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STUDIES ON THE COMMUNITY STRUCTURE OF THE TIPULOIDEA (INSECTA, DIPTERA) ASSAMBLAGES OF THE DUPĂ LUNCĂ MARSH, EASTERN CARPATHIANS

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TIPULOIDEA (INSECTA, DIPTERA) EGYÜTTESEK VIZSGÁLATA A KELETI KÁRPÁTOK FENEK RÉTLÁPJÁN

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KIVONAT: A Keleti Kárpátok Fenek rétlápjáról 2004 és 2005 között májustól augusztusig összesen 574 Tipuloidea egyed 79 fajtát azonosítottunk kifejlett példányok alapján. A Tipuloidea együttesek szerkezetét vizsgálatuk a láp 4 különböző élőhely-foltjában, nedves kaszálón, nyílt lápfoltokban, magaskórós-bokros vegetációban és a folyóvizeket (Maros, környező patakot) kísérő ártéri bozótokban. Magas diverzitás értéket kaptunk a magaskórós-bozótos vegetáció esetében, úgy a lápban, mind a lápot kísérő Maros folyó és patakok mentén. A magaskórós-bokros vegetáció magas fajszámmal és egyedszámmal valószínűleg faj-koncentrált élőhely a nyári periódusban, mivel a legtöbb faj napközben kerül a nyílt élőhelyekre. A nyílt nedves élőhelyeken (nedves kaszáló, lápfoltok) alacsony fajszámot találtunk, de néhány faj igen magas egyedszámban csak ezeken az élőhelyeken gyűjthető, mint a *Molophilus (M.) ater*.

ABSTRACT: A total of 574 adult craneflies belonging to 79 species of Tipuloidea were identified in summer (late May to August between 2004 and 2005) in four different types of habitats from the După Luncă swampy area, Eastern Carpathians. The community structure of the Tipuloidea assemblages from four different habitat, damp meadow, open fen, bushy vegetation in the swamp and shrubs along water courses outside the marsh were analyzed, based on Shannon diversity, abundance and equitability. The bushy vegetation in the marsh and shrubs along the water courses show a highest value of diversity and equitability, these habitats offer suitable refuge for Tipuloidea fauna from here and concentrate a high number of species and individuals during summer. The open grass vegetation are avoided by the majority of the species, but some of them were collected in high number only in such habitats (*Molophilus (M.) ater*).

Key words: Tipuloidea, adult craneflies, community structure, marshy habitats

Introduction

According to their complex relation to the aquatic or semiaquatic environment, a high number of species belongs to Tipuloidea, mostly Limoniidae and Pediciidae are suitable as good bioindicators for such ecosystems. Tipuloids are frequently collected in wet areas and represents a very diverse group, that includes animals of various sizes and shapes at various levels in the food web (e.g. humus feeders, saprophages, algae-eating or fungivorous species, predators, etc.) (MENDL 1978, REUSH 1996). Despite the important role of Tipuloidea as adults, as well as larvae in many ecological processes, knowledge concerning the habitat preference and distribution of many species is scarce (STARY and BARTAK 2000).

Focused only on the significance of biodiversity studies in natural ecosystems, the simple species list will never drive us to understand the significant ecological processes in natural conservation, like extinction, recolonization and recovery (GALLÉ 2002). In particular, in the case of Tipulidae, Limoniidae and Pediciidae families, with important number of species within Diptera, studies concerning the community structure of different ecosystems are rather sporadic (FROUZ 1999).

The “După Luncă” peat bog is a protected area of particular geobotanic interest owing to the presence of hygro-hydrophilic vegetation, which is considered a glacial relict since it occurs at higher altitudes or in north-eastern regions (DONIȚĂ et al. 1992). In addition several microthermic relicts are to be found, such as *Spirea ulmifolia*, *Evonymus nana*, *Drosera rotundifolia*, *Pedicularis sceptrum-carolinum*, *Ligularia sibirica*, *Polemonium coeruleum*.

In Transylvania studies concerning the Tipuloidea families, like Tipulidae, Limoniidae and Pediciidae are limited on some more or less comprehensive faunistic investigation, and as a result, only a few species list were published, avoid any quantitative data (THALHAMMER 1900; ERHAN and THEOWALD 1961; WEINBERG and ASTANEI 1979; ERHAN and CEIANU 1986; UJVAROSI 2003; UJVAROSI and STARY 2003).

