ISSN 0013-8738, Entomological Review, 2023, Vol. 103, No. 1, pp. 15–20. © Pleiades Publishing, Inc., 2023.
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Reproductive Behavior of *Forficula vicaria* Semenov, 1902 (Dermaptera, Forficulidae)

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Received December 25, 2022; revised January 17, 2023; accepted January 17, 2023

Abstract—Data on reproduction of the earwig *Forficula vicaria* Semenov (Dermaptera, Forficulidae) in Primorskii Territory of Russia are presented. The total period of reproductive activity lasts from 47 to 52 days. The earliest mating couples were recorded at the beginning of the last third of August, and the latest ones, in mid-October. The time spent by the male and female in the cage before mating was 28 days for the couple formed in late July, 17 days for that formed in early August, 5 days for that formed in mid-August, and less than a day for that formed in late August. The couples mated repeatedly 11–17 times over the entire period of observation. From 1 to 3 copulations were recorded daily, each lasting from 30 min to 10 h with intervals varying from 20 min to 9 h. Active feeding was observed for 1.5–4 h after mating. Females started laying eggs in late September; their fecundity ranged from 52 to 71 eggs per female, and from 4 to 33 eggs were laid daily between copulations. Mature eggs were present in the ovaries of dissected females until mid-October. *Forficula vicaria* is characterized by parental care; starting with mid-September, the adults make wintering shelters in which they hibernate protecting their eggs.

Keywords: earwigs, Dermaptera, Forficulidae, *Forficula vicaria*, reproductive behavior, copulation, oviposition

DOI: 10.1134/S0013873823010037

Earwigs of the genus *Forficula* L. hibernate at the embryonic and adult stages. The biology of the common earwig *F. auricularia* L., 1758 has been quite well studied in Europe (Crumb et al., 1941; Behura, 1956; Beier, 1959; Buxton and Madge, 1974), North America (Lamb and Wellington, 1974, 1975; Lamb, 1976), Australia (Kirkland et al., 2020), and New Zealand (Burnip et al., 2002). In European Russia, the I instar nymphs of *F. auricularia* appear on the soil surface since the first 10 days of May and molt to adults in mid-July. Mating is observed from the last third of August to mid-November. Mature eggs were found in the ovaries of *F. auricularia* females sampled from the last third of August to November (Aleksanov, 2015). In the south of the Russian Far East, the I instar nymphs of *F. vicaria* were observed since the end of the middle third of May, and the final molt took place since the end of the first 10 days of July for males or since the middle of July for females (Markova et al., 2022).

This paper is focused on the reproductive behavior of *F. vicaria* in the south of the Russian Far East. Our results provide an assessment of the reproductive potential of this species and can be used to predict its population density in agrocenoses.

MATERIALS AND METHODS

The observations and material collection were carried out from April to October 2020–2022 in the south of Primorskii Territory of Russia. Large adults of *F. vicaria* were kept in cages (made of Petri dishes) since mid-July 2021 to study their reproductive behavior. The male placed in a cage usually became accustomed to the new conditions within 24 h, as could be judged by its calm behavior, the beginning of feeding, and marking the territory with feces; then a female was placed in the same cage. The number of couples studied was $n = 10$. If there was no copulation, the potential mates were

Fig. 1. Reproductive behavior of *Forficula vicaria* Semenov kept in a Petri dish: (*1*) premating behavior; (*2*) mating; (*3*) female with its egg clutch; (*4*) female protecting its eggs from the male.

replaced. The duration of copulation (not counting breaks of 7–10 min) and the number of eggs laid were recorded. The insects were offered ant pupae, corn grains, and other foods rich in proteins and carbohydrates. The couples were observed for 18 h every day, from 6 a.m. to midnight; their nocturnal activity was not recorded. The eggs laid by each female were counted daily at the same time.

For comparison, observations of earwigs under natural conditions were also carried out. The plant leaves were examined in agrocenoses, the fruits showing traces of feeding damage and excrement were dissected. The objects were documented with photos. To study the overwintering conditions and other biological features of *F. vicaria*, we observed the nest building activity of the earwigs and excavated the soil around their nests. Three sample plots 1 m^2 in area were marked out during autumn and winter. The females were dissected to detect mature eggs.

