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N O T E

Flight Period of *Sirex nigricornis* (Hymenoptera: Siricidae) in Western North Carolina[1]

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The 2004 detection of the nonnative woodwasp *Sirex noctilio* F. (Hymenoptera: Siricidae) in New York (Hoebeke et al. 2005, Newsl. Mich. Entomol. Soc. 50: 24–25) raised concerns of potential tree mortality in North America because *S. noctilio* has caused extensive mortality of pine trees in the Southern Hemisphere (Ciesla 2003, J. For. 101: 18–23). Unlike in the Southern Hemisphere, pine woodwasps and associated parasitoids are native to North America (Schiff et al. 2012, Can. J. Arthr. Ident. No. 21). Determining the phenology of native woodwasps in the United States should help to determine the susceptibility of native forests to invasion by *S. noctilio*.

Two trapping studies were conducted in the Nantahala National Forest near Murphy, NC; one in 2011 and the other in 2015. In both studies, pairs of multiple-funnel traps were deployed along Forest Service Road 307, adjacent to the Beech Creek Seed Orchard (N 35.0875°, W 84.1246°) at an elevation of 480–495 m above sea level. The forest was dominated by eastern white pine (*Pinus strobus* L.), with pockets of shortleaf pine (*Pinus echinata* Miller) and Virginia pine (*Pinus virginiana* Miller). Trap pairs were spaced 100–200 m apart with traps spaced 10–15 m apart within a pair. Traps were hung on rope strung between trees with collection cups 0.2–0.5 m above ground. Each cup contained approximately. 150 ml of a solution of water and propylene glycol (Splash RV & Marine Antifreeze, Fox Packaging Inc., St. Paul, MN) to kill and preserve woodwasps caught in traps (Miller and Duerr 2008, J. Econ. Entomol. 101: 107–113). Trap catches were collected at intervals of 12–16 d with fresh glycol solution added to cups on each occasion. Ethanol and α-pinene ultra-high-release lures with release rates of 0.5 g/d and 1–6 g/d, respectively, were obtained from Contech Enterprises Inc. (Victoria, British Columbia, Canada).

In 2011, 10 pairs of eight-unit multiple-funnel traps (Contech Enterprises Inc.) were baited with ethanol and α-pinene lures hung on the outside of each trap. Traps

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Table 1. Total numbers of female woodwasps (Siricidae) caught in 20 multiple-funnel traps baited with ethanol and α-pinene near Murphy, NC, in 2011.

Collection Date	*Sirex nigricornis*	*Tremex columba*	*Urocerus albicornis*	*Urocerus cressoni*
17 May	—	—	—	—
2 June	—	—	1	—
14 June	—	—	—	—
28 June	—	—	1	—
12 July	—	—	—	—
26 July	—	—	—	—
9 August	—	2	—	—
23 August	—	—	—	2
8 September	9	—	1	—
24 September	22	—	—	2
4 October	4	—	—	—
20 October	38	—	—	—
7 November	12	—	—	—
21 November	—	—	—	—
Total	85	2	3	4

baited with ethanol and α-pinene are broadly attractive to wood-boring insects including Siricidae (Coyle et al. 2012, Environ. Entomol. 41: 91–97; Erbilgin et al. 2017, J. Chem. Ecol. 43: 172–179). In 2011, trapping started on 4 May and ended on 21 November. The 2015 study consisted of 15 pairs of 10-unit multiple-funnel traps (Synergy Semiochemicals Corp., Delta, British Columbia, Canada) that were modified to allow ethanol and α-pinene lures to be hung within the trap (Miller et al. 2013, J. Econ. Entomol. 106: 206–214). Randomly determined, one trap in each pair was baited with ethanol + α-pinene whereas the other trap was baited with α-pinene alone. In 2015, trapping started on 12 August and ended on 2 December. Pinned specimens of Siricidae were deposited in the Collection of Arthropods, Georgia Museum of Natural History, University of Georgia (Athens). Analysis of data collected in 2015 were conducted with the two-tailed paired *t* test using the SigmaStat (ver. 3.01) statistical package (SYSTAT Software Inc., Point Richmond, CA).

