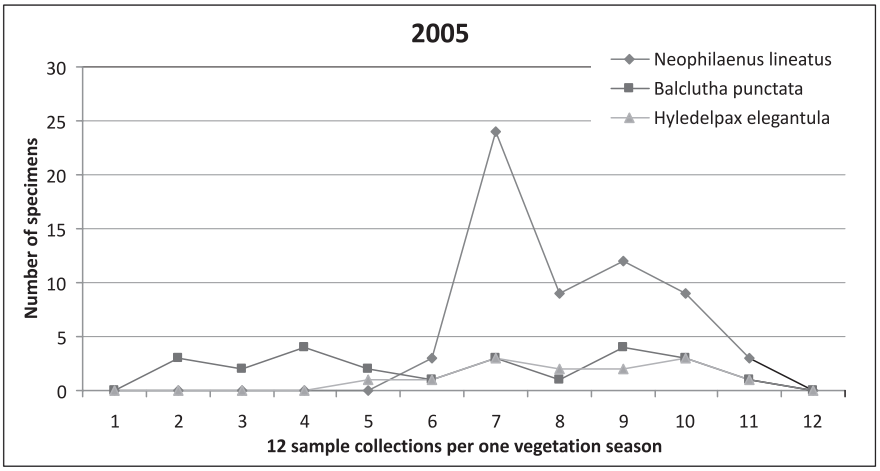
The dynamics of species abundance among the species dominating on the plot 26 was as follows: the species *Neophilaenus lineatus* had its maximum of appearance in the first half of August. The species *Balclutha punctata* had two maxima of appearance, one in the middle of June, the other in the middle of September (Fig. 27).

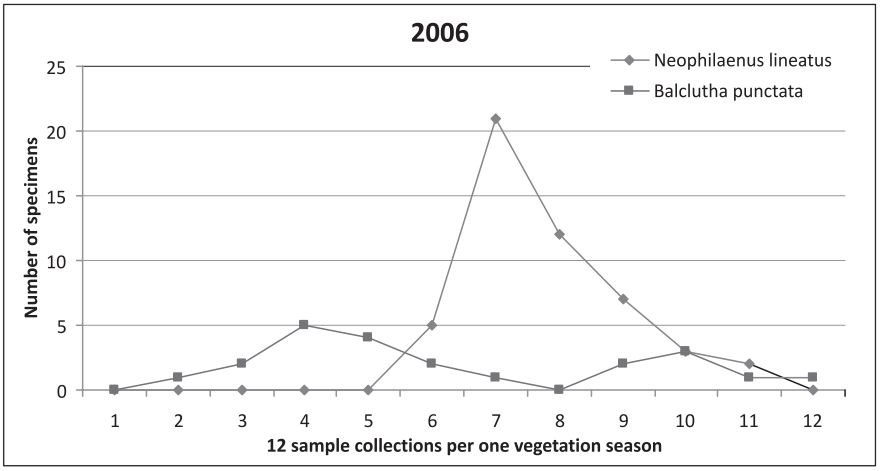
Table 29. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 26 – *Picea excelsa – Vaccinium myrtilus*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Hyledelphax elegantula (Boh.)	6.89	25	IV	13.12	13.4	58.33	II	27.95	7.69	33.33	III	16
Javesella pellucida (F.)	–	–	–	–	–	–	–	–	2.56	16.66	IV	6.53
Neophilaenus lineatus (L.)	72.41	33.33	III	49.12	61.85	50	III	55.61	61.53	50	III	55.46
Balclutha punctata (F.)	20.68	41.66	III	29.35	24.74	83.33	I	45.4	28.2	83.33	I	48.47

Fig. 27. The dynamics of species abundance among the species dominating on the plot 26.







Plot 27 (*Picea excelsa – Deschampsia flexuosa*)

On the plot 27 from 2004 to 2006 there were collected 256 representatives of the Fulgoromorpha and Cicadomorpha belonging to 5 species.

In the years 2004–2006 the eudominant species was *Neophilaenus lineatus* (77.1%, 34.61% and 48.42% respectively). In 2005 and 2006 the eudominant status was achieved also by the species *Balclutha punctata* (42.3% and 35.78% respectively). Moreover, in 2004 the subdominant status was achieved by *Balclutha punctata* (13.25%) and in 2005 by *Hyledelphax elegantula* (14.1%) (Tab. 30).

As for the constancy of occurrence, in 2005 and 2006 to the first class there belonged the species *Balclutha punctata*, and to the second class, in 2005, the species *Hyledelphax elegantula* (Tab. 30).

The highest value of the *Q* index during the three research seasons was achieved by the following species: *Balclutha punctata* (23.49; 59.37; 54.6) and *Neophilaenus lineatus* (56.67, 41.59 and 44.91 respectively) (Tab. 30).

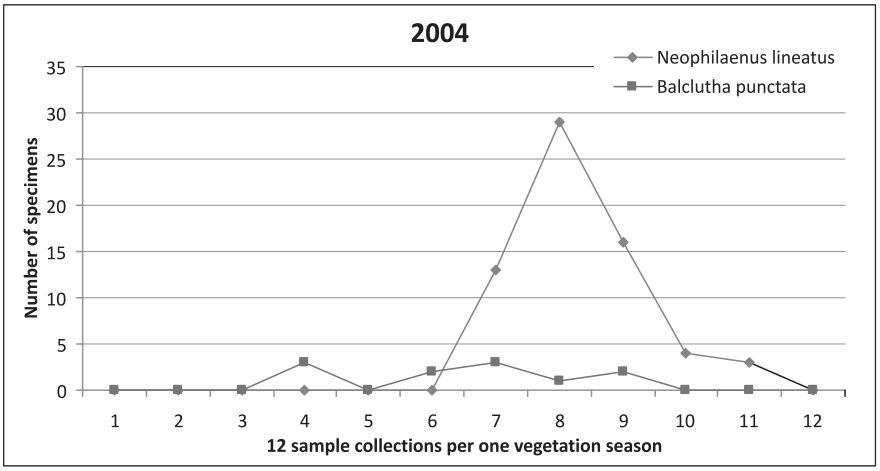
The characteristic species for the plot 27 was *Javesella discolor* (66.66%) (Annex 1).

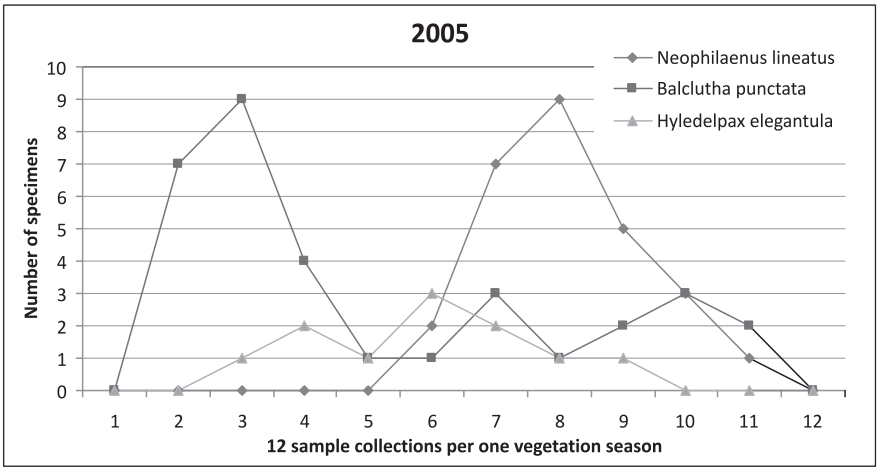
The dynamics of species abundance among the species dominating on the plot 27 was as follows: the species *Neophilaenus lineatus* had its maximum of appearance in the middle of August. The species *Balclutha punctata* had two maxima of appearance, one at the beginning of June, the other lasting from the middle of August to the middle of September (Fig. 28).

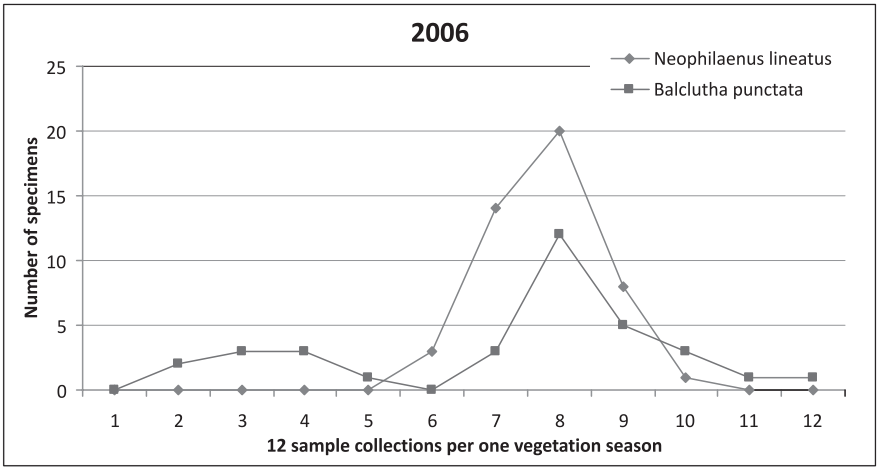
Table 30. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 27 – *Picea excelsa – Deschampsia flexuosa*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Hyledelphax elegantula (Boh.)	2.4	16.66	IV	6.32	14.1	58.33	II	28.67	8.42	50	III	20.51
Javesella discolor (Boh.)	3.61	16.66	IV	7.75	2.56	16.66	IV	6.53	1.05	8.33	IV	2.95
Neophilaenus lineatus (L.)	77.1	41.66	III	56.67	34.61	50	III	41.59	48.42	41.66	III	44.91
Balclutha punctata (F.)	13.25	41.66	III	23.49	42.3	83.33	I	59.37	35.78	83.33	I	54.6
Jassargus distinguendus (Fl.)	3.61	16.66	IV	7.75	6.41	33.33	III	14.61	6.31	33.33	III	14.5

Fig. 28. The dynamics of species abundance among the species dominating on the plot 27.







Plot 28 (*Picea excelsa – Trientalis europaea*)

On the plot 28 from 2004 to 2006 there were collected 444 representatives of the Fulgoromorpha and Cicadomorpha belonging to 19 species.

During the three-year research period on the plot 28 the eudominant status was achieved by the species *Neophilaenus lineatus* (33.33%, 40.51% and 33.29% respectively). The dominant status was achieved in 2005 by the species *Hyledelphax elegantula* (21.02%), and the subdominant status was achieved in the years 2004–2006 by the species *Balclutha punctata* (18.88%, 11.79% and 15.09% respectively). Furthermore, in 2004 the subdominant status was also achieved by the species *Jassargus distinguendus* (15.55%) (Tab. 31).

As for the constancy of occurrence, in 2006 the species *Balclutha punctata* belonged to the first class, in 2005 – to the second class, in 2004 – to the third class. To the second class there also belonged such species as *Hyledelphax elegantula* and *Javesella pellucida* in 2005, *Hyledelphax elegantula* and *Neophilaenus lineatus* in 2006 (Tab. 31).

The highest value of the *Q* index was achieved by the species *Neophilaenus lineatus* (33.33, 45 and 44.06 respectively) (Tab. 31).

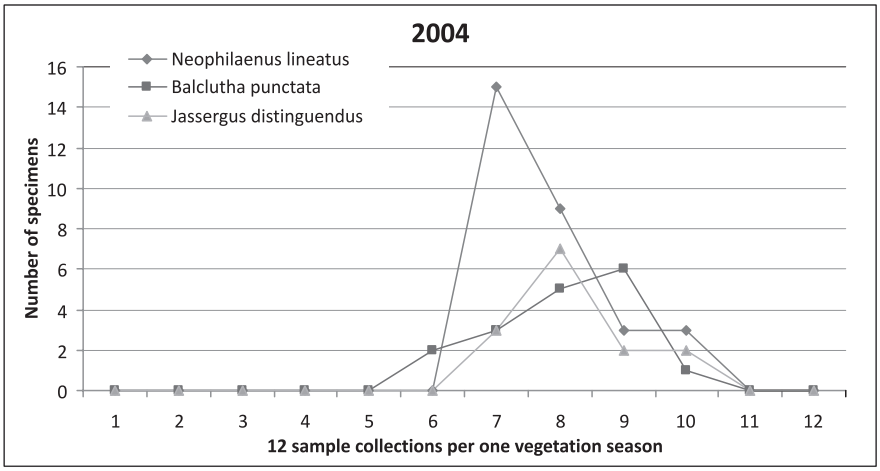
The differential species on the plot 28 was *Diplocolenus bohemani* (100%), while the characteristic species included *Oncopsis flavicollis* (83.33%), *Dikraneura variata* (60%) and *Elymana kozhevnikovi* (58.33%) (Annex 1).

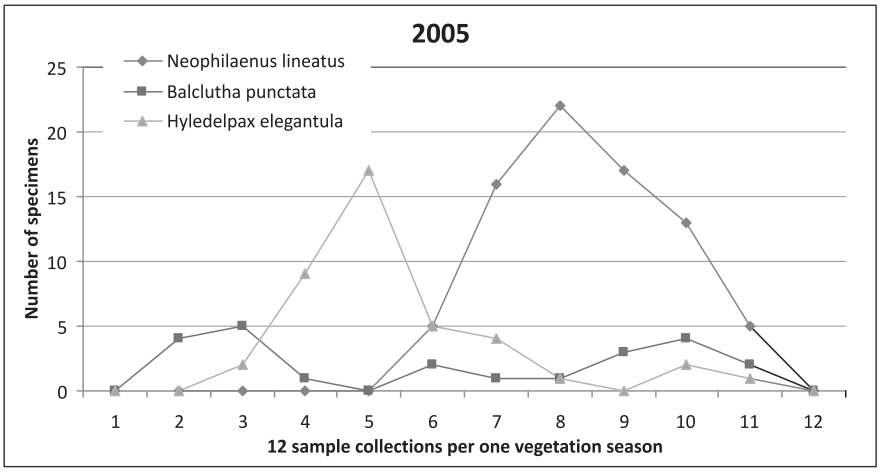
The dynamics of species abundance among the species dominating on the plot 28 was as follows: in 2004 the species *Neophilaenus lineatus* was most abundant at the beginning of August, and in the years 2005 and 2006 in the middle of August. The species *Hyledelphax elegantula* had its single maximum of appearance at the beginning of June (Fig. 29).

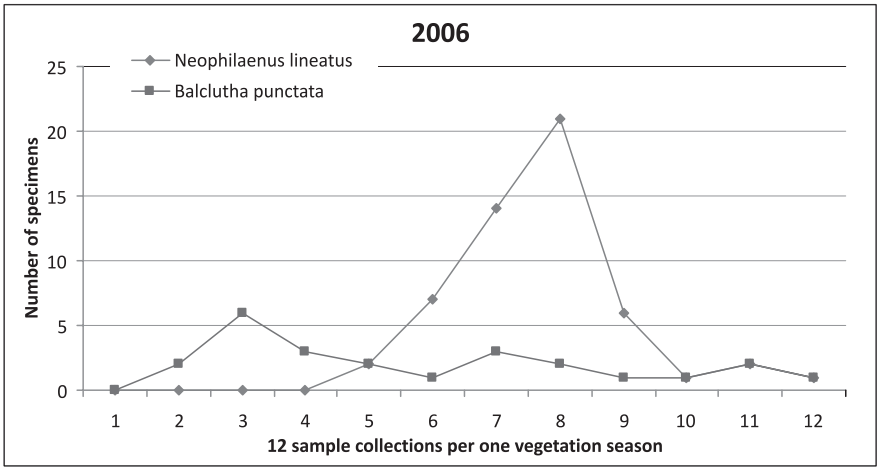
Table 31. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 28 – *Picea excelsa* – *Trientalis europaea*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Hyledelphax elegantula (Boh.)	6.66	16.66	IV	10.53	21.02	66.66	II	37.43	7.54	58.33	II	20.97
Javesella discolor (Boh.)	–	–	–	–	–	–	–	–	1.25	16.66	IV	4.56
Javesella pellucida (F.)	–	–	–	–	6.15	58.33	II	18.94	6.91	50	III	18.58
Neophilaenus lineatus (L.)	33.33	33.33	III	33.33	40.51	50	III	45	33.29	58.33	II	44.06
Philaenus spumarius (L.)	5.55	25	IV	11.77	–	–	–	–	–	–	–	–
Oncopsis flavicollis (L.)	–	–	–	–	–	–	–	–	3.14	16.66	IV	7.23
Cicadella viridis (L.)	2.22	16.66	IV	6.08	–	–	–	–	–	–	–	–
Dikraneura variata Hardy	–	–	–	–	2.05	25	IV	7.15	1.25	16.66	IV	4.56
Balclutha punctata (F.)	18.88	41.66	III	28.04	11.79	75	II	29.73	15.09	91.66	I	37.19
Macrosteles laevis (Rib.)	–	–	–	–	1.02	16.66	IV	4.12	–	–	–	–
Doratura stylata (Boh.)	1.11	8.33	IV	3.04	–	–	–	–	–	–	–	–
Allygus mixtus (F.)	–	–	–	–	0.51	8.33	IV	2.06	–	–	–	–
Elymana kozhevnikovi (Zschv.)	–	–	–	–	1.53	16.66	IV	5.04	2.51	25	IV	7.92
Elymana sulphurella (Zett.)	–	–	–	–	–	–	–	–	8.17	41.66	III	18.44
Streptanus marginatus (Kbm.)	7.77	25	IV	13.93	3.58	16.66	IV	7.72	7.54	33.33	III	15.85
Jassargus alpinus neglectus (Then)	–	–	–	–	2.56	33.33	III	9.23	5.66	41.66	III	15.35
Jassargus distinguendus (Fl.)	15.55	33.33	III	22.76	–	–	–	–	–	–	–	–
Diplocolenus bohemani (Zett.)	–	–	–	–	1.02	16.66	IV	4.12	1.88	16.66	IV	5.59
Diplocolenus sudeticus (Kol.)	8.88	41.66	III	19.23	8.2	33.33	III	16.53	5.66	41.66	III	15.35

Fig. 29. The dynamics of species abundance among the species dominating on the plot 28.







Plot 29 (*Betula pendula – Pteridium aquilinum*)

On the plot 29 from 2004 to 2006 there were collected 425 representatives of the Fulgoromorpha and Cicadomorpha belonging to 18 species.

In 2004, on the plot 29, the dominant species was *Hyledelphax elegantula* (21.49%), while in 2005 and 2006 it was the species *Neophilaenus lineatus* (25.62% and 21.51% respectively). The subdominant status was achieved by such species as *Neophilaenus lineatus* (13.08%), *Balclutha punctata* (16.82%), *Jassargus distinguendus* (12.14%) and *Verdanus abdominalis* (17.75%) in 2004; *Hyledelphax elegantula* (18.75%) and *Balclutha punctata* (14.37%) in 2005; *Hyledelphax elegantula* (15.18%), *Javesella pellucida* (10.75%) and *Balclutha punctata* (16.45%) in 2006 (Tab. 32).

As for the constancy of occurrence, to the first class there belonged the species *Balclutha punctata* (2005 and 2006), and to the second class such species as *Hyledelphax elegantula* (2005 and 2006) and *Javesella pellucida* (2006) (Tab. 32).

The highest value of the *Q* index during the three research seasons (2004–2006) was achieved by the following species: *Balclutha punctata* (29, 34.6 and 37.02 respectively) and *Neophilaenus lineatus* (18.08, 35.79 and 32.79 respectively) (Tab. 32).

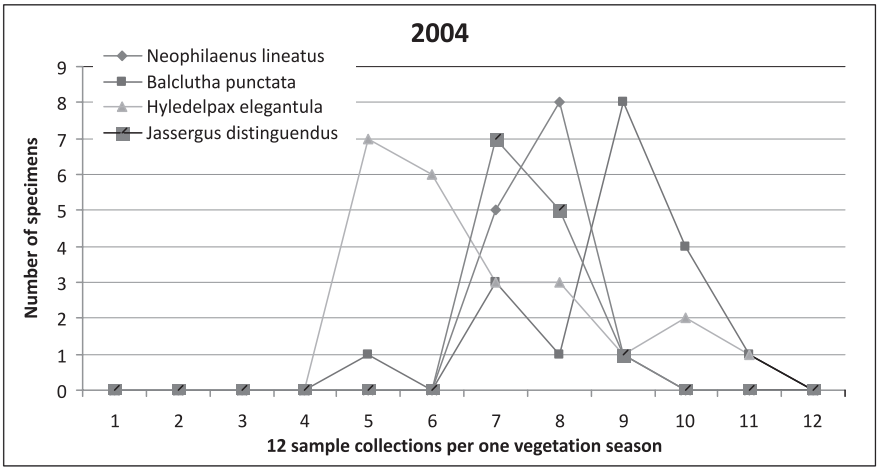
The differential species on the plot 29 was *Kybos smaragdulus* (100%), while the characteristic species was *Oncopsis tristis* (54.54%) (Annex 1).

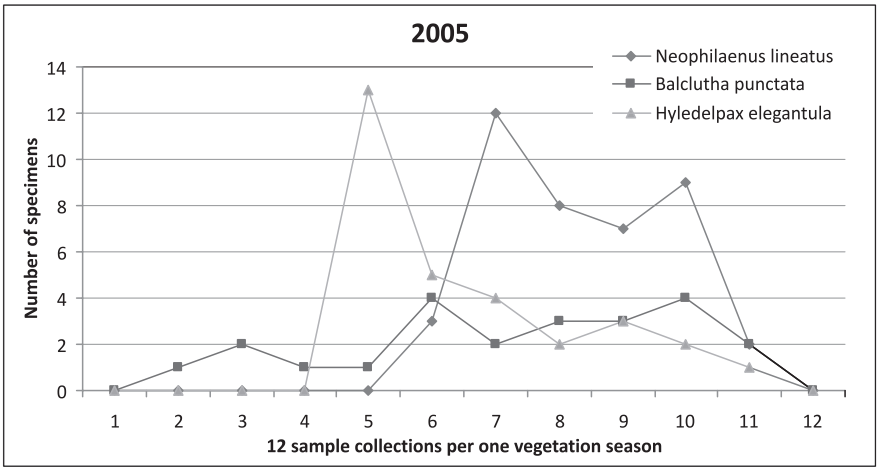
The dynamics of species abundance among the species dominating on the plot 29 was as follows: in 2004 the species *Neophilaenus lineatus* had its maximum of appearance in the middle of August, and in the years 2005 and 2006 at the beginning of August. In all three research seasons the species *Hyledelphax elegantula* had its single maximum of appearance in the middle of July (Fig. 30).

