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NEST CHARACTERISTICS AND PREY SELECTION OF *SCELIPHRON DESTILLATORIUM* (APOIDEA, SPHECIDAE) ON THE TERRITORY OF THE RIVNENSKYI NATURE RESERVE

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Nest Characteristics and Prey Selection of *Sceliphron destillatorium* (Apoidea, Sphecidae) on the Territory of the Rivnenskyi Nature Reserve. Pytel-Huta, S., Yanul, V., Franchuk, M., Zatushevsky, A. & Tsaryk, J. —The nesting behaviour and prey selection of *Sceliphron destillatorium* remains poorly studied in Ukraine. In the present study we analysed a total of 59 nests of *S. destillatorium*. The main morphometric parameters of *S. destillatorium* nests, especially cell length and width, were determined by measuring the nest cells. The spiders found in the nest cells were identified to determine the trophic relationships of the *S. destillatorium* larvae. The main prey of *S. destillatorium* was found to be terrestrial orb-weavers (Araneidae), crab-weavers (Thomisidae), tangle-weavers (Theridiidae), with a clear predominance of Araneidae. Six species of spiders previously undocumented in the Rivnenskyi Nature Reserve were discovered.

Key words: Hymenoptera, wasps, nests, morphometry, spiders, Ukraine.

Introduction

The genus *Sceliphron* Klug, 1801, which belongs to the family Sphecidae, is represented in Europe by seven species. Currently, six of these species are enrolled in Ukraine, three of which are invasive. The species *Sceliphron curvatum* (Smith, 1870) occurs in all regions of Ukraine. The rare species *Sceliphron caementarium* (Drury, 1773) (Tymkiv et al., 2015) and *Sceliphron deforme* (F. Smith, 1856) (Kletʹonkin and Parkhomenko, 2023) are also present in Ukraine. In addition, three native species are found: *Sceliphron spirifex* (Linnaeus, 1758) and *Sceliphron madraspatanum* (Fabricius, 1781) are rare and scarce species, with a known distribution limited to the southern regions of Ukraine. In contrast, *Sceliphron destillatorium* (Illiger, 1807) occurs throughout the territory of Ukraine (GBIF; http://www.gbif.org).

The genus *Sceliphron* Klug, 1801, is currently comprised of 35 species distributed across the globe. These are classified into two subgenera: *Sceliphron* s.s. and *Prosceliphron* (now *Hensenia*) (Pulawski, 2024). The subgenus *Sceliphron* is characterised by the construction of nests in the form of cells, which are joined together with an additional layer of soil to form a large mud nest. In contrast, representatives of subgenus *Hensenia* build their nests in the form of individual mud cells (Yuan et al., 2022).

Sceliphron destillatorium belongs to the subgenus *Sceliphron* s.s. Its geographic range encompasses North Africa and Western Europe, extending through Central Europe, Southwestern Asia, Central Asia, and reaching as far as Western Siberia, Mongolia, and Northern China (Bury, 2021). Currently, Poland, Turkey, the Czech Republic, Germany, Austria, Croatia, Greece, Hungary, Slovakia, Italy, Spain, France, and other countries have documented the presence of this species (Pulawski, 2024). On the territory of Ukraine, *S. destillatorium* was first recorded by Wierzejski in 1868 in Stanisławów, which is currently known as Ivano-Frankivsk (Wierzejski, 1868). Currently, the species is distributed across all regions of Ukraine (GBIF; http://www.gbif.org).

South Palaearctic species — *S. destillatorium* is subjected to extensive biological studies. Female wasps construct nests of wet soil material, initially in the form of tubular cells, which are subsequently covered with an additional layer of soil. This provides protection for the offspring from changeable environmental conditions, predators, and parasites (Park et al., 2022). The nests are composed of soil material with a prevalence of sand (typically fine) or coarse dust (Pytel-Huta et al., 2024). Being a synanthropic species, females of *S. destillatorium* build their nests in human dwellings and outbuildings, including attics and balconies. These nests are attached to wooden beams under the roof or to other objects.

The offspring are fed spiders. Each egg is deposited in a cell and is attached to the first captured spider (Yuan et al., 2022). The number of spiders in a cell depends on their size and the sex of the wasp offspring (Joothi et al., 2021; Patil and Arade, 2011; Polidori et al., 2007; Yuan et al., 2022).

