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Short communication

FEEDING BEHAVIOR OF PREDATORY BUG *NABIS FERUS* (HETEROPTERA: NABIDAE) TOWARD APHIDS

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This study investigated the feeding behavior of the generalist predator *Nabis ferus* (Heteroptera: Nabidae) toward various Aphididae species as prey in a laboratory setting. Data were obtained on the predatory behavior of *N. ferus*, including a ranking of the most preferred species for feed. Eight representatives of the Aphididae family were used as prey: *Schizaphis graminum*, *Rhopalosiphum padi*, *Aphis fabae*, *Megoura viciae*, *Brevicoryne brassicae*, *Aphis pomi*, *Myzus cerasi* and *Aphis urticata*. The average number of prey ranged from 11.2±1.18 in the case of bird cherry-oat aphid to 13.7±0.38 in case of the apple aphid. The consumption of *M. viciae* individuals was significantly lower, averaging 6.6±1.03 aphids per predator. These studies have implications for the biological control of phytophagous pests in agriculture. These findings highlight the potential of *N. ferus* as a sustainable and effective control agent to organic farming.

Keywords: *Nabis ferus*, predator, prey, entomophagous insect, biological control

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Introduction

Population dynamics of phytophagous pests are significantly influenced by numerous, polyphagous, and eurytopic species within the genus *Nabis*, commonly found in natural and agricultural ecosystems. *Nabis* species feed on eggs, larvae, and even adults of various arthropods, including many significant pests such as the Colorado potato beetle, alfalfa weevil, cereal leaf beetle, various aphids, bugs, leafhoppers, thrips, mites, lepidopterans, and sawflies. They are crucial natural regulators of insect pest populations in agriculture and forestry (Bokina 2013, 2018; Esenbekova 2013; Cornelise et al. 2021; Shrestha et al. 2021; Smith et al. 2022).

In the Asian part of Russia, there are six species of the genus *Nabis*, belonging to two subgenera: *Nabis* Latr. and *Himacerus* Wolff. Five species from the genus *Nabis* predominantly inhabit herbaceous vegetation, including cereal agroecosystems. These species are *N. ferus* L., *N. punctatus* A. Costa, *N. brevis* Scholtz, *N. limbatus* Dahlbom, and *N. flavomarginatus* Scholtz. Several studies highlight the significant role of nabids in agroecosystems (Bokina 2013; Fernandez-Maldonado et al. 2017; Bokina 2018; Kim et al. 2019). For instance, species of the genus *Himacerus*, known as dendro-tamno-hortobionts, notably *H. apterus* Fabricus, exert a substantial impact on the population of tree and shrub consumers (Bokina 2013).

Despite the abundance of natural populations of the Nabidae family, they have not yet been widely applied in the practice of biological plant protection. There are only a few studies dedicated to individual representatives of this group. Techniques for maintaining such predators as *N. pseudoferus* Remane and *N. rugosus* Linnaeus under laboratory conditions exist (Roth et al. 2008; Efe, Karaea 2013; Fernandez et al. 2020). *Nabis pseudoferus* is positioned as a promising agent for controlling the tomato leaf miner *Tuta absoluta* (Cabello et al. 2009; Mohammadpour et al. 2020). Currently, *N. stenoferus* Hsiao is considered as a biological control agent against phytophagous pests, which, due to its zoophytophagy, can damage flowering crops (Park et al. 2023). *Nabis americoferus* is also considered as a biological control agent against the dangerous strawberry pest *Lygus lineolaris* (Dumont et al. 2023).

One of the widely distributed species across the Eurasian continent is *N. ferus*, a zoophytophagous predator that ambushes its prey. To effectively use this bug for crop protection, it is necessary to find suitable environmental conditions (Park et al. 2023), including additional feed sources. Overall, the prey spectrum of *Nabis ferus* is insufficiently studied. Some studies report *N. ferus* feeding on cereal aphids, while information about the consumption of other Aphidoidea prey and other insects is sporadic (Puchkov 1980; Bokina 2013, 2018). A goal of this study was to determine the spectrum of potential prey for the adults of *N. ferus* for assessing its potential as a biological control agent to organic farming.

