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Early spring moths (Lepidoptera: Noctuidae) captured in traps baited with (Z)-11-hexadecenal

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Moth sex pheromones are relatively specific; their attractiveness is limited to 1 or a few species. Such specificity is achieved in part by the diversity of chemical structures found as pheromones, and with combinations or blends of these compounds (Mayer & McLaughlin 1991). Specificity of sex pheromones is important for the maintenance of reproductive isolation, and prevention of mating mistakes among species of moths (e.g., Greenfield & Karandinos 1979; Roelofs & Carde 1974).

Specificity is also an important attribute of sex pheromones or sex attractants when used as lures for monitoring pest moths. However, when non-target moths are captured in monitoring traps deployed for a particular pest species, trap-checking is more difficult and misidentifications may become false positives for the target species. An example is the response of *Leucania* species to sex pheromone lures for the fall armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae), and the corn earworm, *Helicoverpa zea* (Boddie) (Lepidoptera: Noctuidae) (Weber & Ferro 1991).

The compound (Z)-11-hexadecenal (Z11-16ALD) is part of the sex pheromone of a number of moths (Mayer & McLaughlin 1991; Steck et al. 1982), including major pest species such as corn earworm (Klun et al. 1980) and tobacco budworm, *Heliothis virescens* (Fabricius) (Lepidoptera: Noctuidae) (Tumlinson et al. 1975). (Z)-11-hexadecenal also is a part of a sex attractant for the wheat head armyworm, *Dargida (Faronta) diffusa* (Walker) (Lepidoptera: Noctuidae) (Underhill et al. 1977). Efforts to detect and monitor wheat head armyworm moths in wheat fields in eastern Washington State, USA, revealed that Z11-16ALD attracts other moth species that occur in the same habitat (Landolt & Roberts 2012; Landolt et al. 2017). Incidental to these published studies were captures of small numbers of additional moth species early in the spring. The objective of this study was to properly determine and document these species of early spring-flying noctuid moths trapped with the compound Z11-16ALD.

The study involved the placement of traps baited with Z11-16ALD, paired with unbaited traps, at multiple sites in eastern Washington, and maintenance of those traps through spring. All traps were Unitraps (International Pheromone Systems, Inc., Wallasey, Wirral, United Kingdom), a bucket-type trap with a yellow funnel over the white bucket and topped with a green cover. Z11-16ALD was loaded into pre-extracted red rubber septa (WestPharma Inc., Lionville, Pennsylvania, USA), at 1 mg Z11-16ALD in 100 μ L methylene chloride per septum followed by an additional 100 μ L methylene chloride. Loaded septa were air-dried in a fume hood for 24 h, then stored in capped glass vials in a freezer (-10 °C) until use. A single treated septum was put into the plastic mesh basket provided by the manufacturer with the trap and placed beneath the center of the trap lid. A 2.5 square cm piece of

Vaportape (Hercon Environmental Inc., Emigsville, Pennsylvania, USA) was put in the trap bucket to kill captured insects. Baited and unbaited traps were placed about 10 m apart at field sites, with 1 pair of traps per site. Replicates of paired traps were placed > 2 km apart. The 32 trap sites, each with a pair of baited and unbaited traps, were in uncultivated riparian habitats. Trap site locations are provided in Table 1. Traps were operated in Mar and Apr of 2016 and 2017 (Table 1). Traps were checked and captured insects removed weekly. Lures and Vaportape were replaced at 4 wk.

For each species, numbers of moths caught were summed for each trap over the course of the trap placement. Summed trap catch data were used to compute the mean and standard error for each species of moth. Only data from sites that were positive for capture of that species of moth were included in the computations. Voucher specimens of reported moth species were deposited in the M. T. James Arthropod Collection, Washington State University, Pullman, Washington, USA.

One thousand sixty-four noctuid moths were trapped. All moths captured were male, and these were members of 6 non-pest species. No moths were captured in any of the unbaited traps.

The species of moth caught most abundantly was *Egira rubrica* (Harvey) (Lepidoptera: Noctuidae). This species was captured at 28 of the 32 sites (Table 1). For the 28 sites with positive catches in Z11-16ALD traps, the mean trap catch was 28.4 ± 6.4 males per trap, and the total captured was 796. *Egira rubrica* is widely distributed in the western U.S. and Canada, is univoltine, and flies in early spring. The larvae feed on leaves of broad leaf trees and shrubs such as *Populus* and *Salix* (both Salicaceae) (Miller & Hammond 2000). (Z)-11-hexadecenal has not been reported as an attractant or pheromone of this moth although Landolt and Smithhisler (1998) trapped several *E. rubrica* males with the combination of Z11-16ALD and (Z)-11-hexadecenyl acetate. (Z)-11-hexadecenal is not known as an attractant or pheromone for other species of *Egira*, although McDunnough et al. (1982) isolated (Z)-11-hexadecenal from glands of female *Egira curialis* (Grote) (Lepidoptera: Noctuidae) and showed that chemical to be attractive to *E. curialis* males. Steck et al. (1982) trapped several *Egira (Xylomyges) dolosa* (Grote) (Lepidoptera: Noctuidae) males with (Z)-7-dodecenyl acetate.

