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European earwig, *Forficula auricularia* L. (Dermaptera: Forficulidae), at the Hanford Reach National Monument, Washington State

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EUROPEAN EARWIG, *FORFICULA AURICULARIA* L. (DERMAPTERA: FORFICULIDAE), AT THE HANFORD REACH NATIONAL MONUMENT, WASHINGTON STATE

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ABSTRACT.—The European earwig, *Forficula auricularia* L., was surveyed using pitfall traps at 3 sites at the Hanford Reach National Monument in south central Washington State. Pitfall traps were collected weekly from April 2002 through April 2003. The earwig was consistently taken during all months of the year at a disturbed, weedy site along the Columbia River (White Bluffs Ferry site) but was rare or not collected in 2 less-disturbed shrubsteppe habitats. Highest numbers occurred during April–May, when immatures accounted for the majority of the catch; immatures reached the adult stage during mid-July, and the species is univoltine at the site. Possible reasons why earwigs have not colonized the monument's shrubsteppe habitat include the arid climate with lack of available moisture, especially for breeding purposes, and a lack of burrow sites.

Key words: Forficula auricularia *L., Dermaptera, European earwig, shrubsteppe, invasive species, Hanford Nuclear Site, Washington.*

RESUMEN.—La tijereta Europea, *Forficula auricularia* L., fue estudiada usando trampas de caída en tres sitios del Hanford Reach National Monument en el sur del estado de Washington. Se colectaron los contenidos de las trampas de caída semanalmente desde abril de 2002 hasta abril de 2003. La tijereta apareció constantemente durante todos los meses del año en un sitio perturbado de vegetación herbácea en la orilla del Río Columbia (el lugar del antiguo transbordador White Bluffs) pero su colecta fue escasa o nula en dos hábitats de estepa arbustiva menos perturbados. Los mayores números ocurrieron durante abril y mayo cuando los organismos inmaduros representaron la mayoría de los especímenes capturados; éstos alcanzaron la etapa adulta a mediados de julio y la especie es univoltina en este sitio. Posibles causas de que las tijeretas no hayan colonizado el hábitat de estepa arbustiva del Monumento podrían incluir su clima árido carente de agua disponible, especialmente para la reproducción, y una falta de sitios para madrigueras.

During 2002–2003, we conducted an intensive arthropod survey of the Hanford Reach National Monument, located in south central Washington State. The primary purpose of the survey was to begin to document the arthropod fauna of the monument, especially endemic and invasive species. The monument was created in 2000 (O'Connor and Rickard 2003) from portions of the Hanford Nuclear Reservation, the Saddle Mountain National Wildlife Refuge, and the Wahluke Wildlife Area. Some portions of the monument have suffered significant human disturbances, while others are relatively undisturbed. All sections of the monument that were surveyed for this study are significantly or partially disturbed. One of the survey sites was used as a river-ferry landing, while the others are used for recreational purposes, such as hunting. Climate in this area consists of hot, dry summers and cold winters, with annual precipitation ranging from 10 to 20 cm. Temperatures range from average highs of 3 °C in January to 33 °C in July; temperatures of 32 °C or above occur an average of 56 days per year (ERDA 1975). The generalized habitat is stabilized sand, with sparse sagebrush (*Artemisia tridentata* Nutt.), rabbitbrush (*Chrysothamnus viscidiflorus* [Hook.] Nutt.), buckwheat (*Eriogonum niveum* Dougl. ex Benth.), and cheatgrass (*Bromus tectorum* L.) as the dominant plant taxa (Daubenmire 1970, Sackschewsky and Downs 2001). Specific survey-site descriptions are detailed in the methods section.

The European earwig, *Forficula auricularia* L., is native to Europe, western Asia, and the northern fringe of Africa (Lamb and Wellington 1975). It is distributed in temperate areas

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throughout the world and was recorded from Seattle, Washington, in 1907, Oregon as early as 1909, and Rhode Island in 1911 (Fulton 1924, Crumb et al. 1941). Today, the earwig is widespread throughout New England, the middle Atlantic states, and the western states (Weems and Skelley 2007). Earwigs are principally nocturnal and will take refuge in a wide variety of hiding places during the day. This behavior makes the insect an excellent candidate for dispersal through human activities. Fulton (1924) notes that European earwigs were intercepted several times on nursery stock and plant bulbs and postulates that import of these plant materials may have been the avenue of introduction into Oregon. Both Fulton (1924) and Crumb et al. (1941) provide excellent discussions of the biology of the species, including factors that influence micro- and macrohabitat distributions.