Material and methods

Laboratory rearing of *Nabis ferus*. *Nabis ferus* was isolated in May 2023 from nature in Krasnoobsk (54.915278 N, 82.978686 E) and Poros (55.368912 N, 83.712526 E), Novosibirsk Province, Western Siberia, Russia, and introduced into a laboratory culture. It is maintained in the Laboratory of the Biological Control of Phytophagous Pests and Phytopathogens at the Siberian Federal Scientific Centre of Agrobiotechnologies of the Russian Academy of Sciences

(SFSCA RAS). The rearing of this entomophagous bug is conducted in 40×40×40 cm cages on wheat sprouts infested with the wheat aphid, *Schizaphis graminum* Rond. The culturing regime is day:night 18:6, relative humidity 50–60 %, and temperature 25 °C. *Nabis ferus* adults, kept without food for one day before the experiment, was used for experiments.

Feed sources. Various representatives of the Aphididae family were used as prey. The wheat aphid (*Schizaphis graminum* Rond.), the bird cherry-oat aphid (*Rhopalosiphum padi* L.), the black bean aphid (*Aphis fabae* Scopoli), the vetch aphid (*Megoura viciae* Buckton), and the cabbage aphid (*Brevicoryne brassicae* L.) are reared year-round in the Laboratory of Biological Control of Phytophagous Pests and Phytopathogens at SFSCA RAS on suitable species of host plants: wheat, fodder beans, and white cabbage. The apple aphid (*Aphis pomi* De Geer), the cherry aphid (*Myzus cerasi* Fabricius), and the nettle aphid (*Aphis urticata* J.F. Gmelin) were collected from natural and agricultural habitats.

Experimental design. In Petri dishes (Ø 9 cm) with moistened filter paper, a plant leaf with 15 insect prey individuals for each replication was placed, followed by the introduction of one *Nabis ferus* adults regardless of sex. Control treatments without the predator were used to account for the effects of transplantation, natural mortality, and to calculate Abbott's corrected mortality. After 24 hours, the numbers of dead and surviving phytophagous insects were recorded. All treatments in the trial were replicated using the same number of different individuals of *N. ferus* (n = 15 insects/day) for each day. After assessing the mortalities of the insects on each counting day, the insects and Petri dishes corresponding to that day were removed from the experiment.

Statistical analysis. The numbers of dead prey in each treatment were analyzed after verifying normal distribution of the data using QQ-plots, and differences between treatments were determined using the Kruskal–Wallis test followed by Dwass-Steel-Critchlow-Fligner (DSCF) test for multiple comparisons (Jamovi for Windows 2.3.28.0, Jamovi Computer Software, https://www.jamovi.org/). Descriptive statistics and graphs were produced using LibreOffice 7.6. Differences were considered statistically significant at $p < 0.05$.

Percent mortality of aphids was determined according to Abbott (Abbott, 1925):

$$\text{Efficacy} = \left(\frac{X-Y}{X}\right) \times 100\ \%,$$

X – the percent living in the control,
Y – the percent living in the threated plat.

Results and Discussion

The study found significant differences between the number of individuals consumed by the entomophagous bug between *Megoura viciae* and five species of aphids: *S. graminum* (p=0.032), *A. fabae* (p< 0.001), *A. pomi* (p< 0.001), *M. cerasi* (p= 0.028), *A. urticata* (p< 0.001), where the average number of prey ranged from 11.2±1.18 in the case of bird cherry-oat aphid to 13.7±0.38 with the apple aphid (Fig. 1). The consumption of *Megoura viciae* individuals was significantly lower, averaging 6.6±1.03 aphids per predator. The amount of prey also differs significantly between *A. pomi* and *M. cerasi* (p=0.035) (Fig. 1).

