

**HOST RECORDS OF BRACONIDAE (HYMENOPTERA)
OCCURRING IN MIRIDAE (HEMIPTERA:
HETEROPTERA) FOUND ON LODGEPOLE PINE
(*PINUS CONTORTA*) AND ASSOCIATED CONIFERS**

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Abstract.—The plant bug (Hemiptera: Heteroptera: Miridae) fauna of lodgepole pine (*Pinus contorta* Douglas ex Loud) and associated conifers was examined in Oregon and Wyoming, United States of America. Parasitoid larvae of Braconidae were recovered from 20 species of Miridae previously unrecorded as braconid hosts, representing 10 genera of bugs, four of which have not been previously recorded as hosts. The parasitoid larvae were found only in the immature stages of the bugs. A sequence of species of Miridae occurs on the host tree through time but only the earlier species are parasitized. *Pinus contorta* is the most widespread conifer in North America, its four subspecies extending from Baja California Norte to the Yukon Territory, Canada. Over 50 species of Miridae have been found on this tree species. Other parasitized species will certainly be found.

Key Words.—Insecta, Braconidae, conifers, Miridae, parasitoids, plant bugs, *Pinus*.

The only known Hymenoptera parasitoids of immature and adult Miridae are the Braconidae, *Leiophron* Nees and *Peristenus* Foerster (Brindley 1939; Leston 1959, 1961; Loan 1974a, b, 1980, 1983; Glen 1977; Marsh 1979; Wheeler & Loan 1984). Some of the Miridae genera contain economically important species (e.g., *Adelphocoris* Reuter, *Leptopterna* Fieber, and *Lygus* Hahn) and work is being carried out to utilize these parasitoids for biological control. Considerable effort has been made to collect these two genera of Braconidae from various parts of the world and bring them into North America for ultimate release. Leston (1961) reported 31 genera and 51 species of Miridae parasitized by Braconidae in Great Britain and Lattin & Ozanne (1993) added additional species there. Marsh (1979) listed 19 genera and 28 species parasitized by species of *Leiophron* and *Peristenus* in North America. Loan (1980) reported additional bug genera and species, bringing the total to 22 genera and 34 species. Here, we add 20 additional bug species found in 10 genera that were parasitized by braconids, including four additional genera.

We collected Miridae at six sites in Oregon and Wyoming during the 1986 season. Seven sites in Oregon, including the three in this study, were sampled every two weeks in 1985 and in 1988. Most of the effort was made on three subspecies of *Pinus contorta* Douglas ex Loud and, to a limited extent, the other species of conifers found in association with these pines. *Pinus contorta* is the most widespread species of pine in North America and is considered to have four subspecies (Critchfield 1957, 1980, 1984, 1985; MacDonald & Cwynar 1985, but

see Forrest 1980a, b). Three subspecies were sampled: *Pinus contorta latifolia* Engelm in Wyoming and Oregon, *P. contorta contorta* Douglas ex Loud and *P. contorta murrayana* (Greville and Balfour) Engelm in Oregon. Approximately 20 genera and 50 species of Miridae are found on *Pinus contorta* based on the available literature and our studies, and material supplied to us by several mirid specialists. Because parasitism was known to occur chiefly in the nymphal stages, samples of late instar nymphs were dissected, but samples of adults also were examined. We found 10 genera and 18 species of Anthocoridae (Hemiptera: Heteroptera) on the same sites and "host" trees (Lattin & Stanton 1992).

Leston (1959, 1961) described a group of mirids he referred to as "arboreal and early" whose parasitoids emerged from the adult stage. At least four other species he listed had the larva emerging from mature bug nymphs during the same period. Brindley (1939) stated that the mirid is usually parasitized as a second- or third-instar nymph. That would place the time of parasitoid oviposition about three or four weeks ahead of emergence of the mature parasitoid larva. Parasitism prolongs the time required for the bug to reach maturity, if it ever does (Leston 1959, Loan 1983). The stylized life history of a mirid parasitoid is shown in Fig. 1 (after Loan 1983). We found mature parasitoid larvae only in nymphs and none in adults. Observation numbers were low for some taxa because of the scarcity of parasitized nymphs but species of other genera (e.g., *Phoenicocoris* Reuter and *Microphylellus* Reuter) were well represented.