During early sampling at the Hanford Reach National Monument, we were surprised to find earwigs, because the environment there is relatively warm and xeric. We surveyed earwigs through pitfall trapping and discovered that earwigs were not evenly distributed throughout the monument. In this paper, we discuss the distribution of *F. auricularia* at the monument as well as the insect's seasonality.

METHODS

The study was conducted in Grant (shrubsteppe sites 1 and 2) and Franklin (White Bluffs Ferry site) counties in south central Washington State. These areas lie on the Saddle Mountain National Wildlife Refuge and the Wahluke Wildlife Area, respectively. Climate in this area is as described above for the Hanford site. The nearest meteorological site is located approximately 15 km from the survey sites, at the same elevation (Hanford Meteorological Station 2009). Data recorded at this site during the period of collection (April 2002–March 2003) show a total precipitation of 17.98 cm, with 12.83 cm falling December through February. Temperature during the period was within 1 °C of the 61-year quarterly average for each quarter during which collections were made (Hanford Meteorological Station 2009). Weather data for individual sites are not available for the study period, but climate and weather differences between sites are minimal. Geographic coordinates were recorded with a Garmin eTrex Summit GPS unit and were taken at the center of a transect of 10 traps.

Three sites were selected for study. The first, shrubsteppe site 1 (46°42.064′N, 119°38.271′W; 145 m elevation), was established in an area of sandy soil, with primary vegetation consisting of scattered sage and rabbitbrush and some buckwheat, lupine (*Lupinus* spp.), balsamroot (*Balsamorhiza careyana* Gray), and cheatgrass. Plant ground cover was about 65%, with the remainder as bare ground. The surface had little debris, and the closest water source was approximately 3 km from the site.

Shrubsteppe site 2 (46°41.496′N, 119° 35.444′W; 136 m elevation) was located at the termination end of an irrigation catch-basin runoff system (Zack and Johnson 2008). Soil at the site was sandy, with small amounts of big sagebrush, rabbitbrush, and buckwheat, sparse cheatgrass, and a variety of weedy species. Plant coverage was approximately 40% at the site, with the remainder being bare ground. The traps were placed in the midst of a series of small ponds, pools, and irrigation canals that fluctuated in water depth throughout the year, with maximum levels in late July and early August and total dryness in the late winter and early spring (January through early April). Traps were placed 25 to 200 m from water and in areas with little plant ground cover or debris.

Site 3, the White Bluffs Ferry site (46° 40.541′N, 119°26.949′W; 128 m elevation), was in a depression approximately 50 m from the Columbia River near the site of the previous White Bluffs Ferry landing that had been established in the 1880s and used until the early 1940s. No remnants of the ferry landing or any associated buildings still exist, but the site is presently used as a boat launch. Vegetation at the site consists of some very scattered sage but mostly mixed, weedy vegetation with varying amounts of cheatgrass. Vegetation at the site is not riparian. The soil is sandy but packed. Vegetative ground cover at the site is approximately 85% with 15% bare soil. There is an abundance of vegetation as well as human-created debris. The depression in which the traps were placed was approximately 55 m long, 15 m wide, and 3–4 m deep and was created through road construction and maintenance. Education at PNNL (2009) gives a short history of the White Bluffs area.

A transect of 10 pitfall traps was placed at each site, with 10-m intervals between traps. Pitfall traps consisted of "one-pound" plastic deli cups with an open-top diameter of

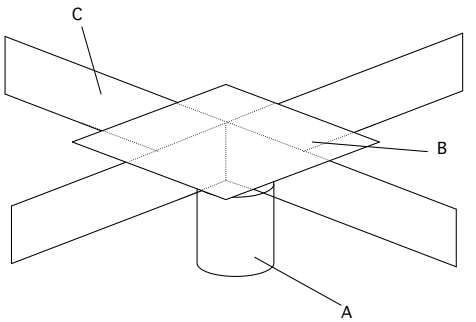

Fig. 1. Schematic of pitfall trap: A, trap receptacle; B, cover; C, baffle.

approximately 11.5 cm and a depth of approximately 8.25 cm. Cups were buried flush with the soil. Each trap was covered with an X-shaped set of 7.5-cm-high runners with a span of 46 cm from the center of the trap. The runners were designed to increase the functional trap perimeter (Morrill et al. 1990). A 30.5 × 30.5-cm lid was placed over the runners and in the center of the trap (Fig. 1). Cups were filled to a depth of approximately 2.5 cm with propylene glycol (Sierra®) diluted 1:1 with water. Traps were collected approximately every week, from 11 April 2002 to 11 April 2003. Records of individual trap catches were not kept, but all 10 traps were pooled into a single sample. Voucher specimens of earwigs are deposited in the M.T. James Entomological Collection at Washington State University (WSU).