Females of five species of Siricidae were caught in the studies with *Sirex nigricornis* F. being the most common in both years (Tables 1, 2); no males were caught in the studies. The other species caught in the studies were *Eriotremex formosanus* (Matsumura), *Tremex columba* (L.), *Urocerus albicornis* (F.), and

Table 2. Total numbers of female woodwasps (Siricidae) caught in 30 multiple-funnel traps baited with α-pinene or ethanol and α-pinene near Murphy, NC, in 2015.

Collection Date	*Eriotremex formosanus*	*Sirex nigricornis*	*Tremex columba*	*Urocerus cressoni*
26 August	—	—	—	1
9 September	—	4	—	2
23 September	—	12	1	—
7 October	—	12	—	—
21 October	—	18	—	1
3 November	—	25	—	—
19 November	—	28	—	—
2 December	1	—	—	—
Total	1	99	1	4

Urocerus cressoni Norton. In 2015, the mean ± SE numbers of female *S. nigricornis* caught in traps baited with α-pinene and ethanol + α-pinene were 4.1 ± 0.5 and 2.9 ± 0.8, respectively, with no significant difference between means (paired $t_{13} = 1.953$, $P = 0.073$). One pair of traps was omitted from the analyses due to lack of any *S. nigricornis* in either trap.

Both pale and dark color morphs of female *S. nigricornis* were caught in the two studies. The dark form was previously recognized as *Sirex edwardsii* Brullé but was synonymized recently with *S. nigricornis* (Schiff et al. 2012). The ratio of pale to dark morphs was 3.72:1 in 2011 and 2:1 in 2015. A 2:1 ratio of pale to dark morphs of *S. nigricornis* was noted in Arkansas (Keeler 2012, M.Sc. Thesis, Univ. Arkansas, Fayetteville) whereas a ratio of 1:1 was noted in Minnesota (Coyle et al. 2012). As in Arkansas and Minnesota, the flights of the two morphs in western North Carolina occurred at the same time with no temporal separation between the two morphs.

In western North Carolina, the flight period of female *S. nigricornis* started in early September and ended by mid-November (Tables 1, 2). In contrast, *S. nigricornis* in central Louisiana and northern Mississippi fly a little later, starting in mid-October and ending in mid-December (Chase et al. 2014, J. Econ. Entomol. 107: 1142–1149; Haavik et al. 2013, Entomol. Exp. Appl. 149: 177–184; Johnson et al. 2013, J. Entomol. Sci. 48: 173–183). In central Arkansas, flight starts in early October and ends in late November (Keeler 2012). In the northeastern United States and southern Canada, flights begin much earlier, starting in late July–September and ending in September–October (Schiff et al. 2012; Coyle et al. 2012). Emergence and flight activity of *S. nigricornis* is likely influenced by drops in mean daily temperatures with year-to-year variations not uncommon (Haavik et al. 2013; Hartshorn et al. 2015, Fla. Entomol. 98: 933–938; Hartshorn et al. 2016, Agric. For. Entomol. 18: 206–213).

Most species of bark- and wood-boring insects start to emerge and attack new hosts in the spring or early summer. In contrast, flight of *S. nigricornis* seems to be quite late in the season, regardless of location, suggesting some type of selection pressure forcing the flight of the species away from periods earlier in the season. It is possible that competition from pine bark beetles and pine sawyers exerts pressure on *S. nigricornis* to fly later in the season. Additionally, larvae of species such as *Monochamus carolinensis* (Olivier) (Coleoptera: Cerambycidae) can act as facultative predators on larvae of other species encountered under tree bark (Dodds et al. 2001. Environ. Entomol. 30: 17–22). If true, then an early flyer like the nonnative *S. noctilio* could face significant impediments to establishment from pine bark and wood-boring beetles (Ryan et al. 2012. Agric. For. Entomol. 14: 187–195).

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