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Title: The Miridae (Hemiptera:Heteroptera) Associated with Noble Fir, Abies procera Rehd.

Abstract approved: John D. Lattin

Dr. John D. Lattin

The Miridae, or plant bugs, associated with noble fir, Abies procera Rehd., are discussed. Thirty six species of the Miridae were collected from noble fir. Twenty five of these species are considered only "visitors" to noble fir. The study does not deal with these species. Noble fir is a host of the eleven other species: Deraeocoris incertus Knight, Deraeocoris piceicola Knight, Dichrooscytus sp. A, Orthotylus sp. A, Paradacerla formicina (Parshley), Phytocoris neglectus Knight, Phytocoris sp. A, Pinalitus solivagus (Van Duzee), Plagiognathus sp. A and Psallus spp. A and B. Fifth instar larvae and the adults of these eleven species were examined and described.

The plant bugs were collected from the noble fir foliage every seven to fourteen days from early May to mid-October, 1979 from Marys Peak in the Oregon Coast Range and the H.J. Andrews Experimental Forest in the Oregon Cascade Mountains. Distributional data were added from collecting trips in Oregon on Grass Mountain and around Mt. Hood and in Washington state at White Pass and Stevens Pass.

The larvae and adults of the eleven noble fir mirid species were observed in a growth chamber. Feeding observations were recorded for eight species. The larvae and adults were examined for external signs of insect parasitism. Sticky traps placed on the boles of noble fir trees on Marys Peak collected very few mirids, suggesting that the

mirids remain on the foliage and branches. Collections were made from three noble fir stands of increasing age in the Andrews Forest. All mirid species associated with the fir were present once the stand was 15-18 years old. The degree of host specificity is discussed for the eleven species.

Eight species were collected regularly on noble fir from Marys Peak and ten from the Andrews Forest. Mirids were more abundant on Marys Peak than in the Andrews Forest. Possible causal factors are discussed. The periods of occurrence of the larvae and adults of the eleven species are graphed. The larvae and adults of five mirid species appeared approximately five to seven days earlier on Marys Peak than in the Andrews Forest. The adults of two other species appeared earlier in the Andrews Forest and the periods of occurrence of the remaining four species differed little between the two areas. The two species of Deraeocoris occurred concurrently while the two species of Phytocoris or Psallus were nearly temporally isolated from each other on noble fir. Adult males were collected earlier in the season than females and only females were seen late in the collecting season for seven species.

The Miridae (Hemiptera:Heteroptera) Associated with Noble Fir, *Abies procera* Rehd.

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THE MIRIDAE (HEMIPTERA:HETEROPTERA) ASSOCIATED WITH NOBLE FIR, ABIES PROCERA REHD.

INTRODUCTION

The family Miridae, or plant bugs, is the largest of the order Hemiptera. Species are found on diverse host-plants such as grasses, herbs, shrubs, and deciduous and coniferous trees. The mirid fauna of conifers in western North America is poorly known. This thesis will describe and discuss the plant bugs associated with noble fir, Abies procera Rehd.

Noble fir is a conifer generally restricted to moderate elevations (900-2200 m) in the central Cascade Mountains and Coast Ranges of Oregon and southwestern Washington. Its range extends south from the Stevens Pass area of Washington to southern Oregon. California red fir, Abies magnifica A. Murr., taxonomically and ecologically similar to noble fir, is found in the northern and central Sierra Nevada Mountains of California. In southern Oregon and northern California, stands exist that are intermediate to these two firs to varying degrees (Zavarin et al., 1978). The commerical importance of noble fir has increased greatly since the recent concern in the utilization and management of higher-elevation sites where noble fir occurs (Franklin, 1964). Other references provide additional information on noble fir (Franklin, 1962; Fowells, 1965; Franklin and Ritchie, 1970; Liu, 1971). Remarkably, the recorded insect fauna on this fir species is very limited and includes no mirid species.

Many North American investigators have conducted taxonomic studies on the Miridae but biological information on the vast majority of North American mirid species is poorly documented. The biologies of the European Miridae have been studied in greater detail. The majority of species of plant bugs is phytophagous although predaceous and partially predaceous species, or mixed feeders, are recognized. Leston (1961b) concluded the subfamilies Deraeocorinae, Cyclopinae and Isometopinae were exclusively carnivorous and most Phylinae were mixed feeders. Cobben (1978) discussed the evolutionary trends in the feeding prefer-

ences (i.e., carnivory, phytophagy or mixed) in the Heteroptera which included the Miridae. The eggs and oviposition sites have been described for only a small number of North American plant bugs. Cobben (1968) discussed mirid egg morphology and physiology but dealt only with European species although many genera and a few species are found also in North America. The periods of occurrence of the five larval instars and the adults and the number of generations per year are still relatively unknown for the North American Miridae. The host-plants of many western North American species are only partially known.