RESULTS AND DISCUSSION

Figure 2 delineates survey sites, numbers, and dates of earwig capture. Lack of a date sequence indicates that no earwigs were collected during that period of time. During April and May, no earwigs were taken at shrubsteppe site 1 and only 4 adults at shrubsteppe site 2. In contrast, the highly disturbed White Bluffs Ferry site produced specimens throughout the year, with large numbers of immatures occurring April through May. With some weekly exceptions, earwigs were one of the few arthropods collected throughout the winter months of December through February; snow did not occur at the site during the collecting period. Immature earwigs were taken only at the White

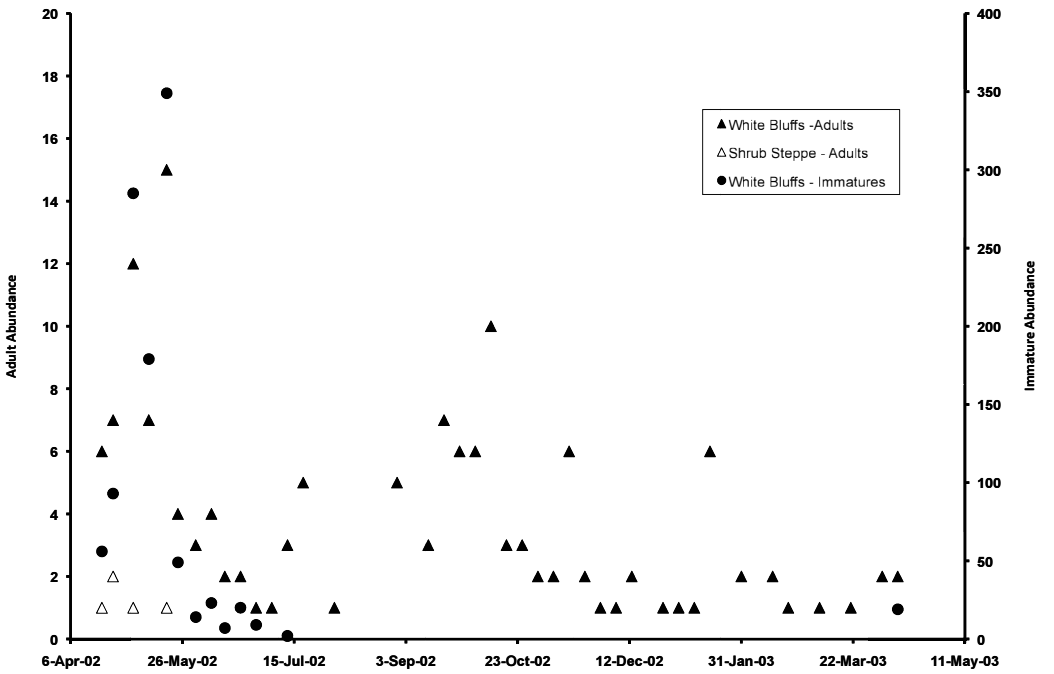

Fig. 2. Survey sites, collection dates, and number and stage of the European earwig, *Forficula auricularia* L., taken at the Hanford Reach National Monument, Washington.

Bluffs Ferry site. They began to occur in April and were most numerous during April and May, during which time they made up the majority of the collections. Immatures were collected until mid-July. No immatures were taken at shrubsteppe site 2.

These collections indicate that *F. auricularia* is common at the White Bluffs Ferry site on the Columbia River but has not spread into the shrubsteppe habitat to a significant degree. The earwig may have been introduced at the White Bluffs Ferry site through commerce, as equipment and farm commodities were moved back and forth across the river from the 1880s until the early 1940s when the site was closed to the public. Today, the general site serves as an infrequently used recreational boat launch. It is unknown when introductions of the earwig first occurred, as we could locate no specimens of *F. auricularia* from the general White Bluffs Ferry site area in collections.

Several circumstances may be limiting the earwig to the White Bluffs Ferry site. The European earwig is very moisture sensitive and requires highly saturated conditions for the survival of eggs, which are laid in small, earwig-created or natural burrows (Crumb et al. 1941, Lamb and Wellington 1974). The relative atmospheric humidity of the monument is very low throughout most of the year. But given the monument's proximity to the Columbia River and the fact that traps were located in a depression perpendicular to the river and only a few feet higher in elevation, soil moisture may be adequate to support the eggs and early nymphs. Adults are much less moisture sensitive (Lamb and Wellington 1974) and may be better adapted to survive the hot and dry late spring and summer months. A common area in which the earwig is found at other locations is in margins of beaches above the high-water mark (Lamb and Wellington 1975). Additionally, the more packed structure of the soil at the White Bluffs Ferry site and the abundance of debris under which earwigs can construct their overwintering and egg burrows may provide them with adequate habitat in which to survive, even though generalized climatic conditions at the monument are not optimal (for discussions of optimal conditions, see Crumb et al. 1941, Lamb and Wellington 1974, 1975, Lamb 1976).