In the text below, *n* is the number of specimens and *m* is the mean value.

RESULTS AND DISCUSSION

Similar to many other insects, *Forficula vicaria* has a multiple or repeated copulation, with a considerable time gap between mating and actual fertilization of the eggs (Bey-Bienko, 1980, etc.).

The reproductive activity of the earwigs was recorded starting with the last third of August. Before the onset of mating, the males and females kept together in cages did not engage in any contacts or moved apart immediately after a brief contact of their antennae. Later on, the individuals moved close together, touching one another's cerci (Fig. 1). The time spent together by the mates before copulation was 28 days for the couple formed at the end of July, 17 days for that formed in early August, 5 days for that formed in mid-August, and less than 24 h for that formed at the end of August (Table 1). From 1 to

3 copulations were recorded during the daily observation period of 18 h; each lasted from 0.5 to 10 h, with intervals varying from 0.3 to 8.7 h. Active feeding of the insects was observed for 1.5–4 h after mating. The number of repeated copulations before oviposition ranged from 7 to 15, and the total number of copulations recorded for a couple, from 11 to 17 (Table 2).

Oviposition of *F. vicaria* was observed since the end of September. The number of eggs laid daily between the copulations ranged from 4 to 33 ($m = 16.7$; $n = 19$). According to our observations in stationary cages, the fecundity of this species, i.e., the total number of eggs laid by a female during its life, ranged from 52 to 71 ($m = 59.6$; $n = 5$) (see Table 2). According to the literature, females of *F. auricularia* lay 40 eggs on average (with a maximum of 60 eggs), their number showing a positive correlation with the body mass of the female (Crumb et al., 1941; Behura, 1956; Lamb and Wellington, 1975).

After oviposition in a cage, the female collected its eggs in a pile and covered them with its head and fore legs (see Fig. 1). The male kept to the periphery of the cage and continued feeding. The ethology of parental care in *F. auricularia* has been described by many authors; these earwigs are known to care for their eggs and to protect and feed the hatched nymphs (Lamb, 1976; Volovnik, 1987; Meunier et al., 2012). We observed aggressive behavior in a female of *F. vicaria* towards the male, similar to that reported previously for *F. auricularia* (Crumb et al., 1941; Beier, 1959; Lamb, 1976): the female raised its cerci and used its fore legs to push the male away from the eggs (see Fig. 1, *4*).

The whole period of reproductive activity of *F. vicaria* varied from 47 to 52 days ($m = 49.4$; $n = 10$). The observed couples continued mating after the end of oviposition; the insects survived until mid-November at a constant air temperature of +25°C. The dissected females contained undeveloped eggs in their ovaries.

Under natural conditions, the females dug burrows on their own or together with the males a month after the onset of copulation, i.e., starting with mid-September; these burrows served as wintering shelters and nesting places. We also found burrows that contained only males. The wintering shelters were located mainly in humid areas covered with moss. The tunnels dug by the males varied in length from 3.5 to 5 cm ($n = 31$), those dug by the females, from 10 to 13 cm ($n = 10$). The tunnels containing both males and females were 8 to 10 cm long, with males positioned closer to the surface and females in the deeper parts. By the end of September, the females deepened their tunnels to 15–18 cm and built nesting chambers for oviposition.

When digging tunnels, the earwigs carried small soil particles to the surface in their mandibles and used their hind legs to push rounded lumps of soil outwards. Some burrows were merely short tunnels, while others were mazes of interconnected tunnels with several exits. Sometimes the earwigs made their burrows in earthworm tunnels. In all the cases, the earwigs were located in the burrows with their heads upward. Examination of three sample plots of 1 m^2, marked out on 19.IX.2021, revealed from 31 to 40 exit holes positioned 0.3 to 40 cm apart; these holes varied in diameter from 0.3 to 0.5 cm, and together with the soil mounds, from 1.5 to 5 cm (Fig. 2).

The females collected from their shelters in mid-October ($n = 10$) contained mature eggs; these data are consistent with our observations in stationary cages.