The crane-flies (Limoniidae, Pediciidae, Tipulidae) fauna of the După Luncă marshy area has not yet been studied. This paper is the first contribution to the tipuloidea coenosis from this particular ecosystem and new information to the knowledge of the Eastern Carpathians Tipulidae, Limoniidae and Pediciidae fauna.

Study area

The “După Luncă” peat bog in the Eastern Carpathians is situated near Gheorgheni (Voşlobeni) (46°40' N; 25°37' E), below the northern slope of the Harghita Mountains. It is a marshy plain extended 600 000 m² at 670 m.a.s.l. The region is characterized by a moderate continental climate. The mean annual temperature is about 4 °C in the Gheorgheni Depression. The annual precipitation reaches 700-600 mm in the intramountainous regions. The maximum precipitations is observed in June. The number of foggy days is 66 per year in average.

The După Luncă mountainous fen is the remnant of a once existing large marsh-complex lying in the Giurgiului Basin near the River Mures, nowadays characterized by a mosaic of different habitats (both eutrophic and oligo-mesotrophic habitats with isolated groups of bushes; between damp meadows; shrubs follow the riversides, etc.). This protected area is a northern marshy unit from a complex of interconnected swamp areas in the southern part of the Eastern Carpathians, with a particular scientific value (POP 1960).

The oligotroph surfaces are partly covered by mosses (*Sphagnum ssp.* and *Polytrichum strictum*) with areas of hydrophytes (*Typha latifolia*, *Equisetum limosum*). The substrate, which consists partly of peat, is covered by grass (*Molineta*) and acid peat bog communities (*Caricetalia* with *Carex vulgaris*, *C. flava*, *C. panicea*, *C. lepidocarpa*, *C. leporina*, *C. vesicaria*). The marginal zone on the dry ground is covered by *Nardeto*- and *Molinio*- communities and by "islands" of shrubs (*Betula verrucosa*, *B. pubescens*, *Alnus glutinosa*, *A. incana*, *Sorbus aucuparia*, *Viburnum opulus*, *Padus racemosa*, *Salix cinerea*, *S. pentandra*). Isolated exemplars or small group of spruce fir trees (*Picea excelsa*) are found in the margins or even in the middle of the bog. About 200-300 m from the marginal zone is the River Mureş, with characteristic riparian vegetation, formed by shrubs and hydrophytes (*Typha sp.*, *Alnus sp.*, *Salix sp.*).

Material and methods

The adult Limoniidae, Pediciidae and Tipulidae were collected during summer (late May to August) in 2003 and 2004 with a hand net of 45 cm diameter. A total of 72 samplings were carried out on 4 different habitats: in the marginal zone (damp meadow - dm) in the fen with open swampy patches (om), in the fen with bushes and trees (mb) and in the shrubs along the River Mures and streams, framing the fen (sr).

The samples were taken three times in each type of habitat from an area of 10 x 10 m (100 m²) which was netted 10 minutes. The collected material was transferred in microvials, containing 70% alcohol.

The identification of the adult Tipulidae, Limoniidae and Pediciidae was done using some reference literature data (SAVCHENKO 1964-1989).

The community structure of adult Tipuloidea from each habitat investigated was analyzed using different methods. Species richness was measured through the number of species, density through the number of individuals, using STATISTICA computer program. The most frequently method of species diversity measurements, the Shannon Wiener equation was used (PEET 1974).

Non metric multidimensional scaling using Bray-Curtis metric and cluster analysis with Jaccard index was applied to show the similarity pattern among the assemblages collected from different habitat in the După Luncă swampy area.

All species from the present study are deposited in the Ujvarosi L. collection, Department of Taxonomy and Ecology, Cluj Napoca, Romania.

Results

A total of 79 species of Tipuloidea (Limoniidae 41, Tipulidae 36, Pediciidae 2) are recorded from the După Lunca marshy area (Table1). The most important records were the presence of some Limoniidae and Tipulidae flies, like *Hexatoma (Eriocera) grisea* (Riedel, 1914) , *Idioptera macropteryx* (Tjeder, 1955), *Phylidorea (Phylidorea) abdominalis* (Staeger, 1840), *Tipula (Lunatipula) affinis* Schummel, 1833, *T. (L.) humilis* Staeger, 1840, *T. (L.) rufula* Mannheims and Theowald, 1959, which are recorded for the first time for the Romanian fauna from this marshy area (Ujvarosi, 2003, 2005, in print). Some rare species are also present, like *Tipula (Yamatotipula) quadrivittata quadrivittata* Staeger, 1840, which were collected only once in Romania, in the Retezat Mountains, at 700 m a.s.l (Erhan-DINĂ 1986).

