

Distribution of the robber flies (Diptera: Asilidae) in the agricultural landscape in the Leningrad Region

Распределение ктырей (Diptera: Asilidae) в агроландшафте Ленинградской области

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KEY WORDS: biodiversity, species composition, robber flies, species richness.

КЛЮЧЕВЫЕ СЛОВА: биоразнообразие, видовой состав, ктыри, видовое разнообразие.

ABSTRACT. Ten species of robber flies (Diptera: Asilidae) were recorded in the mosaic agricultural landscape of the Menkovo Research Station (2005–2025), a patchwork of crop fields embedded within semi-natural habitats. Field margins adjoining forest edges were the most species-rich and abundant habitats of asilids. This affected the higher occurrences of *Leptogaster cylindrica*, *Tolmerus atricapillus* and *Dioctria* spp. in cultivated fields. *Dioctria atricapilla* turned out to dominate assemblages, particularly in perennial forage stands and spring-sown cereals, despite being regarded as locally distributed in the Leningrad Region.

РЕЗЮМЕ. За период с 2005 по 2025 г. в мозаичном агроландшафте, включающем различные агроценозы и окружающие биотопы, было зарегистрировано 10 видов ктырей (Diptera: Asilidae). Обочины полей, примыкающие к опушкам леса, характеризуются наиболее высоким биоразнообразием и обилием этих двукрылых и способствуют увеличению обилия *Leptogaster cylindrica*, *Tolmerus atricapillus* и представителей рода *Dioctria* на возделываемых землях. Наиболее многочисленный в агроландшафте, особенно в агроценозах многолетних трав и яровых зерновых культур вид — *Dioctria atricapilla*, ранее локально встречавшийся в Ленинградской области.

Introduction

Adult robber flies (Diptera: Asilidae) are prominent predators in terrestrial food webs, attacking insects across Orthoptera, Hemiptera, Diptera, Lepidoptera, Hymenoptera and Coleoptera [Shurovenkov, 1962; Lehr, 1964, 1965; Esipenko, 1978; Astakhov, 2013,

2015; Sakinah *et al.*, 2023]. Their larvae develop in soil and prey on click beetle larvae (Elateridae) and other phytophagous insects [Shurovenkov, 1962].

However, modern agricultural intensification can suppress populations of predatory flies [Larsen, Meier, 2004], making asilids currently scarce in agricultural landscapes of the Leningrad Region.

In the region under study, robber flies are typically associated with forest habitats, and adults of many species are frequently encountered at forest edges [Stackelberg, 1953]. However, their habitat distribution in a mosaic setting — where diverse agrocenoses are interspersed with field margins directly adjoining forest tracts — has not been examined.

Characterising asilid diversity and abundance across habitat types, and identifying species-specific habitat associations within such mosaics, might help both to infer habitat requirements and to develop practical approaches for conserving these predators in agricultural landscapes.

Material and methods

The work was carried out in this agricultural landscape of the Menkovo Research Station (MRS) of the Agrophysical Research Institute in the village of Menkovo (59°24'57" N, 30°02'04" E) of the Gatchina District of the Leningrad Region. Data were collected during the 2005–2025 period at MRS. This work continues a series of insect studies carried out in the MRS [Guseva, Shpanev, 2019; Guseva, Koval, 2020, 2021].

The agricultural landscape of the MRS is representative of the North-West of Russia, where cultivated fields are bordered by margins that merge into forest edges (Figs 1, 2) with combine herbaceous vegetation (*Aegopodium podagraria*, *Leucanthemum vulgare*, *Artemisia vulgaris*, *Festuca pratensis*).



Fig. 1. A crop field and its margin adjoining a forest edge.
Рис. 1. Поле и его обочина, примыкающая к опушке леса.



Fig. 2. Agricultural landscape of the Menkovo Research Station.
Рис. 2. Агрорландшафт Меньковской опытной станции.

sis, *Phleum pratense*) and shrubs (*Prunus padus* and *Salix caprea*).

Asilidae were collected with a standard insect net, window traps and manual in the different biotopes. The research was carried out on forest edges, field margins, spring grain crops (wheat, oat and barley), winter grain crops (winter wheat and rye), potato and perennial grasses (clover and timothy grass).

Altogether, 158 individuals of Asilidae were collected and determined. Most specimens we identified by D.M Astakhov (Russia, Volgograd). Taxonomic treatment follows Geller-Grimm [2004].