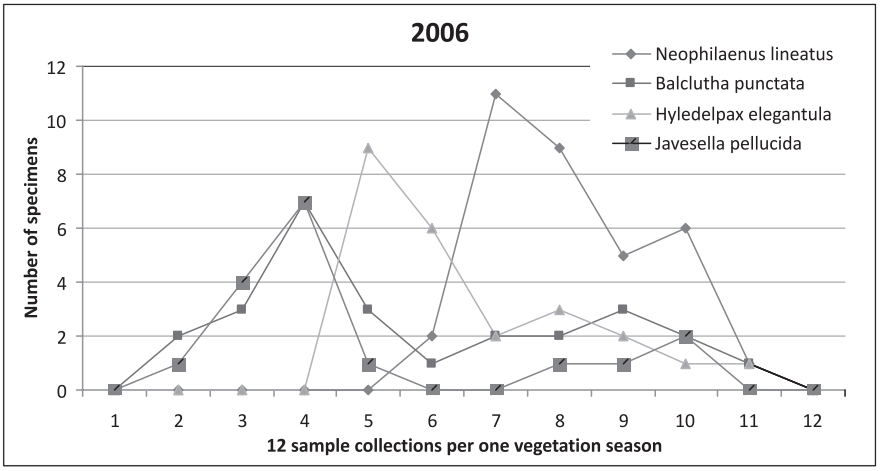
Table 32. List of domination (*D*) [%], constancy (*C*) [%] and *Q* index for particular species of the Fulgoromorpha and Cicadomorpha collected by sweep netting method for the purpose of quantitative research (plot 29 – *Betula pendula – Pteridium aquilinum*).

Name of species	Year											
	2004				2005				2006			
	D	*C*		*Q*	*D*	*C*		*Q*	*D*	*C*		*Q*
Hyledelphax elegantula (Boh.)	21.49	58.33	II	35.4	18.75	58.33	II	33.07	15.18	58.33	II	29.75
Muellerianella brevipennis (Boh.)	–	–	–	–	1.25	16.66	IV	4.56	2.53	25	IV	7.95
Javesella pellucida (F.)	7.47	33.33	III	15.77	6.25	50	III	17.67	10.75	58.33	II	25.04
Neophilaenus lineatus (L.)	13.08	25	IV	18.08	25.62	50	III	35.79	21.51	50	III	32.79
Oncopsis tristis (Zett.)	4.67	25	IV	10.8	5	33.33	III	12.9	3.16	25	IV	8.88
Agallia brachyptera (Boh.)	0.93	8.33	IV	2.78	–	–	–	–	2.53	25	IV	7.95
Dikraneura variata Hardy	0.93	8.33	IV	2.78	1.25	16.66	IV	4.56	0.63	8.33	IV	2.29
Kybos smaragdulus (Fall.)	–	–	–	–	0.62	8.33	IV	2.27	–	–	–	–
Balclutha punctata (F.)	16.82	50	III	29	14.37	83.33	I	34.6	16.45	83.33	I	37.02
Paluda flaveola (Boh.)	–	–	–	–	3.12	33.33	III	10.19	1.89	25	IV	6.87
Elymana kozhevnikovi (Zachv.)	–	–	–	–	1.87	16.66	IV	5.58	1.26	16.66	IV	4.58
Streptanus marginatus (Kbm.)	7.47	33.33	III	15.77	10	41.66	III	20.41	3.16	25	IV	8.88
Arocephalus longiceps (Kbm.)	–	–	–	–	0.62	8.33	IV	2.27	–	–	–	–
Psammotettix alienus (Dhlb.)	–	–	–	–	0.62	8.33	IV	2.27	–	–	–	–
Jassargus alpinus neglectus (Then)	–	–	–	–	3.75	33.33	III	11.17	3.79	33.33	III	11.23
Jassargus distinguendus (Fl.)	12.14	25	IV	17.42	–	–	–	–	5.69	33.33	III	13.77
Diplocolenus sudeticus (Kol.)	6.54	25	IV	12.78	2.5	33.33	III	9.12	5.06	41.66	III	14.51
Verdanus abdominalis (F.)	8.41	33.33	III	24.32	4.37	25	IV	10.45	6.32	33.33	III	14.51

Fig. 30. The dynamics of species abundance among the species dominating on the plot 29.







5.2. QUALITATIVE ANALYSIS

The material for qualitative analysis was collected in the years 2003–2006 in the Stołowe Mountains National Park both by sweep netting and by hand collecting method, and resulted in collecting 90 species of the Fulgoromorpha and Cicadomorpha. Out of this number 58 species were also collected while conducting the quantitative research, i.e. in the specific research areas, and 26 species were collected solely while conducting the qualitative research, outside the boundaries of the research areas described in previous sections (Tab. 3).

5.3. INDICES OF SPECIES RICHNESS AND SPECIES EVENNESS

Shannon-Weaver diversity index (*H'*) for the selected Fulgoromorpha and Cicadomorpha communities in the Stołowe Mountains National Park had the values between 0.39 and 1.2. The lowest value (0.39) was recorded in the *Picea excelsa-Vaccinium myrtilus* community (plot 26), and the highest (1.2) in the *Holcus lanatus* community (plots 19 and 20), where the values were 1.19 and 1.2 respectively (Annex 2 and Annex 12).

Pielou evenness index (*J'*) for the selected Fulgoromorpha and Cicadomorpha communities in the SMNP had the values between 26.48 and 38.69. The lowest value (26.48) was recorded in the *Nardus stricta* community (plot 6), and the highest in the *Eriophorum latifolium* community (plot 23) (Annex 2).

Brillouin diversity index ($\hat{H}$) for the selected Fulgoromorpha and Cicadomorpha communities in the SMNP had the values between 0.37 and 1.18. The lowest value (0.37) was recorded in the *Picea excelsa-Vaccinium myrtilus* community (plot 26) and the highest in the *Holcus lanatus* community, i.e. on the plots 19 (1.17) and 20 (1.18) (Annex 2 and Annex 13).

Simpson diversity index (*I'*) (sampling-related index of actual species diversity) for the selected Fulgoromorpha and Cicadomorpha communities in the SMNP had the values between 0.51 and 0.92. The lowest value (0.51) was recorded in the *Picea excelsa-Vaccinium myrtilus* community (plot 26), and the highest (0.92) in the *Holcus lanatus* community, i.e. on the plots 19 (0.91) and 20 (0.92) (Annex 2 and Annex 14).

The value of the potential diversity index I_p was the lowest on the plot 26, and equaled 0.75, while on the plots 19 and 20 it was the highest, and in both cases equaled 0.97 (Annex 2). The species diversity of the Fulgoromorpha and Cicadomorpha on the plot 26 was lower than the potential one by 32%, while on the plot 20 it was lower than the potential one by about 5% (Annex 2).

5.4. SIMILARITIES OF THE FULGOROMORPHA AND CICADOMORPHA COMMUNITIES IN THE RESEARCH PLOTS

Application of the agglomerative algorithm (Fig. ~~34~~) allowed to distinguish five faunistic groups within the investigated areas (two groups in forest communities and three in communities associated with open areas):

- the first group consists of communities associated with the *Caricion davalianae* alliance (plots 23, 24);
- the second group consists of communities associated with the *Vaccinio-Piceeion* alliance (plots: 25, 26, 27, 28, 29) and *Alno-Ulmion* alliance (plots 21, 22);
- the third group consists of communities associated with the *Holcus lanatus* alliance (plots 19, 20);
- the fourth group consists of communities associated with the *Filipendulion ulmariae* alliance (plot 3) and *Nardion* alliance (plots 5, 6);
- the fifth group consists of communities associated with the *Caltion palustris* alliance (plots 1, 2, 4, 11, 12, 15, 16), *Arrhenatherion elatioris* alliance (plots 7, 8, 9, 10, 17, 18) and *Alopecurion pratensis* alliance (plots 13, 14).

The application of the Principal Component Analysis (PCA) resulted in dividing the communities encountered in particular research areas during the years 2004–2006 into two faunistic groups (Annex 16). One is associated with meadow communities (plots 1–20), and the other is associated with forest communities (plots 21–29).

The most abundant species on the plots 1–20 included: *Verdanus abdominalis*, *Jassargus distinguendus*, *Philaenus spumarius*, *Errastunus ocellaris* and *Arthaldeus pascuellus*.

The most abundant species on the plots 21–29 included: *Neophilaenus lineatus*, *Hyledelphax elegantula*, *Diplocolenus sudeticus* and *Balclutha punctata.*

5.5. DISCRIMINANT ANALYSIS

The application of the discriminant analysis (Annex 3) allowed for establishing the following indicators:

- numerical index of habitat mosaicity (*Dn*), which had the minimal value (0.14) on the plots 13 and 16, and the maximum value (0.86) on the plot 29;
- species index of habitat mosaicity (*Ds*), which had the minimal value (0.6) on the plots 13, 16 and 27, and the maximum value (0.96) on the plot 25.

5.6. CHOROLOGICAL ANALYSIS

The widely distributed elements have the greatest share in the collected material and include the following: Euro-Siberian (30.1%), European (19.42%), Transpalearctic (16.5%), Siberian (10.68%), Westernpalearctic (5.83%), Holarctic (6.8%), Northen European (4.85%), Mediterranean (1.94%) and Euroalpine (1.94%) (Annex 4). The rarest elements, represented by single species, include: Kazakh and Western European ones, which collectively constitute 0.97% of the collected material (Annex 4). The share of particular chorological elements in the Fulgoromorpha and Cicadomorpha communities associated with the investigated plant communities is shown in Annex 5, 6 and 7.

Meadow areas (Annex 5, Annex 6):

In the collected material the largest group includes the widely distributed species, which constitute over 75% of the material collected from all research areas. These species belong to such elements as: Transpalearctic, European, Euro-Siberian, West-Palearctic, Holarctic and Siberian.

Among the ecological elements represented by single species there can be found:

- Northern European element represented by *Eupteryx signatipennis* (Boh.) and *Macrosteles ossiannilssoni* Ldb.
- Mediterranean element represented by *Cercopis sanguinolenta* (Scop.) and *Megophthalmus scanicus* (Fall.)
- Kazakh element represented by *Chlorita paolii* (Oss.)
- Euroalpine element represented by *Diplocolenus sudeticus* (Kol.).

Forest areas (Annex 7):

In the collected material the largest group includes the widely distributed species, which constitute over 75% of the material collected from all research areas. These species belong to such elements as: Transpalearctic, Euro-Siberian, Westernpalearctic and Holarctic.

Among the ecological elements represented by single species there can be found:

- European element represented by *Muellerianella brevipennis* (Boh.), *Cercopis vulnerata* Rossi, *Planaphrodes nigrita* (Kbm.), *Allygus mixtus* (F.) and *Arocephalus longiceps* (Kbm.)
- Siberian element represented by *Paluda flaveola* (Boh.), *Elymana kozhevnikovi* (Zachv.), *Streptanus marginatus* (Kbm.) and *Sorhoanus xanthoneurus* (Fieb.)
- Northern European element represented by *Nothodelphax distincta* (Fl.)
- Euroalpine element represented by *Diplocolenus sudeticus* (Kol.)

5.7. ECOLOGICAL ANALYSIS

Among the species of cicada fauna collected in the investigated area in the years 2003–2006 there dominated mezohygrophilous taxons, constituting 59.22% of the total material. Hygrophilous species, i.e. ones associated with damp habitats constituted 31.07%, and xerothermophilous ones, i.e. those associated with dry biotopes, constituted 9.71% (Annex 8).

With respect to such a factor as sunshine intensity in the investigated area, the most abundant were the mezoheliophilous species, constituting 61.17% of the total material collected, followed by heliophilous species including 37 taxons (35.92% of the total material), and skiophilous species, constituting 2.91% of the total material collected (Annex 8).

The analysis of trophic structure resulted in distinguishing 40 oligophagous species (38.83%), 40 monophagous species (38.83%) and 23 polyphagous species, which constituted 22.33% of the total material collected (Annex 8).

With respect to life strategy (Annex 8) the oligotopic and stenotopic species were the dominant ones (35.92% and 30.1% respectively), followed by the eurytopic species (19.42%). The remaining group included pioneering species (4.85%), being an accidental and foreign element in the homeostatic habitats, as well as dendrophilous species (9.71%), whose presence in grassland phytocenoses was also accidental.

The share of particular ecological elements in the Fulgoromorpha and Cicadomorpha communities associated with the investigated plant communities is displayed in Annex 9, 10 and 11.

6. A REVIEW OF RARE SPECIES OF THE FULGOROMORPHA AND CICADOMORPHA COLLECTED IN THE STOŁOWE MOUNTAINS NATIONAL PARK

Anakelisia perspicillata (Boheman, 1845)

During the qualitative research, on 28th August 2006, there was collected 1♂ individual in the vicinity of the "Pośna" – "Mały Karłów" stream.

The species is widely distributed in Europe and has also been recorded in Mongolia and Central Siberia. In Poland it has been encountered in the Mazovian Lowland, in Śródborów (Otwock poviat) (Nast, 1973), in the Lesser Poland Upland, in Grabowiec nature reserve (Pińczów poviat) (Nast, 1973), in the Kraków-Wieluń Upland, in Pilica (Lis, 1988) and in the Pieniny Mountains, in Krościenko (Smreczyński, 1954) and Podłaźce (Nast, 1976a).

The species inhabits xerothermic grasslands and dry meadows, and can be encountered on blue sedge (*Carex flacca*) and pill sedge (*C. pilulifera*) (Nickel, 2003).

Eurybregma nigrolineata Scott, 1875

There were collected 3 individuals: 1♀ (28th May 2004) in the "Łężyckie Skałki" nature reserve; 1♀ (10th June 2004) in the region of "Mały Karłów"; 1♀ (29th June 2005) in the region of "Mały Karłów".

The species is widely distributed in western, central and southern Europe.

In Poland its presence has been recorded in 5 localities so far: Lower Silesia, Wielisław Złotoryjski (Nast, 1973); Kraków-Wieluń Uppland, Olsztyn (Świerczewski & Gębicki, 2004; Świerczewski, 2006); Sanodmierz Lowland, Krzemienica, the Stołowe Mountains (Gaj & Drożdż-Gaj, 2005) and Upper Silesia, Sosnowiec (Walczak, 2005).

The species can be encountered mainly in steppe areas, on dry meadows, in ruderal areas and on road borders (Nickel, 1994). It is an oligophagous species, feeding on high grasses such as quackgrass (*Elymus repens*), common velvet grass (*Holcus lanatus*) and orchard grass *Dactylis glomerata*) (Nickel, 2003).

In Sudety Mountains its presence for the first time describe Gaj (Gaj & Drożdż-Gaj, 2005).

Acanthodelphax denticauda (Boheman, 1847)

About a dozen individuals were collected on grasslands associated with the *Arrhenatherion elatioris* alliance.

The species is distributed over central and northern Europe. In Poland it has been recorded in a few lowland localities: Mazovian Lowland (Nast, 1973), Pomeranian Lakeland (Wagner, 1941), Silesia (Wagner & Franz, 1961), and the Świętokrzyskie Mountains (Nast, 1938a).

The species inhabits mainly dry meadows. It is a monophagous species feeding on *Deschampsia cespitosa*, but encountered also on *Calamagrostis lanceolata*. Being bivoltine, it hibernates as nymph (Nickel & Remane, 2002).

The species had never been recorded in Polish mountains before.

Erythria manderstjernii (Kirschbaum, 1868)

About a dozen individuals were collected in forest areas with *Fagus silvatica* admixture in the period between July and September.

The species is widely distributed within the mountain ranges of the Sudetes and the Carpathians (Pilarczyk & Szwedo, 2004). Furthermore, it is encountered in the mountains of France, Italy and Romania, and has also been recorded in Azerbaijan (Nast, 1976a).

Due to its external similarity to the *Erythria manderstjernii* (Kirschbaum, 1868), a species belonging to the Deltocephalinae subfamily, is often labeled incorrectly. It is a Euro-Alpine mountain endemic species.

The species prefers sunny habitats and is mezohygrophilous. It hibernates as imago and is polyphagous (LeQuesne & Payne, 1981; Reimer 1992). Its host plants include mainly such genera as *Ranunculus*, *Senecio*, *Vaccinum*, *Crepis*, *Trifolium*, and *Plantago* (Nickel, 2003).

Florodelphax leptosoma Vilbaste, 1968

There were collected two individuals belonging to this species, namely 1♂ (1st October 2005) in the "Łężyckie Skałki" nature reserve (plot 20) and 1♂ (16th September 2006) in the vicinity of the Batorów village (plot 1).

The species is widely distributed in Poland (Gębicki *et al.*, 1982; Smreczyński, 1906, 1954; Szulczewski, 1933; Wagner, 1941). Moreover, its presence has been recorded in Asia Minor (Nast, 1976a).

The species is encountered in damp and boggy meadows; it is a monophagous species feeding on *Juncus articulatus*. Being bivoltine, it hibernates as nymph (Nickel & Remane, 2002).

The species had never been recorded in the Sudetes before.

Muellerianella extrusa **(**Scott, 1871)

The individuals of this species were collected solely during qualitative research: 1♂ (29th June 2005) and 1♀ (16th July 2005) in the vicinity of "Mały Karłów".

The distribution of this species is not well known, as it is probably often mistaken for *Muellerianella fairmairei* (Perris, 1857). Its presence has been recorded in Białowieża National Park and the Western Beskid Mountains (Nast, 1986), and it can also be encountered in northern and western Europe, Spain, former Yugoslavia and Greece (Nast, 1987). Data concerning the distribution of this species in Japan and China needs additional confirmation (Anufriev & Emel'yanov, 1988).

The natural habitat of the species includes peat bogs, boglands and other similar ecosystems in the lowlands and foothills (Booij, 1981, 1982; dellaGiustina & Remane, 1992). The species is monophagous and feeds on *Molinia caerulea*. Being a univoltine species, it hibernates in egg form (Nickel & Remane, 2002).

Anaceratagallia ribauti (Ossiannilsson, 1938)

During qualitative research there was collected 1♂ (29th June 2005) in the vicinity of the "Pośna" – "Mały Karłów" stream.

In Poland the species in widely distributed in the lowland areas (Smreczyński, 1954; Wagner, 1941), and also encountered in the Pieniny Mountains and the Western Beskid Mountains (Pilarczyk & Szwedo, 2005). Apart from Europe, its presence has been recorded in Altai and Armenia (Nast, 1976a).

It is a single-generation species, inhabiting inland and coastal dunes, loose sandy grasslands and dry tall-herb vegetation (Szwedo, 1999). The species is characterized by a wide trophic spectrum, including *Thymus*, *Plantago*, Fabaceae, Lamiaceae (Nickel & Remane, 2002).

Eupteryx signatipennis (Boheman, 1847) (Table 2, Fig. 31, 32, 33)

On the meadows in the vicinity of the "Pośna" – "Mały Karłów" stream there were collected 11 individuals.

The species is widely distributed in northern Europe (Scandinavia, the Baltic countries, Great Britain, Ireland), encountered also in France, Belgium, Switzerland, the Netherlands (Nast, 1972, 1987) and the northern parts of Germany (Mecklenburg, Brandenburg, Saxony). It is rarely collected, in the period from June to September, and develops local populations (Nickel, 2003).

The individuals of this species have green-yellow bodies with frequent presence of a pair of round darker patches on the head and pronotum. Delicate dark patches on the wings make the species similar to such taxons as *Eupteryx aurata* (Linné, 1758) and *E. atropunctata* (Goeze, 1778), for which it might be mistaken in the past (Ossiannilsson, 1981).

The species inhabits damp and shady meadows, pastures and road borders. It is a monopahgous species, feeding on *Filipendula ulmaria*. It is a two-generation species, hibernating in egg form (Nickel & Remane, 2002). In the mountain regions (in the Alps) its presence is limited to the height of 1200 m a.s.l. (Nickel, 2003).

The species had never been recorded in Poland before.

Diplocolenus sudeticus (Kolenati, 1860)

Many individuals of this species were collected in forest areas where the *Picea excelsa* was dominant, and encountered also in grasslands situated in the vicinity of such areas.

It is an Alpine-Sudetian endemic species, encountered in the Limestone Alps (Shneeberg) in Austria (Pilarczyk & Szwedo, 2005), Czech Republic (Orlicke Hory; Morawy), France (Nast, 1987) as well as in the Bystrzyckie Mountains (Nast, 1973) and the Śnieżnik Mountains (Wagner, 1948) in Poland. It inhabits subalpine pastures and avalanche debris, trophically associated with grasses (*Deschampsia cespitosa*, *Nardus stricta*). Being univoltine, it hibernates in egg form (Nickel & Remane, 2002).

The species was synonymized by Knight, 1974 with *Diplocolenus penthopitta* (Walker, 1851) but it seems that it should be regarded as a separate species (Pilarczyk & Szwedo, 2005).

Elymana kozhevnikowi (Zachvatkin, 1938)

About a dozen individuals were collected, mainly in the thinned out forests where *Picea excelsa* was dominant, and in the vicinity of such forests.

The species originates from the Siberian taiga and is distributed all over Central Europe, but encountered only locally and thus rarely collected. In Poland it has been recorded in Pomeranian Lakeland (Świerczewski & Gębicki, 2003), Masurian Lakeland (Wagner & Franz, 1961), Białowieża Forest (Karpiński, 1958), Lesser Poland Upland (Gębicki, 1983) and Upper Silesia (Gębicki, 1979).

The species is mezohygrophilous, prefers to inhabit thinned out forests. It is trophically associated with grasses (*Poa arundinacea, P. varia, P. canescens*) Being a single-generation species, it hibernates in egg form (Nickel & Remane, 2002; Nickel, 2003).

Fig. 31. *Eupteryx signatipennis* (Boheman, 1847): male specimen collected on 17. 07. 2005: Stołowe Mountains National Park; plot 11

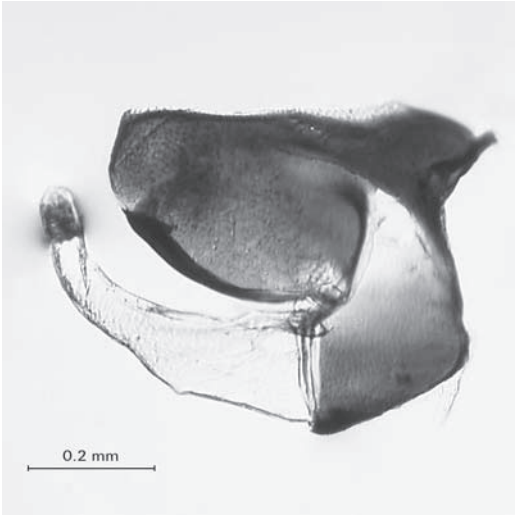


Fig. 32. *Eupteryx signatipennis* (Boheman, 1847): Lateral lobe of pygofer from interiorly, inner appendage with broad base, apex forked (male specimen collected on 17. 07. 2005: Stołowe Mountains National Park; plot 11

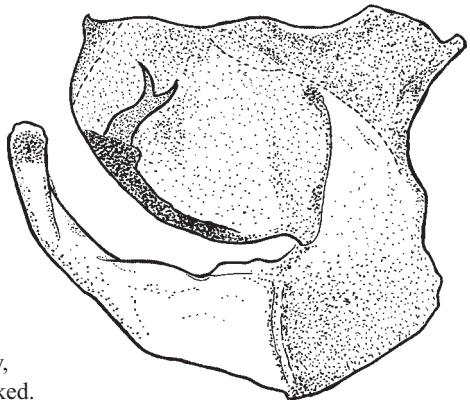


Fig. 33. *Eupteryx signatipennis* (Boheman, 1847): same lateral lobe of pygofer from interiorly, inner appendage with broad base, apex forked.