The majority of research conducted on the members of the genus *Sceliphron* is focused on the structure of nests (Bogusch, 2022; Chatenoud et al., 2012; Joothi et al. 2021; Park et al., 2022; Pytel-Huta et al., 2024), the impact of invasive species on native species, and the trophic relationships of wasps' larvae (Kletʹonkin and Parkhomenko, 2023; Pham, 2016; Tymkiv et al., 2015; Wiśniowski et al., 2013). However, such studies have not been carried out on the territory of Ukraine yet.

In the aforementioned context, the objective of our study was to determine the principal morphometric parameters of *Sceliphron destillatorium* nests and the trophic relationships of wasp larvae within the territory of the Nature Reserve "Rivnenskyi".

Material and Methods

2.1. Mud nest collecting

A potential nesting site (Massif Somyne, Karasyn department of the Nature Reserve "Rivnenskyi" (Fig. 1)) was identified as part of dissertation research on Crabronidae and Sphecidae wasps. This discovery was made following observations of adult *Sceliphron destillatorium* near the farm building in June—July 2023.

The nests were discovered in November 2023 in the attic of the building, at a height of 3 m. This is the only such nest in an area of more than 1 km², and it is situated approximately 4.5 km from the nearest settlement. The building measures 6 × 4 m and is 4 m from Lake Somyne.

The majority of nests were attached to wooden beams situated beneath the roof on the eastern side of the building.

The Massif Somyne is a mesotrophic swamp, interrupted by strips of dry land and adjacent forest swamps. Transitional and oligotrophic peat swamps are characteristic of the massif. The massif is characterised by a diverse vegetation cover and rich flora, including a number of rare species. The massif has a single hydrological complex with Lake Somyne and plays an important role in its conservation (Chronicle of Nature, 2020).

The mud nests were found to be either closed by *S. destillatorium* or repopulated by representatives of other orders (Hymenoptera, Diptera). Many of the nests had open cells, which precluded the possibility of determining their age. To separate the nests from the spots of their locations, a knife was used.

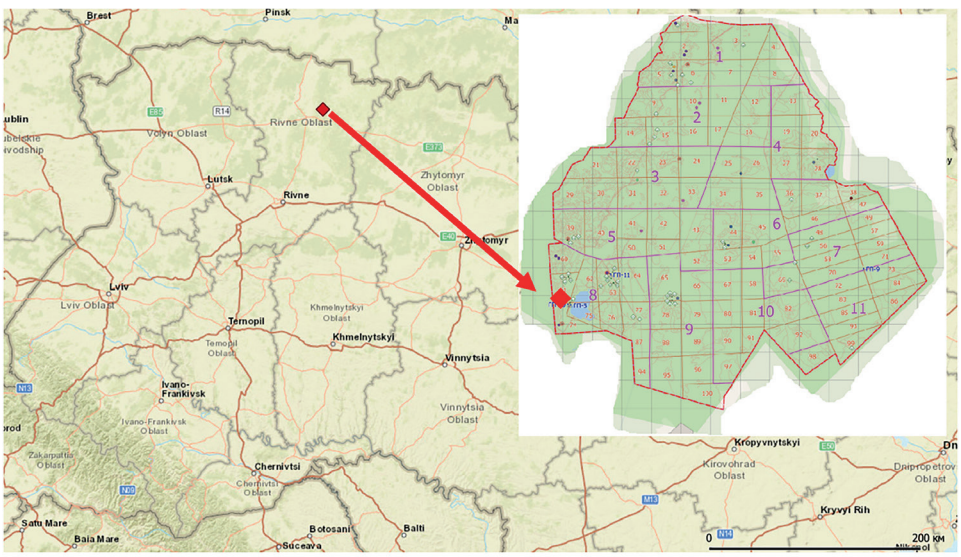

Fig. 1. Nest collection site Karasyn department (Nature Reserve "Rivnenskyi")

2.2. Examination of the nest contents

Prior to dismantling, all the nests were weighed with technical and chemical scales Axis A500. Each cell was then opened and the main morphometric parameters (length and width of the cells) were measured with the help of an automatic digital caliper 0–150 mm. The spiders which were found in the cells were preserved in eppendorf tubes with a purpose of establishing the trophic relationships.

The spiders were identified with the assistance of the appropriate keys provided in the online resource "Spiders of Europe" (Nentwig et al., 2024). It is noteworthy that the identification of certain individual spiders presented certain challenges due to the presence of damage caused by various factors. These included the drying of samples during their period of residence in nests, the presence of feeding traces left by larvae, and the fouling of specimens by fungi. These impacts caused structural changes, including deformations of the epigynum in some Araneidae individuals.