The species richness was estimated by the popular Margalef index: $Dmg = (S - 1) / \ln N$, where S is the number of the species recorded and N is the total number of individuals of all the species [Magurran, 1988]. Quantitative analyses used a habitat-by-species matrix, with habitats as columns, species as rows and cell entries representing numbers of individuals recorded across all sampling approaches. Using the rarefaction function from the vegan package in the R software environment [R Core Team, 2020], we carried out a comparative analysis of the species richness in different biotopes and constructed rarefaction curves that reflected an increase in the number of revealed species depending on the sample size.

Results and discussion

Across 2005–2025, ten asilid species were recorded in this model landscape (Gatchina District, Leningrad Region) using multiple methods (see Table).

Species richness peaked on field margins and was lowest in the potato agrocenosis.

Asilids were most abundant in sweep-net samples from field margins adjoining the forest edge: *Leptogaster cylindrica* — 6 individuals/100 net sweeps

(17.VI.2024) и *Dioctria atricapilla* — 4 individuals/100 net sweeps (15.VII.2019); by contrast, sweep-netting within crop fields yielded only isolated individuals.

In cultivated fields, asilid assemblages were dominated by *Dioctria* (see Table). This is likely because its adults can hunt flying over the crop early in the day and later work within dense vegetation, manoeuvring through tightly packed stems [Lehr, 1964, 1965]. *Leptogaster* shows a similar within-vegetation hunting strategy [Lehr, 1964].

Together, these records allowed us to characterise dominance patterns and habitat associations of asilids across the agricultural mosaic.

Dioctria atricapilla was the dominant asilid in the MRS landscape despite having been regarded as only locally distributed in the Leningrad Region [Stackelberg, 1958] and being more widespread farther south. The species is reported as abundant in Germany and Denmark [Geller-Grimm, 1996; Larsen, Meier, 2004 and as the most frequent asilid in Mordovia [Astakhov *et al.*, 2019].

Despite theoretical expectations, at the MRS *D. atricapilla* occurred across all surveyed crop habitats, while being consistently most numerous in dense vegetation. Наибольшее число особей этого вида зарегистрировано на полях многолетних трав (клевера и тимофеевки) (see Table). Abundance peaked in perennial forage fields (clover and timothy), where it comprised 71% of all asilids recorded, and it also dominated assemblages in spring-sown cereals.

Forest edges are often described as the characteristic habitat of *Dioctria atricapilla* in the Leningrad Region [Stackelberg, 1958]. At Menkovo, however, its propor-

Table. Asilidae (Diptera) collected in agricultural fields and on the field margins.
Таблица. Asilidae (Diptera), собранные на полях и их обочинах.

Subfamily, species	Biotope					M
	spring grain crops	winter grain crops	potato	perennial grasses	field margins, forest edges	
Asilinae						
<i>Didymachus picipes</i> (Meigen, 1820)					3	S
<i>Neoitamus socius</i> (Loew, 1871)					12	M, S, W
<i>Tolmerus atricapillus</i> (Fallén, 1814)	11	2	4	1	8	S, W, M
<i>Tolmerus cingulatus</i> (Fabricius, 1781)	8				5	S
Dioctriinae						
<i>Dioctria atricapilla</i> Meigen, 1804	19	3	3	20	14	S, W, M
<i>Dioctria cothurnata</i> Meigen, 1820	3	1		2	2	S, W, M
<i>Dioctria rufipes</i> (De Geer, 1776)	2			1	6	S, M
Laphriinae						
<i>Laphria gibbosa</i> Linnaeus, 1758				1	1	M
<i>Laphria flava</i> (Linnaeus, 1761)					2	M
Leptogastrinae						
<i>Leptogaster cylindrica</i> (De Geer, 1776)	10	1		3	10	S, M
No of species	6	4	2	6	10	
Dmg	1.26	1.54	0.51	1.50	2.17	

M — methods: W — window traps, S — sweeping, M — manual collection.

М — методы: W — оконные ловушки, S — кошение энтомологическим сачком, М — ручной сбор.