Abbott's corrected mortality ranged from 88.8 ± 2.7 % in the case of the black bean aphid to 70.5 ± 5.8 % in the case of the cabbage aphid (Fig. 2). Abbott's corrected mortality for the vetch aphid was significantly lower compared to the other treatments, amounting to 31.1 ± 9.1 %. When calculating Abbott's corrected mortality considering the natural mortality of aphids, significantly different data were obtained between *M. viciae* and three variants: *S. graminum* (p < 0.001), *Rh. padi* (p < 0.001), *A. fabae* (p=0.004) and *M. cerasi* and two variants: *S. graminum* (p < 0.001), *Rh. padi* (p = 0.008), in pair *S. graminum* – *B. brassicae* (p=0.025).

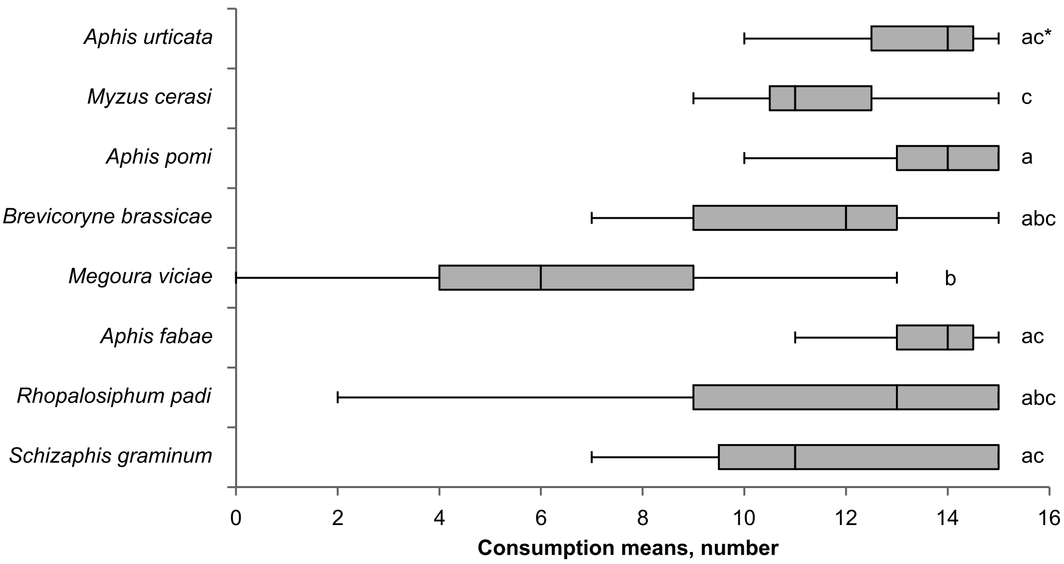

Figure 1. Box-plot of daily prey consumption by adults of *Nabis ferus* depending on aphid species (n=15) with maximum, minimum and median. *Boxes followed by the same letter within a column are not significantly different at $p < 0.001$ ($x^2 = 36$; df =7). DSCF multiple comparisons were used as a post hoc test for the Kruskal–Wallis test

Рисунок 1. Суточное потребление жертв имаго Nabis ferus в зависимости от вида тли (n=15) с обозначением максимума, минимума и медианы. *Одинаковыми буквами в основании столбцов диаграммы обозначены статистически не различающиеся значения при $p < 0.001$ ($x^2 = 36$; df =7). DSCF тест использовался в качестве апостериорного анализа для теста Краскела–Уоллиса