The insect fauna of many North American species of trees have been surveyed but few faunal surveys have included the Miridae. The economically important insects associated with western tree species were discussed in Western Forest Insects by Furniss and Carolin (1977). A similar work was completed for the eastern trees in Eastern Forest Insects by Baker (1972). Each publication discussed only a few pest species in the Miridae. Furniss and Carolin (1977) acknowledged that the Miridae are found on many trees but noted their role has not been recorded. No mirid species were found in the list of insects associated with Pinus jeffreyi Grev. and Balf. (76 species listed) (Lange, 1937), Pseudotsuga menziesii glauca (Mirb.) Franco. (153 species listed) (Bedard, 1938), Pinus edulis Engelm. (Little, 1943), oaks in southern California (Brown and Eads, 1965), the eastern pines of Canada (Rose and Lindquist, 1973), the eastern spruces, fir and hemlock of Canada (Rose and Lindquist, 1977), and the eastern Canadian larch, cedar and juniper (Rose and Lindquist, 1980). These investigators listed primarily economically important insect species. Varty (1963) conducted a survey of the sucking insects of the three birch species (Betula spp.) in the Maritime Provinces of Canada. He listed four mirid species.

European insect faunal studies of tree species have listed the Miridae. Reuter (1908) recorded 45 mirid species that completed full life cycles on Palearctic conifers. Six common mirid species were listed from Juniperus communis L. in southern England (Ward, 1977).

The pests of Siberian larch, Larix sibirica Ledb., included three plant bug species (Rozhkov (ed.), 1970). The insect fauna of European white birch, Betula verrucosa Ehrh., Alnus glutinosa Gaert., Alnus incana Moench. and European larch, Larix decidua Mill. were found to include seventeen, three, three and six mirid species, respectively (Wiackowski (ed.), 1977).

References to the mirid species associated particularly with North American coniferous trees can be found in the major works of Knight (1923, 1941, 1968) and the review of the Heteroptera of eastern North America by Blatchley (1926). Recent taxonomic reviews of the conifer-inhabiting mirid genera Platylygus (Kelton and Knight, 1970), Bolteria (Kelton, 1972a), Dichrooscytus (Kelton, 1972b,c; Kelton and Schaffner, 1972) and Pinalitus (Kelton, 1977), and the predominantly coniferous-associated genus Pilophorus (Knight, 1973) have provided additional records of host-plants and periods of occurrence.

The insect species known from noble fir, Abies procera, are limited to fifteen species (Fowells, 1965; Furniss and Carolin, 1977; Scurlock, 1978). No species of the Miridae were listed. The lack of knowledge of the mirid species on noble fir and the poorly known biologies of most western North American plant bugs prompted this study. This thesis is the initial study of the mirid species associated with Abies procera. The adults and fifth instar larvae are described and biological information is presented for all plant bugs associated with noble fir. Only species that had larvae observed regularly and in numbers relative to those of the adults were considered noble fir mirids; all other species were considered "visitor" species. An absence of early instar larvae (first, second or third instars) did not eliminate a species as a noble fir mirid since the early instar larvae were easily overlooked due to their small size.

LITERATURE REVIEW

The two major reviews of North American mirid species were published by Knight (1941, 1968) but little biological information except host records was included. Recent biological information for North American species of the Miridae is scattered in many publications dealing with a small number of species (e.g., Wheeler and Henry, 1977, 1978). The following discussions of each mirid species from noble fir have specific references dealing with the biologies of other species in the same genus. In contrast to the Nearctic species, Butler (1923), Kullenberg (1946), Southwood and Leston (1959) and Strawinski (1964) gave detailed biologies of many common Palearctic mirid species.