Table1. List of species with their relative abundance in different habitats (dm-damp meadow; om- open swampy patches; sr-shrubs along rivers and streams; mb-swamp with bushes and trees)

Species	dm	om	sr	mb
Limoniidae				
<i>Erioconopa trivialis</i> Meig.	10	0	0	0
<i>Erioptera (E.) flavata</i> (West.)	0	0,6	0,4	0
<i>Erioptera (E.) sordida</i> Zetterst.	0	0	0,4	0
<i>Erioptera (Mesocyphona) fossarum</i> (Loew)	0	0	2	0
<i>Hoplolabis (Parilisia) vicina</i> (Tonnoir)	0	0	0,4	0
<i>Idiocera (Euptilostena) jucunda</i> (Loew)	0	0	0,4	0
<i>Molophilus (M.) ater</i> (Meig.)	0	76	1,2	1,8
<i>Molophilus (M.) crassypiga</i> Meijere	0	0	0,4	0
<i>Molophilus (M.) medius</i> Meij.	0	0	0	1,8
<i>Molophilus (M.) propinquus propinquus</i> (Egger)	0	0	2,4	0,6
<i>Eloeophila (E.) maculata</i> (Meig.)	0	0	2	0,6
<i>Epiphragma ocellare ocellare</i> (L.)	0	0	0,8	0
<i>Euphyllidorea aperta</i> (Verall)	5	0	0	0
<i>Hexatoma (Eriocera) grisea</i> (Riedel)	0	0	1,2	0
<i>Idioptera macropteryx</i> (Tjed.)	0	0	0,4	1,2
<i>Limnophila (L.) schranki</i> Oosterbr.	0	0	0	6
<i>Limnophila (Limnophila) pictipennis</i> (Meig.)	15	0,6	0	0
<i>Limnophila (Limnophila) schranki</i> Oosterbr.	0	1,8	0,8	0
<i>Neolimnomyia (Brachilimnophila) nemoralis</i> (Mieg.)	0	0,6	1,6	3,6
<i>Phylidorea (Paraphylidorea) fulvonervosa</i> (Schumm.)	0	0,6	0	1,2
<i>Phylidorea (Ph.) abdominalis</i> (Staeger)	5	0	0	0
<i>Phylidorea (Ph.) ferruginea</i> (Meig.)	5	0	0	0
<i>Phylidorea (Ph.) longicornis</i> (Schumm.)	0	0	0	1,8
<i>Phylidorea (Ph.) nervosa</i> (Schumm.)	5	0	0,4	0
<i>Phylidorea (Ph.) squalens squalens</i> (Zetterst.)	20	4,2	0	0,6
<i>Pilaria discicollis discicollis</i> (Meig.)	0	0	0	0,6
<i>Dicranomyia (D.) distendens distendens</i> Lundstr.	0	0	0,8	3,6
<i>Dicranomyia (D.) modesta</i> (Meig.)	5	0,6	0,8	0
<i>Dicranomyia (Melanolimonia.) occidua</i> Edw.	5	0	0	0
<i>Dicranomyia (Melanolimonia) morio</i> (Fabricius)	5	0	0	0
<i>Dicranoptycha fuscescens</i> (Schumm.)	5	0	1,6	0,6
<i>Dicranoptycha paralivescens</i> Stary	0	0	0,8	0
<i>Limonia alpicola</i> (Lacksch.)	0	0	0	1,2
<i>Limonia flavipes</i> (Fabricius)	0	0	0	3
<i>Limonia nubeculosa</i> Meig.	0	0	0,4	0
<i>Limonia pannonica</i> (Kowitz)	0	0	0,4	0
<i>Limonia phragmitidis</i> (Schr.)	10	0	2,4	1,2
<i>Metalimnobia (M.) bifasciata bifasciata</i> (Schrank.)	0	0	0,4	0
<i>Metalimnobia (M.) quadrinotata quadrinotata</i> (Meig.)	0	0	0,8	3
<i>Orimarga (O.) attenuata</i> (Walk.)	0	0	2,4	0
<i>Rhyphidia (R.)_tenophore</i> (Loew.)	0	0	0	0,6