MATERIALS AND METHODS

We collected Hemiptera: Heteroptera from six sites in Oregon and Wyoming during the 1986 season. Seven sites in Oregon, including the three in this study, also were sampled regularly during 1985. Sampling was done by a beating sheet held under a branch. Ten beats with an ax handle were made and all bugs collected. If any bugs were found, another ten beats were made. This effort was continued until no further bugs were collected in a ten beat effort. Ten trees were sampled at each site every two weeks throughout the season. At times, such efforts would produce over 100 specimens of Miridae on a single branch. Such regular sampling collected all instars of most species. Sampling dates began before most bugs appeared and continued into late summer until no further specimens were recovered.

Site Descriptions

Oregon

Site 5—South Beach State Park (SBSP) is 1.6 km south of Newport, Lincoln County, Oregon at an elevation of 7 m (SW $\frac{1}{4}$ of Sec. 20, T11S, R11W) and is adjacent to the Pacific Ocean. A vigorous young stand of shore pine (*P. contorta contorta*) was sampled on a partially stabilized low dune behind the foredune. A few, very small, Sitka spruce (*Picea sitchensis*) (Bongard) Carrière were scattered through the stand with low willow (*Salix* sp.) adjacent. Older, stabilized dunes to the east contained larger shore pine and some large Sitka spruce.

Site 7—Ochoco Mountains (OM) is 40 km east of Prineville, Crook County, Oregon at an elevation of 1476 m; specifically 0.3 km south of Hwy 25 on FS road 2620 (Sw $\frac{1}{4}$ of Sec. 2, T13S, R19E). Most sampling was done on the west side of FS 2620, on an easterly facing slope. The site contained an open stand of



Figure 1. Generalized life cycle of braconid parasitoid and host mirid (after Loan 1983).

mature ponderosa pine (*P. ponderosa* Douglas ex Lawson) with some regeneration, a few larch (*Larix occidentalis* Nuttall), and mostly young lodgepole pine (*P. contorta latifolia*). A few mature trees also were present.

Site 8—Three Creeks Meadow (TCM) site is 26 km south of Sisters, Deschutes County, Oregon at an elevation of 2069 m (Sw $\frac{1}{4}$ of Sec. 13, T17S, R9E). It is a moist, subalpine meadow dissected by several small streams. Sierra lodgepole pine (*P. contorta myrrayana*) occurs around the edge of the meadow and up onto the drier slopes surrounding it. Engelmann spruce (*Picea engelmanni* Parry ex Engelmann) was scattered within the pine stand in the meadow. Subalpine fir (*Abies lasiocarpa* (Hooker) Nuttall) occurred among the pine on the drier slopes surrounding the meadow. Sampling was done on trees in the southeastern corner of the meadow, which consisted of both mature and young trees. A few of the older trees were being attacked by the mountain pine beetle, *Dendroctonus pon-*

derosa Hopkins. The dwarf mistletoe, *Arcenthobium americanum* Nuttall ex Engelm., was common on the pines, especially on the older trees.)

Wyoming

Site 2—Happy Jack road (HJR) sites are in the Laramie Range, Medicine Bow National Forest, 19 km east of Laramie, Albany County, Wyoming at an elevation of 2500 m. Site 2.1 (Yellow Pole Campground). They had open stands of mature timber (*P. flexilis* James) and ponderosa pine (*P. ponderosa*) on a south-facing slope (Sec. 25, T15N, R72W). Stands of mature lodgepole pine (*P. contorta latifolia*) were sampled a few km east of this spot at site 2.2 (Sec. 30, T15N, R71W). Lodgepole pines were sampled in both open stands on a south-facing slope, and closed stands on a north facing slope.

Site 3—Sand Lake Road (SLR) site is on the east side of the Snowy Range Mountains about 60 km west of Laramie, Albany County, Wyoming (Sec. 17, T16N, R78W). The specific site lies immediately east of the North Fork campground at an altitude of 2800 m. The stand had been thinned and consisted of second growth lodgepole pine (*P. contorta latifolia*) interspersed with subalpine fir (*A. lasiocarpa*) and some Engelmann spruce (*P. engelmannii*).