Stretchia plusiaeformis (H. Edwards) (Lepidoptera: Noctuidae) was captured at 13 of the 32 sites (Table 1). The total trapped was 117 males, and the mean trap catch was 22.3 ± 9.5 for Z11-16ALD-baited traps at those 13 positive sites. There is little published information on its biology, but it was reported as a pest of currants (*Ribes*) (Grossulariaceae) in Colorado by Hoerner (1937) and utilizes wild currant shrubs as a larval host plant (Miller & Hammond 2000; Tietz 1972). Currants are abundant in the riparian areas of eastern Washington. This species

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Table 1. Locations and dates for traps baited with (Z)-11-hexadecenal in 2016 and 2017, and the numbers captured of the 3 noctuid moth species. All moths captured were male, and no moths were caught in unbaited traps.

Location	Trapping Dates	<i>Egira rubrica</i>	<i>Stretchia plusiaeformis</i>	<i>Annaphila danisticta</i>
Yakima Co., 2.6 km east of Tampico, 565 masl; 46.5294°N, 120.6144°W	2 Mar to 13 Apr 2016	11	1	0
Yakima Co., Ahtanum Mission, 524 masl; 46.5316°N, 120.7669°W	2 Mar to 13 Apr 2016	9	1	0
Yakima Co., Ahtanum Mission, 380 masl; 46.5405°N, 120.6144°W	2 Mar to 13 Apr 2016	12	0	0
Yakima Co., Goodman Road, 305 masl; 46.5566°N, 120.5011°W	2 Mar to 31 May 2016	0	0	1
Yakima Co., Fullbright Park, 309 masl; 46.5391°N, 120.4816°W	2 Mar to 13 Apr 2016	7	3	1
Yakima Co., Parker, 271 masl; 46.4908°N, 120.4291°W	2 Mar to 13 Apr 2016	3	4	0
Yakima Co., Donald, 261 masl; 46.4694°N, 120.3977°W	2 Mar to 13 Apr 2016	15	18	0
Yakima Co., Parker, 271 masl; 46.4908°N, 120.5427°W	15 Mar to 13 Apr 2017	0	3	0
Yakima Co., Sawyer, 255 masl; 46.4341°N, 120.3608°W	15 Mar to 13 Apr 2017	1	4	0
Yakima Co., northwest of Buena, 249 masl; 46.4433°N, 120.3477°W	15 Mar to 13 Apr 2017	8	5	0
Yakima Co., southwest of Buena, 235 masl; 46.4038°N, 120.3161°W	15 Mar to 13 Apr 2017	46	26	0
Yakima Co., Toppenish National Wildlife Reserve, 226 masl; 46.3208°N, 120.4172°W	10 Mar to 12 Apr 2017	8	0	0
Yakima Co., Route 97, Satus Creek, 309 masl; 46.3852°N, 120.7208°W	10 Mar to 12 Apr 2017	40	0	0
Yakima Co., Route 97, Satus Creek, 344 masl; 46.3508°N, 120.8047°W	10 Mar to 12 Apr 2017	66	11	1
Yakima Co., Route 97, Satus Creek, 487 masl; 46.1663°N, 120.9188°W	10 Mar to 12 Apr 2017	53	3	42
Yakima Co., Route 97, Satus Creek, 395 masl; 46.2691°N, 120.8497°W	10 Mar to 12 Apr 2017	20	28	1
Yakima Co., Route 97, Satus Creek, 384 masl; 46.3272°N, 120.7916°W	10 Mar to 12 Apr 2017	54	10	7
Yakima Co., Route 97, Satus Grade, mp 35, 585 masl; 46.0450°N, 120.5722°W	31 Mar to 21 Apr 2017	14	0	42
Yakima Co., Route 97, Satus Grade, mp 34, 596 masl; 46.0380°N, 120.5866°W	31 Mar to 21 Apr 2017	0	0	41
Yakima Co., south fork Ahtanum Creek, 757 masl; 46.8475°N, 120.5544°W	7 to 28 Apr 2017	6	0	1
Yakima Co., south fork Ahtanum Creek, 767 masl; 46.8444°N, 120.5558°W	7 to 28 Apr 2017	3	0	1
Yakima Co., south fork Ahtanum Creek, 768 masl; 46.8458°N, 120.3033°W	7 to 28 Apr 2017	6	0	0
Yakima Co., south fork Ahtanum Creek, 773 masl; 46.8438°N, 120.4533°W	7 to 28 Apr 2017	2	0	0
Yakima Co., south fork Ahtanum Creek, 777 masl; 46.8438°N, 120.5605°W	7 to 28 Apr 2017	3	0	0
Yakima Co., south fork Ahtanum Creek, 781 masl; 46.8438°N, 120.9466°W	7 to 28 Apr 2017	3	0	0
Yakima Co., south fork Ahtanum Creek, 775 masl; 46.8491°N, 120.5538°W	30 Mar to 28 Apr 2017	1	0	0
Yakima Co., south fork Ahtanum Creek, 766 masl; 46.0308°N, 120.5525°W	30 Mar to 28 Apr 2017	0	0	0
Whitman Co., Pullman, Koppel Farm, 721 masl; 46.7216°N, 117.1672°W	29 Mar to 27 Apr 2017	116	0	0
Whitman Co., Pullman Koppel Farm, 721 masl; 46.7200°N, 117.1658°W	29 Mar to 27 Apr 2017	113	0	0
Whitman Co., Pullman, Route 270, 729 masl; 46.7216°N, 117.1525°W	29 Mar to 27 Apr 2017	89	0	1
Whitman Co., Pullman, USDA Farm, 744 masl; 46.7255°N, 117.1430°W	29 Mar to 27 Apr 2017	56	0	0
Whitman, Co., Pullman, Washington State University Sheep Farm, 750 masl; 46.7288°N, 117.1991°W	29 Mar to 27 Apr 2017	31	0	0