Males and females of *F. vicaria* were found until mid-September on the soil surface, in natural shelters, and in sunlit areas. Males were also observed near the underground nests in late September and early October. No earwigs could be found on the soil surface after the first autumn frost.

Fragments of two sample plots 0.3 m^2 in area were thoroughly examined in 18–26.IV.2022, down to a depth of 12 cm. Only dead males ($n = 6$) were found at the soil surface and in the upper 1 cm of the soil, while inactive females ($n = 11$) and eggs were located at depths from 1 to 12 cm.

According to the literature, males of *F. auricularia* are driven by the females from underground nests and appear on the soil surface in spring or winter in the West European and North American regions with milder climates (Crumb et al., 1941; Good, 1982); in contrast, males of this species do not survive until spring in the regions of North America, Ireland, and the Czech Republic with relatively cold climates (Jones, 1917; Sullivan, 1943; Kocarek, 1998). In European Russia, according to the preliminary data of Aleksanov (2015), males of *F. auricularia* do not survive the winter and do not even hibernate in autumn, but remain active on the soil

Table 1. Timing of the premating period and egg development in *Forficula vicaria* Semenov in cages

Parameter	No. of couple				
	1	2	3	4	5
Date and place of collection	In stationary cage with nymphs of the dock bug *Coreus marginatus orientalis* (Kir.), 15.VIII.2021, ♂♀	Under the bark of a tree stump, 7.VIII.2021, ♂; 24.VII.2021, ♀	Under the bark of a tree stump, 26.VII.2021, ♂; 24.VII.2021, ♀	Between the leaves of a cabbage head, 26.VIII.2021, ♂; under the bark of a tree stump, 18.VII.2021, ♀	Between the leaves of a cabbage head, 26.VIII.2021, ♂; on a flower head of an *Aster* plant, 27.VIII.2021, ♀
Duration of the premating period	5 days	17 days	28 days	1 min	13 h
Period between mating and start of oviposition	20.VIII–30.IX.2021	24.VIII–6.X.2021	24.VIII–9.X.2021	26.VIII–10.X.2021	28.VIII–6.X.2021

Table 2. Duration of copulation of *Forficula vicaria* Semenov and the number of eggs laid

Date	No. of couple				
	1	2	3	4	5
30.IX.2021	C (3 h) O (12)	C (3.2 h) C (3.8 h)	C (3.2 h)	C (3 h) C (4.8 h) C (0.7 h)	C (2.2 h) C (3.8 h)
1.X.2021	C (3 h) O (13)	C (1.7 h) C (0.9 h)	C (8.6 h)	C (1.1 h)	C (2.9 h)
2.X.2021	–	–	C (0.9 h)	–	C (2.2 h)
3.X.2021	C (3 h)	–	–	C (3.8 h)	–
4.X.2021	C (1 h) C (0.7 h) O (15)	C (2.8 h)	C (2.8 h)	C (0.7 h)	C (2.8 h)
5.X.2021	C (1 h) O (17)	–	–	C (1 h)	C (2.8 h)
6.X.2021	–	O (18)	–	C (1.1 h)	O (9)
7.X.2021	O (14)	O (32)	C (2.3 h)	C (0.7 h)	O (13)
8.X.2021	–	C (0.8 h)	C (0.8 h)	C (1 h)	O (15)
9.X.2021	–	–	C (0.8 h) O (33)	C (0.8 h)	C (0.7 h)
10.X.2021	–	–	O (15)	C (0.8 h) O (12)	O (13)
11.X.2021	–	O (6)	O (4)	C (0.8 h) O (16)	O (13)
12.X.2021	–	–	–	O (28)	–
14.X.2021	–	C (2 h) C (1 h)	C (1.3 h)	–	C (1 h)
15.X.2021	–	C (1.8 h)	–	–	C (0.5 h)
16.X.2021	–	–	–	–	C (2.9 h)
Number of eggs	71	56	52	56	63

C, copulation (duration in parentheses); O, oviposition (number of eggs laid in parentheses); dash, no reproductive activity.