7. DISCUSSION

One of the crucial issues of ecology is the study of the structure of animal communities (Petrusewicz, 1966). The organization of a population and how it is distributed over the area it inhabits is of fundamental importance not only for the population in question, but also for the populations of other species living in the same habitat. Describing the structure of the biocenosis in a truly complex way is impossible in practice, thus fragmentary studies are conducted, focusing on a selected group of species forming part of the ecosystem (Trojan, 1992). Such a group constitutes a model representing the network of relations within the biocenosis.

In this study the term *community* is used with reference to a group of species of the Fulgoromorpha and Cicadomorpha whose internal interactions are not well investigated, including both the species inhabiting a particular phytocenosis and those which appear in there only temporarily or accidentally, as a result of migration from another habitat or the change of a host plant.

The associations of such communities of the Fulgoromorpha and Cicadomorpha, related to particular types of phytocenoses, linked to the syntaxons of higher units, are often patterned into clearly distinguishable groups, constituting the so-called circles of communities. The presence of such circles of the Fulgoromorpha and Cicadomorpha communities had already been confirmed in the broad-leaved forests in the neighborhood of Pińczów (Gębicki, 1983), in sand excavations in the vicinity of Jaworzno-Szczakowa and Bukowno (Szwedo, 1997), and in grassland communities of the Częstochowa Uppland (Świerczewski, 2006). Their presence had also been confirmed with reference to the Miridae communities (Heteroptera, Miridae) encountered in the herbaceous, grassland and forest phytocenoses (Herczek, 1987).

The research was conducted in 29 research plots representative of both meadows and forests of the Stołowe Mountains National Park (Tab. 1 and Fig. 1).

The non-forest areas of the SMNP, which is a comparatively new established national park, mostly include post-agricultural areas (*Agrostis-Holcus-Cirsium heterophyllum*) and sparse grasslands of the *Nardo-Callunetea* class. There can be found mown meadows which, similarly to forest areas of anthropogenic origin, are subject to the protection and/or plant community shaping scheme (Kozłowska & Solon, 1999).

The most important species, constituting the core of communities, abundant in all non-forest areas, included: *Verdanus abdominalis*, *Arthaldeus pascuellus*, *Errastunus ocellaris*, *Balclutha punctata*, *Cicadula persimilis* and *Jassargus distinguendus*. In the forest areas the most important species included *Neophilaenus lineatus* and *Balclutha punctata*.

Among the communities of the Fulgoromorpha and Cicadomorpha associated with non-forest communities, those associated with the *Nardus stricta* grasslands (plot 5 and plot 6) have a noticeable identity, and the presence of 26–29 species was recorded there (Tab. 8 and Tab. 9). For meadow communities with the participation of plants

characteristic of the *Nardo-Callunetea* class, 61 species were recorded by Bednarczyk and Gębicki (1998) in the surroundings of Janów Lubelski, and Klimaszewski *et al.* (1980a) recorded 30 species in the surroundings of Dąbrowa Górnicza (Upper Silesia). While gathering material for the present study, in all research seasons the dominant and very abundant taxons included *Verdanus abdominalis* and *Doratura stylata*, which remained in accord with the results which had been obtained earlier by the above mentioned authors. Differential species (Annex 1) included *Anoscopus flavostriatus* (plot 5), encountered also in the surroundings of Janów Lubelski, and *Streptanus aemulans* (plot 6). Moreover, for the latter area, there were also recorded the following characteristic species: *Eupelix cuspidata*, *Doratura stylata*, *Rhopalopyx preyssleri* and *Psammotettix cephalotes* (Annex 1). The latter species is also a characteristic one in the Upper Silesia region, while the species *Eupelix cuspidata* is a characteristic one in the surroundings of Janów Lubelski. The above-described community of the Fulgoromorpha and Cicadomorpha is characterized by the largest number of differential and characteristic species among all of the investigated plots.

Furthermore, the community is characterized by a comparatively large participation of xerophilous and heliophilous species (5 and 9 respectively), which is probably connected with the slope gradient and its southern exposure, which results in the grassland growing in the area being the "driest" one among all of those investigated during the research conducted in the area of the SMNP.

The above-described zoocenosis (associated with the *Nardus stricta* grassland) is also characterized by a rich species composition and large abundance of individuals, among which there prevail the specialized species, i.e. oligotopic and stenotopic ones, hibernating in egg form.

Furthermore, in comparison to the community associated with meadows of the *Molinio-Arrhenathereta* class (Annex 9 and 10), in the above-described community there was observed a significantly lower number of polyphagous species, which suggests an advanced process of the "ripening" of the phytocenosis, related to the succession processes (Novotný, 1994a). Seemingly, in stable ecosystems the polyphagous and eurytopic taxons feeding on plants which have the highest nutritional value are being replaced by more specialized species, i.e. the ones which are capable of feeding on plants with comparatively low nutritional value (Waloff, 1980; Hill, 1982; Prestidge, 1982). The increase of an ecosystem's floral richness and the changes in its structure directly influence the increase in the number of the Fulgoromorpha and Cicadomorpha present (Waloff & Solomon, 1973; Tallamy & Denno, 1979; Györffy & Körmöczi, 1987; Novotný, 1990). In such a community there dominate the species with narrower nutritional and habitat preferences, and at the same time rather narrowly distributed ones.

The situation is different in the case of hay-growing meadows of the *Molinio-Arrhenathereta* class, where 18 communities of the Fulgoromorpha and Cicadomorpha belonging to 5 phytosociological associations were investigated. The analysis of the collected material revealed the general similarities among the Fulgoromorpha and Cicadomorpha inhabiting these phytocenoses, which is reflected by the similar share

of particular ecological (Annex 9 and 10) and chorological elements (Annex 5 and 6). In comparison to the grasslands of the *Nardo-Callunetea* class, the share of polyphagous and eurytopic species is larger, while the share of monophags, oligophags and stenophags is smaller. What is more, there are more species hibernating in larval stages or as imago, constituting the measure of environmental disturbances (Waloff, 1980; Hollier *et al.*, 1994).

As has already been mentioned, the hay-growing meadows of the *Molinio-Arrhenathereta* class constitute the second group of the investigated plant communities, where the presence of the largest number of the Fulgoromorpha and Cicadomorpha was recorded (from 15 to 35 taxons). Several dozens species encountered in similar phytocenoses had also been described by Andrzejewska (1971, 1976), Bednarczyk and Gębicki (1998), Chudzicka (1989), Doskocil and Hurka (1962), Gębicki (1979), Gębicki *et al.* (1977), Klimaszewski *et al.* (1980a) and Szwedo (1992). The presence of slightly fewer taxons was recorded in the city lawns characterized by species composition similar to that of the meadows of the *Molinio-Arrhenathereta* class (Chudzicka, 1986, Kubicka *et al.*, 1986). Basic species which belong to this type of a community in the area of the SMNP include *Javesella pellucida*, *Psammotettix cephalotes*, *Verdanus abdominalis*, *Arthaldeus pascuellus*, *Errastunus ocellaris* and *Cicadula persimilis*, which confirms the results of the studies that had previously been conducted in various regions of Poland. However, in some cases the presence of the species *Javesella pellucida* as a dominant or subdominant one may suggest that we have to do with a habitat with non-steady conditions, i.e. with a phytocenosis which is biologically imbalanced (Andrzejewska, 1976).

The communities of the Fulgoromorpha and Cicadomorpha associated with the *Cirsietum rivularis* community (plots: 1, 2, 4, 15, 16) can be divided into three groups according to the humidity factor.

The first group includes the community on the plot 4, situated in the neighborhood of "Małe Torfowisko Batorowskie". In this community the presence of 23 species of the Fulgoromorpha and Cicadomorpha was recorded (Tab. 7), of which 30.43% were hygrophilous, and 65.22% mezohygrophilous species (Annex 9). The most abundant species included *Balclutha punctata* and *Verdanus abdominalis*. The characteristic species in this community was *Doliotettix lunulatus* (Annex 1), the monophag feeding on *Agrostis stolonifera*, far less abundant in other areas of the SMNP, where it was only sporadically collected (Tab. 3).

The second group includes the community of *Cirsietum rivularis*, slightly less damp than the previous one (plot 1 and plot 2), where the presence of 20 species of the Fulgoromorpha and Cicadomorpha was recorded (Tabs. 4 and 5). The most abundant species in this community include *Verdanus abdominalis*, *Balclutha punctata* and *Arthaldeus pascuellus*, while the characteristic and differential species are absent. As for ecological preferences, in comparison to the *Cirsietum rivularis* community of the previous area, there is a higher number of xerophilous species (10%) while the number of hygrophilous species is lower (20–25%) (Annex 9).

The third group includes the communities of the plot 15 and plot 16, situated within the "Łężyckie Skałki" nature reserve, where 17 and 15 species of the Fulgoromorpha and Cicadomorpha were identified, respectively (Tabs. 18 and 19). The areas in question are characterized by lower humidity than the previously mentioned ones, which is reflected by further decrease in the number of hygrophilous species (5.88% and 0.0% respectively), with the simultaneous increase of the xerophilous species (11.76 and 20% respectively) (Annex 10).

The most important species encountered in this phytocenosis include *Philaenus spumarius*, *Errastunus ocellaris* and *Verdanus abdominalis*, while *Chlorita paolii* is a differential species on the plot 15 (Annex 1). The latter species had been encountered before in large numbers in xerothermic communities (Schiemenz, 1969; Świerczewski, 2006). In both communities eurytopic species were the dominant ones.

Another community of the *Calthion palustris* association is the *Deschampsia caespitosa* community, encountered on the plot 11 and plot 12, which are inhabited by 23 and 25 species of the Fulgoromorpha and Cicadomorpha, respectively (Tabs. 14 and 15). Dominant species in these areas include *Cicadula persimilis* and *Balclutha punctata*, of which the latter is characterized by high constancy of occurrencee. Characteristic species include *Eupteryx atropunctata* and probably also *E. signatipennis* (Annex 1). The distinct character, stability and internal diversity of this phytocenosis are additionally confirmed by the occurrence of skiophilous species, scarce presence of pioneering species (Annex 10), and finally also the high values of the numerical diversity index (0.69 and 0.49 respectively) and species diversity index (0.95 and 0.92 respectively) (Annex 3), which indicates the presence of well developed microhabitats.

The community related to the *Filipendulion ulmariae* association can be encountered on the plot 3 situated in the neighborhood of "Małe Torfowisko Batorowskie". The presence of 27 species of the Fulgoromorpha and Cicadomorpha was recorded there (Tab. 6). The most abundant species was *Verdanus abdominalis*, and the differential species in this type of habitat included *Cercopis sanguinolenta*, *Aphrodes makarovi* and *Fagocyba cruenta* (Annex 1). As far as ecological preferences are concerned, there dominate mezohygrophilous (66.67%) and mezoheliophilous (88.89%) species with strictly specified abiotic requirements (i.e. oligotopic ones) (Annex 9). In its species composition the phytocenosis in question resembles the grasslands of the *Nardo-Callunetea* class. In the course of studying the *Filipendulo-Petastion* community in the surroundings of Biebrza (Gębicki, 1983) there was recorded the presence of 10 species, of which three (*Aphrophora alni*, *Neophilaenus lineatus* and *Verdanus abdominalis*) are common for both types of habitats in question.

The community related to the *Arrhenatherion elatioris* association (plots: 7, 8, 9, 10, 17 and 18) was inhabited by 18–32 species of the Fulgoromorpha and Cicadomorpha (Tables 10, 11, 12, 13, 20 and 21).

In communities associated with a similar phytocenosis in the Ojców National Park, Szwedo (1992) recorded the presence of 50 species, while Doskocil and Hurka (1962) recorded the presence of 31 species in their complex study of the Luzany

region in Czech Republic. Differential and characteristic species were absent from the community in question, and the most important species constituting the community included the following: *Verdanus abdominalis*, *Arthaldeus pascuellus*, *Balclutha punctata*, *Javesella pellucida* and *Acanthodelphax spinosa*. The species are widely distributed and abundant in the area of the SMNP. Their presence as dominants or companions had been confirmed in the above-mentioned studies on similar communities. What is more, a similar fauna of subdominants had also been identified by the studies conducted in Silesia (Gębicki *et al.*, 1977; Gębicki, 1979) on the *Arrhenatheretum medioeuropaeum* community. It seems, however, that the ecosystems of which there form part the *Arrhenatherum elatius* association and the community with *Cirsium heterophyllum*, do not have a constant, strictly specified and repeatable structure.

The dominant species *Cicadula persimilis* and *Errastunus ocellaris* (plot 13 and plot 14) were encountered in the *Alopecurus pratensis* community (Tabs. 16 and 17). Differential and characteristic species were absent from the community, and the share of the *Verdanus abdominalis* species, a dominating one in this phytosociological class, was diminished. This fact is probably connected with the initial character of this community, which seems to be confirmed by a large share of macropteric forms, pioneering species and trophically unspecialized species in it (Denno & Roderick, 1990; Novotný, 1994b).

The community of the Fulgoromorpha and Cicadomorpha associated with the *Holcus lanatus* community (plot 19 and plot 20) was characterized by a large share of such species as *Verdanus abdominalis* and *Macrosteles laevis* (Tabs. 22 and 23). Differential species included *Notus flavipennis*, *Macrosteles ossiannilssoni* and *Cicadula quadrinotata*, while characteristic species included *Ribautodelphax collina*, *Eupteryx vittata* and *Forcipata citrinella* (Annex 1). The Fulgoromorpha and Cicadomorpha community in question was characterized by the highest level of species diversity among all research areas. Such a high level of fauna and flora diversity was reflected by the high values of the Brillouin, Shannon-Weaver and Simpson diversity indices (Annexes 2, 12, 13 and 14). Furthermore, it seems that apart from the already listed species, another one which ought to be mentioned in connection with the community in question is *Kelisia guttula*, unrecorded in any other community investigated in the area of the SMNP.

The commonality of the same dominant and subdominant species in various communities belonging to the *Molinio-Arrhenathereta* class can be explained by the similarity of the floristic structure of these phytocenoses and their wide distribution. Their homogeneity probably results from the fact that the areas in question are comparatively "young", post-agricultural ones, and are subject to strong anthropopressure. In the area of the SMNP, the communities in question form spacious "fields", which seems to facilitate not only migration of species characterized by wide ecological spectrum, but also those with narrow trophic specialization. Moreover, in the collected material the macropteric forms, which easily spread over neighboring ecosystems, constituted the prevailing number of individuals (Denno & Roderick, 1990; Novotný,

1994b), while the presence of brachypteric species was only sporadically recorded. Another important factor seems to be the characteristic mountain climate. It has been proved that mountain areas constitute synthetic environments which in compact spaces contain vertically patterned and slightly modified, horizontal land formations (Pawłowski, 1967), which is related to the height above sea level. As shown by studies conducted in the northern part of the Alps, the higher an area is situated, the smaller the overall number of species becomes, and particularly the lowland species are replaced by forest mountain and boreal-mountain species. At the same time, it has been observed that the presence of monophagous and oligophagous species does not match the presence of their host plants typically present in the investigated area (Nickel, 1999). The characteristic mountain microclimate with its shortened vegetation season influences the presence and abundance of particular species, which in consequence leads to the diversification in the maximum of appearance of the dominant species.

The distribution of the Fulgoromorpha and Cicadomorpha is also influenced by strong mountain winds (Glick, 1939; Mani, 1962). This fact is exemplified by the presence of the *Verdanus abdominalis* species in the forest areas of the SMNP neighboring with vast grassland areas, and its absence from the lowland forest communities (Klimaszewski *et al.*, 1980b; Bednarczyk & Gębicki, 1998).

The analysis of the Fulgoromorpha and Cicadomorpha communities inhabiting forest areas allows for distinguishing two major circles of communities (Annex 15). One is associated with the communities of lowland and transitory turf peat bogs, and the other with spruce forests and deciduous forests with spruce admixture.

As for the Fulgoromorpha and Cicadomorpha associated with the *Eriophorum latifolium* community (plot 23 and plot 24), there was recorded the presence of 10 species (Tabs. 26 and 27). The dominant species in this type of habitat was *Nothodelphax distincta*. Together with the *Sorhoanus xanthoneurus* species they were classified as characteristic ones (Annex 1). Both species were collected in the areas characterized by the presence of *Eriphorum latifolium*, which contradicted the results of earlier studies suggesting that the species in question had only one host plant, namely *E. vaginatum* (Nickel, 2003).The studies of peat bogs conducted in the Sudetes and the Carpathians (Szwedo *et al.*, 1998) and in the area of Biebrza Basin (Gębicki *et al.*, 1982) resulted in recording from 14 to 61 species and confirmed the presence of the characteristic taxons, proving the individual character of this type of phytocenoses.

In the community associated with the *Alno-Ulmion* alliance (communities with *Betula pendula*), there was recorded the presence of 14 species on the plot 21 (Tab. 24), and the presence of 16 species on the plot 22 (Tab. 25). Major species included *Neophilaenus lineatus*, *Balclutha punctata* and *Speudotettix subfusculus*. The latter species was identified by Szwedo (1992) as a characteristic one for the *Querco-Fagetea* class, which includes the above-mentioned community.

Another characteristic thing is the presence, in this phytocenosis, of the *Psammotettix alienus* species, which had previously been encountered in other areas with *Betula pendula* (Klimaszewski *et al.*, 1980b; Simon & Szwedo, 2005). *Planaphrodes nigrita* was the differential species, while *Ribautodelphax albostriata*

was the characteristic species (Annex 1). The presence of the latter species, together with the presence of *Oncopsis tristis*, confirmed the results of CHUDZICKA's study (1981), focused on the phytocenosis with *Betula pendula* in the surroundings of Warsaw.

The communities related to the *Vaccinio-Piceeion* association in the SMNP (plots: 25, 26, 27, 28, 29) included form 5 to 26 species (Tabs. 28, 29, 30, 31 and 32). In communities associated with a similar phytocenosis GĘBICKI (1979) recorded the presence of 24 species, and KLIMASZEWSKI *et al.* (1980b) – 28 species. The most important species included *Neophilaenus lineatus*, *Balclutha punctata* and *Hyledelphax elegantula*. As for differential species in this type of communities in the SMNP, they included *Kybos smaragdulus* and *Diplocolenus bohemani*, while the characteristic ones included *Cercopis vulnerata*, *Diplocolenus sudeticus*, *Javesella discolor, Oncopsis flavicollis*, *Oncopsis tristis*, *Dikraneura variata* and *Elymana kozhevnikovi* (Annex 1). It seems, however, that the presence of the differential species *Javesella discolor* on the plot 27 is rather a result of the low species diversity of this particular phytocenosis, and the scarce number of individuals collected in it. Thus, the species in question ought not to be taken into account as a differential one in this case. A similar situation can be observed in the community encountered on the plot 26, also characterized by low species diversity and inhabited only by such species of the Fulgoromorpha and Cicadomorpha which are unspecialized and widely distributed over the area of the SMNP.

As for the above-mentioned forest communities, it ought to be mentioned that apart from the characteristic and differential species whose presence has been recorded, some species common in this type of habitat may also live in tree crowns (TROJAN *et al.*, 1994) and require being studied separately. A specific vertical distribution of the resources of a given phytocenosis results in a modification of the distribution patterns of the organisms which utilize these resources (BROWN, 1991).

With respect to species composition, the Fulgoromorpha and Cicadomorpha communities of the SMNP forests are similar to the grassland communities in the Park. This fact is probably associated with conditions characteristic of the forest habitats such as, for example, thinning out, drying up, or the reshaping of the flora species composition, i.e. the factors which may cause the instability of the forest ecosystems.

The mezohygrophilous and hygrophilous species had the largest share in the collected material (59.22% and 31.07% respectively), while the xerophilous species had the smallest share (9.71%) (Annex 8). Simultaneously, in comparison with grassland areas, forest areas contained a higher percentage of the mezohygrophilous species, and the lower percentage of xerophilous species. Such a pattern of distribution seems to be justified, as it reflects the environmental conditions in the investigation area; a significant part of the investigated forest areas is situated within the degraded peat bogs or boglands (WORONKO, 1998).

A similar interdependency is noticeable as far as the life strategy of the Fulgoromorpha and Cicadomorpha is concerned. Generally, the oligotopic and stenotopic species constitute the most numerous group in the SMNP (35.92% and 30.1% respectively)

(Annex 8). The situation is slightly different in forest areas, where eurytopic species play the most important role, this fact being probably connected with the reshaping of this type of habitat by humans, as a result of which the even-aged, single-species pine forests are the dominant forest formations. Such a situation is further confirmed by low species diversity of the Fulgoromorpha and Cicadomorpha, which ranges from 4 to several dozens taxons. Similarly, while analyzing the percentage of polyphagous species in the forest areas, especially ones which are characterized by low biodiversity with reference to the Fulgoromorpha and Cicadomorpha, there can be noticed a much higher percentage share of such species (up to 60%) in comparison with the average percentage for the SMNP area, which is 22.33% (Annex 8). This fact confirms the thesis that the ecosystem is unstable, as Novotný (1994a) has proved in his study that polyphagous species are mainly associated with unstable habitats, contrary to monophags (38.83%) and oligophags (also 38.83%), which inhabit the stable ones.

According to the results of the chorological analysis, the Euro-Siberian and European elements constituted the highest percentage of the collected material (30.1% and 19.42% respectively), while the least abundant were the following elements: Mediterranean, Euroalpine, Kazakh and Western European, represented only by single species (Annex 4). In forest areas there was observed a larger share of the Transpalearctic element (Annex 7), and the smaller share of the European element in comparison to meadow areas (Annexes 5 and 6). Furthermore, the following elements were encountered only in grassland areas: Western European (plots: 3, 5, 6 and 9), Kazakh (plot 15) and Mediterranean (plots: 3, 5, 13 and 19). Euroalpine element were represented by 2 species, and the presence of *Diplocolenus sudeticus* had been previously recorded in Poland only in the Sudetes, while the presence of *Erythria manderstjernii* had been previously recorded also in the Carpathians. In the collected material there were also identified two Mediterranean species (*Megopthalmus scanicus* and *Cercopis sanguinolenta*). These taxons are widely distributed all over Poland, and their presence has recently been confirmed in the neighborhood of "Babia Góra" (Pilarczyk, 2007).