(1. táblázat folytatása)

Species	dm	om	sr	mb
Pediciidae				
<i>Tricyphona (T.) unicolor</i> (Schumm.)	0	1,8	0	11,4
<i>Ula (U.) sylvatica</i> (Meig.)	0	0,6	0	0
Tipulidae				
<i>Ctenophora (Ct.) festiva</i> Meig	0	0	0,4	0
<i>Tanyptera (T.) atrata atrata</i> (L.)	0	0	0,4	0
<i>Nephrotoma aculeata</i> (Loew)	0	0,6	1,6	1,2
<i>Nephrotoma analis</i> (Schumm.)	0	0	0,8	0
<i>Nephrotoma appendiculata</i> (Pierre)	0	0	0,8	0
<i>Nephrotoma crocata crocata</i> (L.)	0	0	0,4	0
<i>Nephrotoma dorsalis</i> (Fabricius)	5	0	3,6	0,6
<i>Nephrotoma flavescens</i> (L.)	0	0,6	0,8	0,6
<i>Nephrotoma pratensiss pratensis</i> (L.)	0	0	0,4	0,6
<i>Nephrotoma scalaris</i> (Meig.)	0	0	0,4	0
<i>Nephrotoma scurra</i> (Meig.)	0	0	0,4	1,8
<i>Nephrotoma tenuipes</i> (Riedel)	0	0	0,4	0
<i>Nigrotipula nigra nigra</i> (L.)	0	3,6	5,2	5,4
<i>Tipula (Acutipula) fulvipennis</i> Geer	0	0	2	1,2
<i>Tipula (Acutipula) luna</i> Westh.	0	0	0,8	0
<i>Tipula (Acutipula) tenuicornis</i> Schumm.	0	0	0,8	0
<i>Tipula (Beringotipula) unca unca</i> Wiedem.	0	0	0,4	0
<i>Tipula (Lunatipula) affinis</i> Schumm.	0	0	0,4	0
<i>Tipula (Lunatipula) fascipennis</i> Meig.	5	0,6	14,7	12
<i>Tipula (Lunatipula) humilis</i> Staeger	0	0	3,6	0,6
<i>Tipula (Lunatipula) lunata</i> L.	0	0	1,2	0,6
<i>Tipula (Lunatipula) rufula</i> Mannh. and Theow.	0	0	1,2	0
<i>Tipula (Lunatipula) vernalis</i> Meig	0	0	20,7	0
<i>Tipula (Lunatipula) verrucosa</i> Pierre	0	0	0,4	0
<i>Tipula (Pterelachisus) crassiventris</i> Riedel	0	0	0,4	0,6
<i>Tipula (Pterelachisus) truncorum</i> Meig.	0	0	0	0,6
<i>Tipula (Pterelachisus) varipennis</i> Meig.	0	0	0,8	6
<i>Tipula (T.) paludosa</i> Meig.	0	6,6	0	7,2
<i>Tipula (Vestiplex) hortorum</i> L.	0	0	0,8	0
<i>Tipula (Vestiplex) scripta</i> Meig.	0	0	0,8	1,2
<i>Tipula (Yamatotipula) coerulescens</i> Lacksch.	0	0	0,4	0
<i>Tipula (Yamatotipula) couckeii</i> Tonn.	0	0	0,4	0,8
<i>Tipula (Yamatotipula) lateralis</i> Meig.	0	0	1,6	0
<i>Tipula (Yamatotipula) montium</i> Egger	0	0	0	0,6
<i>Tipula (Yamatotipula) pruinosa</i> Wied.	0	0	4	0,6
<i>Tipula (Yamatotipula) quadrivittata quadrivittata</i> Staeger	0	0	0	3,6
Number of species	13	15	57	38
Number of individuals	20	166	237	151

The most species rich family was the Limoniidae, with 3 subfamilies and 17 genera, from which the hygrophilous *Phylidorea* species was the most numerous (five species). Between Tipulidae, the most species rich genus was *Tipula*, with 18 species, the majority belonging to the *Lunatipula* subgenus (7 species) and *Yamatotipula* (6 species).

The highest adult abundance (ind/100 m²) was found in shrubs along the Rives Mures and streams in surroundings, where the highest number of species was found (Fig. 1). Totally 57 species were found here, but only 2 of them, *Tipula* (*Lunatipula*) *fascipennis* and *Tipula* (*Lunatipula*) *vernalis* were common, highly dominated (up to 10%).