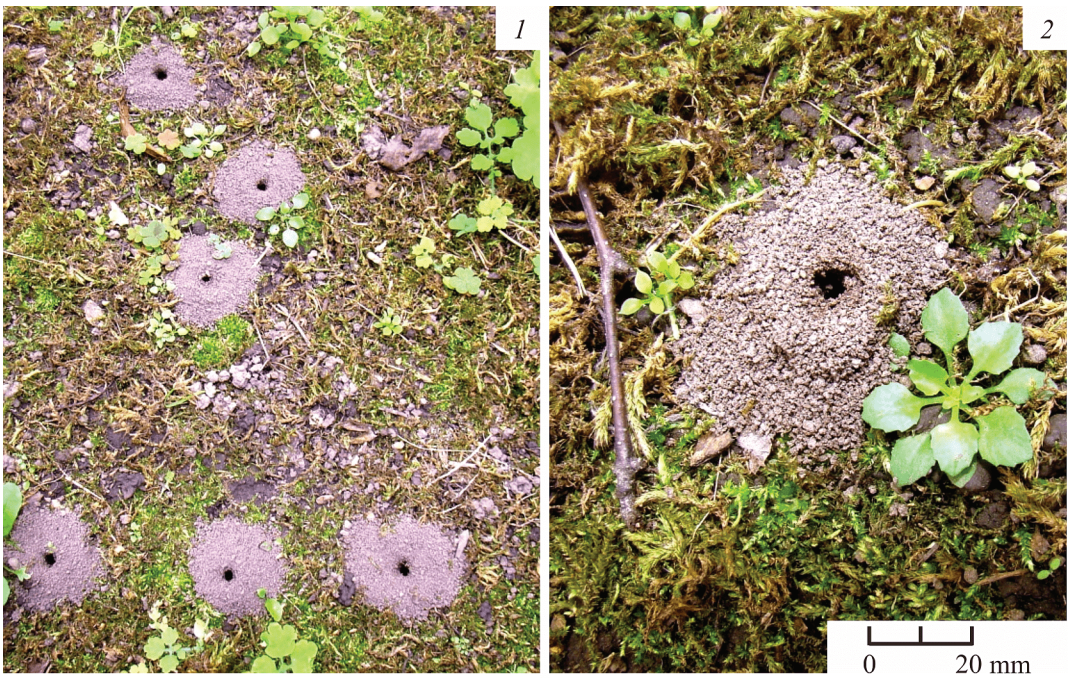

Fig. 2. Wintering shelters of *Forficula vicaria* Semenov under natural conditions: (*1*) arrangement of shelters in the sample plot; (*2*) enlarged photo showing the size of the burrow.

surface. Our observations show that males of *F. vicaria* in Primorskii Territory participate in the construction of underground nests, but are subsequently driven out closer to the soil surface by the females and die after the first ground frost. The females stay in the nests until the end of the middle third of May, and the nymphs appear on the soil surface since early June (Markova et al., 2022). Occasional females of the overwintered generation can be found until the middle of June.

ACKNOWLEDGMENTS

We are sincerely grateful to S.Yu. Storozhenko (Federal Scientific Center of the East Asia Terrestrial Biodiversity, Far Eastern Branch of the Russian Academy of Sciences, Vladivostok), V.V. Aleksanov (Kaluga Regional Ecological and Biological Center), L.N. Anisyutkin, and B.A. Korotyaev (Zoological Institute of the Russian Academy of Sciences, St. Petersburg) for advice and critical comments during preparation of this paper.

FUNDING

The research was carried out within the framework of the state assignment of Ministry of Science and Higher Education of the Russian Federation (theme No. 121031000120-9).

COMPLIANCE WITH ETHICAL STANDARDS

Conflict of interest. The authors declare that they have no conflict of interest.

Statement on the welfare of animals. All the applicable international, national, and/or institutional guidelines for the care and use of animals were followed. All the procedures performed in studies involving animals were in accordance with the ethical standards of the institution or practice at which the studies were conducted.

REFERENCES

Aleksanov, V.V., Life cycle and habitats of the European earwig *Forficula auricularia* L. (Dermaptera, Forficulidae) in Kaluga, Russia, *Euroasian Entomol. J.*, 2015, vol. 14, no. 3, p. 285.
https://www.elibrary.ru/item.asp?id=25408914

Behura, B.K., The biology of the European earwig, *Forficula auricularia* Linn., Ann. Zool., 1956, vol. 1, p. 117.