A similar distribution of the chorological elements to that characteristic of the SMNP can be encountered in other regions of Poland (Szwedo, 1999; Pilarczyk & Szwedo, 2005; Simon & Szwedo, 2005; Pilarczyk, 2007).

Brillouin, Shannon-Weaver and Simpson diversity indices analyzed in this study (Annexes 2, 12, 13 and 14) clearly show that the highest level of species diversity can be encountered on the plots 19 and 20 (the community with *Holcus lanatus*).

This situation is due to the fact that the species encountered in the above-mentioned communities inhabit meadows of the *Arrhenatheretalia* order, the richest ones with respect to floristic composition. The species richness of the Fulgoromorpha and Cicadomorpha in this phytocenosis confirms the high level of its stability and organization (Witkowski, 1970), which is also further confirmed by the high value of the Pielou evenness index (Annex 2) calculated as the proportion of actual species diversity of a given community and the maximum species diversity (Cieślak, 1980).

The lowest value of species diversity index was recorded on the plots 26 and 27. This was related to low flora diversity (spruce monocultures with poorly developed ground layer) resulting in low species diversity, as well as with the fact that one dominant species, namely *Neophilaenus lineatus*, had the largest share in the structure of the community in question, which had already been observed by Simon and Szwedo (2005).

In analyzing similarities for the purpose of establishing the hierarchy of the investigated communities, both dendrite methods and the Principal Components Analysis (PCA) were utilized (Annexes 15 and 16). This allowed for distinguishing two major circles of communities together with their characteristic species of the Fulgoromorpha and Cicadomorpha. One of them is associated with forest areas, within which there can be observed the similarity between communities inhabiting spruce forest and those inhabiting areas where *Betula pendula* is present. A separate group within this circle comprises the communities associated with boglands and thinned out spruce forests (Annex 15). The other circle encompasses the non-forest areas. The dendrogram which results from utilizing Euclidean distance as a similarity metric in accord with Ward's method, shows the mutual similarity of communities associated with the *Nardus stricta* community and the *Lysimachio-Filipenduletum* association. An analogous dependency can be observed among the remaining communities of the *Molinio-Arrhenatheretea* class, with the exception of the *Holcus lanatus* community, constituting a separate group (Annex 15). The individual character of this phytocenosis is probably connected with its high floristic diversity and the richness and abundance of the Fulgoromorpha and Cicadomorpha species encountered within it.

The method of estimating cenotic diversity based on analyzing the random distribution of resources (MacArthur 1957 after Trojan and Smoleński, 2002) allows for distinguishing within the investigated community a group of species associated with the mosaicity of the ecosystem (Annex 3). The highest values of the numerical index of habitat mosaicity (*Dn*) and species index of habitat mosaicity (*Ds*) were recorded for meadow areas of the *Cirsietum rivularis* association (plot 1 and plot 2), and the heavily thinned out communities of the *Vaccinio-Piceeion* association (plot 25 and plot 29). This fact seems to confirm the internal diversity of these habitats and the heterogeneity of such phytocenoses. The lowest values of the *Dn* and *Ds* indices were recorded for these areas which were the poorest with respect to their flora and fauna (and where the species diversity of the Fulgoromorpha and Cicadomorpha was also low), indicating the fact that the phytocenosis was degraded and contained no microhabitats.

The studies based on the discriminant analysis were conducted by Trojan (1997) and Durska (2001) on the communities of Tabanidae (Diptera) and resulted in obtaining definitely higher values of the *Dn* and *Ds* indices in mountain regions. The researchers provided the values of the above-mentioned indices for the following locations: Białowieża Forest (0.0054 and 0.39 respectively), Kampinos Forest (0.0329 and 0.44 respectively), the Bieszczady Mountains (0.13 and 0.76 respectively) and the Pieniny Mountains (0.52 and 0.89 respectively). The results obtained for the area of the SMNP

are presented in Annex 3. These results are, in most cases, similar to those obtained for the phytocenoses of other National Parks situated in highland areas. Performing this type of analysis as part of studies seems justified, as the adopted measures take into account both the number of species and the community structure.

As far as the species diversity of the Fulgoromorpha and Cicadomorpha is concerned, the Carpathians and the Sudetes have not been sufficiently studied so far in comparison with other regions of Poland (Pilarczyk & Szwedo, 2005). The situation is similar with respect to other National Parks, as in only 6 of them there have been conducted comparatively thorough faunistic studies (Pilarczyk *et al.*, 2004), and only in Ojców National Park there was conducted a study on the Fulgoromorpha and Cicadomorpha in particular plant communities (Szwedo, 1992).

The present state of knowledge on the invertebrate fauna, and especially the insects of the Stołowe Mountains National Park is far from satisfactory (Andrzejewski *et al.*, 1999; Pilarczyk *et al.*, 2004). So far, there has been recorded the presence of only 4 species strictly from the Park's area, and as far as its buffer zone and surrounding areas are concerned, the number of recorded species has been merely 18 (Nast, 1976a; Pilarczyk *et al.*, 2004; Gaj & Drożdż-Gaj, 2005), while it has been 204 in the Pieniny Mountains (Nast, 1976b; Chudzicka & Stroiński, 2001), 166 in the Tatra Mountains (Lauterer & Okali, 1974; Pilarczyk *et al.*, 2004) and 115 in the Bieszczady Mountains (Pilarczyk & Szwedo, 2005). The present study includes information on 103 species of the Fulgoromorpha and Cicadomorpha and significantly contributes to the state of knowledge on the species diversity of this group of hemipteran insects not only in the area of the SMNP, but also in the Sudetes. It is so, since 32 species mentioned in the study had never been recorded in the Sudetes before, and 1 out of this number had never been recorded in Poland, either. With the results of the present study, the knowledge on species diversity of the Fulgoromorpha and Cicadomorpha in the Sudetes has significantly developed, since the initial number of species recorded in the area was 127 (Nast, 1976, Gaj & Dróżdż-Gaj, 2005, Pilarczyk & Szwedo, 2005) and it is 159 now.

The present study has provided the very first description of the Fulgoromorpha and Cicadomorpha communities inhabiting the particular plant communities encountered in the Sudetes.

8. SUMMARY

1. In total, during the studies conducted in the Stołowe Mountains National Park in the years 2003–2006 there were collected 103 species of the Fulgoromorpha and Cicadomorpha, which constituted 20% of the Polish Fulgoromorpha and Cicadomorpha fauna.
2. While conducting the quantitative study of the structure and dynamics of species abundance in particular communities of the Fulgoromorpha and Cicadomorpha in selected plant communities of the SMNP, there were identified 77 species, which constituted 15% of the Polish Fulgoromorpha and Cicadomorpha fauna.
3. While conducting the qualitative study in the area of the SMNP, there were identified, in total, 90 species of the Fulgoromorpha and Cicadomorpha, which constituted nearly 17.3% of the Polish Fulgoromorpha and Cicadomorpha fauna (32 species never recorded in the Sudetes before and one never recorded in Poland before, i.e. *Eupteryx signatipennis* (Boheman, 1847) – Table 2, Fig. 31, 32, 33).
4. With reference to such criteria as domination, constancy of occurrence and fidelity, there were characterized the communities of the Fulgoromorpha and Cicadomorpha related to the *Cirsietum rivularis* and *Lysimachio-Filipenduletum* associations, the communities of *Deschampsia caespitosa*, *Holcus lanatus*, *Nardus stricta*, *Eriophorum latifolium*, *Betula pendula* and the considerably thinned out communities with the dominant species of *Picea excelsa*. These communities are characterized by stable and repeatable structure.
5. As for the Fulgoromorpha and Cicadomorpha communities related to the *Arrhenatherum elatius* association, to the community with *Cirsium heterophyllum* and to the poor monoculture with *Picea excelsa*, which is of an anthropogenic origin (even-aged forests with poorly developed ground and scrub layers) and constitutes the major component of the Park's forest area, it can be observed that the communities in question mainly comprise the common, polyphagous species showing a strong tendency to migrate. Hence, such communities do not have a stable and repeatable structure and do not contain differential and characteristic taxons.
6. It has been shown, with the help of the Brillouin, Shannon-Weaver, Simpson and Pielou diversity indices utilized in the species diversity and species evenness analyses that the community with the highest level of diversity was the community with *Holcus lanatus*, of the *Arrhenatheretalia* class.
7. As a result of the analysis of similarities and the principal components analysis, there were distinguished two circles of communities, one associated with forest areas, and the other associated with non-forest areas.
8. As a result of the discriminant analysis it has been proved that the highest level of internal diversity (microhabitats) was characteristic of the *Cirsietum rivularis* association and the communities of thinned out spruce forest, while the lowest level of internal diversity was characteristic of the degraded monocultures with *Picea excelsa*.

9. Due to the fact that the research was being conducted in the spring-to-autumn period, it was possible to provide also a general outline of the phenological changes of the Fulgoromorpha and Cicadomorpha fauna inhabiting the investigated grassland and forest communities. The maxima of appearance of the Fulgoromorpha and Cicadomorpha population were recorded at the beginning of June and at the break of August and September.
10. The chorological analysis of the collected material has shown that the Euro-Siberian and European elements were the most abundantly represented ones in the investigated area.
11. The ecological analysis of the collected material has shown that the mezohygrophilous, mezoheliophilous, oligophagous and oligotopic species were the most abundantly represented ones in the investigated area.

9. REFERENCES:

Achtziger R., Nickel H. 1997. Zikaden als Bioindikatoren für naturschutzfachliche Erfolgskontrollen im Feuchtgrünland. *Beiträge zur Zikadenkunde*, 1: 3–16.

Andrzejewska L. 1971. Productivity investigation of two types of meadows in the Vistula Valley. VI. Production and population density of leafhopper (Homoptera, Auchenorrhyncha) communities. *Ekologia Polska*, Warszawa, 19: 151–172.

Andrzejewska L. 1976. The effect of mineral fertilization of a meadow on the Auchenorrhyncha (Homoptera) fauna. *Polish Ecological Studies*, 2: 111–127.

Andrzejewska L. 1979. Herbivorous fauna and its role in the economy of grassland ecosystems. I. Herbivores in natural and managed meadows. *Polish Ecological Studies*, 5: 5–44.

Andrzejewska L., Kajak 1966. Metodyka entomologicznych badań ilościowych na łąkach. *Ekologia Polska*, Warszawa, 12 (3): 241–261.

Andrzejewski R., Chudzicka E., Skibińska E. 1999. Fauna Parku Narodowego Gór Stołowych. [In:] Zgorzelski M. (red.) Góry Stołowe: 176–187. Wydawnictwo Akademickie "Dialog", Warszawa: 1–256.

Anufriev G.A., Emel'yanov A.F. 1988. Podotriad Cicadinea (Auchenorrhyncha) – Cikadovye. [In:] Ler P.A. (red.) Opredelitel' nasekomykh Dal'nego Vostoka SSSR, II, Ravnokrylye I poluzhestokrylye, Nauka, Leningrad: 12–495.

Bednarczyk J., Gębicki C. 1998. Piewiki (Homoptera, Auchenorrhyncha) okolic Janowa Lubelskiego. *Fragmenta Faunistica*, 41: 233–245.

Biedermann R., Niedringhaus R. 2004. Die Zikaden Deutschlands. Wissenschaftlich Akademischer Buchvertrieb-Fründ, Scheeßel: 1–409.

Bieman C.F.M. den. 1987. Host plant relations in the planthopper genus *Ribautodelphax* (Homoptera, Delphacidae). *Ecological Entomology*, 12: 16–172.

Blady K., Woźny M. 1996. Stan zbadania fauny pająków (Aranei) Parku Narodowego Gór Stołowych. [In:] Ogorzałek (red.) Sympozjum "Środowisko Przyrodnicze Parku Narodowego Gór Stołowych". Szczeliniec, Kudowa-Zdrój, *Wydawnictwo Park Narodowy Gór Stołowych*: 181–184.

Bokłak E., Gębicki C., Szwedo J. 2003. Zbiór piewików (Hemiptera: Fulgoromorpha et Cicadomorpha) Muzeum Górnośląskiego w Bytomiu z dawnych i obecnych terenów Polski. *Acta Entomologica Silesiana*, 9–10: 5–21.

Booij C.J.H. 1981. Biosystematics of the *Muellerianella* complex (Homoptera, Delphacidae): taxonomy, morphology and distribution. *Netherlands Journal of Zoology*, 31: 572–595.

Booij C.J.H. 1982. Biosystematics of the *Muellerianella* complex (Homoptera, Delphacidae): host-plants, habitats and phenology. *Ecological Entomology*, 7: 9–18.

Bourgoin TH., Campbell B.C. 2002. Inferring a Phylogeny for *Hemiptera*: Falling into the 'Autapomorphic Trap'. [In:] Holzinger W. (red.) Zikaden – Leafhoppers, Planthoppers and Cicadas (*Insecta*: *Hemiptera*: *Auchenorrhyncha*), *Denisia*, 4, zugleich Kataloge des Oberösterreichisches Landesmuseum. Landesmuseums, Neue Folge Nr. 176: 67–82.

Brown V.K. 1991. The effects of changes in habitat structure during succession in terrestrial communities. [In:] Bell S.S., Mccoy E.D., Mushinsky H.R., (red.) Habitat Structure: the Physical Arrangement of objects in Space. Chapmann & Hall, New York: 141–168.

Celary W. 2003. Fauna zwierząt bezkręgowych (Invertebrata) masywu Babiej Góry nie objętych szczegółowymi opracowaniami. [In:] Wołoszyn B.W., Wołoszyn D., Celary W. (red.) 2003. Monografie fauny Babiej Góry: 373–396.

Chudzicka E. 1980. Morphological variability in *Streptanus aemulans* (Kbm.) (Homoptera, Cicadellidae). *Annales Zoologici*. Vol. 35, 13: 205–213.

Chudzicka E. 1981. Piewiki (Auchenorrhyncha, Homoptera). [In:] Garbarczyk H., Pisarska R. (red.) 1981. Zoocenologiczne podstawy kształtowania środowiska przyrodniczego osiedla mieszkaniowego Białołęka Dworska w Warszawie. Część I. Skład gatunkowy i struktura fauny terenu projektowanego osiedla mieszkaniowego. *Fragmenta Faunistica*, Warszawa, 26 (11): 175–191.

Chudzicka E. 1986. Structure of leafhopper (Homoptera, Auchenorrhyncha) communities in the urban green of Warsaw. *Memorabilia Zoologica*, Warszawa, 42: 67–99.

Chudzicka E. 1989. Leafhoppers (*Homoptera, Auchenorrhyncha*) of moist meadows on the Mazovian Lowland. *Memorabilia Zoologica*, Warszawa, 43: 93–118.

Chudzicka E. 2004. Piewiki (Auchenorrhyncha = Cicadomorpha + Fulgoromorpha). [In:] Bogdanowicz W., Chudzicka E., Pilipiuk I., Skibińska E. (red.) Fauna Polski – Charakterystyka i wykaz gatunków. Tom I Muzeum i Instytut Zoologii Polska Akademia Nauk Warszawa: 178–192.

Chudzicka E., Stroiński A. 2000. Piewiki (Hemiptera: Auchenorrhyncha). Flora i Fauna Pienin – *Monografie Pienińskie*, 1: 163–168.

Chudzicka E., Skibińska E., Janoszek M. 2001. The invertebrate fauna of Góry Stołowe National Park, its specificity and value. *Fragmenta Faunistica*, Warszawa, 44: 1–19.

Cichocki W. 1993. Pluskwiaki równoskrzydłe. [In:] Mirek Z., Piękoś-Mirkowa H. (red.) Przyroda Kotliny Zakopiańskiej. Poznanie, przemiany, zagrożenia i ochrona. Tatrzański Park Narodowy, Kraków-Zakopane, Tatry i Podtatrze, 2: 258–293.

Cieślak M. 1980. Propozycja określenia struktury dominacji i różnorodności gatunkowej zespołów. *Wiadomości Ekologiczne*. 26 (2): 141–150.

Curry J.P. 1994. Grassland invertebrates. Ecology, influence on soil fertility and effects on plant growth. Chapman & Hall, London: 1–437.

Czechowski W., Mikołajczyk W. 1981. Methods for the study of urban fauna. *Memorabilia Zoologica*, 34: 49–58.

DellaGiustina W., Remane R. 1992. La Faune de France des Delphacidae. II. Note de chasses faites, pour l'essentiel, en 1990 (Homoptera, Auchenorrhyncha). *Bulletin de la Societe Entomologique de France*, 96 (4): 313–330.

Denno R.F., Roderick G.K. 1990. Population Biology on Planthoppers. *Annual Review of Entomology*, 35: 489–520.

Dittrich R. 1906. Über die niedere Tierwelt des Riesengebirges. [In:] Festschrift zur Feier des 25 jährigen Bestehens der Ortsgruppe Breslau des Riesengebirgs-Vereins Breslau: 63–74.

Dlabola J. 1954. Fauna ČSR – I. Křísi – Homoptera. Československá Akademie Věd, Praha, 1: 1–339.

Dmitriev D.A. 1999. Obzor vidov roda *Rhopalopyx* Ribaut, 1939 (Homoptera, Cicadellidae). *Entomologičeskoe Obozrenie*, 78: 610–624.

Doskocil J., Hurka K. 1962. Entomofauna louky (skaz *Arrhenatherion elatioris*) a jej vyvoj. *Rozpravy Ceskoslovenské Akademie Věd Rada Matematickych a Prírodních Věd,* Praha, 72 (7): 1–99.

Durska E. 2001: Secondary succession of scuttle fly (Diptera: *Phoridae*) communities in moist pine forest in Białowieża Forest. *Fragmenta Faunistica*, 44: 81–130.

Dworakowska I. 1968a. Materiały do znajomości krajowych gatunków z rodzaju *Doratura* J. Shlb. (Homoptera, Cicadellidae). *Annales Zoologici*, 25: 381–401.
Dworakowska I. 1968b. Notes on the Genus *Elymana* Delong (Homoptera, Cicadellidae). *Bulletin de l'Académie Polonaise des Sciences Cl. II. Série des sciences biologiques*, 16: 233–238.
Dworakowska I. 1970. On the genus *Zygina* Fieb. and *Hypericiella* sgen. n. (Auchenorrhyncha, Cicadellidae, Typhlocybinae). *Bulletin de l'Académie Polonaise des Sciences* Cl. II, Varsovie, 18: 559–567.
Gaj D., Drożdż-Gaj D. 2005. Nowe dane o rozmieszczeniu *Eurybregma nigrolineata* Scott, 1875 (Hemiptera: Fulgoromorpha, Delphacidae) na terenie Polski. *Acta Entomologica Silesiana,* 12–13: 29–32.
Gajewski A. 1961. Krajowe gatunki z rodzaju *Macrosteles* Fieb. (Homoptera, Jassidae). *Fragmenta Faunistica*, Warszawa, 9: 87–106.
Gębicki C. 1979. Charakterystyka zgrupowań piewików (Homoptera, Auchenorrhyncha) wybranych środowisk rejonu Huty "Katowice". *Acta Biologica*, Katowice, 8: 29–44.
Gębicki C. 1983. Zgrupowania piewików (Homoptera, Auchenorrhyncha) w borach i grądach okolic Pińczowa. *Acta Biologica,* Katowice, 13: 83–98.
Gębicki C. 2002. Nowe stanowisko *Utecha lugens* (Germar, 1821) w Polsce (Hemiptera, Ulopidae). *Acta Entomologica Silesiana*, 9–10: 23–26.
Gębicki C., Głowacka E., Karwańska J., Klimaszewski S.M., Wojciechowski W. 1977. Zgrupowania piewików, mszyc i koliszków (Homoptera: Auchenorrhyncha, Aphidodea i Psyllodea) wybranych środowisk rejonu huty "Katowice". *Acta Biologica*, Katowice, 4: 95–122.
Gębicki C., Bartnicka J., Bokłak E., Małkowski E. 1982. Piewiki (Homoptera, Auchenorrhyncha) Kotliny Biebrzy. *Acta Biologica*, Katowice, 10: 13–21.
Gębicki C., Szwedo J. 1991. *Speudotettix montanus* sp. nov. (Homoptera, Cicadellidae) from Bieszczady. *Acta Biologica Silesiana*, Katowice, 18 (35): 17–21.
Glick P.A. 1939. The distribution of Insects, Spiders and Mites in the air. Technical Bulletin: United States Department of Agriculture, Washington, 673: 1–150.
Gnezdilov V.M. 2000. On the Palaearctic species of the genus *Forcipata* DeLong & Caldwell (Homoptera: Cicadellidae, Typhlocybinae). *Zoosystematica Rossica*, 8: 283–286.
Gotkiewicz M., Szafer W. 1950. Ojców jako teren wycieczek szkolnych i wczasów. Chrońmy Przyrodę, 6 (7/8): 3–59.
Gromadzka J., Trojan P. 1967. Comparison of the usefulness of the entomological net, photo eclector and biocenometer for investigation of entomocenoses. *Ekologia Pol*ska, A, 15: 505–529.
Györffy G., Körmöczi L. 1987. Short term structural changes of Auchenorrhyncha communities on sandy grassland. *Proceedings, 6-th Auchenorrhyncha Meeting*, Turin, Italy, 7–11 Sept. 1987: 155–162.
Herczek A. 1987. Zgrupowania tasznikowatych (Miridae, Heteroptera) wybranych zbiorowisk kserotermicznych okolic Pińczowa. *Acta Biologica Silesiana*, Katowice, 6 (23): 130–147.
Hill M.G. 1982. Feeding strategies of grassland leafhoppers. *Zoologische Jahrbücher. Abteilung für Systematik*, 109: 24–32.
Hollier J.A., Brown V.K., Edwards-Jones G. 1994. Successional leafhopper assemblages: Pattern and process. *Ecological Research*, 9: 185–191.
Holzinger W.E., Kammerlander I., Nickel H. 2003. The Auchenorrhyncha of Central Europe – I. Brill Academic Publishers, Leiden-Boston: 1–673.
Janoszek M., Tarnawski D. 2001. Sprężykowate (Coleoptera: Elateridae) Parku Narodowego Gór Stołowych i jego otuliny. Szczeliniec, 5: 115–147.
Jędryszczak E. 1999. Lasy Parku Narodowego Gór Stołowych. [In:] Zgorzelski M. (red.) Góry Stołowe: 138–141. Wydawnictwo Akademickie "Dialog", Warszawa, 1–256.
Jędryszczak E., Miścicki S. 2001. Lasy Parku Narodowego Gór Stołowych. Szczeliniec, 5: 79–103.
Jońca E., Radziejowski J., Skrężyna J. 1998. Z historii Parku Narodowego Gór Stołowych. *Szczeliniec*, 2: 3–7.
Karpiński J.J. 1949. Materiały do bioekologii Puszczy Białowieskiej. *Rozprawa Sprawozdawcza Instytutu Badawczego Leśnictwa*, A, 56: 1–212.