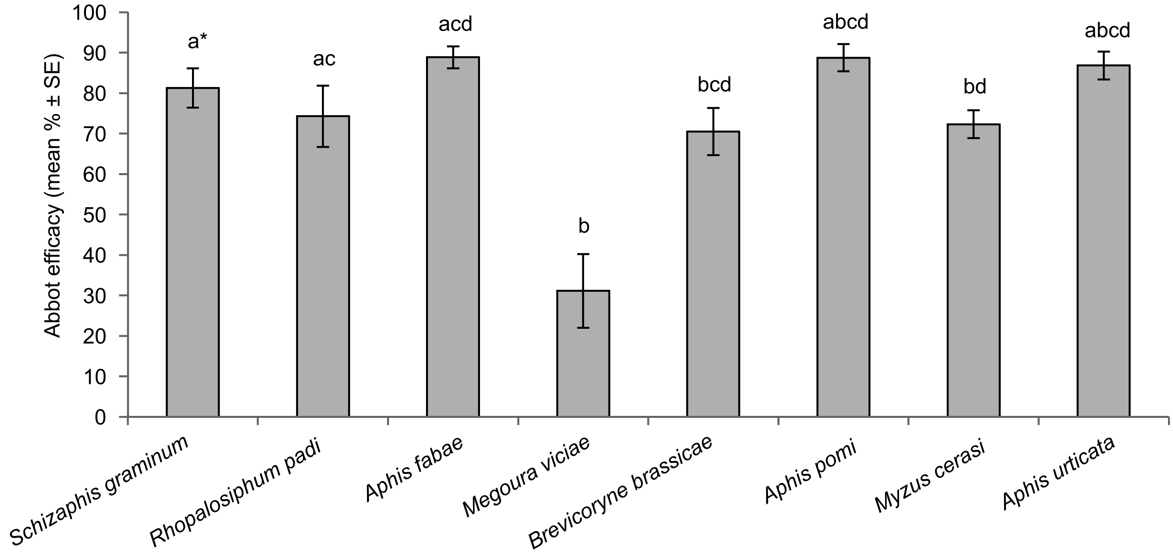

Figure 2. Abbott corrected mortality (mean % ± SE) of *Nabis ferus*.
*Bars followed by the same letter within a column are not significantly different at $p < 0.001$ ($x^2 = 35.96$; df =7). DSCF multiple comparisons were used as a post hoc test for the Kruskal–Wallis test

Рисунок 2. Биологическая эффективность (среднее значение % ± SE) *Nabis ferus*.
*Одинаковыми буквами в основании столбцов диаграммы обозначены статистически не различающиеся значения при $p < 0.001$ ($x^2 = 35.96$; df =7). DSCF тест использовался в качестве апостериорного анализа для теста Краскела–Уоллиса

Studying the trophic relationships of potential agents of biological plant protection will determine the possibility of their mass rearing and application in various agroecosystems. The complex feeding relationships of polyphagous predators complicate the prediction of their contribution to pest suppression. Alternative prey may distract predators from attacking target phytophagous pests, thereby weakening pest control measures. At the same time, a diverse array of insect species can provide feed that supports larger communities of predators during the absence of the “optimal” prey for its targeted work (Campos et al. 2020; Park et al. 2023).

The study established that *N. ferus* attacked significantly fewer vetch aphids compared to S. *graminum, A. fabae, A. pomi, M. cerasi,* and *A. urticata*. This selectivity may be related to the physiological characteristics of *M. viciae* and to the interactions in the phytophagous pest–plant system: allelochemical interactions, impact of host plants on the physiology of aphid (Shih et al. 2023). Another reason for the lower consumption of the vetch aphid by the bug could be its morphometric indicators, as this species is larger relative to other tested species (Ivanovskaya, 1977). Also, the vetch aphid *M. viciae* may exhibit earlier defensive behavior under the influence of alarm pheromones, escaping attack through thanatosis and active movement on the plant (Kunert et al. 2008; Bruno et al. 2018). The influence of aphid endosymbionts (for example *Buchnera, Spiroplasma, Wolbachia*) on unspecialized entomophagous insects also cannot be ruled out. Insect symbionts can directly affect the host’s interactions with natural enemies, but also indirectly through changes in plant physiology and the emission of herbivore-induced plant volatiles. (Vorburger 2018).

