Bark- and Wood-Infesting Insects (Coleoptera and Hymenoptera) and Associated Parasitoids Reared from Yellow Birch (Betula alleghaniensis) in Ingham County, Michigan

Robert A. Haack
USDA Forest Service, rhaack@fs.fed.us

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Recommended Citation
Haack, Robert A. . "Bark- and Wood-Infesting Insects (Coleoptera and Hymenoptera) and Associated Parasitoids Reared from Yellow Birch (Betula alleghaniensis) in Ingham County, Michigan," The Great Lakes Entomologist, vol 54 (1)
Available at: https://scholar.valpo.edu/tgle/vol54/iss1/10

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Two of the earliest major reports on birch-infesting insects in the United States were those of Packard (1890) and Felt (1905). The bronze birch borer, *Agrilus anxius* Gory (Coleoptera: Buprestidae), was recognized as a major pest of birch since the late 1800s (Chittenden 1898), and still today often reaches outbreak levels especially when trees are stressed by drought and defoliation (Haack and Petrice 2019). Several species of bark- and wood-infesting insects, often called borers, have been associated with various species of birch in North America, including Coleoptera (e.g., Buprestidae, Cerambycidae, and Scolytinae), Hymenoptera (e.g., Siricidae and Xiphydriidae), and Lepidoptera (e.g., Sesiidae) (Smith 1976, Taft et al. 1991, Solomon 1995, Smith and Schiff 2001).

This paper reports on borers and parasitoids reared from yellow birch (*Betula alleghaniensis* Britton) at the same Michigan location where Haack (2020) reported rearing records from shagbark hickory (*Carya ovata* Mill.) K. Koch and slippery elm (*Ulmus rubra* Muhl.). The study site was near Dansville in Ingham County, where I lived for about 30 years. This property was over 13 ac (5.3 ha) in size, and along with the neighboring properties contained over 60 ac (24 ha) of contiguous mature forest of the beech-maple type (Cohen 2008). The most common tree species growing in this Dansville woodlot were listed in Haack (2020). Although these rearing records are decades old, they still provide valuable new information with respect to larval host plants, adult seasonal emergence, and new state records for Michigan insects.

**Methods.** On 19 April 1986, I cut two stems (12- and 15-cm-diam) of an apparently healthy, multi-stemmed yellow birch tree near ground level in the Dansville woodlot (N 42.5481° Lat, W 84.3189° Long). The two stems were placed upright and left leaning against the trunk of the tree from which they were cut for the next 12 months. On 26 April 1987, I cut the two stems into more than 20 sections, mostly between 40–55 cm long, and down to a final branch diameter of about 3 cm. When examining the cut ends of each section it was clear that the greatest borer activity was in the sections that were 3 to 10 cm in diameter. Therefore, I collected 16 trunk and branch sections that were in this diameter range (about 7 m total length for all 16 sections) and placed them all in a single rearing cage (ca. 60 cm wide, 45 cm deep, and 45 cm tall). The cage had a wood floor, a sliding Plexiglas front panel, and fine screening on the other three side walls and
upper surface. The cage was kept on a counter, inside a covered shed (ca. 8 x 12 ft or 2.4 x 3.7 m), that had double doors at opposite ends that remained open to allow air flow. The shed received direct sunlight during the early morning hours, but later was shaded, and therefore the indoor temperatures of the shed were similar to ambient conditions.

The cage was generally checked every 1–2 days for recently emerged insects through August 1987, and then less frequently through October 1987. After each collection, all insects were placed in labeled vials and then frozen. Later, once individuals of each morphospecies had been identified by experts (see Table 1 and acknowledgments), the insects were tallied by species and emergence date. Specimens of each species were retained by the identifiers in their personal or institutional collections. All parasitoids were identified by staff at the US Department of Agriculture, Systematic Entomology Laboratory in Beltsville, MD.