Karpiński J.J. 1951. *Centrobia annae* sp. n. (Hymenoptera, Trichogrammatidae) pasożyt jaj szkodnika leśnego *Cicadetta montana* Scop. (piewik górski) z Puszczy Białowieskiej. *Prace Komisji Nauk Rolniczych i Komisji Nauk Leśnych*, 4: 61–68.

Karpiński J.J. 1958. Materiały do poznania pluskwiaków równoskrzydłych podrzędu Homoptera Cicadina biocenozy lasu Białowieskiego Parku Narodowego. *Prace Komisji Nauk Rolniczych i Komisji Nauk Leśnych*, Warszawa, 31: 49–60.

Kasprzak K., Niedbała W. 1981. Wskaźniki biocenotyczne stosowane przy porządkowaniu i analizie danych w badaniach ilościowych. [W:] Górny M., Grüm L. (red.) Metody stosowane w zoologii gleby. Państwowe Wydawnictwo Naukowe, Warszawa: 379–416.

Kicińska B., Żmudzka E., Olszewski K. 1999. Ogólne cechy klimatu Parku Narodowego Gór Stołowych. [In:] Zgorzelski M. (red.) Góry Stołowe: 142–147. Wydawnictwo Akademickie "Dialog", Warszawa: 1–256.

Klimaszewski S.M., Wojciechowski W., Gębicki C., Czylok A., Jasińska J., Głowacka E. 1980a. Zgrupowanie wybranych grup owadów ssących (Homoptera i Heteroptera) zbiorowisk trawiastych i zielnych rejonu huty "Katowice". *Acta Biologica*, Katowice, 8: 9–21.

Klimaszewski S.M., Wojciechowski W., Czylok A., Gębicki C., Hreczek A., Jasińska J. 1980b. Zgrupowanie wybranych grup pluskwiaków równoskrzydłych (Homoptera) i różnoskrzydłych (Heteroptera) w lasach rejonu huty "Katowice". *Acta Biologica*, Katowice, 8: 22–39.

Knight W.J. 1965. Techniques for use in the identification of leafhoppers (Homoptera: Cicadellidae). *Entomologist's Gazette*, 16: 129–136.

Knight W.J. 1974. The evolution of the Holarctic leafhoppers genus *Diplocolenus* Ribaut, with descriptions and keys to subgenera and species (Homoptera: Cicadellidae). *Bulletin of the British Museum (Natural History)*, Entomology, 29(7): 359–413.

Kondracki J. 2000. Geografia regionalna Polski. Wydawnictwo Naukowe PWN, Warszawa: 1–440.

Košťák B. 2001. Rock movement analysis of the monument of inanimate nature table hill – Szczeliniec Wielki. *Szczeliniec*, 5: 3–39.

Kozłowska A., Solon J. 1999. Charakterystyka roślinności Parku Narodowego Gór Stołowych. [In:] Zgorzelski M. (red.) Góry Stołowe: 132-137. Wydawnictwo Akademickie "Dialog", Warszawa: 1–256.

Kubicka A., Chudzicka E., Wysocki C. 1986. Structure of the fauna of Warsaw. The study area. *Memorabilia Zoologica*, Warszawa, 41: 11–69.

Lauterer P., Okali I. 1974. Auchenorrhyncha. *Zbornik prác o Tatranskom Národnom Parku*, 16: 115–131.

Le Quesne W.J. 1974. *Eupteryx origani* Zakhvatkin (Hem., Cicadellidae) new to Britain and related species. *Entomologist's Monthly Magazine*, 109: 203–206.

Le Quesne W.J., Payne K.R. 1981. Handbooks for the identification of British Insects. Cicadellidae (Typhlocybinae) with a check List of the British Auchenorrhyncha (Hemiptera, Homoptera). *Royal Entomological Society of London*, II, part 2(c): 1–95.

Letzner K. 1871. Verzeichniss der Käfer Schlesiens. Zeitschrift für Entomologie, Breslau, 2(24): 1–328.

Lis J. 1988 (ms.). Piewiki (Homoptera: Auchenorrhyncha) wybranych zbiorowisk roślinnych okolic Pilicy. Praca magisterska. Uniwersytet Śląski, Katowice.

Logvinenko V.M. 1975. Fulgorojdni Cikadovi. Fulgoroidea. Fauna Ukrainy, Tom 20, Vypusk 2. Akademija Nauk Ukrainskoi RSR. Vydavnyctvo "Naukova Dumka", Kyiv: 1–287.

Łomnicki M. 1884. Pluskwy różnoskrzydłe (*Hemiptera-Homoptera*) znane dotychczas z Galicyi. *Sprawozdanie Komisji Fizjograficznej*, Kraków, 18: 230–238.

Mani M.S. 1962. Introduction to High Altitude Entomology. Insect Life above the Timberline in the North-West Himalaya. London: 1–302.

Matuszkiewicz W. 2001. Przewodnik do oznaczania zbiorowisk roślinnych Polski. *Polskie Wydawnictwo Naukowe* PWN, Warszawa: 1–537.

Michalski J. 1996. Korniki (Coleoptera, Scolytidae) na terenie Parku Narodowego Gór Stołowych. [W:] Ogorzałek (red.) Sympozjum "Środowisko Przyrodnicze Parku Narodowego Gór Stołowych". Szczeliniec, Kudowa-Zdrój, Wydawnictwo Park Narodowy Gór Stołowych: 189–195.

Mirek Z., Piękoś-Mirkowa H., Zając A., Zając M. 2002. Flowering plants and pteridophytes of Poland. A checklist. Instytut Botaniki im. W. Szafera PAN, Kraków: 1–442.
Nast J. 1936. Nowe dla Polski lub mniej znane gatunki Homoptera. *Fragmenta Faunistica*, Warszawa, 2: 323–326.
Nast J. 1938a. Przyczynki do znajomości fauny Homoptera Polski. II. Homoptera okolic Kielc. *Fragmenta Faunistica*, Warszawa, 3: 225–234.
Nast J. 1938b. Nowe dla Polski lub mniej znane gatunki Homoptera. II. *Fragmenta Faunistica*, Warszawa, 3: 431–434.
Nast J. 1955. Nowe dla Polski lub mniej znane gatunki Homoptera. III. *Fragmenta Faunistica*, Warszawa, 7: 213–231.
Nast J. 1958. Homopterological Notes XXII. *Acta Zoologica Cracov*iensia 2: 887–899.
Nast J. 1966. Two new Palaearctic Delphacidae (Homoptera). *Bulletin de l'Académie Polonaise des Sciences* Cl. II, Varsovie, 13: 643–646.
Nast J. 1972. Palaearctic Auchenorrhyncha (Homoptera) an annotated check list. Państwowe Wydawnictwo Naukowe, Warszawa: 1–550.
Nast J. 1973. Uzupełnienia i sprostowania do fauny Auchenorrhyncha (Homoptera) Polski. *Fragmenta Faunistica*, Warszawa, 19: 39–53.
Nast J. 1976a. Piewiki – Auchenorrhyncha (Cicadodea). Katalog Fauny Polski. Część XXI, zeszyt 1; 25: 1–256.
Nast J. 1976b. Piewiki (Homoptera, Auchenorrhyncha) Pienin. *Fragmenta Faunistica*, Warszawa, 21: 140–176.
Nast J. 1979. Auchenorrhyncha (Homoptera) Wyżyny Lubelskiej i Roztocza. Część I – Fulgoroidea. *Fragmenta Faunistica*, Warszawa, XXV, Nr. 1.
Nast J. 1981. Homopterological Notes XIII-XX. *Annales Zoologici*, Warszawa, 34(2): 27–37.
Nast J. 1986. Notes on some *Auchenorrhyncha* (*Homoptera*). 6–10. *Annales Zoologici*, Warszawa, 40(3): 297–307.
Nast J. 1987. The Auchenorrhyncha (Homoptera) of Europe. *Annales Zoologici*, Warszawa, 40(15): 535–661.
Nast J., Chudzicka E. 1990. Homoptera – pluskwiaki równoskrzydłe. Auchenorrhyncha. [In:] J. Razowski (red.) Wykaz zwierząt Polski. Tom I, część XXXII/17. Wydawnictwo Ossolineum, Wrocław: 91–101.
Nickel H. 1994. Wärmeliebende Zikaden (Homoptera, Auchenorrhyncha) im Sulichen Niedersachsen. *Braunschweiger Naturkundliche Schriften*, 4: 533–551.
Nickel H. 1999. Life strategies of Auchenorrhyncha species on river floodplains in the northern Alps, with description of a new species: *Macropsis remanei* sp. n. (Hemiptera). *Reichenbachia* 33: 157–169.
Nickel H. 2003. The Leafhoppers and Planthoppers of Germany (Hemiptera, Auchenorrhyncha): Patterns and strategies in a highly diverse group of phytophagous insects. Pensoft Publishers, Sofia-Moscow: 1–460.
Nickel H., Holzinger W.E., Wachmann E. 2002. Mitteleuropäische Lebensräume und ihre Zikaden (Insecta: Hemiptera: Auchenorrhyncha). [In:] Holzinger, W. (red.) Zikaden – Leafhoppers, Planthoppers and Cicadas (Insecta: Hemiptera: Auchenorrhyncha), *Denisia*, 4, zugleich Kataloge des Oberösterreichisches Landesmuseum, Neue Folge Nr. 176: 279–328.
Nickel H., Remane R. 2002. Artenliste der Zikaden Deutschlands, mit Angabe von Nährpflanzen, Nahrungsbreite, Lebenszyklus, Areal und Gefährdung (Hemiptera, Fulgoromorpha et Cicadomorpha). *Beiträge zur Zikadenkunde*, 5: 27–64.
Nickel H., Hildebrandt J. 2003. Auchenorrhyncha communities as indicators of disturbance in grasslands (Insecta, Hemiptera) – a case study from the Elbe flood plains (northern Germany). *Agriculture, Ecosystems and Environment*, 98: 183–199.
Niemczyk V. 1999. Współczesny stan wiedzy geologicznej na temat Gór Stołowych (Sudety Środkowe). *Szczeliniec*, 3: 3–19.
Nowicka B. 1998. System krążenia wody w Parku Narodowym Gór Stołowych. *Szczeliniec* Nr 2: 31–47.
Nowicka B. 1999. Wody powierzchniowe Parku Narodowego Gór Stołowych. [In:] Zgorzelski M. (red.) Góry Stołowe: 96–115. Wydawnictwo Akademickie "Dialog", Warszawa: 1–256.

Nowicki M. 1868. Wykaz pluskwówek galicyjskich (Rhynchota, Hemiptera). *Sprawozdanie Komisji Fizjograficznej*, Kraków, 2: 91–107.
Novotný V. 1990. Are the parameters of leafhoppers (Auchenorrhyncha) and plant communites confluent? A case study on grass and sedge vegetation. *Acta Entomologica Bohemoslovaca* 87: 459–469.
Novotný V. 1994a. Association of polyphagy in leafhoppers (Auchenorrhyncha, Hemiptera) with unpredictable environments. *Oikos*, 70: 223–232.
Novotný V. 1994b. Relation between temporal persistence of host plants and wing length in leafhoppers (Hemiptera: Auchenorrhyncha). *Ecological Entomology*, 19: 168–176.
Ossiannilsson F. 1978. The Auchenorrhyncha (Homoptera) of Fennoscandia and Danmark. Part 1. *Fauna Entomologica Scandinavica*, 7: 1–222.
Ossiannilsson F. 1981. The Auchenorrhyncha (Homoptera) of Fennoscandia and Danmark. Part 2. *Fauna Entomologica Scandinavica*, 7: 223–593.
Ossiannilsson F. 1983. The Auchenorrhyncha (Homoptera) of Fennoscandia and Danmark. Part 3. *Fauna Entomologica Scandinavica*, 7: 594–979.
Pawłowski J. 1967. Chrząszcze (Koleoptera) Babiej Góry. *Acta Zoologica Cracoviensia*, 12: 419–665.
Pawłowski J., Szeptycki A. 1977. Inne bezkręgowce lądowe. [In:] Przyroda Ojcowskiego Parku Narodowego. *Studia Naturae*, B, 28: 343–369.
Pax F. 1921. Die Tierwelt Schlesiens. *Fischer-Verlag,* Jena: 1–342.
Petrusewicz K. 1966. Dynamics, organization and ecological structure of population. *Ekologia Polska.* Seria A, 14: 413–436.
Pilarczyk S. 2007. (ms.). Zgrupowania piewików (Hemiptera: Fulgoromorpha et Cicadomorpha) wybranych zbiorowisk roślinnych Babiogórskiego Parku Narodowego. Praca doktorska. Uniwersytet Śląski, Katowice.
Pilarczyk S., Szwedo J. 2005. Piewiki (Hemiptera: Fulgoromorpha et Cicadomorpha) gór Polski. *Acta Entomologica Silesiana,* 12–13: 55–77.
Pilarczyk S., Gaj D., Szwedo J. 2004. Piewiki (Hemiptera: Fulgoromorpha et Cicadomorpha) Parków Narodowych w Polsce. *Wiadomości Entomologiczne*, 23, 45 Zjazd Polskiego Towarzystwa Entomologicznego, Suplement 2: 99–109.
Prestidge R.A. 1982. Instar duration, adult consumption, oviposition and nitrogen utilization efficiencies of leafhoppers feeding on different quality food (Auchenorrhyncha: Homoptera). *Ecological Entomology*, 7: 91–101.
Reimer H. 1992. Beiträge zur Zoogeographie und Ökologie von Zikaden (Homoptera: Auchenorrhyncha) in Mittelgebirgen am Beispiel der Rhön. Thesis, University of Marburg: 1–252.
Remane R. 1960. Zur Kenntnis der Gattung *Arthaldeus* Ribaut (Homoptera Cicadina, Cicadellidae). *Mitteilungen der Münchner Entomologischen Gesellschaft* E. V., 50: 72–82.
Scamoni A. 1967. Wstęp do fitosocjologii praktycznej, PWN, Warszawa: 1–247.
Schiemenz H. 1969. Die Zikadenfauna mitteleuropäischer Trockenrasen (Homoptera, Auchenorrhyncha). Untersuchungen zu ihrer Phänologie, Ökologie, Bionomie und Chorologie. *Entomologische Abhandlungen. Staatliches Museum für Tierkunde in Dresden*, 36: 201–280.
Simon E., Szwedo J. 2005. Zgrupowania piewików na hałdach kopalnianych Rudy Śląskiej i Mikołowa (Hemiptera: Fulgoromorpha et Cicadomorpha). *Acta Entomologica Silesiana*, 12–13: 79–144.
Skibińska E., Chudzicka E. 2000. Owady w monitoringu przyrodniczym. *Wiadomości Entomologiczne*, 18(2): 289–302.
Skorupski M., Gołojuch P. 1996a. Roztocze (Acari, Mesostigmata) wybranych mikrośrodowisk Parku Narodowego Gór Stołowych. Parki Narodowe i Rezerwaty Przyrody, 15, 3: 73–79.
Skorupski M., Gołojuch P. 1996b. Wstępne wyniki badań nad roztoczami z rzędu Mesostigmata (Acari) Parku Narodowego Gór Stołowych. [In:] Ogorzałek (red.) Sympozjum "Środowisko Przyrodnicze Parku Narodowego Gór Stołowych". *Szczeliniec,* Kudowa-Zdrój, Wydawnictwo Parku Narodowego Gór Stołowych: 185–195.
Smreczyński S. 1906. Wykaz pluskwiaków nowych dla fauny galicyjskiej. *Sprawozdanie Komisji Fizjograficznej*, Kraków, 40: 72–79.
Smreczyński S. 1910a. Spis pluskwiaków zebranych w Gorcach w r. 1909. *Sprawozdanie Komisji Fizjograficznej*, Kraków, 44: 109–122.

Smreczyński S. 1910b. Pluskwiaki nowe dla fauny galicyjskiej. Wykaz II. *Sprawozdanie Komisji Fizjograficznej*, Kraków, 44: 123–125.
Smreczyński S. 1954. Materiały do fauny pluskwiaków (Hemiptera) Polski. *Fragmenta Faunistica*, Warszawa, 7: 1–146.
Smreczyński S. 1955. Uzupełnienie do "Materiałów do fauny pluskwiaków (Hemiptera) Polski". *Fragmenta Faunistica*, Warszawa, 7: 209–211.
Solon J. 1999. Park Narodowy Gór Stołowych na tle wybranych regionalizacji. [In:] Zgorzelski M. (red.) Góry Stołowe: 12-14. Wydawnictwo Akademickie "Dialog", Warszawa: 1–256.
Solon J., Świerkosz K. 1999. Flora Parku Narodowego Gór Stołowych. [In:] Zgorzelski M. (red.) Góry Stołowe: 122–127. Wydawnictwo Akademickie "Dialog", Warszawa: 1–256.
Stobiecki S. 1886. Materiały do fauny W. Ks. Krakowskiego. *Sprawozdanie Komisji Fizjograficznej*, Kraków, 49: 126–219.
Szerszeń L., Kabała C. 1999. Charakterystyka pokrywy glebowej Parku Narodowego Gór Stołowych. [In:] Zgorzelski M. (red.) Góry Stołowe: 68–82. Wydawnictwo Akademickie "Dialog", Warszawa: 1–256.
Szklarzewicz T., Jankowska W., Łukasiewicz K., Szymańska B., 2007: Structure of the ovaries and oogenesis in *Cixius nervosus* (Cixiidae), *Javesella pellucida* and *Conomelus anceps* (Delphacidae) (Insecta, Hemiptera, Fulgoromorpha). Arthropod Structure & Development 36 (2007): 199–207.
Szulczewski J. 1933. Beitrag zur Cicadinefauna des Posener Landes. Dtsch. Wiss. Z. Polen, Poznań 26: 95–103.
Szwedo J. 1992. Piewiki (Homoptera, Auchenorrhyncha) wybranych zbiorowisk roślinnych Ojcowskiego Parku Narodowego. *Prądnik*. Prace Muzeum Szafera, 5: 223–233.
Szwedo J. 1997. (ms.). Zgrupowania piewików (Homoptera: Auchenorrhyncha) fitocenoz w wyrobiskach po eksploatacji piasku w rejonie Jaworzna-Szczakowej i Bukowna. Praca doktorska. Uniwersytet Śląski, Katowice.
Szwedo J. 1999. Piewiki Puszczy Białowieskiej (Homoptera: Auchenorrhyncha). *Parki Narodowe i Rezerwaty Przyrody* 18.1 (supl.): 109–124.
Szwedo J. 2001a. Subordo (podrząd) Auchenorrhyncha – piewiki. [In:] Gutowski J.M., Jaroszewicz B. (red.) *Katalog fauny Puszczy Białowieskiej*. Białowieski Park Narodowy. IBL Instytut Badawczy Leśnictwa, Warszawa: 109–112.
Szwedo J. 2001b. 16. Pluskwiaki równoskrzydłe (Homoptera). 16.1. Piewiki (Fulgoromorpha et Cicadomorpha) Bieszczadów. [Planthoppers and leafhoppers (Fulgoromorpha et Cicadomorpha) from the Bieszczady Mountains.] *Monografie Bieszczadzkie*, 7 (2000): 205–215.
Szwedo J., Gębicki C., Wegierek P. 1998. Leafhopper communities (Homoptera, Auchenorrhyncha) of selected peat-bogs in Poland. *Annals of the Upper Silesia Museum of Natural History*, Bytom, 15: 154–176.
Szwedo J., Bourgoin TH., Lefebvre F. 2004. Fossil Planthoppers (Hemiptera: Fulgoromorpha) of the World. An annotated catalogue with notes on Hemiptera classification. Studio 1, Warszawa: 1–208.
Świerczewski D. 2006. (ms.). Zgrupowania piewików (Hemiptera: Fulgoromorpha et Cicadomorpha) wybranych zbiorowisk murawowych Wyżyny Częstochowskiej. Praca doktorska. Uniwersytet Śląski, Katowice.
Świerczewski D., Gębicki C. 2003. Nowe i rzadkie gatunki piewików w faunie Polski (Hemiptera: Fulgoromorpha et Cicadomorpha). *Acta Entomologica Silesiana,* 11: 63–73.
Świerczewski D., Gębicki C. 2004. Piewiki Wyżyny Częstochowskiej (Insecta: Hemiptera: Fulgoromorpha et Cicadomorpha). [In:] Partyka J. (red.) Zróżnicowanie i przemiany środowiska przyrodniczo-kulturowego Wyżyny Krakowsko-Częstochowskiej, Tom I Przyroda. Wydawnictwo Ojcowski Park Narodowy, Ojców: 317–322.
Tarnawski D., Janoszek M. 2004. Sprężykowate (Coleoptera: Elateridae) środowisk naturalnych w Parku Narodowym Gór Stołowych. *Wiadomości entomologiczne*, 23, 45 Zjazd Polskiego Towarztstwa Entomologicznego, Suplement 2: 205–207.
Tallamy D.W., Denno R.F. 1979. Sap-feeders response to host plant structure. *Environmental Entomology*, 8: 1021–1028.