When calculating Abbott’s corrected mortality that adjusts for control mortality, and accordingly natural mortality in the population, the same trend was maintained. There were no significant differences between *S. graminum, Rh. padi, A. fabae, A. pomi,* and *A. urticata*. However, predator efficiency was significantly lower for *M. viciae*, *B. brassicae* and *M. cerasi*. Thus, the entomophagous bug *N. ferus* demonstrated its ability to feed on a fairly wide range of species in the family Aphididae.

Conclusion

The results of this study extend our knowledge of additional feed sources of *N. ferus* used for plant protection.

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References

Abbot WS (1925) A method of computing the effectiveness of an insecticide. *J Econ Entomol* 18:265–267. https://doi.org/10.1093/jee/18.2.265a

Bokina IG (2018) [Cereal aphids (Heteroptera: Aphididae) and predatory bugs (Heteroptera: Nabidae, Anthocoridae) according to spring wheat cultivation practices in the northern forest-steppe of Western Siberia]. *Eurasian Entomol J* 17(1):1–10 (In Russian) https://doi.org/10.15298/euroasentj.17.1.01

Bokina IG (2013) [Nabid bugs (Heteroptera, Nabidae) in agrocenoses of grain crops in the forest-steppe of Western Siberia]. *Zoologicheskiy Zhurnal* 92(4):450–456 (In Russian) https://doi.org/10.7868/s0044513413020049

Bruno D, Grossi G, Salvia R, Scala A, Farina D et al (2018) Sensilla Morphology and Complex Expression Pattern of Odorant Binding Proteins in the Vetch Aphid *Megoura viciae* (Hemiptera: Aphididae). *Front Physiol* 9:777. https://doi.org/10.3389/fphys.2018.00777

Cabello T, Gallego Granados J, Fernandez-Maldonado F, Soler A, Beltran D et al (2009) The damsel bug *Nabis pseudoferus (Hem.: Nabidae)* as a new biological control agent of the South American Tomato Pinworm, *Tuta absoluta (Lep.:*

Gelechiidae), in tomato crops of Spain. *Bulletin IOBC/WPRS* 49:219–223

Campos Medina V, Araya JE, Zuazúa F (2020) Depredación de *Nabis punctipennis* en *Acyrthosiphon pisum* en presencia de la presa alternativa *Aphis craccivora* en alfalfa. *Chil J Agric Anim Sci* 36(1):35–43. http://dx.doi.org/10.4067/S0719-38902020005000104

Cornelis M, Diez F, Coscaron MDC (2021) A new subgenus of *Nabis latreille* (Heteroptera: Nabidae) from South America and a key to the subgenera worldwide, with notes about comparative morphology of the genitalia. *An Acad Bras Ciên* 93:e20191516. https://doi.org/10.1590/0001-3765202120191516

Dumont F; Solà M; Provost C; Lucas E (2023) The Potential of *Nabis americoferus* and Orius insidiosus as Biological Control Agents of *Lygus lineolaris* in Strawberry Fields. *Insects* 14:385. https://doi.org/ 10.3390/insects14040385

Esenbekova PA (2013) [Bugs (Heteroptera) of Kazakhstan]. Nur-print, Almaty (In Russian)

Efe D, Karaca İ (2013) Life table of *Nabis pseudoferus* Rem. (Hemiptera: Nabidae) feeding on *Spodoptera littoralis* Boisd. (Lepidoptera: Noctuidae) under laboratory conditions. *Fresenius Environ Bull* 22(10):2925–2928

Fernandez FJ, Gamez M, Garay J, Cabello T (2020) Do Development and Diet Determine the Degree of Cannibalism in Insects? To Eat or Not to Eat Conspecifics. *Insects* 11:242 https://doi.org/10.3390/insects11040242