A high adult abundance was also found in the open swampy patches without bushes, but only a moderate number of species (15) were identified. Here one species *Molophilus* (*M.*) *ater* dominate (72 %) upon the all other species, being highly specialized and common for swampy areas (Fig. 1)

Roughly a same abundance was found in the swampy areas with compact bushy vegetation, where the species number grows up to 38. The bushy vegetation is ideal for shelter during the day for the majority of Tipuloidea species, mostly for the biggest ones, here the same dominant species we will found, like in the shrubs along rivers, here the commonest species was *Tipula* (*Lunatipula*) *fascipennis* (with 12%), and an other species, *Tricyphona* (*T.*) *unicolor* (11,4%), frequently collected in similar habitats (Fig. 1).

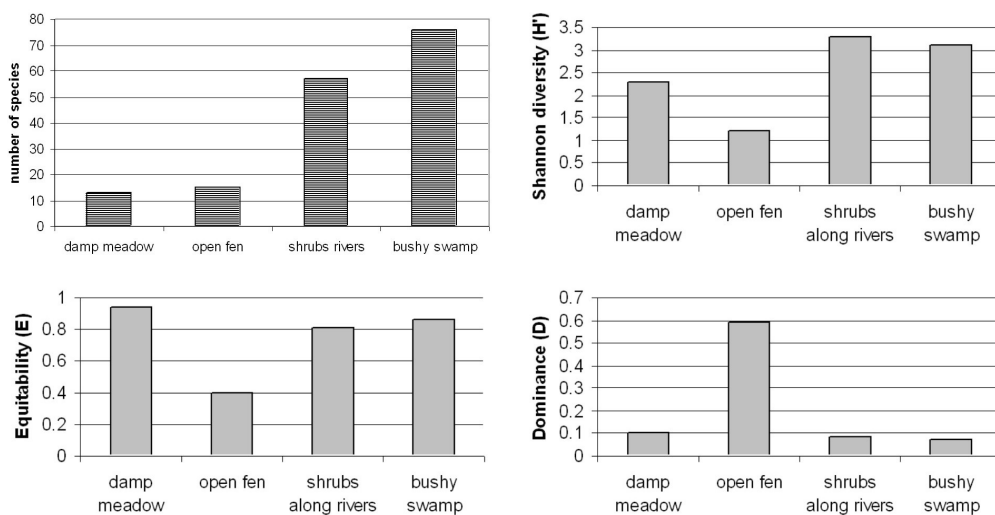


Figure 1. The Tipuloidea community changes from different types of habitat investigated in the După Luncă marsh.

The diversity (H') was high in shrubs along water courses (rivers and streams) and also in bushy patches in the swamp, decrease slightly in damp meadow and a very low value has in the open fen. The equitability (E) value has a same tendency, but here the highest value was identified in the damp meadow, where a moderate number of species were collected in more or less equal number of individuals. In the case of the shrubs along different water courses and in bushy vegetation in the swamp the number of individuals belongs to different species were more variable,

but the equitability value was also extremely high. The open fen habitats were preferred by a low number of specialized species, were they develop in high number of individuals.

Based on the similarities of the species composition it can be stated that the Tipuloidea assemblages found in the shrubs along water courses and bushy vegetation in the swamp are the most similar (around 35%), presenting one cluster and the species composition of the damp meadows were the most different (Fig. 2).

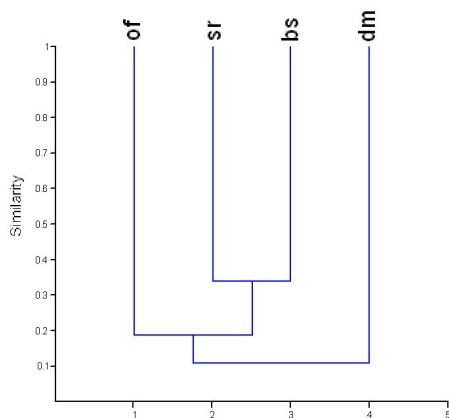


Figure 2. Cluster analysis (Jaccard distances) of different types of habitat in the După Luncă swampy area, based on the presence/absence of Tipuloidea species (of – open fen; sr – shrubs along river and streams; bs – bushy vegetation in the swamp; dm - damp meadow)