Tišečkin D. JU. 1998. Akustičeskie signaly i morfologičeskie osobennosti cikadok gruppy *Aphrodes bicinctus* (Homoptera, Cicadellidae) iz evropejskoj časti Rossii. *Zoologičeskij Žurnal*, 77: 669–676.
Trojan P. 1992. Analiza struktury fauny. *Memorabilia Zoologica*, 47: 1–120.
Trojan P. 1994. The shaping of the diversity of invertebrate species in the urban green spaces of Warsaw. *Memorabilia Zoologica*, 49: 167–173.
Trojan P. 1997. Distribution Pattern of Diachlorini s. str. (Diptera: Tabanidae), *Fragmenta Faunistica,* 40(6): 59–71.
Trojan P., Bańkowska R., Chudzicka E., Filipiuk I., Skibińska E., Sterzyńska M., Wytwór J. 1994. Secondary succession of fauna In the pine forests of Puszcza Białowieska. *Fragmenta Faunistica*, Warszawa, 37(1): 1–104.
Trojan P., Smoleński M. 2002. Ocena różnorodności gatunkowej w założonych układach ekologicznych [In:] Banaszak G. (red.) Wyspy środowiskowe, bioróżnorodność i próby topologii. Akademia Bydgoska im. Kazimierza Wielkiego, Bydgoszcz: 261–273.
Waga A. 1854a. *Ledra aurita* to jest skoczek uszaty. *Dziennik Warszawski*, (281): 3–4, (282): 3–4, (283): 3–4.
Waga A. 1854b. *Ledra aurita* to jest skoczek uszaty. [In:] Ungra J. (red.) Kalendarz, Warszawa, 10 (1855): 63–69.
Waga A. 1856. O owadach, z okoliczności tych, które zniszczyły niedawno jęczmień i owies w guberni Radomskiej. *Gazeta Warszawska*, (149), 4.
Waga A. 1857. Zwierzęta niższych gromad. [In:] Waga A., Stronczyński K., Taczanowski W. (red.) Sprawozdanie z podróży naturalistów odbytej w r. 1854 do Ojcowa. Biblioteka Warszawska, (2): 161–227.
Waga A. 1860. *Ledra aurita* tojest [sic!] skoczek uszaty. [In:] Przewodnik po Ojcowskiej Dolinie, Warszawa: 55–68.
Wagner W. 1941. Die Zikaden der Provinz Pommern. *Dohrniana*, Stettin, 20: 95–184.
Wagner W. 1948. Neue deutsche Homopteren und Bemerkungen uber schon bekannte Arten. *Verhandlungen des Vereins für Naturwissenschaftliche Heimatfroschung zu Hamburg*, 29 (1947): 72–89.
Wagner W. 1950. Balclutha boica n. sp., eine neue Jasside aus Bayern. – Bericht der Naturforschenden Gesellschaft Augsburg, 3: 97–100.
Wagner W., Franz H. 1961. Uberfamilie Auchenorrhyncha (Zikaden). [In:] Franz H. (red.) Die Nordost-Alpen im Spiegel ihrer Landtierwelt. Eine Gebietsmonographie umfassend Fauna, Faunengeschichte, Lebensgemeinschaften und Beeinflussung der Tierwelt durch den Menschen. Innsbruck, 2: 1–992.
Walczak M. 2005. Piewiki (Hemiptera, Auchenorrhyncha) zieleni miejskiej Sosnowca. *Acta Entomologica Silesiana,* 12–13: 145–154.
Waloff N. 1980. Studies on grassland leafhoppers (Auchenorrhyncha, Homoptera) and their natural enemies. *Advances in Ecological Research*, 11: 81–215.
Waloff N., Solomon M.G. 1973. Leafhoppers (Auchenorrhyncha: Homoptera) of acidic grasslands. *Journal of Applied Ecology*, 10: 189–212.
Weigel J. A.V. 1806. Geographische, naturhistorische und technologische Beschreibung des souverainen Herzoghthums Schlesien. 10. Verzeichnis der bisher entdeckten in Schlesien lebenden Thiere, Berlin: 1–358.
Wheeler A.G. Jr. 2003. Bryophagy in the Auchenorrhyncha: Seasonal history and habits of a moss specialist *Javesella opaca* (Beamer) (Fulgoroidea: Delphacidae). *Proceedings of the Entomological Society of Washington*, 105: 599–610.
Wicik B. 1999a. Utwory powierzchniowe i pokrywa glebowa Parku Narodowego Gór Stołowych. [In:] Zgorzelski M. (red.) Góry Stołowe: 56-67. Wydawnictwo Akademickie "Dialog", Warszawa: 1–256.
Wicik B. 1999b. Krajobrazy geochemiczne Parku Narodowego Gór Stołowych. [In:] Zgorzelski M. (red.) Góry Stołowe: 158–166. Wydawnictwo Akademickie "Dialog", Warszawa: 1–256.
Wiktor A. 1964. Mięczaki Ziemi Kłodzkiej i gór przyległych. Studium faunistyczno-zoogeograficzne. Poznańskie Towarzystwo Przyjaciół Nauk XXIX (1): 1–129.

Witkowski Z. 1970. Zagadnienia różnorodności gatunkowej w badaniach biocenotycznych. *Wiadomości Ekologiczne* 16(2): 117–132.
Wocke M.F. 1874. Über die schlesichen Arten der Cicadinen-Familie *Typhlocybae*. *Jahresberichte Schlesien Gesellschaft für Vaterland*. Cult., Breslau, 51: 1–181.
Woronko D. 1998. Warunki występowania i funkcjonowania obszarów podmokłych w Parku Narodowym Gór Stołowych. Szczeliniec, 2: 23–29.
Zgorzelski M. 1999a. Cele ochrony Parku Narodowego Gór Stołowych. [In:] Zgorzelski M. (red.) Góry Stołowe: 19–20. Wydawnictwo Akademickie "Dialog", Warszawa: 1–256.
Zgorzelski M. 1999b. Struktura użytkowania ziemi i struktura własnościowa gruntów w Parku Narodowym Gór Stołowych. [In:] Zgorzelski M. (red.) Góry Stołowe: 142–147. Wydawnictwo Akademickie "Dialog", Warszawa: 1–256.
Zgorzelski M. 1999c. Góry Stołowe. [In:] Zgorzelski M. (red.) Góry Stołowe: 9–11. Wydawnictwo Akademickie "Dialog", Warszawa: 1–256.

STRESZCZENIE

Piewiki (Fulgoromorpha Evans, 1946 et Cicadomorpha Evans, 1946) to grupy pluskwiaków występujące współcześnie prawie we wszystkich siedliskach świata. Obydwie jednostki uważano wcześniej za wspólną grupę zwaną Auchenorrhyncha Duméril, 1806, jednakże badania morfologiczne i molekularne w ostatnich latach wskazywały, że Fulgoromorpha i Cicadomorpha należą do dwóch różnych podrzędów w obrębie rzędu Hemiptera. Należy zwrócić uwagę, że ostatnie badania procesu oogenezy i struktury jajników omawianych owadów (Szklarzewicz *et al.* 2007) wyraźnie świadczą za monofiletycznym pochodzeniem Auchenorrhyncha. Piewiki są ważnym elementem sieci troficznych ekosystemów lądowych, w których tworzą charakterystyczne zgrupowania gatunków o złożonej strukturze i dynamice liczebności ich występowania, a zarazem są czułym wskaźnikiem do oceny stanu i zmian zachodzących w środowisku. Owady te charakteryzują ścisłe związki z roślinami żywicielskimi, znaczna część piewików uznawana jest za gatunki troficznie wyspecjalizowane – mono- i oligofagiczne, związane w głównej mierze z roślinami nasiennymi i znacznie rzadziej z mszakami i paprotnikami. Z ponad 1700 gatunków piewików występujących na terenie Europy, około 520 zostało wykazanych z obszaru Polski, co stanowi ponad 30% europejskiej cykadofauny. Fauna ta w Polsce jest dość dobrze, choć nierównomiernie zbadana. Cykadofauna górska, zawłaszcza Karpat i Sudetów pod względem poznania różnorodności gatunkowej piewików należy do obszarów wciąż słabo poznanych. Badania prowadzone w rejonie Sudetów, wraz z wchodzącym w ich skład Parkiem Narodowym Gór Stołowych (PNGS) przyczyniły się do wykazania dotychczas 127 gatunków piewików i tylko 4 gatunków stricte z terenu Parku Narodowego Gór Stołowych, a wraz z otuliną PNGS, 18 taksonów. Podobny stan poznania fauny Auchenorrhyncha obserwujemy w większości PN, z których tylko 6 doczekało się szerszych opracowań faunistycznych i jedynie Ojcowski Park Narodowy opracowano pod kątem zgrupowań skoczków związanych z określonymi zbiorowiskami roślinnymi. Przeprowadzone badania cykadofauny PNGS miały na celu: inwentaryzację fauny Fulgoromorpha i Cicadomorpha, określenie jej struktury ekologicznej i chorologicznej oraz przedstawienie jej genezy. Park Narodowy Gór Stołowych został utworzony 16.09.1993 roku, jako dziewiętnasty polski obiekt chroniony tej rangi. Całkowita powierzchnia parku wynosi 6339,75 ha, z czego 5779,15 ha (91,2% powierzchni parku) zajmują zbiorowiska leśne, a nieco ponad 560 ha przypada na państwowe i prywatne obszary nieleśne. Został on powołany w głównej mierze do ochrony występujących na jego terytorium form skalnych oraz ochrony ekosystemów, fauny i flory. Rozciągający się w obrębie niecki środkowosudeckiej Masyw Gór Stołowych wykształcony został ze skał górnokredowych, które tworzyły się w płytkim epikontynentalnym morzu w warunkach klimatu ciepłego. Osady zostały wykształcone w postaci piaskowców cisowych oraz margli plenerskich. Skały te zalegają nieckowato, ale bardzo płasko, tworząc strukturę o wierzchowinach przypominających z daleka stół. Poziom najwyższy Gór Stołowych obejmuje: Szczeliniec Wielki (919 m) i Skalniak (915 m). Z obszaru parku wykazano łącznie 743 taksony

flory naczyniowej oraz 560 obejmujących rośliny zarodnikowe i mchy. W szacie roślinnej dominują jednowiekowe i jednowarstwowe bory świerkowe, zajmując ponad 85% ogólnej powierzchni lasów PNGS, w pozostałej części parku przeważają drzewostany mieszane z udziałem buka, jaworu, modrzewia, brzozy i sporadycznie jodły. Rozpoznanie faunistyczne Parku Narodowego Gór Stołowych i jego otuliny jest niezadowalające, jak dotychczas, stwierdzono występowanie 167 gatunków kręgowców oraz 929 bezkręgowców na ponad 33 tysiące zarejestrowanych na obszarze Polski.

Badania prowadzono w latach 2003–2006, na obszarze całego PNGS. Do badań ilościowych wyznaczono 29 powierzchni badawczych. Wyznaczone powierzchnie badawcze zlokalizowano w obrębie płatów różnych zbiorowisk: łąkowych o charakterze półnaturalnym i antropogenicznym zaliczanych do klasy *Molinio-Arrhenathereta* i *Nardo-Callunetea*, zbiorowisk leśnych należących do klasy *Vaccinio-Piceetea*, zbiorowisk zastępczych klasy *Querco-Fagetea*, zbiorowisk torfowisk mszysto-turzycowych i mszarów klasy *Scheuchzerio-Caricetea*. Szczególną uwagę zwrócono na następujące typy siedlisk: *Lysimachio-Filipenduletum*, *Cirsietum rivularis*, *Nardus stricta*, *Cirsium heterophyllum*, *Arrhenatherum elatius* oraz na płaty roślinności z dominacją następujących gatunków: *Picea excelsa*, *Carex flava*, *Carex remota*, *Alopecurus pratensis*, *Calamagrostis epigejos*, *Dactlis glomerata*, *Deschampsia caespitosa*, *Deschampsia flexuosa*, *Holcus lanatus*, *Molinia caerulea*, *Eriophorum latifolium*, *Betula pendula*, *Trientalis europaea*, oraz *Vaccinium myrtilus*. Na wyznaczonych powierzchniach badawczych zebrano łącznie 1044 próby (po 36 prób z każdej powierzchni) z 20431 okazami piewików należącymi do 77 gatunków. Ponadto zbierano materiał metodami jakościowymi, poza powierzchniami badawczymi z określonych gatunków roślin za pomocą czerpaka i metodą "na upatrzonego". Zastosowano standardowy czerpak entomologiczny (Ø 30 cm). Pojedynczą próbę stanowiło po 25 uderzeń czerpaka, wykonane w 4 transektach o szerokości 1 m (4 x 25 x 100) na powierzchni około 500 m^2 (20 x 25 m). W ten sposób odłowiono kilkaset okazów piewików należących do 90 gatunków. Aż 58 gatunków odłowiono zarówno metodami ilościowymi jak i jakościowymi, 19 znaleziono wyłącznie na powierzchniach badawczych, natomiast 26 odłowiono wyłącznie poza wyznaczonymi powierzchniami badawczymi. **Łącznie podczas czterech sezonów badań znaleziono przedstawicieli 103 gatunków piewików w tym 32 nowe dla pasma Sudetów, w tym 1 nowy dla fauny kraju: *Eupteryx signatipennis*. Tym samym różnorodność skoczków z obszaru Sudetów zwiększyła się do 159 gatunków.**

Analizując zebrany materiał badawczy posłużono się wskaźnikami analitycznymi i syntetycznymi. Przeprowadzono także analizę wskaźników umożliwiających wnioskowanie o różnorodności gatunkowej badanych zgrupowań piewików. Przeprowadzono analizę struktury dominacji piewików w oparciu o pięć klas: **eudominanty** – stanowiące ponad 30%, **dominanty** – od 20,01% do 30,00%, s**ubdominanty** – od 10,01% do 20,00%, **recedenty** – od 5% do 10,00%, **subrecedenty** – stanowiące poniżej 5%. Stałość występowania wyróżniono na podstawie czterech klas stałości: **I Klasa** – od 75,01% do 100%, **II Klasa** – od 50,01% do 75,00%,

III Klasa – od 25% do 50,00%, **IV Klasa** – poniżej 25%. Wyróżniono cztery klasy wierności: gatunki wyróżniające, charakterystyczne, towarzyszące, przypadkowe. W celu określenia gatunkowej różnorodności biologicznej wykorzystano następujące wskaźniki: **wskaźnik różnorodności gatunkowej Shannona–Weavera *H'*, wskaźnik równomierności Pielou *J'*, wskaźnik różnorodności gatunkowej Brillouina $\hat{H}$, wskaźnik różnorodności gatunkowej Simpsona *I*.** Podobieństwa zgrupowań przedstawiono w postaci graficznej i opracowano w oparciu o algorytm aglomeracji (dla oszacowania danych wybrano metodę Warda – dendrogram), oraz w oparciu o analizę składowych głównych (Principal Components Analysis – PCA). Obrazem graficznym tej analizy jest płaszczyzna czynnikowa generowana przez wybraną parę osi, na którą rzutowane są punkty z przestrzeni wektorowej. Przeprowadzono także analizę dyskryminacyjną w oparciu o wskaźniki mozaikowatości środowiska: numeryczny wskaźnik mozaikowatości środowiska i gatunkowy wskaźnik mozaikowatości środowiska. Do wykonania analizy ekologicznej ustalono i posłużono się następującymi kryteriami: kryterium wilgotnościowe i środowiskowe, nasłonecznienie oraz powiązania troficzne. W celu przeprowadzenia analizy chorologicznej wyróżniono następujące elementy: eurosyberyjski, europejski, transpalearktyczny, syberyjski, zachodniopalearktyczny, holarkyczny, północnoeuropejski, śródziemnomorski, euroalpejski, geopolityczny, kazachski, borealny i górski. Gatunkami głównymi (tworzącymi trzon zgrupowań), licznie występującymi na wszystkich powierzchniach nieleśnych były: *Verdanus abdominalis*, *Arthaldeus pascuellus*, *Errastunus ocellaris*, *Balclutha punctata*, *Cicadula persimilis* i *Jassargus distinguendus* natomiast na powierzchniach leśnych taką rolę pełniły *Neophilaenus lineatus* i *Balclutha punctata*.

Zbiorowiska nieleśne z murawami *Nardus stricta*:

Wśród zgrupowań związanych ze zbiorowiskami nieleśnymi wyraźnie zaznacza się odrębność zbiorowisk związanych z murawami *Nardus stricta* (powierzchnie: 5 i 6), na których wykazano 26–29 gatunków (Table 8 i 9). Dominującymi i bardzo licznie występującymi taksonami we wszystkich sezonach badawczych były *Verdanus abdominalis* i *Doratura stylata*. Taksonami wyróżniającymi (Annex 1) były *Anoscopus flavostriatus* (powierzchnia 5) i *Streptanus aemulans* (powierzchnia 6). Ponadto dla tej ostatniej powierzchni wykazano gatunki charakterystyczne: *Eupelix cuspidata*, *Deltocephalus pulicaris*, *Doratura stylata*, *Rhopalopyx preyssleri* oraz *Psammotettix cephalotes* (Annex 1). Zgrupowanie to charakteryzuje się największą liczbą gatunków wyróżniających i charakterystycznych spośród wszystkich przebadanych powierzchni. Stwierdzono, iż to zgrupowanie charakteryzuje się odpowiednio wysokim udziałem taksonów kserofilnych (5 gatunków) i heliofilnych (9 gatunków). Powyższa zoocenoza (związana z murawą *Nardus stricta*) charakteryzuje się również bogatym składem gatunkowym oraz wysoką liczebnością osobników z przewagą taksonów wyspecjalizowanych oligo- i stenotopowych, zimujących pod postacią jaja.

Zbiorowiska łąk świeżych z klasy *Molinio-Arrhenathereta*:

Drugą grupę zbiorowisk roślinnych stanowią fitocenozy łąk świeżych zaliczanych do klasy *Molinio-Arrhenathereta*, w obrębie których zbadano 18 zgrupowań zaliczanych **głównie do następujących związków fitosocjologicznych: *Cirsietum rivularis*, *Caltion palustris*, *Filipendulion ulmariae*, i *Arrhenatherion elatioris.*** Odnotowano tu największą liczbę gatunków piewików (od 15 do 35 taksonów). Podstawowymi gatunkami budującymi tego typu zgrupowania na terenie PNGS są: *Javesella pellucida*, *Psammotettix cephalotes*, *Verdanus abdominalis*, *Arthaldeus pascuellus*, *Errastunus ocellaris* i *Cicadula persimilis*. Analizując zebrany materiał uwidacznia się ogólne podobieństwo składu gatunkowego skoczków bytujących w tych fitocenozach, co ma swoje odzwierciedlenie choćby w zbliżonym udziale poszczególnych elementów ekologicznych (Annex 9 i 10) i chorologicznych (Annex 5 i 6). Zgrupowania związane ze zbiorowiskiem *Cirsietum rivularis* (powierzchnie: 1; 2; 4; 15; 16) można pod względem wilgotności podzielić na trzy grupy. Pierwsza z nich obejmuje zgrupowanie na powierzchni 4 leżącej w okolicy Małego Torfowiska Batorowskiego. W obrębie niej stwierdzono 23 gatunki piewików (Table 7), z czego na element higrofilny przypada 30,43%, a na mezohigrofilny aż 65,22% (Annex 38). Do gatunków o największej liczebności zaliczyć można *Balclutha punctata* i *Verdanus abdominalis*. Gatunkiem charakterystycznym dla tego zgrupowania był *Doliotettix lunulatus* (Annex 1). Druga grupa obejmuje nieco mniej wilgotne zbiorowisko *Cirsietum rivularis* od poprzedniej powierzchni (stanowiska: 1 i 2) liczące sobie po 20 taksonów (Annex 4 i 5). Ilościowo przeważają tu gatunki *Verdanus abdominalis*, *Balclutha punctata* oraz *Arthaldeus pascuellus*, brak natomiast gatunków charakterystycznych i wyróżniających. W porównaniu do zbiorowiska *Cirsietum rivularis* powierzchni poprzedniej wystąpił wzrost liczby gatunków kserofilnych (10%) kosztem higrofilnych (20–25%) (Annex 9). Trzecią grupę stanowią powierzchnie (15, 16) leżące w obrębie rezerwatu "Łężyckie Skałki" liczące odpowiednio 17 i 15 taksonów (Table 18 i 19). Charakteryzują się mniej wilgotną strukturą niż poprzednie, co ma odzwierciedlenie w dalszej redukcji form higrofilnych (5,88%; 0,0%) na korzyść taksonów kserofilnych (11,76–20%) (Annex 10). Podstawowymi gatunkami tego zgrupowania były *Philaenus spumarius*, *Errastunus ocellaris* i *Verdanus abdominalis* a wyróżniającym (na powierzchni 15) *Chlorita paolii* (Annex 1). W obu zgrupowaniach dominowały gatunki eurytopowe.

Kolejne zgrupowanie związane z zbiorowiskiem *Deschampsia caespitosa* ze związku *Caltion palustris*, występujące na powierzchniach 11 i 12, zawiera odpowiednio 23 i 25 taksonów (Annex 14 i 15). Dominującymi gatunkami były tu *Cicadula persimilis* i *Balclutha punctata*, z których ostatni charakteryzował się dużą stałością. Do gatunków charakterystycznych zalicza się *Eupteryx atropunctata* oraz prawdopodobnie *E. signatipennis* (Annex 1). O odrębności, stabilizacji i wewnętrznej różnorodności tej fitocenozy może dodatkowo świadczyć występowanie taksonów skiofilnych, niska liczebność gatunków pionierskich (Annex 10), oraz wysokie wartości współczynników różnorodności numerycznej (0,69; 0,49) i specyficznej (0,95; 0,92) (Annex 3) świadczących o bardzo dobrze rozwiniętej strukturze mikrosiedlisk.

Zgrupowanie związane ze związkiem *Filipendulion ulmariae* występuje na powierzchni 3 leżącej w okolicy "Małego Torfowiska Batorowskiego". Odnotowano w nim 27 gatunków piewików (Table 6), z których najliczniej występującym był *Verdanus abdominalis*, zaś taksonami wyróżniającymi dla tego typu siedliska były *Cercopis sanguinolenta*, *Aphrodes makarovi* i *Fagocyba cruenta* (Annex 1). Pod względem preferencji ekologicznych dominowały formy mezohigrofilne (66,67%), mezoheliofilne (88,89%) o ściśle określonych warunkach abiotycznych (oligotopowe) (Annex 9). Składem gatunkowym fitocenoza ta nawiązuje do muraw z klasy *Nardo-Callunetea*. Zgrupowanie związane ze związkiem *Arrhenatherion elatioris* (powierzchnie: 7; 8; 9; 10; 17; 18) zawierało od 18 do 32 gatunków piewików (Table: 10, 11, 12, 13, 20 i 21). Brak tutaj gatunków wyróżniających i charakterystycznych, a głównymi gatunkami budującymi to zgrupowanie były: *Verdanus abdominalis*, *Arthaldeus pascuellus*, *Balclutha punctata*, *Javesella pellucida* i *Acanthodelphax spinosa*. Gatunki te są szeroko rozmieszczone i licznie występują na obszarze PNGS. Do klasy *Molinio-Arrhenathereta* należały również powierzchnie ze zbiorowiskami *Alopecurus pratensis* i *Holcus lanatus.* W zgrupowaniu związanym ze zbiorowiskiem *Alopecurus pratensis* (powierzchnie: 13 i 14) podstawowymi gatunkami były *Cicadula persimilis* i *Errastunus ocellaris* (Annex 16 i 17). Brak tu gatunków wyróżniających i charakterystycznych, przy jednoczesnym ograniczeniu liczebności *Verdanus abdominalis* – taksonu dominującego w zgrupowaniu klasy *Molinio-Arrhenathereta*. Związane jest to prawdopodobnie z inicjalnym charakterem tego zgrupowania, o czym może świadczyć duży udział form makropterycznych, gatunków pionierskich i zróżnicowanie troficzne.