The recorded insect fauna on noble fir includes the fir seed chalcid, Megastigmus pinus Parfitt; the fir coneworm, Dioryctria abietivorella (Grotê); the aphid, Adelges nüsslini (Börner); the bark beetles, Pseudohylesinus dispar Blackman and P. nobilis Swaine; the root aphid, Prociphilus americanus (Walker); and the root-collar weevil, Pissodes dubious Randall (Furniss and Carolin, 1977). Fowells (1965) listed the following additional insect records: the seed gall midge, Dasyneura abiesema Foote; the flatheaded fir borer, Melanophila drummondi (Kirby); the roundheaded borers, Poliaenus oregonus (LeConte) and Tetropium sp.; a twig beetle Pityophthorus pseudotsugae Swaine; a bark weevil, Pissodes piperi Hopkins (now called P. dubious Randall) and the balsam wooly aphid, Chermes piceae (now called Adelges piceae (Ratzeburg)). In his unpublished thesis, Scurlock (1978) added the records of the following cone and seed insects from noble fir: the fir cone maggots, Earomyia barbara McAlpine and E. longistylata McAlpine; a fir cone moth, Eucosma prob. siskyouana (Kearfott); a fir seed moth, Laspeyresia prob. bracteatana (Fernald); a fir cone looper, prob. Eupithecia sp.; and a fir-seed gall midge, Dasineura sp. No mirid species were listed in these references indicating that previous to the present thesis, the mirid fauna on noble fir was unrecorded.

STUDY SITES

Marys Peak in the Coast Range and the H.J. Andrews Experimental Forest in the Cascade Mountains were selected in 1979 to study the periods of occurrence of the five larval instars and the adult males and females of all plant bugs associated with noble fir, the influence of elevation on the phenology and distribution of the mirids, the effect of the age of the noble fir stands on the distribution of the mirid species, the geographical effect of the Coast Range and the Cascade Mountains on the mirid distribution on noble fir and the movement of the insects on the trees.

Marys Peak

Marys Peak is about 14 miles west of Corvallis, Benton County, Oregon. It is the highest point (1250 m. or 4100 ft.) in the Coast Ranges of Oregon and Washington. Noble fir was found naturally growing from approximately 975 m. (3200 ft.) to 1190 m. (3900 ft.) in nearly pure stands intermixed with low, varying densities of Pseudotsuga menziesii (Mirb.) Franco. and Tsuga heterophylla (Raf.) Sarg. The first two sites listed below were sampled on every trip to Marys Peak. Data used for the periods of occurrence of the noble fir mirids from Marys Peak were combined from these two sites. The two sites differed by 76 m. (250 ft.) but no apparent difference in the periods of occurrence were observed so the data from both sites were pooled. The following three sites represent different elevations. Five sites including these three sites were sampled at various times through the 1979 collecting season from May 9 - October 10. Sampling was conducted on Marys Peak every seven to ten days, resulting in seventeen samples.

Collecting Sites

Curve in Road: Township(T)12S, Range(R)7W, Section(Sec)19, SE 1/4 (Quarter-section); 990 m. (3250 ft.), west-facing slope, old-growth noble fir and scattered saplings intermixed with Pseudotsuga menziesii and Prunus sp. around an open, grassy field.

Saddle Meadow: T12S, R7W, Sec20, SW 1/4; 1065 m. (3500 ft.), ridge top generally running east to west, scattered old growth and saplings of noble fir, mostly mid-growth noble fir with Pseudotsuga menziesii and Tsuga heterophylla of varying ages bordering an old field. The center of the field is the low point with both ends of the field at higher elevations.

Peak Parking Lot: T12S, R7W, Sec21, SW 1/4; 1140 m. (3750 ft.), northeast-facing slope, pure stand of old-growth, mid-growth and saplings of noble fir bordering a field and a paved parking lot.

H.J. Andrews Experimental Forest (HJA)

The Andrews Forest is situated eleven miles northeast of Blue River, Lane County, Oregon in the Willamette National Forest in the central Oregon Cascade Mountains. Noble fir was seen in the HJA from approximately 1220 m. (4000 ft.) to 1525 m. (5000 ft). It was found naturally growing in mixed stands with Abies amabilis (Dougl.) Forbes, Pseudotsuga menziesii, Tsuga heterophylla and Tsuga mertensiana (Bong.) Carr. The last two sites listed below were sampled on every trip to the HJA. Data used for the periods of occurrence of the noble fir mirids from the HJA were combined from these two sites. The sites differed by 150 m. (490 ft.) but no apparent differences in the periods of occurrence were observed so the data from both sites were pooled. The following three sites represent three different age classes of noble fir. Five sites including these three sites were sampled at various times through the 1979 collecting season from May 25 - October 16. Sampling was conducted in the Andrews Forest every seven to fourteen days, resulting in thirteen samples.

Collecting Sites

1977 Stand: T15S, R5E, Sec24, NE 1/4; 1175 m. (3850 ft.), south facing slope, noble fir seedlings planted in 1977 in a clear-cut, brush competition appears heavy. The clearcut is surrounded by old-growth Pseudotsuga menziesii and mid-growth Tsuga heterophylla but no mid-or old-growth Abies procera.