The collection of a few adult earwigs at shrubsteppe site 2 in April and May may reflect dispersal of adults into this area, but breeding conditions, such as high moisture and burrow sites, may be lacking. Although no immatures were collected, breeding could still take place at the site. No adult specimens were collected after mid-May (Table 1), so the insect probably occurs in this area only on a marginal basis. Successful breeding may take place in years when winter and spring moisture are significantly

TABLE 1. Survey sites, collection dates, and number and stage of the European earwig, *Forficula auricularia* L., taken at the Hanford Reach National Monument, Washington.

Dates	Number of earwigs collected
White Bluffs Ferry site	
11–20 Apr 2002	6 adults, 56 immatures
20–25 Apr	7 adults, 93 immatures
25 Apr–4 May	12 adults, 285 immatures
4–11 May	7 adults, 179 immatures
11–19 May	15 adults, 349 immatures
19–24 May	4 adults, 49 immatures
24 May–1 Jun	3 adults, 14 immatures
1–8 Jun	4 adults, 23 immatures
8–14 Jun	2 adults, 7 immatures
14–21 Jun	2 adults, 20 immatures
21–28 Jun	1 adult, 9 immatures
28 Jun–5 Jul	1 adult
5–12 Jul	3 adults, 2 immatures
12–19 Jul	5 adults
26 Jul–2 Aug	1 adult
23–30 Aug	5 adults
6–13 Sep	3 adults
13–20 Sep	7 adults
20–27 Sep	6 adults
27 Sep–4 Oct	6 adults
4–11 Oct	10 adults
11–18 Oct	3 adults
18–25 Oct	3 adults
25 Oct–1 Nov	2 adults
1–8 Nov	2 adults
8–15 Nov	6 adults
15–22 Nov	2 adults
22–29 Nov	1 adult
29 Nov–6 Dec	1 adult
6–13 Dec	2 adults
20–27 Dec	1 adult
27 Dec 2002–3 Jan 2003	1 adult
3–10 Jan	1 adult
10–17 Jan	6 adults
24–31 Jan	2 adults
7–14 Feb	2 adults
14–21 Feb	1 adult
28 Feb–7 Mar	1 adult
14–21 Mar	1 adult
28 Mar–4 Apr	2 adults
4–11 Apr	2 adults, 19 immatures
Shrubsteppe site 1	
No specimens collected	No specimens collected
Shrubsteppe site 2	
11–20 Apr	1 adult
20–25 Apr	2 adults
25 Apr–4 May	1 adult
11–19 May	1 adult

higher than average. The amount of water passing through the irrigation run-off system that feeds into this area may also affect survival of earwig eggs and immatures. Years of greater and longer-lasting surface water availability would support more optimal conditions for earwig survival. The fact that shrubsteppe site 1 provided no earwigs is an indication of this site's lack of suitability to earwig colonization and survival.

Seasonality of *F. auricularia* at the monument is similar to that found in other Pacific Northwest studies of the earwig (Fulton 1924, Crumb et al. 1941). *Forficula auricularia* is univoltine, with immatures occurring in early spring and maturing to adults by mid to late summer and adults overwintering. Crumb et al. (1941) found that the earwig sometimes produces 2 batches of eggs: the first eggs hatching in mid-April and immatures beginning to appear above ground in late April and early May and developing into adults by late June or early July. If a second batch of eggs is produced, the timeline is increased through the summer, with immatures found until late July or early August. Our results, though based on a single year of observations, indicate that a second egg batch may not be produced at the Hanford Monument, as we collected only adults after mid-July. The hot and dry late spring and summer at the monument sites may not provide needed moisture to sustain a second batch of eggs and immatures. We also found immatures during the first few days of April, which may indicate an earlier spring hatching of eggs. An earlier hatching would be consistent with high early spring temperatures at the monument. As did Crumb et al. (1941), we found adults at the surface throughout the winter months (Fig. 2)

While the generalized soil and climatic constructs of the Hanford National Monument do not provide optimal or even adequate suitability for European earwig survival, the insect has been able to invade and survive in areas where microhabitat and climatic conditions are at least sufficient. However, its spread throughout the site seems very unlikely.

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