Zgrupowanie związane ze zbiorowiskiem *Holcus lanatus* (powierzchnie: 19 i 20) charakteryzowało się wysoką liczebnością takich gatunków jak *Verdanus abdominalis* i *Macrosteles laevis* (Annex 22 i 23). Do gatunków wyróżniających należały tu: *Notus flavipennis*, *Macrosteles ossiannilssoni* i *Cicadula quadrinotata*, do charakterystycznych *Ribautodelphax collina*, *Eupteryx vittata* i *Forcipata citrinella* (Annex 1). Zgrupowanie to charakteryzuje się najwyższą różnorodnością gatunkową piewików w obrębie wszystkich powierzchni badawczych. Tak wysoki stopień zróżnicowania fauny i flory ma swoje odzwierciedlenie w wysokich wartościach współczynników różnorodności Brillouina, Shannona-Weavera i Simpsona (Annex: 2, 12, 13 i 14). Wydaje się, że do gatunków dobrze opisujących to zgrupowanie poza wyżej wymienionymi można zaliczyć dodatkowo gatunek *Kelisia guttula* nienotowany w żadnym innym badanym zbiorowisku na terenie PNGS. Podobieństwo występowania gatunków dominujących i subdominujących w różnych zbiorowiskach należących do klasy *Molinio-Arrhenathereta*, można tłumaczyć podobieństwem struktury florystycznej owych fitocenoz oraz ich szerokim rozprzestrzenieniem.

Zgrupowania piewików w zbiorowiskach leśnych:

Analizując zgrupowania zbiorowisk leśnych można wyróżnić dwa główne kręgi zgrupowań (Annex 55). Pierwszy związany ze zbiorowiskami darniowych torfowisk niskich i przejściowych, drugi z borami świerkowymi i lasami liściastymi z domieszką

świerka. W zgrupowaniu związanym ze zbiorowiskiem *Eriophorum latifolium* (powierzchnie: 23 i 24) odnotowanych zostało 10 gatunków piewików (Table 26 i 27). Dominującym był *Nothodelphax distincta*, który wraz z *Sorhoanus xanthoneurus* zaliczono do gatunków charakterystycznych (Annex 1). W zgrupowaniu związanym ze związkiem *Alno-Ulmion* wykazano odpowiednio dla powierzchni 21 – 14 gatunków (Table 24), dla powierzchni 22 – 16 gatunków (Table 25). Głównymi gatunkami były tutaj: *Neophilaenus lineatus*, *Balclutha punctata* i *Speudotettix subfusculus*. Taksonem wyróżniającym był *Planaphrodes nigrita* a charakterystycznym *Ribautodelphax albostriata* (Annex 1). Zgrupowania związane ze związkiem *Vaccinio-Piceeion* na terenie PNGS (powierzchnie: 25; 26; 27; 28 i 29) liczyły od 5 do 26 gatunków (Table: 28, 29, 30, 31 i 32). Głównymi gatunkami były *Neophilaenus lineatus*, *Balclutha punctata* oraz *Hyledelphax elegantula*. Do gatunków wyróżniających dla tego typu zgrupowań badanych na terenie PNGS zaliczyć można *Kybos smaragdulus* i *Diplocolenus bohemani* natomiast do charakterystycznych: *Cercopis vulnerata*, *Diplocolenus sudeticus*, *Javesella discolor, Oncopsis flavicollis*, *Oncopsis tristis*, *Dikraneura variata* oraz *Elymana kozhevnikovi* (Annex 1). W omówionych zgrupowaniach związanych ze zbiorowiskami leśnymi trzeba zwrócić uwagę na fakt, iż poza stwierdzonymi gatunkami charakterystycznymi i wyróżniającymi część gatunków właściwych dla tego typu siedlisk może występować także w koronach drzew i wymagać odrębnych badań. Największy udział w zebranym materiale badawczym miały gatunki mezohigrofilne (59,22%) i higrofilne (31,07%), a najmniejszy kserofilne (9,71%) (Annex 8), przy czym powierzchnie leśne w stosunku do powierzchni o charakterze muraw cechuje zwiększenie udziału procentowego elementu mezohigrofilnego oraz zmniejszenie udziału kserofilnego. Oceniając strategię życiową piewików na terenie PNGS należy stwierdzić, że najliczniejszą grupę stanowią gatunki oligotopowe (35,92%) i stenotopowe (30,1%) (Annex 8). Nieco inaczej jest na obszarach leśnych, gdzie główną rolę odgrywają gatunki o szerokim spektrum (eurytopowe), co związane jest zapewne z antropogenicznym przekształceniem środowiska, w którym dominują nasadzone jednowiekowe i jednogatunkowe bory sosnowe. Stan taki potwierdza ubogie zróżnicowanie gatunkowe badanej grupy pluskwiaków wahające się w granicach od 4 do kilkunastu taksonów. Podobnie, analizując procentowy udział gatunków polifagicznych w zgrupowaniach na obszarach leśnych, zwłaszcza tych o niskiej bioróżnorodności piewików widać wyraźne zwiększenie ich udziału nawet do 60% w stosunku do średniej dla PNGS, która wynosi 22,33%. Monofagi i oligofagi miały udział po 38,83% (Annex 8).

Z analizy chorologicznej wynika, że najwyższy odsetek w całości zebranego materiału badawczego stanowił element eurosyberyjski (30,1%) i europejski (19,42%) a najmniej liczne były elementy: śródziemnomorski, euroalpejski, kazachski i zachodnioeuropejski, reprezentowane tylko przez pojedyncze gatunki (Annex 4). Na powierzchniach leśnych obserwuje się wzrost udziału elementu transpalearktycznego (Annex 7), a zmniejszenie europejskiego w stosunku do powierzchni łąkowych (Annex 5 i 6). Ponadto tylko w zbiorowiskach trawiastych występował element zachodnioeuropejski (powierzchnie: 3, 5, 6 i 9), element kazachski

(powierzchnia 15) i śródziemnomorski (powierzchnie: 3; 5; 13 i 19). Element euroalpejski reprezentowany jest przez 2 gatunki, przy czym *Diplocolenus sudeticus* notowany był na terenie kraju tylko z rejonu Sudetów, natomiast *Erythria manderstjernii* znany jest także z Karpat. W zebranym materiale stwierdzono także dwa gatunki (*Megopthalmus scanicus* i *Cercopis sanguinolenta*) reprezentujące element śródziemnomorski.

Analiza współczynników bioróżnorodności Brillouina, Shannona-Weavera i Simpsona (Annex: 2, 12, 13 i 14) wyraźnie pokazuje, że najwyższe zróżnicowanie gatunkowe występuje na powierzchniach 19 i 20 (zbiorowisko z *Holcus lanatus*). Wiąże się to z tym, iż gatunki występujące w tych zgrupowaniach zasiedlają najbogatsze pod względem florystycznym łąki z rzędu *Arrhenatheretalia*. Bogactwo gatunkowe piewików tej fitocenozy świadczy o wysokiej stabilizacji i organizacji tego środowiska, co potwierdza również wysoka wartość współczynnika równomierności Pielou (Annex 2) wyrażona stosunkiem wartości współczynnika różnorodności gatunkowej zespołu i maksymalną różnorodnością. Natomiast najniższa wartość współczynników różnorodności gatunkowej została odnotowana na powierzchniach 26 i 27. Związane jest to ze słabą różnorodnością flory (monokultury świerka z ubogim runem) i co za tym idzie, niewielką różnorodnością gatunkową.

Analizując podobieństwa w celu ustalenia hierarchii badanych zgrupowań korzystano zarówno z metod dendrytowych jak i analizy głównych składowych (PCA) (Annex 15 i 16). Pozwoliło to na wyodrębnienie dwóch głównych kręgów zgrupowań wraz z charakterystycznymi dla nich gatunkami piewików. Pierwszy z nich związany jest z powierzchniami leśnymi, gdzie uwidacznia się podobieństwo zgrupowań zasiedlających zdegradowany bór świerkowy z powierzchniami z *Betula pendula*. Odrębne grupy stanowią tu zbiorowiska związane z terenami bagiennymi i prześwietlone świerczyny (Annex 15). Drugi krąg zgrupowań obejmuje obszary nieleśne. Dendrogram odległości euklidesowych podobieństw obliczonych metodą Warda pokazuje wzajemne podobieństwo zgrupowań związanych z zbiorowiskiem *Nardus stricta* a zespołem *Lysimachio-Filipenduletum*. Podobna zależność podobieństw widnieje pomiędzy pozostałymi zbiorowiskami z klasy *Molinio-Arrhenatheretea*, z wyjątkiem zbiorowiska z *Holcus lanatus*, które to stanowi osobną grupę (Annex 15). Odrębność tej biocenozy związana jest zapewne z jej dużą różnorodnością florystyczną oraz bogactwem i liczebnością występujących tu gatunków piewików.

Metoda oceny różnorodności zoocenotycznej oparta na rozkładzie przypadkowego podziału zasobów pozwala wyodrębnić z badanego zgrupowania grupę gatunków związanych z mozaikowatością ekosystemu (Annex 3), uwzględnia równocześnie liczbę gatunków i strukturę zgrupowania. Największą wartość osiągają współczynniki różnorodności numerycznej (*Dn*) i specyficznej (*Ds*), dla powierzchni łąk z zespołu *Cirsietum rivularis* (powierzchnie: 1 i 2) oraz mocno prześwietlonych zbiorowisk ze związku *Vaccinio-Piceeion* (powierzchnie: 25 i 29) (Annex 3). Fakt ten przemawia za wewnętrznym zróżnicowaniem tych siedlisk i niejednorodnością takiej biocenozy. Najmniejsza wartość współczynnika *Dn* i *Ds* cechuje powierzchnie ubogie pod względem florystycznym jak i faunistycznym (niskie zróżnicowanie gatunkowe

piewików) wskazując tym samym na zdegradowany charakter fitocenozy wyróżniający się brakiem zróżnicowanych mikrosiedlisk.

Podsumowanie:

W sumie podczas badań prowadzonych w latach 2003–2006 na obszarze Parku Narodowego Gór Stołowych zebrano 103 gatunki piewików (32 nowe taksony dla Sudetów w tym 1 nowy dla fauny Polski: *Eupteryx signatipennis* – Table 2, Fig. 31, 32, 33), co stanowi około 20% cykadofauny Polski.

1. W przeprowadzonych badaniach ilościowych struktury i dynamiki liczebności zgrupowań piewików w wybranych zbiorowiskach roślinnych PNGS stwierdzono 77 gatunków piewików – co stanowi około 15% cykadofauny Polski.
2. W badaniach jakościowych PNGS stwierdzono występowanie 90 gatunków piewików, co stanowi prawie 17,3% cykadofauny Polski.
3. Na podstawie przyjętych kryteriów takich jak dominacja, stałość występowania i wierność scharakteryzowano zgrupowania piewików związane z zespołem *Cirsietum rivularis*, *Lysimachio-Filipenduletum* oraz ze zbiorowiskiem *Deschampsia caespitosa*, *Holcus lanatus*, *Nardus stricta*, *Eriophorum latifolium*, *Betula pendula* oraz mocno prześwietlonych zbiorowisk z dominującym *Picea excelsa*. Zgrupowania te charakteryzuje trwała i powtarzalna struktura.
4. W zgrupowaniach związanych z zespołem *Arrhenatherum elatius*, zbiorowiskiem z *Cirsium heterophyllum* oraz z ubogą monokulturą antropogenicznego pochodzenia z *Picea excelsa* (lasy jednowiekowe i jednogatunkowe ze słabo rozwiniętą warstwą runa i podszytu) stanowiącą główny składnik pokrywy leśnej Parku możemy stwierdzić, iż są one tworzone przez pospolicie występujące, polifagiczne gatunki, o dużej skłonności do migracji. Zgrupowania te nie mają więc trwałej, stałej i powtarzalnej struktury oraz nie cechują się występowaniem taksonów wyróżniających i charakterystycznych.
5. Na podstawie analizy różnorodności i równomierności gatunkowej opartej na współczynnikach *Brillouina*, *Shannona-Weavera*, *Simpsona* i *Pielou* wykazano, iż największą różnorodnością wyróżniało się zgrupowanie związane z zbiorowiskiem *Holcus lanatus* z rzędu *Arrhenatheretalia*.
6. Na podstawie analizy podobieństwa i analizy głównych składowych wyróżniono dwa główne kręgi zgrupowań związane odpowiednio z powierzchniami leśnymi i nieleśnymi.
7. Na podstawie przeprowadzonej analizy dyskryminacyjnej stwierdzono, iż największe wewnętrzne zróżnicowanie (mikrosiedliska) cechuje zespół *Cirsietum rivularis* oraz zbiorowiska prześwietlonych borów świerkowych, najmniejsze zaś – zdegradowane monokultury z *Picea excelsa*.

8. Przeprowadzone badania obejmujące okres wiosna–jesień pozwoliły na opisanie, w ogólnym zarysie, zmian fenologicznych fauny piewików zasiedlających zbiorowiska murawowe i leśne. Maksima liczebności populacji piewików odnotowano na początku lipca oraz na przełomie sierpnia i września.
9. Z analizy chorologicznej zebranego materiału wynika, że najliczniej na terenie badań reprezentowany jest element eurosyberyjski i europejski.
10. Przeprowadzona analiza ekologiczna zebranego materiału wykazała, iż najliczniej na terenie badań występowały gatunki mezohigrofilne, mezoheliofilne, oligofagiczne i oligotopowe.
11. Przeprowadzone badania pozwoliły na opisanie po raz pierwszy zgrupowań piewików występujących w tego typu zbiorowiskach roślinnych usytuowanych na obszarze Sudetów. Okazy dowodowe zebrane na terenie PNGS znajdują się w zbiorach Katedry Zoologii Uniwersytetu Śląskiego w Katowicach.

ANNEXES

Annex 1. List of the characteristic (●) and differential species (○) in the Fulgoromorpha and Cicadomorpha communities inhabiting particular research plots.

Name of species	Plots														
	3	4	5	6	11	15	19	20	21	22	24	25	27	28	29
Nothodelphax distincta											●				
Javesella discolor													●		
Javesella dubia								●							
Ribautodelphax albostriata										●					
Ribautodelphax collina							●								
Cercopis sanguinolenta	○														
Cercopis vulnerata												●			
Oncopsis flavicollis														●	
Oncopsis tristis															●
Eupelix cuspidata				●											
Aphrodes makarovi	○														
Planaphrodes nigrita									○						
Anoscopus flavostriatus			○												
Dikraneura variata														●	
Forcipata citrinella								●							
Notus flavipennis								○							
Kybos smaragdulus															○
Fagocyba cruenta	○														
Chlorita paolii						○									
Eupteryx atropunctata					○										
Eupteryx signatipennis					●										
Eupteryx vittata							●								
Macrosteles ossiannilssoni								○							
Elymana kozhevnikovi														●	
Cicadula quadrinotata								○							
Doliotettix lunulatus		●													
Doratura stylata				●											
Psammotettix cephalotes				●											
Rhopalopyx preyssleri				●											
Streptanus aemulans				○											
Diplocolenus bohemani														○	
Diplocolenus sudeticus												●			
Sorhoanus xanthoneurus											●				

Annex 2. Values of species diversity indices for the Fulgoromorpha and Cicadomorpha collected by sweep netting method in particular research plots.

Plots	Number of species	Brillouin species diversity index	Shannon-Weaver species diversity index		Pielou evenness index	Simpson species diversity index		
		$\hat{H}$	H'	H_{max}	J'	I'	I_p	dI
1	20	1	1.03	2.99	34.44	0.87	0.95	91.57
2	20	0.94	0.97	2.99	32.44	0.84	0.95	88.42
3	27	0.91	0.93	3.29	28.26	0.79	0.96	82.29
4	23	1	1.04	3.13	33.22	0.87	0.95	91.57
5	26	0.96	0.99	3.29	30.09	0.84	0.96	87.5
6	29	0.88	0.89	3.36	26.48	0.78	0.96	81.25
7	25	1.1	1.14	3.21	35.51	0.9	0.96	93.75
8	20	0.98	1.01	2.99	33.77	0.87	0.95	91.57
9	26	0.99	1.02	3.25	31.38	0.85	0.96	88.54
10	32	1.01	1.04	3.46	30.05	0.84	0.96	87.5
11	23	0.98	1.02	3.13	32.58	0.84	0.95	88.42
12	25	0.96	0.99	3.21	30.84	0.83	0.96	86.45
13	23	1.02	1.04	3.13	33.22	0.86	0.95	90.52
14	26	0.99	1.02	3.25	31.38	0.86	0.96	89.58
15	17	0.84	0.86	2.83	30.38	0.81	0.94	86.17
16	15	0.88	0.91	2.7	33.7	0.84	0.93	90.32
17	18	0.89	0.91	2.89	31.48	0.81	0.94	86.17
18	19	0.85	0.86	2.94	29.25	0.8	0.94	85.1
19	34	1.17	1.19	3.52	33.8	0.91	0.97	93.81
20	35	1.18	1.20	3.55	33.8	0.92	0.97	94.84
21	14	0.82	0.85	2.63	32.31	0.79	0.92	85.86
22	16	0.82	0.86	2.77	31.04	0.79	0.93	84.94
23	10	0.86	0.89	2.3	38.69	0.82	0.9	91.11
24	10	0.73	0.76	2.3	33.04	0.73	0.9	81.11
25	26	1.04	1.08	3.25	33.23	0.87	0.96	90.62
26	4	0.37	0.39	1.38	28.26	0.51	0.75	68
27	5	0.48	0.49	1.6	30.62	0.61	0.8	76.25
28	19	0.88	0.92	2.94	31.29	0.81	0.94	86.17
29	18	0.98	1.01	2.89	34.94	0.87	0.94	92.55

Annex 3. Values of the frequency distribution discriminant analysis indices for the Fulgoromorpha and Cicadomorpha collected by sweep netting method in particular research plots.

Plots	**Number of species**	***Dn***	***Ds***
1	20	0.76	0.95
2	20	0.70	0.95
3	27	0.36	0.88
4	23	0.30	0.78
5	26	0.48	0.92
6	29	0.17	0.79
7	25	0.47	0.84
8	20	0.47	0.85
9	26	0.36	0.84
10	32	0.30	0.84
11	23	0.69	0.95
12	25	0.49	0.92
13	23	0.14	0.60
14	26	0.43	0.88
15	17	0.23	0.76
16	15	0.14	0.60
17	18	—	—
18	19	0.32	0.84
19	34	0.17	0.70
20	35	0.18	0.71
21	14	—	—
22	16	0.64	0.93
23	10	—	—
24	10	0.25	0.60
25	26	0.73	0.96
26	4	—	—
27	5	0.16	0.60
28	19	0.63	0.94
29	18	0.86	0.94

Annex 4. The share of particular chorological elements in the total amount of material collected in the area of the Stołowe Mountains National Park.

CHOROLOGICAL ELEMENTS	Number of species	%
Euro-Siberian	31	30.10
European	20	19.42
Transpalearctic	17	16.50
Siberian	11	10.68
Western Palearctic	6	5.83
Holarctic	7	6.80
Northern European	5	4.85
Western European	1	0.97
Mediterranean	2	1.94
Euroalpine	2	1.94
Kazakh	1	0.97

Annex 5. Percentage share of chorological elements in particular research plots: 1–10 (N – sum of the element).

CHOROLOGICAL ELEMENTS	Plots																			
	1		2		3		4		5		6		7		8		9		10	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Euro-Siberian	3	15.00	4	20.00	5	18.52	7	30.43	6	23.08	5	17.24	5	20.00	3	15.00	5	19.23	6	18.75
European	4	20.00	2	10.00	4	14.81	3	13.04	1	3.85	5	17.24	2	8.00	4	20.00	4	15.38	6	18.75
Siberian	2	10.00	2	10.00	3	11.11	2	8.70	2	7.69	3	10.34	2	8.00	1	5.00	2	7.69	1	3.12
Transpalearctic	7	35.00	6	30.00	8	29.63	6	26.09	8	30.76	6	20.69	8	32.00	6	30.00	8	30.77	9	28.13
Western Palearctic	2	10.00	2	10.00	2	7.41	3	13.04	2	7.69	2	6.90	3	12.00	3	15.00	2	7.69	2	6.25
Holarctic	1	5.00	3	15.00	2	7.41	1	4.35	4	15.38	6	20.69	4	16.00	3	15.00	3	11.54	5	15.63
Northern European	1	5.00	1	5.00	1	3.70	–	–	1	3.85	1	3.45	1	4.00	–	–	1	3.85	2	6.25
Western European	–	–	–	–	1	3.70	–	–	1	3.85	1	3.45	–	–	–	–	1	3.85	1	3.12
Mediterranean	–	–	–	–	1	3.70	–	–	1	3.85	–	–	–	–	–	–	–	–	–	–
Euroalpine	–	–	–	–	–	–	1	4.35	–	–	–	–	–	–	–	–	–	–	–	–
Kazakh	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Annex 6. Percentage share of chorological elements in particular research plots: 11–20 (N – sum of the element).

CHOROLOGICAL ELEMENTS	Plots																			
	11		12		13		14		15		16		17		18		19		20	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Euro-Siberian	6	26.08	7	28.00	5	21.74	6	23.08	3	17.65	3	20.00	4	22.22	2	10.53	6	17.65	9	25.71
European	4	17.39	4	16.00	1	4.35	6	23.08	2	11.76	2	13.33	3	16.67	4	21.05	7	20.59	8	22.86
Siberian	2	8.70	2	8.00	1	4.35	1	3.85	1	5.88	–	–	1	5.56	3	15.79	2	5.88	2	5.71
Transpalearctic	6	26.08	8	32.00	8	34.78	8	30.77	4	23.53	5	33.33	6	33.33	5	26.32	11	32.36	9	25.71
Western Palearctic	1	4.35	1	4.00	3	13.04	2	7.69	2	11.76	1	6.67	2	11.11	1	5.26	2	5.88	1	2.86
Holarctic	2	8.70	2	8.00	3	13.04	2	7.69	3	17.65	3	20.00	1	5.56	3	15.79	4	11.76	4	11.43
Northern European	2	8.70	1	4.00	1	4.35	1	3.85	1	5.88	1	6.67	1	5.56	1	5.26	1	2.94	2	5.71
Western European	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mediterranean	–	–	–	–	1	4.35	–	–	–	–	–	–	–	–	–	–	1	2.94	–	–
Euroalpine	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Kazakh	–	–	–	–	–	–	–	–	1	5.88	–	–	–	–	–	–	–	–	–	–

Annex 7. Percentage share of chorological elements in particular research plots: 21–29 (N – sum of the element).