Carpenter Mountain: T15S, R6E, Sec7, SW 1/4; 1330 m. (4360 ft.), southwest-facing slope, clearcut about 20 yrs. ago, planted noble fir seedlings which now are 15-18 yrs. old; intermixed with Abies amabilis, Pseudotsuga menziesii and a few Pinus monticola Dougl.

Half mile north of Frissel Point: T15S, R6E, Sec29, SE 1/4; 1480 m. (4850 ft.), ridge top generally running north to south, natural stand of scattered old-growth and mid-growth noble fir intermixed with Abies amabilis, Pinus contorta Dougl., Pseudotsuga menziesii and Tsuga mertensiana bordering a meadow.

MATERIALS AND METHODS

Collecting

Most specimens were collected from noble fir by beating the branches over a 68 cm. x 80 cm. (27 in. x 32 in.) canvas sheet supported by two cross sticks and aspirating the dislodged specimens. Larvae and adults were either taken to the laboratory for biological observations or preserved in 70 percent alcohol (larvae only) or killed with ethyl acetate and mounted (adults only). A net (diameter 51 cm. or 20 in.) was suspended from a twelve-foot (3.7 m.) pole to sample branches higher in the trees. The net was placed under the branches up to almost 6 m. (20 ft.) off the ground and pushed up and down. The dislodged insects were then aspirated from the net and handled like the insects beaten from the trees.

Sticky traps coated with Stick-um Special® were placed on noble fir boles to determine if any mirid species would be found only on the trunks or the foliage and the trunks. The sticky traps (20 cm. x 25 cm.; 0.64 cm. mesh or 8 in. x 10 in.; 0.25 in. mesh) were in place for seven weeks (July 11 - September 4) at two sites on Marys Peak: Curve in Road and Saddle Meadow. At Curve in Road, one trap was nailed five to six feet above the ground on one of three noble fir trees (diameter at breast height (DBH) 4 in., 12 in., 24 in.). At

Saddle Meadow, one trap was placed five to six feet above the ground on one of four trees. Two trees had a DBH of approximately 24 in. and two trees had a DBH of about 10 in. The traps were checked every seven to ten days for the presence of mirid larvae or adults. The captured specimens were removed and stored in marked vials of 70 percent alcohol for future identification.

The lichen within an arm's reach on the boles of four old-growth noble fir at Saddle Meadow on Marys Peak was vacuummed on two trips (July 3 and 11) using an Echo® PB-400 power blower with the air intake adapted to function as a vacuum.

Rearing Techniques

Mirid larvae from noble fir are difficult to rear. Attempts were made to rear the larvae of eight of the eleven species. The survival rate for the larvae of all the species reared was very low. The larvae (and later the adults) were placed in covered petri dishes in a Sherer plant growth chamber, model CEL-8. The larvae (and adults) were reared at 24°C (75°F) in a 12 hr. light and 12 hr. dark photoperiod. Unfortunately, the chamber had no humidity control but large buckets of water were placed in the chamber in an attempt to avoid low humidity. Small plastic petri dishes (diameter 5 cm. or 2 in.) with moist blotter paper covering the bottoms were used first but were discontinued quickly because the blotter paper dried out in less than a day, probably resulting in low humidity in the dishes. Larger petri dishes (diameter 9 cm. or 3.5 cm.) were used for the vast majority of rearing attempts. The blotter paper was kept moist but not wet (i.e., no standing water). The moist blotter paper provided a substrate for fungal growth which may have adversely affected larval survival. New blotter paper replaced the old when fungal growth on the paper was observed. Sand was tried later to rear the older instar larvae and adults. The sand eliminated this fungal growth but larval survival did not improve. Fresh branchlets of noble fir were supplied every four to five days when the previous branchlet appeared to be slightly dry.

Wheeler and Henry (1977) replaced the host material every two to three days in their rearing of mirids which may have contributed to their greater success in rearing mirids. They used air-tight containers to rear mirids which would have retained better the air moisture but were too expensive to buy and it was too difficult to find similar available containers.

The mirid larvae were given varying species of live aphids. Immature Cinara sp. aphids were provided to the mirids whenever possible since these aphids were of a small size class like the mirid larvae and occurred naturally on the noble fir. If immature Cinara were uncommon or died quickly in the dishes then the larvae were supplied with either Macrosiphum rosae (L.) or Myzus persicae (Sulzer) aphids. The Macrosiphum aphids were removed from rose bushes frequently sprayed to control the aphids. Residual insecticides in the aphids or from the rose leaves may have increased larval mortality although larval mortality did not appear to increase when the mirid larvae were given Macrosiphum rosae.