Beier, M., *Ohrwürmer und Tarsenspinner (Dermaptera – Embioptera). Die neue Brehm-Bücherei Nr. 251*, Lutherstadt Wittenberg: Ziemsen, 1959.

Bey-Bienko, G.Ya., *Obshchaya entomologiya* (General Entomology), Moscow: Vysshaya Shkola, 1980.

Burnip, G.M., Daly, J.M., Hachett, J.K., and Suckling, D.M., European earwig phenology and effect of understorey management on population estimation, *N. Z. Plant Prot.*, 2002, vol. 55, p. 390.
https://doi.org/10.30843/nzpp.2002.55.3938

Buxton, J.H. and Madge, D.C., Artificial incubation of eggs of the common earwig *Forficula auricularia* (L.), *Entomol. Mon. Mag.*, 1974, vol. 110, no. 1316/18, p. 55.

Crumb, S.E., Eide, P.M., Bonn, A.E., *The European Earwig. Technical Bulletin. United States Department of Agriculture, 766*, Washington, 1941.

Good, J.A., Notes on the biogeography and ecology of the common earwig, *Forficula auricularia* (Dermaptera), in Ireland. Part 2: Life cycle, *Ir. Nat. J.*, 1982, vol. 20, no. 12, p. 543.

Jones, D.W., The European earwig and its control, *Bull. U. S. Dep. Agric.*, 1917, no. 566, p. 1.
https://doi.org/10.5962/bhl.title.64569

Kirkland, L.S., Maino, J., Stuart, O., and Umina, P.A., Ontogeny in the European earwig (*Forficula auricularia*) and grain crops interact to exacerbate feeding damage risk, *J. Appl. Entomol.*, 2020, vol. 144, no. 7, p. 605.
https://doi.org/10.1111/jen.12767

Kocarek, P., Life cycles and habitat associations of three earwig (Dermaptera) species in lowland forest and its surroundings, *Biologia (Bratislava)*, 1998, vol. 53, no. 2, p. 205.
https://www.researchgate.net/publication/228598565

Lamb, R.J., Parental behavior in the Dermaptera, with special reference to *Forficula auricularia* (Dermaptera: Forficulidae), *Can. Entomol.*, 1976, vol. 108, no. 6, p. 609.
https://doi.org/10.4039/Ent108609-6

Lamb, R.J. and Wellington, W.G., Techniques for studying the behavior and ecology of the European earwig, *Forficula auricularia* (Dermaptera: Forficulidae), *Can. Entomol.*, 1974, vol. 106, no. 8, p. 881.
https://doi.org/10.4039/Ent106881-8

Lamb, R.J. and Wellington, W.G., Life history and population characteristics of the European earwig, *Forficula auricularia* (Dermaptera: Forficulidae), at Vancouver, British Columbia, *Can. Entomol.*, 1975, vol. 107, no. 8, p. 819.
https://doi.org/10.4039/Ent107819-8

Markova, T.O., Maslov, M.V., and Storozhenko, S.Yu., Phenology of *Forficula vicaria* Semenov, 1902 (Dermaptera, Forficulidae) in the south of the Russian Far East, *Entomol. Rev.*, 2022, vol. 102, p. 1051.
https://doi.org/10.1134/S0013873822080012

Meunier, J., Wong, J.W.Y., Gómez, Y., Kuttler, S., Röllin, L., Stucki, D., and Kölliker, M., One clutch or two clutches? Fitness correlates of coexisting alternative female life-histories in the European earwig, *Evol. Ecol.*, 2012, vol. 26, no. 3, p. 669.
https://doi.org/10.1007/s10682-011-9510-x

Sullivan, D.J., Survey of Inishtrahull: Part 3: Observations on the habits of the common earwig at Inishtrahull, *Ir. Nat. J.*, 1943, vol. 8, no. 4, p. 101.
https://www.jstor.org/stable/25533184

Volovnik, S.V., Parental care in earwigs, *Khim. Zhizn*, 1987, vol. 8, p. 54.