In late summer 1987, after all emergence had apparently stopped, the emergence density of all borers and parasitoids was calculated for each branch. The insect emergence values were based simply on a count of all exit holes seen on the bark surface. At first, I attempted to classify the exit holes as large (about 2.5 mm in diameter or larger) or small (less than 2.5 mm), thinking that the larger holes would represent borers and the smaller holes would represent parasitoids. However, this was not possible because there was considerable overlap between some of the larger parasitoids (e.g., female Aulacidae) and the smaller borers (e.g., male Xiphydriidae). The bark surface area of each trunk or branch section was calculated as a cylinder, based on the average diameter of each cut end and the section length. As a proxy for borer size, the adult dry weight of selected borers and parasitoids was determined by drying undamaged (i.e., no missing body parts) insects to a constant weight, using an analytical balance. The intraspecific size variation value, I, was calculated for these selected species as the ratio of the dry weight of the heaviest individual to the weight of the lightest individual in a method similar to that computed by Anderssen and Nilssen (1983) based on insect length.

**Statistical analyses.** Mean differences in attack density and adult dry weight were tested for significance using a two-tailed t-test. An alpha level of 0.05 was used to test for significance.

**Results.** In 1987, which was assumed the first year after infestation of the two birch stems that were cut in 1986, 190 individual borers, representing four species were reared, including two species of Cerambycidae [Coleoptera: Sternuchus alpha (Say) and Xylotrechus colonus (Fabricius)] and two species of Xiphydriidae (Hymenoptera: Xiphydria mellipes Harris and Xiphydria tibialis Say) (Table 1). The xiphydriid X. mellipes was the most common borer reared, representing 98% of all borers (Table 1). The sex ratio (male:female) of the reared X. mellipes was 1:1.4. Considering all borers, individuals were collected from 17 May to 19 July 1987 (Table 1).

Similarly, 36 individual parasitoids, representing six species (all Hymenoptera), were reared from birch in 1987, including one species of Aulacidae (Aulacus pallipes Cresson), three Braconidae (Atanycolus impressifrons Shenefelt, Cenocoelius sp., and Coelotides rossicus betulae Mason), one Chalcididae (Haltichella sp.), and one Pteromalidae [Xiphydriophagus meyerinckii (Ratzeburg)] (Table 1). The most common parasitoid reared was the aulacid A. pallipes, representing 81% of all parasitoids collected (Table 1). The male:female sex ratio of the reared A. pallipes was 1:2.6. Considering all parasitoids, individuals were collected from 10 May to 21 July 1987 (Table 1).

Overall, 225 exit holes were counted on the 16 trunk and branch sections, which corresponds closely to the 226 borers and parasitoids that were collected. Considering all exit holes, the mean (± SE) density was 2.2 ± 0.7 exit holes/dm$^2$ of bark surface area for all 16 sections. However, if the sections were divided into two groups based on average diameter then it was clear that densities were significantly higher (4.7 ± 0.8 exit holes/dm$^2$) on smaller branches (3–5 cm diam; N = 7 sections) as compared with larger branch and trunk sections (0.3 ± 0.1 exit holes/dm$^2$; 5–10 cm diam; N = 9 sections; t-value = 3.35, P < 0.0001).

The mean dry weights for X. mellipes adults were 7.6 ± 0.5 mg for males (N = 20; range 4.8–12.1 mg) and 21.4 ± 0.5 mg for females (N = 38; range 13.3–27.2 mg); females were significantly larger than males (t-value = 17.8, P < 0.0001). Similarly, the mean dry weights for A. pallipes adults were 3.8 ± 0.5 mg for males (N = 5; range 2.1–4.8 mg) and 6.4 ± 0.5 mg for females (N = 12; 4.0–8.9 mg); females were significantly larger than males (t-value = 3.7, P < 0.003). Using the range of dry weights for the above species, I-ratios were 2.5 and 2.0 for X. mellipes males and females, respectively, and similarly 2.3 and 2.2 for A. pallipes males and females.

