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Observations on Myiasis by the Calliphorids, *Bufolucilia silvarum* and *Bufolucilia elongata*, in Wood Frogs, *Rana sylvatica*, From Southeastern Wisconsin

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**ABSTRACT:** Larvae of certain species of blowflies (Calliphoridae) can cause myiasis in frogs and toads, but there are few reports from North American amphibians. Of these, most are from toads (bufonids). In this study, we observe primary myiasis in a population of juvenile wood frogs, *Rana sylvatica*, collected on 22–23 August 2003, from southeastern Wisconsin and compare our observations with previous studies on myiasis from toads. Two (5%) of 39 frogs were infected by the blow fly *Bufolucilia silvarum*, with an intensity of 28 and 31, whereas 1 (2.5%) of 39 frogs was infected by the blow fly *Bufolucilia elongata* with an intensity of 14. We found that (1) *B. silvarum* lay eggs on healthy wood frogs, (2) eggs hatch, with first-instar maggots penetrating under the skin, (3) maggots develop to mature third instars within 13–16 hr of egg hatching, (4) maggots kill the host within 7–47 hr of egg hatching, and (5) maggots consume the entire frog carcass reducing it to bones within 42–59 hr of egg hatching. Our observations on the time of death and how quickly carcasses of wood frogs were consumed by these maggots compared with previous studies on toads suggest that finding infected juvenile wood frogs may be uncommon. Therefore, myiasis by these flies on wood frogs and other small terrestrial anurans may be a phenomenon that is much more common than is currently observed. This is the first report of *B. silvarum* and *B. elongata* causing myiasis in wood frogs.

Myiasis in amphibians is caused by larvae of dipterans from Sarcophagidae, Calliphoridae, and Chloropidae, some of which can cause substantial mortality in their amphibian hosts (Dasgupta, 1962; Crump and Pounds, 1985; Schell and Burgin, 2001; Bolek and Coggins, 2002). During 2003, the blowflies, *Bufolucilia silvarum* and *Bufolucilia elongata*, were found infesting juvenile wood frogs, *Rana sylvatica*, in southeastern Wisconsin. Members of this genus have been reported as obligate or facultative parasites of amphibians, particularly species of *Bufo*, but there are few reports of these flies causing myiasis in North American ranid frogs (see Bolek and Coggins, 2002). Our observations on the rapid consumption of wood frog carcasses by these maggots suggest that myiasis on small terrestrial anurans may be more common in North America than is currently observed.

In North America, 2 species of *Bufolucilia* have been reported to cause myiasis in 3 species of amphibians. *Bufolucilia elongata* caused myiasis in 1 boreal toad, *Bufo boreas boreas*, and 6 American toads from Colorado and Wisconsin, respectively, whereas *B. silvarum* was reported from 48 bullfrogs, *Rana catesbeiana*, in California, 1 American toad from Nova Scotia (Canada), and 1 American toad from Ontario, Canada (James and Maslin, 1947; Hall, 1948; Anderson and Bennett, 1963; Bleakney, 1963; Briggs, 1975). More recently, studies on the life history of *B. silvarum* from 9 American toads examined by Bolek and Coggins (2002) indicate that these flies deposit eggs on the back and flanks of the amphibian host. The larvae hatch and migrate under the skin where they form a single lesion in the paratoid glands, back, neck, and front or hind legs, where development takes place, and all infected toads die within 1 day to 2 wk of infection (Bolek and Coggins, 2002). No other information is available on these flies infecting North American amphibians. In their review on the life history of *B. silvarum*, Bolek and Coggins (2002) hypothesized that juvenile terrestrial anurans that are diurnal and overlap in their ecology with this fly species may be more prone to parasitism by *B. silvarum* than is currently known. In this study, we report observations on the life history of *B. silvarum* and *B. elongata* in juvenile wood frogs, *R. sylvatica*, from southeastern Wisconsin and compare these data with infections by these 2 species of flies in American toads examined by Briggs (1975) and Bolek and Coggins (2002) from Wisconsin. Our observations indicate that these flies may kill small frogs in the genus *Rana* and consume the carcass more rapidly than toads and therefore may be less commonly observed parasitizing these hosts in nature. These observations may account for the numerous reports of myiasis of *Bufolucilia* spp. and other calliphorids such as *Phaenicia sericata* and *Lucilia illustris* in toads and rarely in other species of North American frogs (Anderson and Bennett, 1963; Stewart and Foote, 1974; Bolek and Coggins, 2002).