is widely distributed in western North America (Powell & Opler 2009). There are no pheromones or sex attractants reported for members of this genus.

A total of 139 male *Annaphila danisticta* (Grote) (Lepidoptera: Noctuidae) moths were captured in Z11-16ALD traps at 11 sites. A mean of 28.4 ± 9.5 moths were captured in those 11 traps. An overview of the genus was provided by Leuschner (1997), but there is little information available on the biology of *A. danisticta*. There are no prior reports of pheromones or sex attractants for moths in this genus.

Small numbers of several other Noctuidae were captured. Three *Egira perlubens* (Grote) and 4 *Stretchia muricina* (Grote) were captured in traps baited with Z11-16ALD. Seven *Xylena cineritia* (Grote) and 2 *Xylena brucei* (Smith) also were captured in Z11-16ALD-baited traps. There are no reports of pheromones or sex attractants for any of these species. However, small numbers of males of *Xylena formosa* Butler were captured by Ando et al. (1977), and *Xylena exoleta* L. by Subchev et al. (1986) in Japan and Europe, respectively, in traps baited with Z11-16ALD.

For *E. rubrica*, *S. plusiaeformis*, and *A. danisticta*, this is the first report of their attraction to Z11-16ALD. The chemical may be a female pheromone component, although the chemical alone is suitably attractive to bring males into traps. Additional studies of female pheromone gland chemistry or volatile emissions might confirm the pheromonal nature of the chemical for these species. It is possible that similar results may be obtained with additional species of *Egira*, *Stretchia*, *Annaphila*, and even *Xylena*.

The responses of males of multiple species of moths to Z11-16ALD may be of interest when using this compound in lures to detect or monitor a specific pest. In the example of Weber and Ferro (1991), non-target moths greatly outnumbered the targeted fall armyworm and corn earworm, increasing the time and skill needed to identify the trap catch. In our study, pest moths were not captured because the study was conducted before the known seasonality of pest moths in this area that use Z11-16ALD as a pheromone compound. These include the corn earworm, the glassy cutworm, *Apamea devastator* (Brace) (Lepidoptera: Noctuidae), and the wheat head armyworm, *Dargida diffusa* (Walker).

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Summary

(Z)-11-Hexadecenal (Z11-16ALD) is a component of the sex pheromone, or a sex attractant, of a number of moth species. Traps baited with this compound in early spring in eastern Washington State captured numbers of males of *Egira rubrica* (Harvey), *Stretchia plusiaeformis* (H. Edwards), and *Annaphila danisticta* (Grote) (all Lepidoptera: Noctuidae), indicating its function as a sex attractant for these species. This new knowledge may be important to pest managers that monitor

moths with Z11-16ALD because such non-target responders to a lure can increase monitoring costs and be counted as “false positives” for pest species.

Key Words: (Z)-11-hexadecenal; sex attractant; monitoring; Noctuidae

Sumário

(Z)-11-Hexadecenal (Z11-16ALD) es un componente de la feromona sexual o un atrayente sexual de varias especies de polillas. Las trampas cebadas con este compuesto a principios de la primavera en el este del estado de Washington capturaron un número de machos de *Egira rubrica* (Harvey), *Stretchia plusiaeformis* (H. Edwards) y *Annaphila danistica* (Grote) (todos Lepidoptera: Noctuidae), lo que indica su función como atrayente sexual para estas especies. Este nuevo conocimiento puede ser importante para aquellos que manejan estas plagas y monitorean las polillas con Z11-16ALD porque tales respondedores no objetivo a un señuelo pueden aumentar los costos de monitoreo y ser contados como “falsos positivos” para las especies de plagas.

Palabras Clave: (Z)-11-hexadecenal; atrayente sexual; monitoreo; Noctuidae

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