CHOROLOGICAL ELEMENTS	Plots															
	21		22		23		24		25		26		27		28		29	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Euro-Siberian	3	21.43	5	31.25	1	10.00	2	20.00	7	26.92	1	25.00	2	40.00	4	21.06	5	27.78
European	1	7.14	–	–	–	–	–	–	2	7.69	–	–	–	–	1	5.26	1	5.55
Siberian	–	–	–	–	1	10.00	1	10.00	1	3.85	–	–	–	–	2	10.53	3	16.67
Transpalearctic	5	35.71	6	37.50	4	40.00	4	40.00	9	34.61	2	50.00	1	20.00	7	36.84	2	11.11
Western Palearctic	2	14.29	2	12.50	1	10.00	1	10.00	3	11.54	–	–	–	–	–	–	2	11.11
Holarctic	3	21.43	3	18.75	1	10.00	–	–	2	7.69	1	25.00	1	20.00	3	15.79	3	16.67
Northern European	–	–	–	–	2	20.00	2	20.00	1	3.85	–	–	1	20.00	1	5.26	1	5.55
Western European	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mediterranean	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Euroalpine	–	–	–	–	–	–	–	–	1	3.85	–	–	–	–	1	5.26	1	5.55
Kazakh	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Annex 8. The share of particular ecological elements in the total amount of material collected in the area of the Stołowe Mountains National Park.

ECOLOGICAL ANALYSIS		
Habitat humidity		
hygrophilous	32 species	(31.07%)
mezohygrophilous	61 species	(59.22%)
xerophilous	10 species	(9.71 %)
Sunshine intensity		
heliophilous	37 species	(35.92%)
mezoheliophilous	63 species	(61.17%)
skiophilous	3 species	(2.91%)
Trophic associations		
monophags	40 species	(38.83%)
oligophags	40 species	(38.83%)
polyphags	23 species	(22.33%)
Life strategies		
pioneering	5 species	(4.85%)
stenotopic	31 species	(30.1%)
oligotopic	37 species	(35.92%)
eurytopic	20 species	(19.42%)
dendrophilous	10 species	(9.71%)

Annex 9. Percentage share of ecological elements in particular research plots: 1–10 (N – sum of the element).

ECOLOGICAL ELEMENTS	Plots																			
	1		2		3		4		5		6		7		8		9		10	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
habitat humidity																				
hygrophilous	5	25.00	4	20.00	7	25.93	7	30.43	6	23.08	4	13.79	4	16.00	3	15.00	6	23.08	8	25.00
mezohygrophilous	13	65.00	14	70.00	18	66.67	15	65.22	18	69.23	20	68.97	18	72.00	15	75.00	19	73.08	22	68.75
xerophilous	2	10.00	2	10.00	2	7.41	1	4.35	2	7.69	5	17.24	3	12.00	2	10.00	1	3.84	2	6.25
sunshine intensity																				
heliophilous	4	20.00	5	25.00	3	11.11	4	17.39	7	26.92	8	27.59	6	24.00	6	30.00	4	15.38	6	18.75
mezoheliophilous	16	80.00	15	75.00	24	88.89	19	82.61	19	73.08	21	72.41	19	76.00	14	70.00	22	84.62	25	78.13
skiophilous	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	3.12
trophic associations																				
polyphagous	4	20.00	4	20.00	8	29.63	5	21.74	5	19.23	3	10.34	5	20.00	5	25.00	7	26.92	9	28.12
oligophagous	8	40.00	11	55.00	13	48.15	13	56.52	15	57.69	18	62.07	15	60.00	10	50.00	14	53.85	17	53.13
monophagous	8	40.00	5	25.00	6	22.22	5	21.74	6	23.08	8	27.59	5	20.00	5	25.00	5	19.23	6	18.75
life strategies																				
eurytopic	6	30.00	7	35.00	5	18.52	6	26.09	6	23.08	6	20.69	6	24.00	6	30.00	6	24	9	28.13
oligotopic	6	30.00	5	20.00	12	44.44	10	43.48	11	42.31	12	41.38	9	36.00	6	30.00	11	44	13	40.63
stenotopic	6	30.00	4	25.00	5	18.52	5	21.74	5	19.23	7	24.14	4	16.00	4	20.00	4	16	3	9.38
pioneering	2	10.00	3	15.00	3	11.11	1	4.35	4	15.38	4	13.79	5	20.00	3	15.00	3	12	5	15.63
dendrophilous	–	–	1	5.00	2	7.41	1	4.35	–	–	–	–	1	4.00	1	5.00	1	4	2	6.25

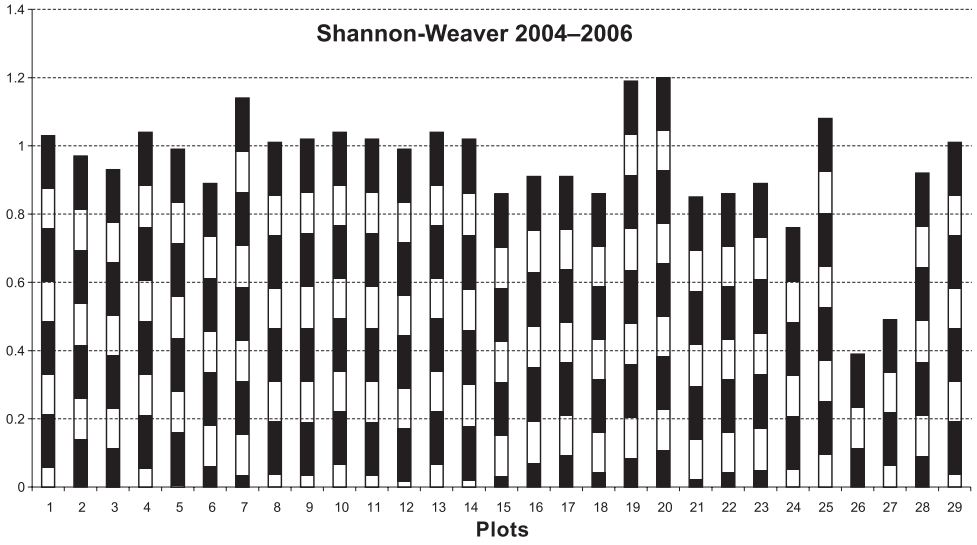
Annex 10. Percentage share of ecological elements in particular research plots: 11–20 (N – sum of the element).

ECOLOGICAL ELEMENTS	Plots																			
	11		12		13		14		15		16		17		18		19		20	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
habitat humidity																				
hygrophilous	5	21.74	5	20.00	4	17.39	7	26.92	1	5.88	–	–	3	16.67	–	–	7	20.59	11	31.43
mezohygrophilous	16	69.57	19	76.00	17	73.91	17	65.38	14	82.35	13	80.00	13	72.22	18	94.74	23	67.65	20	57.14
xerophilous	2	8.70	1	4.00	2	8.70	2	7.69	2	11.76	2	20.00	2	11.11	1	5.26	4	11.76	4	11.43
sunshine intensity																				
heliophilous	5	21.74	4	16.00	7	30.43	8	30.77	8	47.06	3	20.00	3	16.67	7	36.84	9	26.47	9	25.71
mezoheliophilous	17	73.91	20	80.00	16	69.57	18	69.23	9	52.94	12	80.00	15	83.33	12	63.16	25	73.53	26	74.29
skiophilous	1	4.35	1	4.00	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
trophic associations																				
polyphagous	6	26.09	5	20.00	5	21.74	7	26.92	3	17.65	4	26.67	4	22.22	2	10.53	9	26.47	8	22.86
oligophagous	12	52.17	15	60.00	14	60.87	14	53.85	10	58.82	9	60	11	61.11	13	68.42	18	52.94	16	45.71
monophagous	5	21.74	5	20.00	4	17.39	5	19.23	4	23.53	2	13.33	3	16.67	4	21.05	7	20.59	11	31.43
life strategies																				
eurytopic	6	26.09	7	28.00	6	26.09	6	23.08	5	29.41	6	40.00	7	38.89	7	36.84	10	29.41	8	22.86
oligotopic	9	39.13	10	40.00	9	39.13	12	46.15	6	35.29	4	26.67	7	38.89	7	36.84	12	35.29	12	34.29
stenotopic	5	21.74	6	24.00	3	13.04	4	15.38	3	17.65	2	13.33	2	11.11	3	15.79	6	17.65	10	28.57
pioneering	2	8.70	1	4.00	4	17.39	2	7.69	3	17.65	3	20.00	1	5.56	2	10.53	4	11.76	4	11.43
dendrophilous	1	4.35	1	4.00	1	4.35	2	7.69	–	–	–	–	1	5.56	–	–	2	5.88	1	2.86

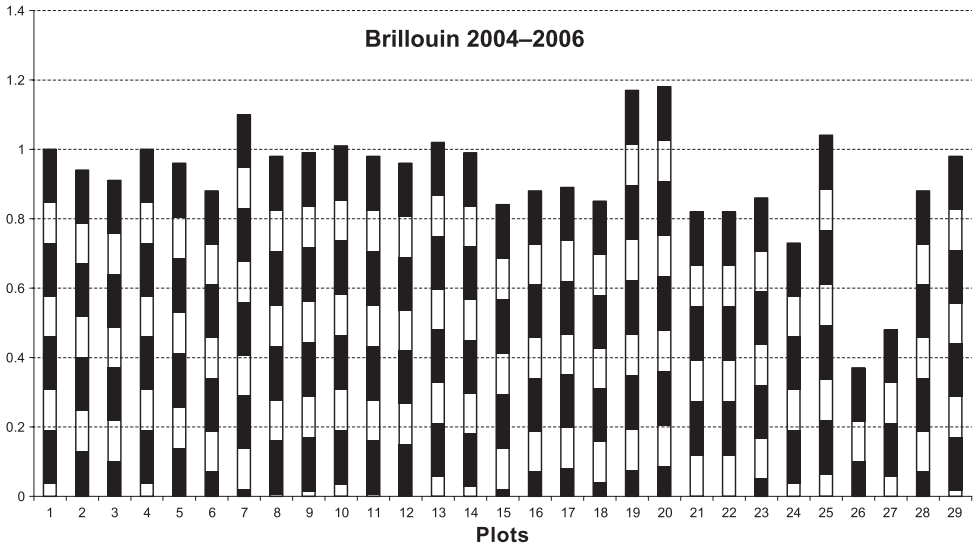
Annex 11. Percentage share of ecological elements in particular research plots: 21–29 (N – sum of the element).

ECOLOGICAL ELEMENTS	Plots																	
	21		22		23		24		25		26		27		28		29	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
habitat humidity																		
hygrophilous	2	14.29	1	6.25	2	20.00	4	40.00	6	23.08	–	–	1	20.00	3	15.79	3	16.67
mezohygrophilous	12	85.71	15	93.8	8	80.00	6	60.00	19	73.08	4	100.00	4	80.00	13	68.42	14	77.78
xerophilous	–	–	–	–	–	–	–	–	1	3.85	–	–	–	–	3	15.79	1	5.556
sunshine intensity																		
heliophilous	3	21.43	5	31.3	3	30.00	3	30.00	6	23.08	1	25.00	1	20.00	4	21.05	5	27.78
mezoheliophilous	11	78.57	11	68.8	7	70.00	7	70.00	19	73.08	3	75.00	3	60.00	14	73.68	13	72.22
skiophilous	–	–	–	–	–	–	–	–	1	3.85	–	–	1	20.00	1	5.26	–	–
trophic associations																		
polyphagous	4	28.57	5	31.25	2	20.00	3	30.00	8	30.77	2	50.00	2	40.00	7	36.84	2	11.11
oligophagous	9	64.29	9	56.25	6	60.00	5	50.00	15	57.69	2	50.00	3	60.00	10	52.63	12	66.67
monophagous	1	7.14	2	12.5	2	20.00	2	20.00	3	11.54	–	–	–	–	2	10.53	4	22.22
life strategies																		
eurytopic	7	50.00	7	43.8	5	50.00	4	40.00	11	42.31	2	50.00	3	60.00	7	36.84	3	16.67
oligotopic	3	21.43	3	18.8	2	20.00	3	30.00	10	38.46	1	25.00	2	40.00	7	36.84	8	44.44
stenotopic	–	–	1	6.25	2	20.00	2	20.00	2	7.69	–	–	–	–	2	10.53	3	16.67
pioneering	2	14.29	3	18.8	1	10.00	1	10.00	3	11.54	1	25.00	–	–	2	10.53	2	11.11
dendrophilous	2	14.29	2	12.5	–	–	–	–	–	–	–	–	–	–	1	5.26	2	11.11

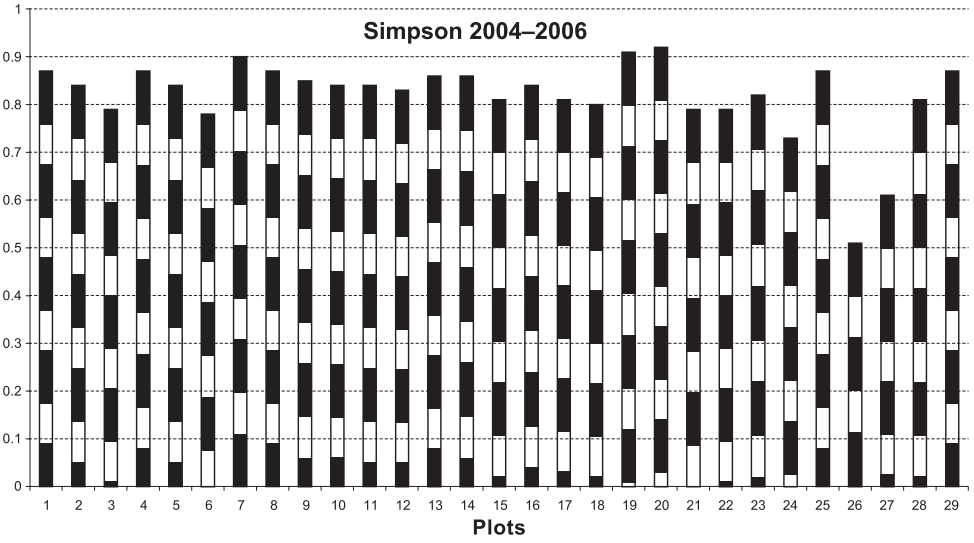
Annex 12. Value of the Shannon-Weaver *H'* species diversity index.



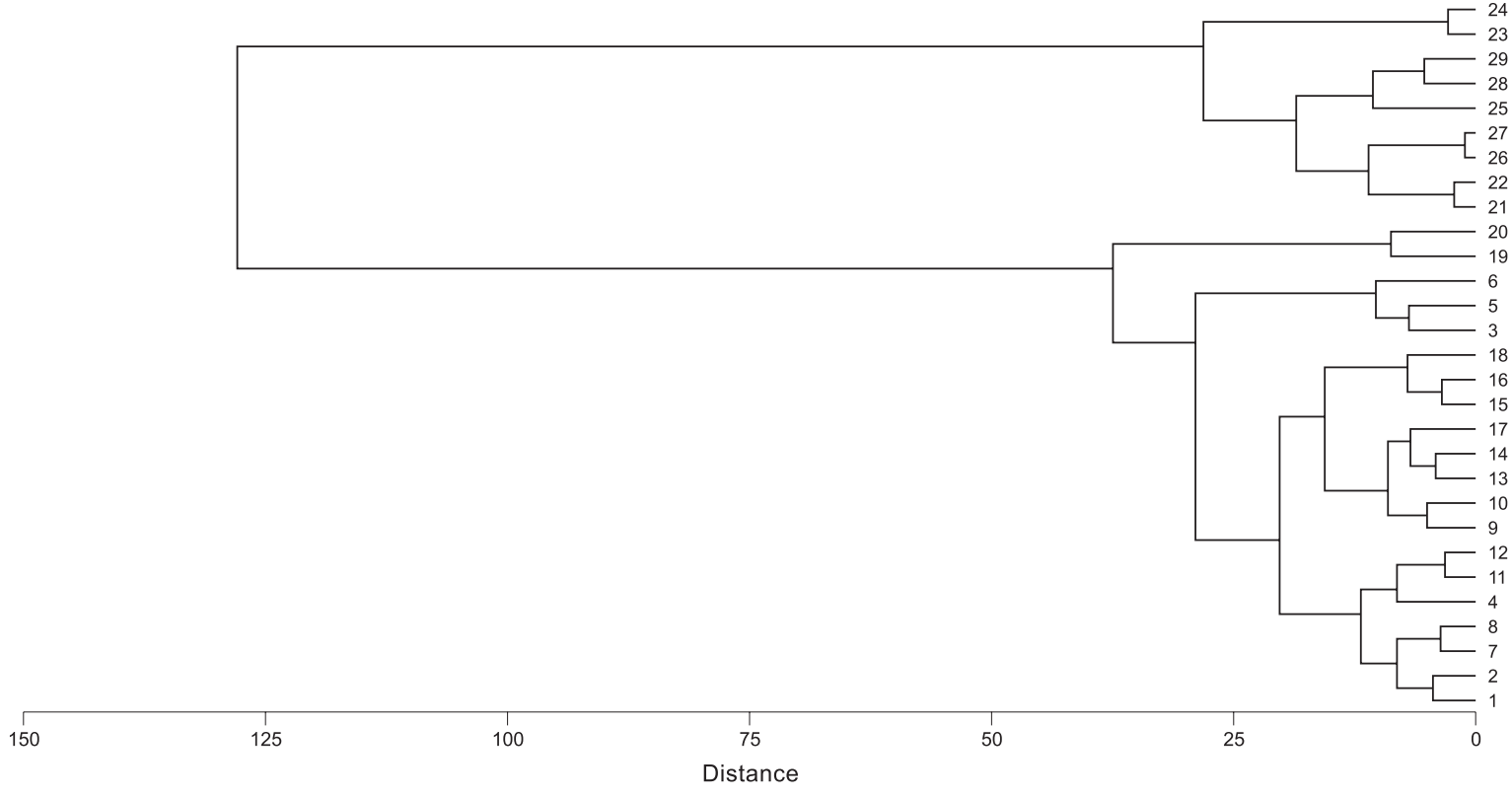
Annex 13. Value of the Brillouin $\hat{H}$ species diversity index.



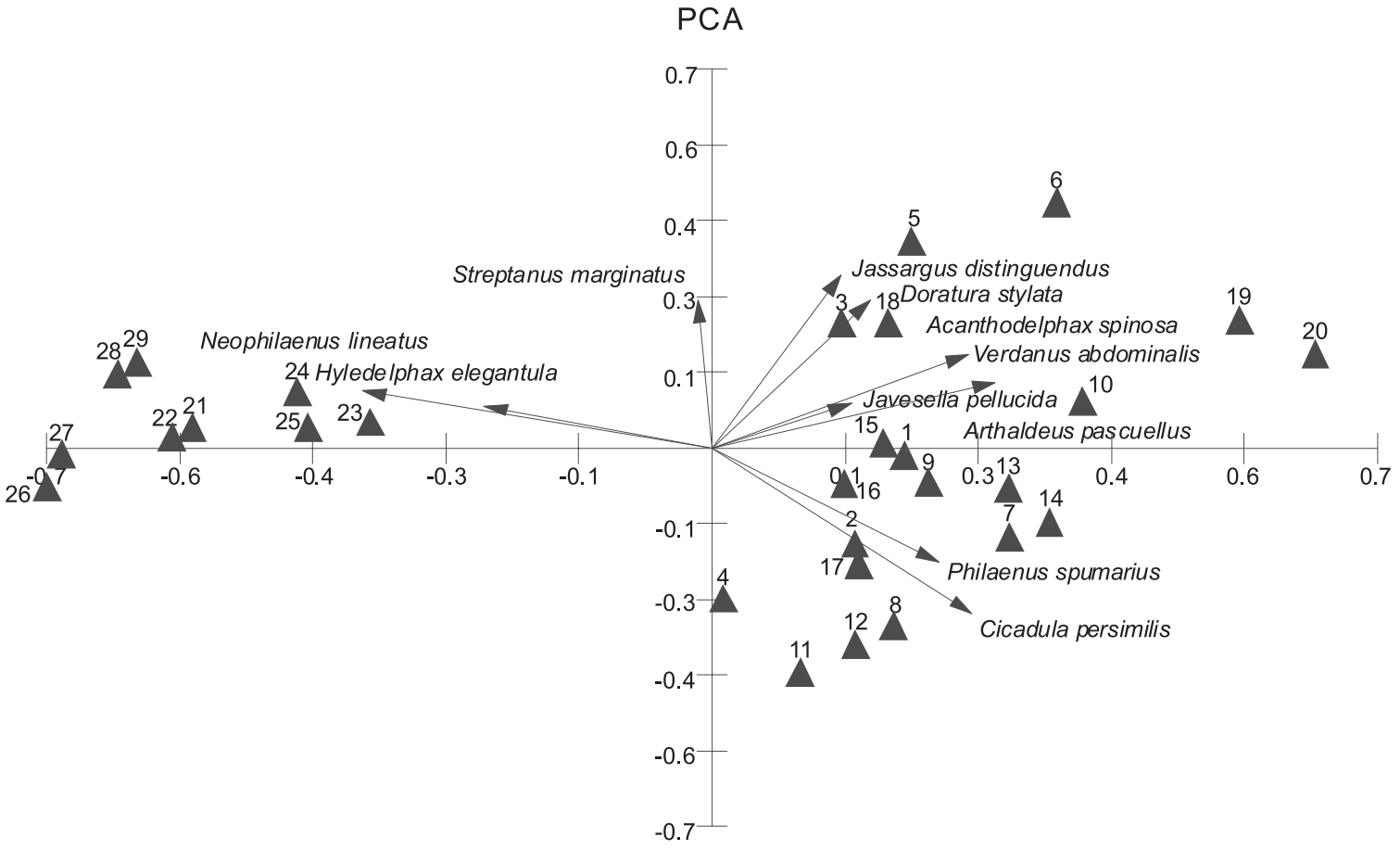
Annex 14. Value of the Simpson *I′* species diversity index.



Annex 15. Dendrogram of Euclidean distances of community similarities based on the calculation of the number of individuals of all species; Ward's method.



Annex 16. Principal Components Analysis (PCA) based on the calculation of the number of individuals of all species.



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Examples: Mazur S. 1984. A world catalogue of Histeridae. Polskie Pismo Entomologiczne, 54: 1–379.

Mulsant E., Rey A. 1844a. Histoire Naturelle des Coléopteres de France. Maison, Paris: vii + 1–196, pl. 1.

Lawrance J. F. 1982. Coleoptera. [in:] Parker S.P. (ed.). Synopsis and Classification of Living Organisms. Vol. 2, McGraw-Hill, New York: 482–553.

Ponomarenko, A. G. 1985. [Beetles from the Jurassic of Siberia and western Mongolia]. Trudy Paleontologicheskogo Instituta, 211: 47–87. [In Russian].

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