Site 4—French Creek Road (FCR) sites are about 90 km west of Laramie (Carbon County) on the west side of the Snowy Range and lie along a back road cutting south from Hwy 130 to French Creek. Site 4.1, at an altitude of 2750 m, was a clear cut east of and adjacent to the highway. (Sec. 1 and 17, T15N, R81W). Regeneration consisted primarily of lodgepole pine (*P. contorta latifolia*) with occasional fir and spruce. Site 4.2 (Sec. 14, T15N, R81W) was at 2650 m. Site 4.3 (Sec. 19, T15N, R80W) was at 2600 m.

PARASITIZED TAXA

Taxonomic problems in several of these plant bug genera prevent precise species assignment and, in at least one instance, involves an undescribed species (to be described later). The presentation of species follows the catalog of Henry & Wheeler (1988) and several later publications that appeared after that date (Stonedahl 1988, 1990; Schuh 1995; Stonedahl & Schwartz 1996).

Deraeocorinae: Clivinematini

Largidea Van Duzee is a North American genus containing 10 species (Henry & Wheeler 1988) all confined to conifers and most on *Pinus* spp. *Largidea shoshonea* Knight was the only species found with braconid larvae: Collection was made in Wyoming, site 2.2 (HJR) ex. *Pinus contorta latifolia*, 9 and 25 Jul 1986 from V instar nymphs.

Deraeocorinae: Deraeocorini

Deraeocoris Kirshbaum is a large, cosmopolitan genus containing around 200 species world-wide (Carvahlo 1957, Razafimahatratra 1980, Razafimahatratra & Lattin 1982). Most known species of *Deraeocoris* are predaceous. *Deraeocoris brevis* (Uhler) is a predator of the pear psylla (Westigard 1973) but Fichter (1984) found it to feed on the douglas-fir tussock moth. Parasitized nymphs of *Dereacoris diveni* Knight were taken in Oregon: site 8 ex *Picea engelmanni*, 23 Jul 1986 from IV and V instar nymphs. *Deraeocoris kennicotti* Knight yielded parasitized

V instar nymphs in Wyoming: site 2.2 ex *P. ponderosa* and *P. flexilis* on 25 Jul 1986. A *Deraeocoris rubroclarus* Knight V instar nymph was collected in Oregon, Benton County, Lobster Valley ex *Pseudotsuga menzessii* on 3 Aug 1986.

Mirinae: Mirini

Dichrooscytus Fieber is Holarctic with 48 described species in America north of Mexico (Henry & Wheeler 1988) where they occur on conifers and usually are regarded as phytophagous (but see Fichter 1984). Loan (1974 b) described the Braconidae, *Peristenus juniperinus*, from Canada, based on species from *Dichrooscytus tinctipennis* Knight. Fifth instar nymphs of *Dichrooscytus* sp. A from Oregon: site 7, ex *Pinus contorta murrayana* were collected 25 Jun–9 Jul 1986 while V instar nymphs of *Dichrooscytus* sp. C were collected from Oregon: site 8 ex *Picea engelmanni* on 6 Aug 1986. Species of *Dichrooscytus* were found at five of the six sites sampled but parasitized nymphs were found only at the sites listed above.

Phytocoris Fallén has world-wide distribution and may be the largest genus in the family. Stonedahl (1988) stated that over 200 species occur in North America alone. Most species are thought to be predaceous (Fichter 1984) but many show remarkable fidelity to "host trees". Leston (1961) reported 2 species that were parasitized. Marsh (1979) reported *Peristenus dumestris* Loan as a parasitoid of *Phytocoris* sp. and Loan (1980) reported the same braconid as a parasitoid of *Phytocoris lasiomerus* Reuter and *P. pallidicornis* Reuter. He reported euphorine larvae from *Phytocoris tibialis* Reuter and *Phytocoris* sp. Four additional species of *Phytocoris* were found parasitized in this present study.