Adults of eight of the eleven species (see "Discussion" for a list of the eight species) were retained in the laboratory to observe their feeding habits and four of the common species (Deraeocoris incertus, D. piceicola, Pinalitus solivagus and Psallus sp. A) were retained to observe their oviposition sites. To observe oviposition, four to eight adults were placed in the larger petri dishes (diameter 8.9 cm. or 3.5 in.) with blotter paper (or sand), aphids and a noble fir branchlet. For an alternative method, the adults (approximately 10-25) were placed in finely screened cages (20 cm. x 20 cm. x 43 cm. or 8 in. x 8 in. x 17 in.) with aphids and a live noble fir seedling three to six inches tall. After all the adults had died, the branchlets or seedlings were examined with a dissecting microscope for the eggs.

Measurements (recorded in millimeters)

Measurements were made under 10x, 30x or 60x magnification depending on the size of the body part.

Total body length: measurement from the base of the clypeus to the posterior tip of the hemelytra or the body (in the case of Paradacerla formicina Parshley) with the insect measured from directly above. The base of the clypeus was chosen because it is commonly visible while the base of the rostrum is usually hidden below the head. If the clypeal base could not be seen, an adjustment was made to include the additional length, as if it were visible.

Body width: widest distance across the hemelytra.

Head width: distance across the eyes.

Vertex: shortest distance between the eyes.

Rostrum length: total length of the rostrum.

Length of the segments I-IV of the rostrum.

Length of the segments I-IV of the antennae.

Length of the pronotum: length of a median line from the anterior to posterior edge of the pronotum.

Anterior width of the pronotum: the shortest line between the left and right angles of the anterior edge. The width was not measured if the anterior angles were broadly and evenly rounded when viewed from above.

Posterior width of the pronotum: widest distance between the posterior angles.

For each description the number of specimens examined included the number needed to represent all color forms, sizes and collection dates and localities. These specimens were examined mostly for variations in the color of body parts. If the number for each sex was fourteen or less then all examined specimens were also measured to obtain the size range for each body part in the adult and larval descriptions. If the number of specimens examined for a sex was greater than fourteen, fourteen were selected to include any apparent

extremes in body size and to represent a variety of collection dates and localities.

Examination for insect parasitism

The larvae and adults of the eleven noble fir mirid species were examined externally for insect parasitism. All specimens were checked, in particular for parasitoid larvae protruding from the bodies of the host larvae or adults and for exit holes indicated by a crushed appearance where the parasitoids emerged. No dissections were made due to the large number of larvae and adults collected and the limited time available to search for parasitism.

GENUS DERAEOCORIS KIRSCHBAUM, 1855

This very large, cosmopolitan genus contains approximately 167 species worldwide (Carvalho, 1957), and 45 species from western America north of Mexico (Razafimahatratra, 1980). Species characteristically have claws that are toothed or thickened at the base, no pulvilli, with setiform parempodia, vertex not grooved, frons not or very faintly striated, tylus not extending forward beyond distal end of first antennal segment and second antennal segment usually nearly linear (Slater and Baranowski, 1978).

The name Deraeocoris was first used by Kirschbaum as a subgenus of Capsus in 1855. Stål (1865) first used Deraeocoris as a generic name although the genus was poorly defined until Distant, in 1904, fixed Cimex olivaceus Fabricius as the type-species of the genus Deraeocoris and Lygaeus punctulatus Fallén as the type-species of the genus Camptobrochis Fieber. Poppius (1912) placed Camptobrochis as a synonym of Deraeocoris. Knight (1921) adopted the synonymy established by Poppius and used Camptobrochis as a subgenus of Deraeocoris. Many important differences between Camptobrochis and Deraeocoris were noted by Razafimahatratra (1980), including overwintering stage (adult

versus egg, respectively) and male and female genital structures (e.g., claspers, vesica and sclerotized rings). He concluded that a comprehensive study of characters such as the male and female genitalia of the species of the world was needed to decide if Camptobrochis deserved generic status.

P.R. Uhler, O.M. Reuter and E.P. Van Duzee described many species of Deraeocoris in the late 19th and early 20th centuries. Knight monographed the genus Deraeocoris in 1921. Recently, several new species have been described by Akingbohungbe (1972) and Kelton (1980). Razafimahatratra (1980) revised the genus for western North America and described five new species.