During the examination, the spiders were placed in a Petri cup filled with 30% glycerine. This procedure made the samples elastic and prevented any further damage during manipulation. Following identification, the spiders were stored in 70% ethanol. The collection of biological samples was conducted in accordance with the terms of the permit No. 378/2023, dated 27/01/2023, issued by the Ministry of the Environment.

Results and Discussion

3.1 Morphometry and cell content of the nests

A total of 59 nests of *S. destillatorium* were subjected to analysis. The morphometric indicators of the cells were measured, and their limits for *S. destillatorium* were determined. The cell length varied from 25 to 40 mm (mean = 31.4; s = 2.35; n = 779 cells), and the width varied from 8 to 14.5 mm (mean = 11.04; s = 1.08; n = 780 cells). The mass of the nests exhibited considerable variation upon weighing, with a range of 7.88–276.34 g (mean = 91.47; s = 77.33); n = 55 nests) dependent on the number of cells in a nest.

The discovered nests exhibited variability in terms of size and the number of cells, with a range of 2 to 57 cells (mean = 17; s = 13.85; n = 59 nests). The presence of open cells in some of the discovered nests posed a challenge in determining whether the nest had been constructed over the course of a single or multiple seasons (Table 1).

Table 1. **Morphometric parameters of the nests of *S. destillatorium***

Morphometric parameters	Max	Min	Mean	Sample standard deviation	Measured nest
Length cells	25 mm	40 mm	31.4 mm	2.35	779 cells
Width cells	8 mm	14.5 mm	11.04 mm	1.08	780 cells
Nest weight	7.88 g	276.34 g	91.47 g	77.33	55 nests
Number of cells	2	57	17	13.85	59 nests

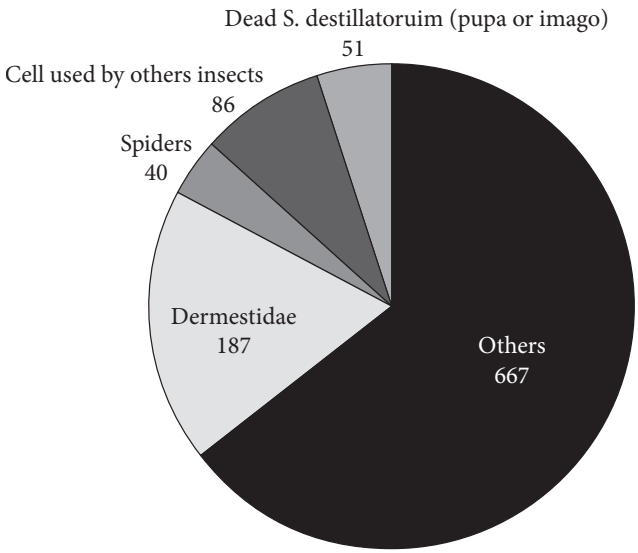

Fig. 2. Ratio of cells in the examined nests of *S. destillatorium*

Fig. 3. Nests of *S. destillatorium*: A — Dermestidae in nest cell; B — repopulation by Hymenoptera of the cell nest of the mud-dauber wasp; C — spiders affected by a fungus

As a result of nest disassembly, Dermestidae or their exuviae were identified in 187 cells (18.14% of all 1,314 cells). Additionally, 51 cells (5%) contained dead samples of *S. destillatorium* at various stages of development (pupa or imago), while 40 cells (3.9%) were filled with spiders. Therefore, in 278 cells (27%) of the examined nests, the offspring of *S. destillatorium* are likely to have perished at various stages of development due to parasites or for unknown reasons (Fig. 2). Of the 1,314 cells examined, 283 were damaged during the process of removal or transport. Additionally, 86 cells (8.34%) of wasp nests were observed to have been abandoned, and were subsequently repopulated by other insects, including Hymenoptera and Diptera (see Fig. 3).

3.2. Prey selection

The spiders were identified using an online identifier from the internet resource "Spiders of Europe" (Nentwig et al., 2024). A total of 59 nests, comprising 1314 cells, were surveyed. A total of 256 spider individuals were recorded, 64 of which were identified to the species level. The data from K. Yevtushenko, which were published in the Chronicle of Nature (2020) and represent the most comprehensive account of the spider fauna in the reserve to date, were used as a control (Fig. 4).