Phytocoris comulus Knight was collected at Wyoming: site 2 ex *Pinus contorta latifolia* and IV instar nymphs were parasitized as was a parasitized V instar nymph ex *P. ponderosa* on 9 Jul 1986. *Phytocoris fraterculus* Van Duzee was collected in Oregon, Deschutes County, 4 km S. of Sisters ex *Pinus ponderosa* on 29 Aug 1989 with V instar nymphs parasitized. *Phytocoris heidemanni* Reuter was collected at Wyoming: site 2 from *Pinus ponderosa* on 9 Jul 1986 where seven IV instar nymphs contained parasite larvae. *Phytocoris stellatus* Van Duzee was recovered from Wyoming: site 2.2 ex *Pinus contorta latifolia* on 9 Jul 1986 where one IV instar nymph was parasitized while a IV instar nymph from site 3 ex *Pinus contorta latifolia* was collected 11 Jul 1986 and a V instar parasitized nymph from the same host tree was collected from site 4 on 17 Jul 1986. This was a common species at Oregon: sites 5 and 8 but no parasites were recovered.

Platylygus Van Duzee is a North American genus containing 31 species (Kelton & Knight (1970). Although four species have been reported on various subspecies of *Pinus contorta* (Kelton and Knight 1970), only two of these were found parasitized. Species occur early in the season and appear to feed on both male and female cones. Rauf et al. (1984a) and Rauf et al. (1984b) reported that *Platylygus luridus* (Reuter) caused conelet abortion on *Pinus banksiana* resulting in 74% damage. *Platylygus luridus* (Reuter) was taken at Wyoming: site 2.2 ex *Pinus ponderosa* on 9 Jul 1986 where four of the seven V instar nymphs contained larvae. *Platylygus rubripes* Knight was recovered at Oregon: site 7 ex *Pinus contorta latifolia*, 10 Jun 1986 where a IV instar nymph contained a parasitic larva.

Phylinae: Phylinae

Knightomiroides Stonedahl and Schwartz contains a small group of species found on conifers, largely *Pinus* (Stonedahl & Schwartz 1996). *Knightomiroides contortae* Stonedahl & Schwartz was collected at Wyoming: site 2 ex *Pinus contorta latifolia* where a V instar nymph, collected on 25 Jul 1986, and a V instar nymph from Wyoming: site 4 from the same host tree contained parasitoid larvae.

Microphylellus Reuter, a North American genus, contains 21 species including one undescribed species found during this study. Knight (1923) reported *M. modestus* Reuter as a predator. Species occur on both broad-leaf and coniferous trees. Condit & Cate (1982) stated that *Peristenus stygicus* Loan, a Braconidae, attacked *Microphylellus maculipennis* (Knight) in the laboratory. *Microphylellus alpinus* Van Duzee was collected at Oregon: site 8 ex *Pinus contorta murrayana* on 25 Jun 1986 and parasite larvae were recovered from IV and V instar nymphs. *Microphylellus* sp. A. occurred at Oregon: site 5 ex *Pinus contorta contorta* where parasitized V instar nymphs were collected on 26 May and 2 Jun 1986.

Phoenicocoris Reuter is a Holarctic genus with nine species found in North America (Schuh 1995). Stonedahl (1990) moved a number of species into this genus, chiefly from *Lepidopsallus* Knight. *Phoenicocoris hesperus* (Knight) was taken at Oregon: site 5 ex *Pinus contorta contorta* where a parasitized V instar nymph was collected on 18 Jun 1986. *Phoenicocoris longirostris* (Knight) occurred at Oregon: site 8 ex *Pinus contorta murrayana* where V instar nymphs collected on 25 Jun and 9 Jul 1986 were parasitized. This bug was also found at Wyoming: site 2 ex *Pinus contorta latifolia* where a V instar nymph collected on 9 Jul 1986 was parasitized.

Sthenarus Fieber is another Holarctic genus with four species described from North America. There is confusion over the exact placement of the species reported here that will be clarified when a new generic placement is established. *Stenaris* sp. A. was collected at Wyoming: site 2 ex *Pinus contorta latifolia* from V instar nymphs collected on 9 Jul 1986 and a V instar nymph from *Pinus ponderosa* collected 26 Jul 1986, which contained parasitoids.