Many morphological characters are used to distinguish species of Deraeocoris. Characters include the width of the vertex compared to the length of the first antennal segment or the width across the eyes; shape, vestiture or coloration of the second antennal segment; punctation of the pronotal disk; shape or coloration of the calli; banding patterns of the femora and tibiae; and types and lengths of the setae on the tibiae and femora (Razafimahatratra, 1980).

The biology of the majority of North American species has not been studied. The biology of Deraeocoris brevis (Uhler) is very well known. Westigard (1973) observed the oviposition site, duration of each larval instar, total development time, overwintering stage and site and feeding habits of D. brevis. The partial biology is known for other North American species such as Deraeocoris fasciolus Knight, D. incertus Knight, D. nebulosus (Uhler) and D. piceicola Knight.

Deraeocoris incertus Knight

(Figure 11, fifth instar larva)

Deraeocoris incertus Knight, 1921: 111, 114; Carvalho 1957: 67; Razafimahatratra 1980: 70.

Deraeocoris rufusculus Knight, 1921: 112, 116; Carvalho 1957: 79.

Adult

Mottled black, brown and yellow with tarsal claws swollen at base and scutellum distinctly punctate. Male and female are distinctly different; the hemelytra of male extend well beyond tip of abdomen while hemelytra of female barely extend beyond tip of abdomen. Male is more slender and darker in coloration than female.

Male. Length 5.04 - 5.67, width 2.03 - 2.45. Head. Width 1.04 - 1.12, vertex 0.31 - 0.36; frons and clypeus dark brown or black with median line yellow or ivory; jugum yellow or ivory; yellow or ivory spots near margin of eye on vertex and behind antennal bases; carina yellow or ivory; collum black. Rostrum. Length 2.00 - 2.21; segment I, 0.43 - 0.45; II, 0.45 - 0.59; III, 0.36 - 0.52; IV, 0.61 - 0.72. Antennae. Length of segment I, 0.36 - 0.41, dark brown or black; II, 1.57 - 1.91, nearly cylindrical, black; III, 0.45 - 0.54, black; IV, 0.41 - 0.50, dark brown or black. Pronotum. Length 0.90 - 1.06, anterior width 0.72 - 0.79, posterior width 1.76 - 1.94; coarsely punctate behind calli; dark brown or black, band of yellow or ivory behind the calli often divided by two dark brown or black spots into three yellow or ivory spots; calli convex, black; anterior and posterior margins narrowly yellow or ivory; collar yellow or white; scutellum punctate, dark brown or black with basal angles, apex and apical half of median line yellow or ivory; mesoscutum black. Legs. Dark brown or black; distal tip of femora light brown, hind femora pale at middle with black spots; tibiae biannulate with yellow or light brown; tarsi dark brown or black; claws slender, not toothed at base. Hemelytra. Translucent, mottled dark brown or black with light brown. Clavus light brown, distal apex dark brown or black; corium dark brown or black, large yellow or light brown spot near anterior apex and often large yellow or light brown median spot; cuneus dark brown or black except anterior end light brown. Venter. Dark brown or black. Vestiture. Short, sparse, light brown setae, except last three antennal segments also with longer, erect, light brown setae beset at constant intervals; tibiae also with distinct row of brown, spinose setae.

Female. Length 4.77 - 5.94, width 2.27 - 2.66. Head. Width 1.03 - 1.17, vertex 0.41 - 0.50. Rostrum. Length 2.07 - 2.36; segment I, 0.47 - 0.54; II, 0.50 - 0.63; III, 0.45 - 0.58; IV, 0.63 - 0.72. Antennae. Length of segment I, 0.34 - 0.45; II, 1.48 - 1.67; III, 0.47 - 0.54; IV, 0.41 - 0.52. Pronotum. Length 0.92 - 1.13, anterior width 0.76 - 1.01, posterior width 1.82 - 2.16. Basic coloration similar to male except more yellow and light brown in first and second antennal segments, pronotum, clavus, cuneus, femora and tibiae. Cuneus is almost entirely light brown in female. Second antennal segment slender and brown, dark brown or black at base, gradually thickening toward black apex. Second antennal segment shorter in female. Female tends to be wider but shorter in body length than male. See "Diagnosis" for hemelytral difference with male.

Description was based on the examination of 36 specimens (14 males) collected on noble fir.