The analysis of the contents of the nests of *Sceliphron destillatorium* revealed the presence of 11 species of spiders belonging to 8 genera and 3 families. The family Araneidae was represented by the following species: *Agalenathea redii, Araneus quadratus, Argiope bruennichi, Larinioides cornutus*, Larinioides* cf. *sclopetarius*, Larinioides patagiatus**, Thomisidae — by *Ebrechtella tricuspidata, Misumena vatia*, Xysticus audax*, Xysticus lanio**, and Theridiidae — by *Steatoda castanea* (Table 2). Among the identified species, six are new to the territory of the Nature Reserve "Rivnenskyi" and are indicated by an asterisk in the text. With the exception of the synanthropic *L.* cf. *sclopetarius* and *S. castanea*, all spider species found in *S. destillatorium* nests are common grass and bush dwellers.

Table 2. **Taxonomic composition of the spiders found in the nests of *S. destillatorium***

Families	Species	ind.	%
Araneidae	*Agalenatea redii* (Scopoli, 1763)	1	0.4
	Araneus quadratus Clerck, 1757	1	0.4
	Argiope bruennichi (Scopoli, 1772)	2	0.7
	Larinioides cornutus (Clerck, 1757)	3	1.2
	Larinioides patagiatus (Clerck, 1757)	41	16
	Larinioides sclopetarius (Clerck, 1757)	4	1.6
	Araneidae gen. sp./spp.	61	23.9
	Larinioides sp./spp.	35	13.6
	Araneus/Larinioides spp.	67	26.2
	Araneus sp./spp.	20	7.8
Theridiidae	*Steatoda castanea* (Clerck, 1757)	1	0.4
Thomisidae	*Ebrechtella tricuspidate* (Fabricius, 1775)	4	1.6
	Misumena vatia (Clerck, 1757)	3	1.2
	Xysticus audax (Schrank, 1803)	2	0.7
	Xysticus lanio C. L. Koch, 1835	1	0.4
	Thomisidae gen. sp./spp.	10	3,9
Total		256	100

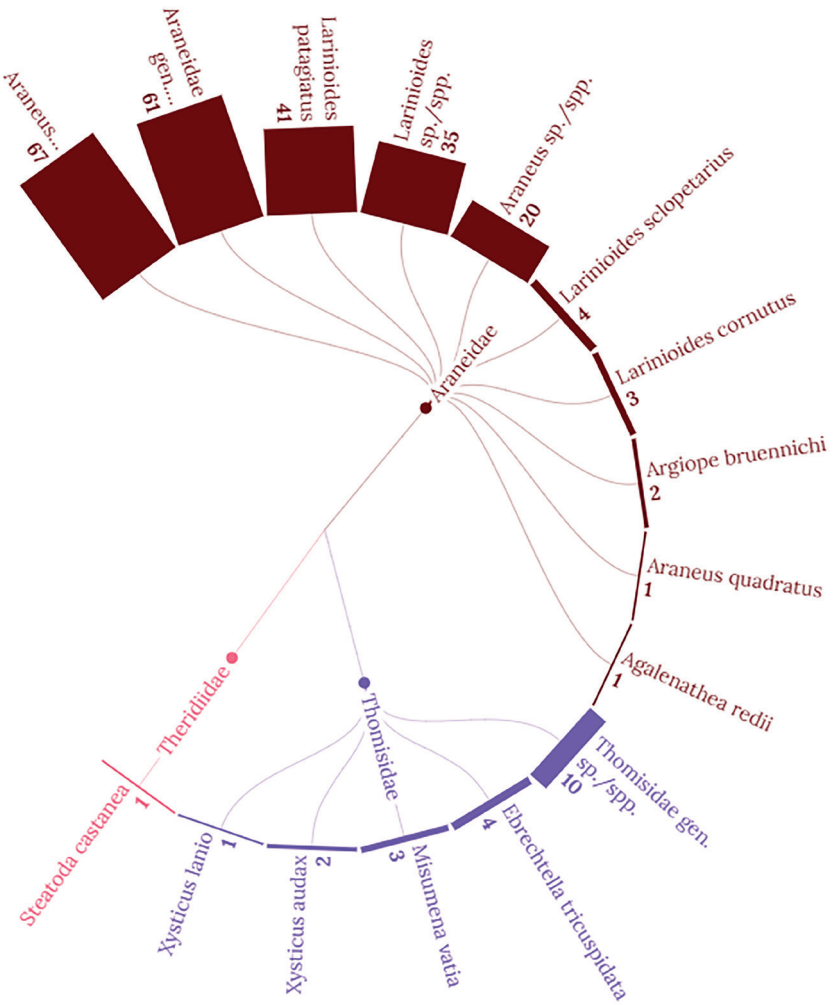

Fig. 4. Taxonomic structure of spiders found in nests of *S. destillatorium.*

Table 3. **Spider composition of 59 nests**

Families	Cells	Individuals	Ind. per cell, min	Ind. per cell, max	Ind. per cell, mean)	Sample standard deviation
Araneidae	57	235	1	10	4.1	2.17
Thomisidae	10	20	1	4	1.9	0.98
Theridiidae	1	1	—	1	—	—
Total	64	256	1	10	4.1	3.15