Fernandez-Maldonado FJ., Gallego JR, Valencia A, Gamez M, Varga Z, et al (2017). Cannibalism: Do risks of fighting and reprisal reduce predatory rates? *Commun Ecol* 18:87–96. https://doi.org/10.1556/168.2017.18.1.10

Ivanovskaya OI (1977) Aphids of Western Siberia: vol 2. Novosibirsk, Nauka. 326 p. (In Russian)

Kim J, Lee H, Jung S (2019) Taxonomic review of the genus *Himacerus* (Hemiptera: Heteroptera: Cimicomorpha: Nabidae) from the Korean Peninsula. *J Asia-Pacif Biodiv* 12:407–410. https://doi.org/10.1016/j.japb.2019.03.003

Kunert G, Schmoock-Ortlepp K, Reissmann U, Creutzburg S, Weisser WW (2008) The influence of natural enemies on wing induction in *Aphis fabae* and *Megoura viciae* (Hemiptera: Aphididae). *Bull Entomol Res* 98:57–62. https://doi.org/10.1017/S0007485307005391

Mohammadpour M, Hosseini M, Michaud JP, Karimi J, Hosseininaveh V (2020) The life history of *Nabis pseudoferus* feeding on *Tuta absoluta* eggs is mediated by egg age and parasitism status. *Biol Control* 151:104401 https://doi.org/10.1016/j.biocontrol.2020.104401

Park Yg, Kwon M, Sarker S, Lim UT (2023) Synergism of a mixed diet of *Myzus persicae* and egg of *Ephestia kuehniella* on fitness of the predator *Nabis stenoferus*. *Sci Rep* 13:9075. https://doi.org/10.1038/s41598-023-35363-6

Puchkov AV (1980) [Features of the biology of predatory *Nabis.*] *Zaschita rasteniy* 4:44 p. (In Russian)

Roth S, Janssen A, Sabelis MW (2008) Odour-mediated sexual attraction in Nabids (Heteroptera: Nabidae). *Eur J Ent* 105:159–162. https://doi.org/10.14411/eje.2008.022

Shih PY, Sugio A, Simon JC (2023). Molecular mechanisms underlying host plant specificity in Aphids. *Ann Rev Ent* 68:431–450. https://doi.org/10.1146/annurev-ento-120220-020526.

Smith OM, Chapman EG, Crossley MS, Crowder DW, Fu Z et al (2022) Alternative Prey and Predator Interference Mediate Thrips Consumption by Generalists. *Front Ecol Evol* 10:752159. https://doi.org/10.3389/fevo.2022.752159

Vorburger C (2018) Symbiont-conferred resistance to parasitoids in aphids–challenges for biological control. *Biol Control* 116:17–26. https://doi.org/10.1016/j.biocontrol.2017.02.004

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Краткое сообщение

ПИЩЕВОЕ ПОВЕДЕНИЕ ХИЩНОГО КЛОПА *NABIS FERUS* (HETEROPTERA: NABIDAE) В ОТНОШЕНИИ ТЛЕЙ

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В данной работе изучено пищевое поведение хищного клопа *Nabis ferus* L. (Heteroptera: Nabidae) по отношению к различным видам Aphididae в качестве добычи в лабораторных условиях. Получены данные о хищном поведении *N. ferus*, включая выделение наиболее предпочитаемых видов для питания. В качестве добычи использовались восемь представителей семейства Aphididae: *Schizaphis graminum, Rhopalosiphum padi, Aphis fabae, Megoura viciae, Brevicoryne brassicae, Aphis pomi, Myzus cerasi* и *Aphis urticata*. Среднее количество добычи варьировало от 11.2±1.18 в случае *R. padi* и до 13.7±0.38 для *A. pomi*. Потребление особей *M. viciae* было значительно ниже, в среднем составляло 6.6±1.03 тли на хищника. Результаты имеют практическое значение для биологического контроля фитофагов в сельском хозяйстве.

Ключевые слова: *Nabis ferus*, хищник, добыча, энтомофаг, биологический контроль

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