**Discussion.** There is a succession of borers, parasitoids and other associated insects that colonize the woody tissues of trees as they decline, die and decay (Blackman and Stage 1924, Savely 1939, Haack and Slansky 1987). For the four borers reared...
in the present study, yellow birch is a new host record for the cerambycid *S. alpha* and the xiphydrid *X. tibialis*, although both have been reared from other *Betula* species, e.g., river birch (*Betula nigra* L.) (Patton 1879, Smith 1976, MacRae and Rice 2007). For the other two borers, Gosling (1986) reared *X. colonus* from yellow birch in Michigan, and Smith (1976) reports that *X. mellipes* is a birch specialist, having been reared from at least five birch species including yellow birch. Of the four parasitoids that were identified to the species level, only the braconid *C. rossicus betulae* has been reared from yellow birch (Mason 1978); however, theaulacid *A. pallipes* has been reared from other birch species (Townes 1950, Smith 2001), and the pteromalid *X. meyerinckii*, which is a European species, has been reared from birch in Europe as well as other hardwoods (Ferrière 1951).

All four borers reared in this study have previously been reported from Michigan (Gosling 1973, Smith 1976, Gosling and Gosling 1977). Similarly, using the online SCAN database (https://scan-bugs.org/) in March 2021, which contains collection records of insects from over 100 North American arthropod collections, Michigan specimens of all four borers currently reside in various collections throughout the United States. With respect to the four parasitoids identified to species, Michigan records have been published for *A. pallipes* (Townes 1950, Smith 2001), *A. impressifrons* (Shenefelt 1943), and *C. rossicus betulae* (Mason 1978). Of these three species, Michigan specimens are reported in SCAN for only *A. pallipes*. In the case of *X. meyerinckii*, no published papers or SCAN records have been found stating that this insect has been previously collected in Michigan, and it is therefore considered a new state record. This pteromalid has been reported in Indiana, parasitizing *Xiphydria maculata* Say in maple (*Acer*) (Deyrup 1984), and reared from larch (*Larix*) in Newfoundland that were infested by the bark beetle *Dendroctonus simplex* LeConte (Coleoptera: Curculionidae: Scolytinae) (Langor 1991). In Europe, *X. meyerinckii* has been reared from at least two species of *Xiphydria* (Schimitschek 1974).

Table 1. Collection data for adult bark- and wood-infesting borers (Coleoptera and Hymenoptera) and parasitoids (Hymenoptera) reared from yellow birch (*Betula alleghaniensis*) trunk and branch sections held outdoors in 1987 in Ingham County, Michigan.

<table>
<thead>
<tr>
<th>FAMILY</th>
<th>SPECIES</th>
<th>NUMBER COLLECTED</th>
<th>RANGE OF COLLECTION DATES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>Males</td>
</tr>
<tr>
<td>BORERS</td>
<td>CERAMBYCIDAE</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Sternidius alpha</em></td>
<td>1</td>
<td>n.a.</td>
</tr>
<tr>
<td></td>
<td><em>Xylotrechus colonus</em></td>
<td>4</td>
<td>n.a.</td>
</tr>
<tr>
<td></td>
<td>XIPHYDRIIDAE</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Xiphydria mellipes</em></td>
<td>181</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td><em>Xiphydria tibialis</em></td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>PARASITOIDS</td>
<td>AULACIDAE</td>
<td>29</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td><em>Aulacus pallipes</em></td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>BRACONIDAE</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><em>Atanycolus impressifrons</em></td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>CHALCIDIDAE</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td><em>Haltichella sp.</em></td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>PTEROMALIDAE</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td><em>Xiphydriophagus meyerinckii</em></td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

1 Cerambycid adults were not sexed.
2 Identifiers: DCLG = David C. L. Gosling, DRS = David R. Smith, EEG = Eric E. Grissell, and PMM = Paul M. Marsh.
I did not attempt to associate the parasitoids reared in this study with their insect hosts; however, Deyrup (1984) did make such associations through detailed dissections of infested branches. For the braconid A. impressifrons, Marsh (1979) reports that it has been reared from cerambycids. Similarly, the Cenocoelius species reared in the present study likely had a cerambycid host. In fact, the braconid Cenocoelius ashmeadii Dalla Torre has been reared from the cerambycid S. alpha, as well as other cerambycids (Marsh 1979), and has been previously collected in Michigan based on SCAN records. Members of the chalcidid genus Halitchella are known to be primary parasitoids of Lepidoptera as well as hyperparasitoids of Braconidae and Tachinidae (Diptera) (Halstead 1990). The only species of Halitchella reported in SCAN to be from Michigan is Halitchella xanticles (Walker), which is recognized as both a primary parasitoid and hyperparasitoid (Halstead 1990).