A comparison of the species composition of spiders of the family Araneidae among the prey of *S. destillatorium* with the data of Yevtushenko (Chronicle of Nature, 2020) reveals a notable absence of coleopterans of smaller size (~3—6 mm) in our material. In the territory of the reserve, these are mainly *Cercidia prominens*, *Cyclosa conica*, *Hypsosinga sanguinea*, *Singa hamata* and *Singa nitidula*.

The number of spider samples per cell varied from 1 to 10 (an average of three samples).

As a result of the determination of the prey of *S. destillatorium*, a significant predominance (in terms of number of individuals detected) of spiders of the family Araneidae was found. The predominance of this family of spiders has also been noted in the prey of other representatives of the genus *Sceliphron* (Polidori et al., 2007; Joothi et al., 2021; Yuan et al., 2022). However, it should be noted that this is the first time that a detailed list of the prey of *S. destillatorium* has been presented.

In the analysis of the age-sex structure of spiders, the following conditional categories were distinguished depending on the degree of material preservation: 1) adult females (89 individuals found in 30 cells); 2) adult males (one individual); 3) subadult males (4 individuals); 4) juveniles (14 individuals found in 7 cells); 5) individuals whose life stage could not be determined (148 individuals found in 13 cells). The prevalence of females and juveniles among captured spiders has been previously documented by other researchers for members of the genus *Sceliphron* (Polidori et al., 2007).

The state of preservation of the material indicates that the spiders of the family Araneidae were the most fragmented. Among the Thomisidae, the integrity of the articulation of the parts (abdomen to cephalothorax) was typically preserved, although deformations of the legs were frequently observed. The juvenile *Steatoda castanea* (Theridiidae) was the most well-preserved specimen.

Thus, spiders of three ecological guilds (according to Cardoso et al., 2010) are represented in the prey of the common *S. destillatorium* in the Nature Reserve "Rivnenskyi". These include orb-weaver spiders (Araneidae), crab spiders (Thomisidae), and tangle-web spiders (Theridiidae) (Table 3).

Conclusions

Within the framework of a dissertation study and the state programme of the Chronicles of Nature, the structure and composition of the nests of *S. destillatorium* and the trophic relationships of their larvae were studied on the territory of continental Ukraine, in particular in the Nature Reserve "Rivnenskyi".

A total of 59 nests of *S. destillatorium* were collected from the attic of a farm building within the boundaries of the Nature Reserve "Rivnenskyi" in the Karasyn department, situated at a height of 3 m.

The size of the nests studied exhibited considerable variation: the number of cells ranged from 2 to 57 (mean = 17; s = 13.85; n = 59 nests). Similarly, the weight of the nests demonstrated a broad range, from 7.88 to 276.34 g (mean = 91.47; s = 77.33; n = 55 nests). The length of the cells varied from 25 to 40 mm (mean = 31.4; s = 2.35; n = 779 cells), while the width of the cells demonstrated a narrower range, from 8 to 14.5 mm (mean = 11.04; s = 1.08; n = 780 cells).

A total of 1314 cells were examined. Of these, 278 cells probably contained wasp offspring that had died for some reason.

The spiders found in *Sceliphron* nests belonged to 3 families, 8 genera, and 11 species. The families Araneidae (6 species) and Thomisidae (4 species) were the

most prevalent, while only one species represented the family Theridiidae. *Larinioides patagiatus* (Clerck, 1757) (Araneidae) constituted 40.7% of all prey.

The analysis of the age-sex structure of the hunted spiders revealed that adult females (89 specimens) constituted a significant majority among the prey of *S. destillatorium*.

Of the 11 species of spiders identified, six are new to the territory of the Nature Reserve "Rivnenskyi". These include *Larinioides cornutus, Larinioides* cf. *sclopetarius, Larinioides patagiatus, Misumena vatia, Xysticus audax,* and *Xysticus lanio.*

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