Thirty-nine juvenile wood frogs were collected by hand in the woods during the day on 22–23 August 2003 at the University of Wisconsin–Milwaukee field station, Ozaukee County, Wisconsin (43°23′N, 88°2′W). All frogs were measured (2.97 ± 0.27 cm) and examined for external lesions, eggs, or maggots. Frogs suspected of being infected...
were placed in individual 8.45-L tanks lined with moist paper towels for observation. Dead frogs were placed in 70-ml plastic jars along with their maggots and observed for time of carcass consumption. All other frogs were killed and necropsied within 72 hr of collection. Third-stage maggots from each frog were placed in individual 70-ml plastic jars containing moist sand and allowed to pupate. Some were boiled in distilled water and fixed in 95% ethanol and cleared in 10% KOH. The cephalopharyngial skeleton and posterior spiracles of some third instars were dissected and mounted in glycerin as temporary slides. Adult flies were fed granulated sugar and banana Peels for at least 24 hr before being killed by freezing and were pinned or preserved in 70% ethanol. Adult flies were identified to genus (Shewell, 1987) and to species by keys of Hall (1941) and Hall and Townsend (1977). Prevalence, intensity, and mean intensity are according to Bush et al. (1997). Student’s t-test was used to compare differences in snout vent length (SVL), mean intensity of Bufolucilia spp. maggots, and time of survival (in hr) of American toads collected by Bolek and Coggins (2002) and wood frogs infected in this study. An approximate t-test was calculated when variances were heteroscedastic (Sokal and Rohlf, 1981). Adult and larval flies were deposited in the Harold W. Manter Laboratory collection (University of Nebraska State Museum, Lincoln, Nebraska; HWML 45414, B. silvarum larvae; 45415, B. silvarum adult flies; HWML 45416, B. elongata larvae; 45417, B. elongata adult flies).

Only 3 of 39 (7.7%) juvenile wood frogs collected on 22–23 August 2003 were infected by green blow flies. Two (5%) of the frogs were infected with B. silvarum with intensities of 28 and 31, whereas 1 (2.5%) frog was infected with B. elongata with an intensity of 14.

The single frog infected with B. elongata was collected with a single lesion on the abdomen, with third-instar maggots being clearly visible; this frog died within 24 hr of collection. The other 2 frogs were collected with deposited fly eggs. These were white and attached to the amphibians back (Figs. 1, 2). Neither individual appeared to show any discomfort or no wound or lesion was observed on the skin of these frogs. Eggs hatched on 1 frog collected on 23 August 2003 sometime between 11.5 and 19 hr after collection during the night, with second instars being present in a single wound on 24 August 2003 (Fig. 3).

Eggs hatched within 13.5–15.5 hr of collection on the second frog. Observations indicated that both frogs had single lesions on the right hip (Fig. 3), with third instars being visible on the 2 frogs within 13–16 hr of egg hatching (Figs. 4, 5). These 2 frogs died within 7 and 47 hr of egg hatching. Maggots of both species of calliphorids continued to feed on the carcass (Fig. 6) reducing it to liquid slurry of tissue and bones (Fig. 7). Maggots consumed the entire frog carcass, reducing it to bones within 42–59 hr of egg hatching (Fig. 8). Third-stage maggots of B. silvarum turned into pupa within 2 days after leaving the carcass remains and emerged as flies within 7–8 days at room temperature. Third-stage maggots of B. elongata turned into pupa within 3 days after leaving the carcass remains and emerged as flies within 7–8 days at room temperature.

Comparisons of SVL, mean intensities of Bufolucilia spp., and time of survival (in hr) of 9 American toads and 3 wood frogs infected with Bufolucilia spp. collected by Bolek and Coggins (2002) from Waukesha County, Wisconsin, during 1998 and this study are given in Table 1. There were statistically significant differences in SVL, intensities, and time of survival among these hosts. Although these sample sizes are small, the 9 juvenile-infected toads were larger, had significantly lower intensities of maggots, and lived significantly longer in the laboratory. It is unclear why wood frogs had higher mean intensity of Bufolucilia spp. than American toads. Observations on egg hatching of Bufolucilia spp. in 2 toads by Bolek and Coggins (2002) indicate that toads vigorously rub their hind legs over their back as if they were trying to dislodge the maggots by dislodging eggs during hatching. More importantly, our observations on the time of death and how quickly carcass of wood frogs were consumed by these maggots suggest that finding infected juvenile wood frogs may be uncommon. Bolek and Coggins (2002) reported that infected toads died within 1 day to 2 wk; the maggots never consumed the entire toad carcass before leaving to pupate. In addition, observations by Briggs (1975) on infections of B. elongata on American toads in Wisconsin indicated that numerous toads were observed alive and dead at his study site.
Table I. Comparisons of SVL, mean intensity (MI), and time until death of juvenile American toads, *Bufo americanus*, and juvenile wood frogs, *Rana sylvatica*, infected with maggots of *Bufolucilia* species from southeastern Wisconsin.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Host</th>
<th>Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>B. americanus</em></td>
<td><em>R. sylvatica</em></td>
</tr>
<tr>
<td>SVL (cm ± 1 SD)</td>
<td>(n = 9*)</td>
<td>(n = 3)</td>
</tr>
<tr>
<td></td>
<td>4.1 ± 0.23</td>
<td>2.6 ± 0.28</td>
</tr>
<tr>
<td>MI (±1 SD)</td>
<td>10.5 ± 7.2</td>
<td>24 ± 9</td>
</tr>
<tr>
<td>Time until death (hr ± 1 SD)</td>
<td>114.33 ± 100.84</td>
<td>26 ± 20</td>
</tr>
</tbody>
</table>

* Data from Bolek and Coggins (2002).