Specimens examined. Two hundred and seventy three specimens were examined from the following localities: California. Tehama Co. Childs Meadows, on Abies concolor (Gord. and Glend.) Lindl., VIII-4-80, G. Cooper. Idaho. Benewah Co.: 4 mis. W. Emida, on Abies grandis (Dougl.) Lindl. and Picea engelmannii Parry, VII-9-79, G. Stonedahl. Oregon. Benton Co.: Grass Mountain, 3200 and 3550', on Abies procera Rehd., IX-17-79, G. Stonedahl; Marys Peak, 3250-3750', on Abies procera, VII-25-79, VIII-3-79 and VIII-29-79, G. Cooper; O.S.U. campus, Corvallis, on Pseudotsuga menziesii (Mirb.) Franco, VII-2-79, G. Stonedahl. Clackamas Co.: Government Camp, 3900', Mt. Hood, on Pinus contorta Dougl., IX-5-79, G. Stonedahl. Deschutes Co.: Three Creeks Meadow, 6300', on Pinus contorta, IX-19-79, J. Lattin. Hood River Co.: 3.2 mis. N. Barlow Pass Summit, 4460', Mt. Hood, on Abies amabilis (Dougl.) Forbes and Abies procera, IX-5-79, G. Cooper and G. Stonedahl; T2S, R9E, Sec10, on Pinus contorta, IX-5-79, G. Stonedahl. Josephine Co.: on Abies procera, VIII-9-79, G. Stonedahl.

Lane-Linn Cos.: Carpenter Mtn., 4360', H.J. Andrews Expt. Forest, on Abies amabilis and A. procera, VII-31-79, G. Cooper and G. Stonedahl; on Abies procera, X-9-79, G. Cooper. Half - 2.0 mis. N. Frissel Pt., 4750-4850', Andrews Forest, on Abies procera, many dates VII-31-79 to X-16-79, G. Cooper. Washington. King Co.: Stevens Pass, Old Stevens Pass Rd., 3200 and 3520', on Abies amabilis, A. procera and Pseudotsuga menziesii, VIII-21-79, G. Cooper and G. Stonedahl. Whatcom Co.: 4 mis. N.E. Welcome, on Abies grandis, VII-22-79, G. Stonedahl. Yakima Co.: 3 mis. E. White Pass Summit, 4200', on Abies procera, G. Cooper and G. Stonedahl.

Fifth instar larva

Red, white and brown or dark brown larva with flattened, lanceolate, black setae. Only noble fir mirid larva heavily covered with white, powdery, flocculent material (larvae of Deraeocoris piceicola Knight have little or no such covering). The white material is lost once the larvae are placed in alcohol.

Male. Length 3.78 - 4.50, width 1.84 - 2.03. Head. Width 0.95 - 1.04, vertex 0.38 - 0.50; frons and clypeus red or reddish brown with median white line, jugum white tinged with red. Rostrum. Length 1.65 - 1.89; segment I, 0.36 - 0.42; II, 0.39 - 0.48; III, 0.37 - 0.45; IV, 0.53 - 0.61. Antennae. Length of segment I, 0.32 - 0.36, light brown, brown or dark brown tinged with red; II, 1.08 - 1.30, light brown or brown often tinged with red, distal end darkening to brown or dark brown; III, 0.40 - 0.47, light brown or brown, distal end brown or dark brown; IV, 0.41 - 0.49, brown. Pronotum. Length 0.52 - 0.68, anterior width 0.81 - 1.01, posterior width 1.19 - 1.44, white marked irregularly with light brown or brown; calli red, reddish brown, brown or dark brown. Legs. Femora and tibiae light brown banded with red, or brown banded with dark brown; amount of banding varies with specimen. Tarsi brown or dark brown. Wing pads. Extend to third or fourth abdominal segment, white tinged with brown and red, or brown or dark brown. Abdomen. Dorsal and ventral surfaces white tinged with red or white with varying size and number of red spots.

Abdominal gland. Gland opening completely doubled as described for the genus (Akingbohungbe, 1974), bordered by red, reddish brown or dark brown. Vestiture. Sparse, flattened, lanceolate setae except short, brown setae and longer, erect, brown setae on antennae and short, brown setae and black spines on femora and tibiae; short brown setae only on tarsi.

Female. Length 3.87 - 4.82, width 1.98 - 2.12. Head. Width 1.01 - 1.08, vertex 0.43 - 0.56. Rostrum. Length 1.85 - 2.05; segment I, 0.40 - 0.46; II, 0.45 - 0.52; III, 0.39 - 0.46; IV, 0.54 - 0.68. Antennae. Length of segment I, 0.32 - 0.36; II, 1.08 - 1.26; III, 0.40 - 0.49; IV, 0.41 - 0.50. Pronotum. Length 0.56 - 0.77, anterior width 0.90 - 1.06, posterior width 1.33 - 1.42. Female very similar to male except notably longer rostrum and more extensive white markings on wing pads: median white spot and white spots on median edges.