Phylinae: Pilophorini

Pilophorus is a Holarctic genus with 44 species in the New World (Schuh & Schwartz 1988). These anti-mimics are found chiefly on trees and shrubs with many on conifers where some species feed on aphids. *Pilophorus americanus* Poppius was the only species found parasitized in this study and parasitoid. V instar nymphs were taken at Wyoming: site 2.2 on *Pinus flexilis* on 25 Jul 1986 and at site 3 on *Pinus contorta latifolia* on 11 Jul 1986. Figure 2 shows a fifth instar nymph of *Pilophorus americanus* with a mature braconid larva inside.

DISCUSSION

The occurrence of braconid larvae in the nymphs of Miridae is not surprising (Leston 1959, 1961; Loan 1980). The absence of such parasitoids in some species of Miridae we collected should not be considered non-occurrence because some mirid species were collected in small numbers. As we learn more about the specific habits of both parasitoids and bugs, some of these points will be clarified. It does appear that parasitism is chiefly an early season phenomenon, at least of tree-inhabiting Miridae, as Leston (1959, 1961) suggested. We collected no par-

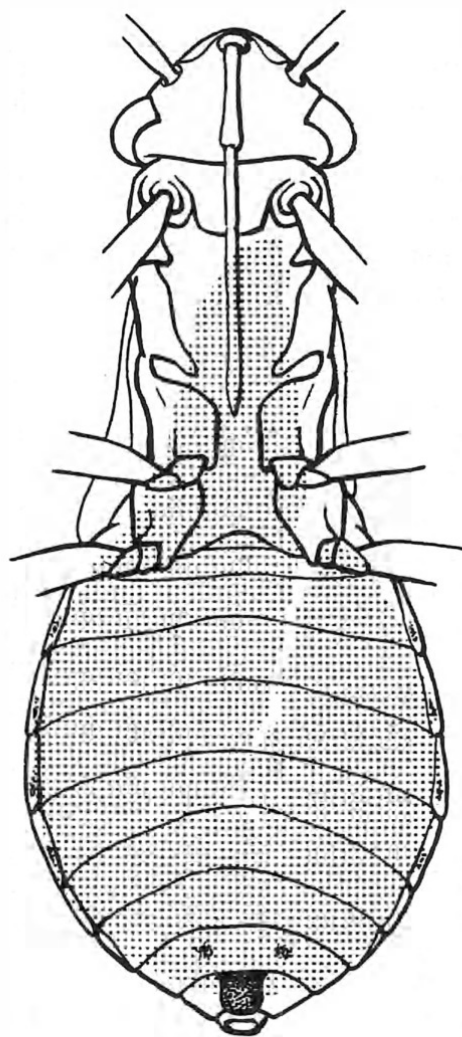


Figure 2. Fifth instar nymph of *Pilophorus americanus* from below, showing parasitoid larva occupying most of the body cavity.

asitized individuals after July so it is possible that the species of bugs occurring later may escape the parasitoids. For example, *Ceratopsus apicatus* Van Duzee was one of the last species to appear in the season from early July to late September, was quite abundant at several sites and yet no parasitoids were recovered from it.

Just why parasitism is more common in the earlier part of the season is not clear. Perhaps only a few polyphagous parasitoid species might be involved at any given site. For example, *Peristenus pallipés* (Curtis) uses at least 9 species of mirid hosts, while *P. juniperinus* appears to attack only a single bug species. Species of braconids attacking certain grass-feeding mirids (i.e., *Acetropis* Fieber, *Irbisia* Reuter, *Leptopterna* Fieber, and *Stenotus* Jakovlev) also must mature early in the season. The tree- and grass-inhabiting mirid species are almost all univoltine. The explanation may be quite simple—if the bug occurs early and is univoltine, the parasitoid must occur at the same time. An examination of the parasitoid system involving the bivoltine, grass-feeding mirid genus *Notostira* Fieber in Europe would be of considerable interest. Are both generations attacked? The same would be true of *Phytocoris stellatus*, normally univoltine in Oregon, Wash-

ington, and on north and east, but multivoltine in southern, coastal California (Stonedahl 1988). Alternatively, parasitoids attacking *Lygus* may occur throughout the season because many species of *Lygus* are multivoltine (Schwartz & Footitt 1998).

The emphasis in field work must shift to the parasitoids themselves to solve these problems. It was our purpose to expand the records of the occurrence of parasitoids in conifer-inhabiting mirid communities and call attention to their existence in many species of our Miridae.

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