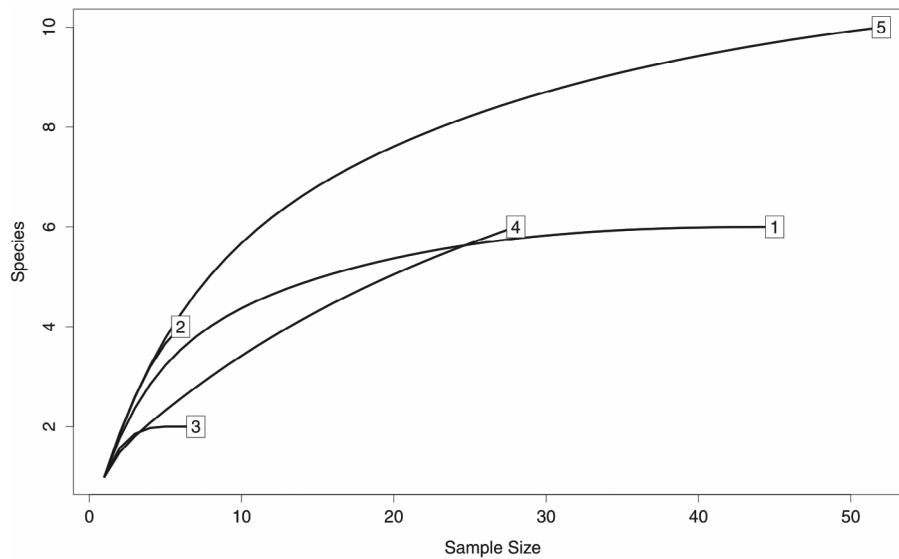


Fig. 3. Rarefaction curves for samples of Asilidae adults in different biotopes: 1 — spring grain crops; 2 — winter grain crops; 3 — potato; 4 — perennial grasses; 5 — field margins and forest edges. Sample size — number of specimens in a sample; Species — number of predicted species.
Рис. 3. Кривые разрежения для сборов имаго ктырей в различных биотопах: 1 — яровые зерновые; 2 — озимые зерновые; 3 — картофель; 4 — многолетние травы; 5 — обочины полей и опушки леса. Sample size — число особей в выборке; Species — число предсказанных видов.

tional contribution on margins adjoining forest edges did not exceed 24%. This is likely because margins and forest edges also support several stenotopic edge specialists that are absent from crop fields, increasing total asilid abundance and thereby reducing the relative share of *D. atricapilla*. These specialists include *Neoitamus socius*, which is restricted to grasses at forest edges and shrub foliage, and *Didymachus picipes*, which we recorded only at forest edges and adjacent margins. Neither species was observed within the agrocenoses of the station during the study period.

Asilid diversity was lowest in potato fields and highest on margins adjacent to forest edges, regardless of sampling method. Field margins differ by high indices of Asilidae biodiversity. They have the highest Margalef index, Dmg (see Table) and highest increase in the number of revealed species depending on the number of sampled individuals (Fig. 3). Calculations show that the lowest growth of recorded species depending on the number of sampled individuals can be observed in the agrocenoses of perennial grasses and potatoes fields (Fig. 3).

High asilid diversity along field margins and forest edges was largely attributable to *Neoitamus socius*, *Didymachus picipes* and *Laphria flava*. However, these species do not establish in the open, exposed conditions of crop fields and thus contribute little to predator richness or abundance within cultivated land.

In contrast to these edge-restricted species, *Tolmerus atricapillus* occurred across several crop habitats and was most frequent in spring-sown cereals, where it accounted for 24 % of all asilids collected.

Spring cereal fields also attracted *Leptogaster cylindrica*, which was recorded both within crops and along field margins. This is consistent with regional observations that *L. cylindrica* typically occurs in the herb layer — particularly in grass (graminoid) stands — along forest edges and in clearings [Stackelberg, 1958].

Winter cereal fields supported only a small subset of the asilid fauna, typically as single individuals (see Table). By contrast, spring cereals were consistently more attractive, consistent with earlier observations [Shpanev *et al.*, 2017]. During the main flight period of the common species (June–July), spring cereals presumably provide more favourable conditions for these predators, reflecting higher prey availability, crop phenology and associated microclimatic differences.

Together, the habitat mosaic at the MRS allowed us to refine species-level habitat distributions and to map the distribution of these generalist predators across farmland. Field margins adjoining forest edges supported the highest asilid richness and abundance and promoted higher numbers of *Leptogaster cylindrica*, *Tolmerus atricapillus* and *Dioctria* spp. within cultivated fields. Overall dominance was driven by *D. atricapilla*, particularly in perennial forage stands and spring-sown cereals, despite its previous characterisation as merely locally distributed in the Leningrad Region.

Acknowledgments. The authors remember with deep gratitude the tragically deceased D.M. Astakhov, who greatly assisted us in identifying the robber flies and creating a collection of these Diptera at the All-Russian Institute of Plant Protection (VIZR). We are also grateful to G.A. Yakovlev for his invaluable help in translating the manuscript.

The study was performed within the framework of the Russian Ministry of Science and Higher Education State Research Project no. FGEU-2025-0012 at the All-Russian Institute of Plant Protection.

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