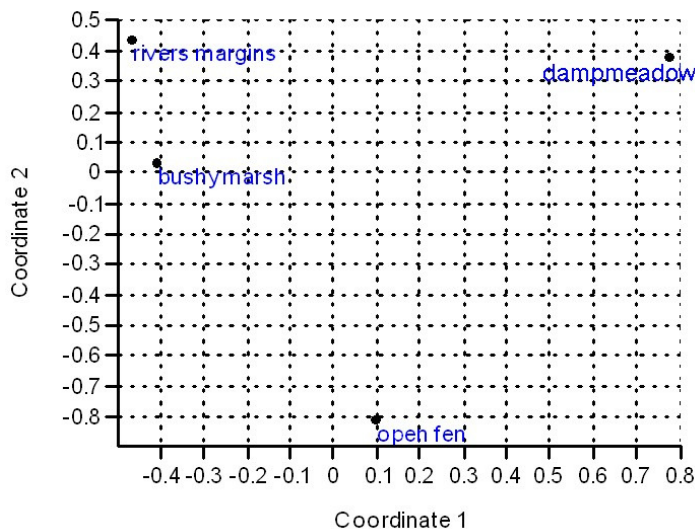


Figure 3. Non-metric multidimensional scaling (PCO) of adult Tipuloidea assemblages between different habitat type

The distribution of Tipuloidea assemblages identified from different habitat investigated from the După Luncă swampy area is presented using non-metric multidimensional scaling (Fig. 3). Four assemblages collected at different sites are indicated in the ordination space. The Tipuloidea assemblages collected from bushy vegetation in the swamp and shrubs along the water courses are more closely connected and well separated from the assemblages from open fen and damp meadow in the positive value of both axes.

Conclusions

Analysis of the Tipuloidea assemblages captured by hand net provides interesting information about the crane fly fauna of this particular mountainous acid peat bog. There are crane flies of slow moving and stagnant water as well as of hygrotropical or dry habitats. The ecology of the species is very different, with high number of species (21) belonging to the aquatic and semiaquatic habitats (*Eleophila maculata*, *Limnophila schranki*, *Neolimnophila nemoralis*, *Euphilidorea aperta*, *Phylidorea ssp.*, *Pilaria discicollis*, *Eriocnopa trivialis*, *Molophilus ssp.*, *Tricyphona ssp.*, *Tipula luna*, *T. couckeii*, *T. lateralis*, *T. pruinosa*, between them a large number of saprophagous or predator species. The rest of species belongs to swampy areas to drier places, like damp meadows (ex. *Nephrotoma ssp.*, *Tipula vernalis*). A particular ecological demand has the *Metalimonia* and *Ula* species, which feed in larval stage with woody or fleshy fungi.

25 species are noted for the first time to the Eastern Carpathians (*Ctenophora festiva*, *Tanyptera atrata*, *Nephrotoma aculeata*, *N. crocata*, *N. dorsalis*, *N. pratensis*, *N. scalaris*, *Nigrotipula nigra*, *Tipula luna*, *T. vernalis*, *T. crassiventris*, *T. truncorum*, *T. varipennis*, *T. hortorum*, *T. coerulescens*, *T. couckeii*, *T. pruinosa*, *T. quadrivittata*, *Euphilidorea aperta*, *Neolimnophila adjuncta*, *Phylidorea nervosa*, *Limonia nubeculosa*, *L. panonica*, *Rhyphidia ctenophora*, *Tricyphona unicolor*).

Concerning the specificity of the Tipuloidea assemblages from different habitat type within the marshy area our result underline the importance of the compact bushy vegetation in the swamp and well developed shrubs vegetation along the water courses bordering the marsh, which concentrate a high number of Tipuloidea species during the summer period. The open swampy area, without bushy vegetation was very poor in species, but some of them, like *Molophilus (M.) ater* were very abundant here. The damp meadow could be characterized with a particular Tipuloidea community, different from the assemblages identified inside the swamp, because of different ecological conditions, modified from the natural swampy conditions, due to the canalization and intensive grazing activity in the area.

In the light of these new results, the "După Luncă" peat bog represent an area of great interest for the crane flies biocoenosis, because of the abundance of populations recorded, the coexistence of species with different ecological needs of different geonomic components with northern, southern and eastern distribution. The importance of humid environments is confirmed and it is necessary to protect them before they are modified by human intervention.

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