Life history studies have been conducted on a few species of Xiphydria. Deyrup (1984) studied X. maculata and its parasitoids on maple in Indiana, and reported two of the same parasitoids as found in this study (C. rossicus betulae and X. meyerincki), as well as two other distinct Aulacus species, one Braconidae, one Ichneumonidae, and one Orussidae (Hymenoptera). In addition, Deyrup (1984) reported univoltine life cycles for the borers and parasitoids in his study, adult flight for most species between late May and early August, and that X. maculata mostly infested maple branches and stems that were 2.5 to 9 cm in diameter. Working in New York, Blackman and Stage (1924) reported that Xiphydria hicoriae Rohwer, which infests hickory (Carya), was univoltine, had adult emergence mostly during July and early August, favored host material 5–9 cm in diameter, and would reinfect the same host material at least once. Smith and Schaff (2001) reported that Xiphydria decem Smith and Schaff was reared from a recently dead branch (2.8–4.1 cm diam) of river birch in southern Illinois in April and May. In studies of Xiphydria picta Konow on alder (Alnus) in the North Caucasus region of southern Russia, Kravchenko (1972) noted that infestation occurs soon after tree death, oviposition is primarily on stems and branches 4–40 cm in diameter, borer densities are highest on smaller diameter trunk and branch sections, the flight season extends from July to early September, and the sex ratio is female biased.

Deyrup (1984) noted that the Aulacus females in his study oviposited on Xiphydria eggs. Worldwide, several Aulacus species use xiphydriids as hosts, especially in the northern hemisphere, as well wood-boring Coleoptera, especially in the southern hemisphere (Evenhuis and Vlug 1975, Smith 2001, Jennings and Austin 2004).

Andersen and Nilssen (1983) reported that intraspecific size variation (I) was generally lower for free-living groups (usually families) of beetles (family medians of 1.1 to 1.4) compared with those that developed in woody tissues (medians of 1.2 for ambrosia beetles (Platypodinae and some Scolytinae) to 2.1 for wood-borers of the cerambycid subfamily Spondylidinae (= Aseminae)). The highest I value for individual species was 3.3 for two Cerambicinae cerambycids. Haack and Slansky (1987) calculated mean I values of 2.8 for 12 Siricidae and 2.8 for 9 Xiphyriddidae, all of which are wood-infesting Hymenoptera. The I index value for X. mellipes, combining data for males and females, is 2.7 based on length data given in Smith (1976) and 3.9 based on dry weights from the present study. For the A. pallipes parasitoids reared in the present study, the I index value for males and females combined is 4.2 based on dry weight. Such wide variation in intraspecific size in wood-boring insects likely reflects, in part, differences in nutritional quality and water content of the woody tissues (Andersen and Nilssen 1983, Haack and Slansky 1987, Shibata 1998, Torres-Vila et al. 2018). Similarly, the broad size variation noted in the borer X. mellipes is likely the main reason for size variation in the parasitoid A. pallipes. Others have found that parasitoid size tends to increase with the size of the larval host in various buprestid and cerambycid borers (Urano and Hijii 1995, Paine et al. 2004, Wang et al. 2008).

Acknowledgments

The author thanks David C. L. Gosling (Glen Oaks Community College, MI), Eric E. Grissell [Systematic Entomology Laboratory (SEL), Beltsville, MD], Paul M. Marsh (SEL), and David R. Smith (SEL) for providing identification services; and Leah S. Bauer and Toby R. Petrice (both at USDA Forest Service, Northern Research Station, Lansing, MI), E. Richard Hoebeke (University of Georgia, Athens, GA), and two anonymous reviewers for commenting on an earlier draft of this paper. The affiliations listed above were those of the researchers at the time when taxonomic assistance was provided. This research was supported in part by the USDA Forest Service.

Literature Cited