Description was based on the examination of 15 specimens (six males) from noble fir.

Biology

Observation of the late larval stadia was based on a single surviving larva. The larva was collected as a third instar nymph and was reared to the adult stage on a diet of Cinara aphids. The fourth stadium was four to five days and the fifth stadium was six days (at 24°C). Westigard (1973) observed that the larval stadia of Deraeocoris brevis from the first through the fifth were 3.5, 3.8, 4.6, 5.4 and 8.0 days respectively. He reared the larvae at 21°C. The average development time from first instar to adult for D. brevis was 25 days under laboratory conditions. Wheeler et al (1975) found the average duration of the five larval instars of D. nebulosus was 2.7, 3.2, 4.3, 4.6 and 5.0 days respectively with an average development time of 19.8 days. The fourth and fifth larval stadia of D. incertus are similar to those of D. brevis and D. nebulosus even though the latter two species were reared at

21°C as opposed to 25°C for D. incertus. Razafimahatratra (1980) observed 20 to 30 day-development times for D. fulgidus (Van Duzee), D. fusifrons Knight and D. rubroclarus Knight. Fourth instar larvae of these three species taken from the field usually became adults in six to twelve days in petri dishes when given fresh leaves and aphids.

Two fifth instar larvae and one adult of D. incertus were observed feeding on live immature Cinara aphids. Razafimahatratra (1980) noted that D. incertus fed on chermids. He reported that adults and nymphs of D. incertus fed occasionally on Douglas-fir twigs even if they were confined with a good supply of Cinara sp. He also found this species feeding on the honeydew of Cinara on fir needles. The species may be only partially predaceous although more feeding observations in the field are needed before a conclusion can be made.

The predaceous tendencies and the prey of North American species of Deraeocoris have been widely reported (e.g., Blatchley, 1926; Knowlton, 1946; Ives, 1967; Westigard, 1973; and MacLellan, 1977). Knight (1921) was one of the first to report the predaceous tendencies of some Deraeocoris species. He found that Deraeocoris aphidiphagus Knight fed on the aphid, Schizoneura americana Riley; D. nitenatus Knight fed on S. lanigera (Patch); D. fasciolus fed on the aphids, Aphis sorbi Kaltenbach on apple, S. crataegi Oestlund on hawthorn and upon Phyllaphis fagi (Linn.) on beech. He noted D. pinicola Knight fed at least in part on the pine-bark aphid, Chermes pinicorticis Fitch. Turnock (1953) considered D. laricicola Knight a predator of larch sawfly eggs and newly hatched larvae. Ives (1967) also reported that D. laricicola was a predator of larch sawfly eggs. McMullen and Jong (1967) considered D. brevis piceatus the second most important natural enemy of the pear psylla, Psylla pyricola Foerster. Wheeler et al. (1975) included an extensive list of the reported prey species for D. nebulosus. They concluded that D. nebulosus could be an important regulator of lace bugs and other pests on ornamental trees. Razafimahatratra (1980) listed aphids, psyllids, chermids and psocids as common prey for both the nymphs and adults of Deraeocoris. He also observed cannibalism in the field and in the laboratory for D. brevis,

D. bakeri Knight, D. fulgidus and D. piceicola Knight. He found larvae would feed on each other even if given adequate supplies of aphids.

Partial phytophagy has been reported for a few species of Deraeocoris. Knight (1921) noted that nymphs and adults of several species could live on plant sap alone if caged with only succulent host-plant material although plant-lice or other small, soft-bodied insects were preferred food. Southwood and Leston (1959) reported D. olivaceus (Fabricius), a British species, was predaceous but also fed on young hawthorn berries. Partial phytophagy was reported for D. brevis by McMullen and Jong (1967) and Razafimahatratra (1980). Razafimahatratra (1980) reared fourth instar larvae of D. fulgides, D. fasciolus and D. piceicola to the adult stage supplied only with the leaves of their respective host: bitterbrush, filbert and spruce. He observed D. fusifrons feeding on oak leaves. Razafimahatratra suggested partial phytophagy may be necessary in host plant recognition where hatching of the eggs must be coordinated with the prey populations and, for some reason, with the host-plant. If that is true, partial phytophagy should be more prevalent in females but no known supporting evidence exists.

Adult males and females were reared together (see "Materials and Methods" for the procedure) in an attempt to observe the oviposition sites. Unfortunately, no eggs could be found on the branchlets or seedlings after all the females had died. The adults lived only a short time (i.e., three to five days), suggesting mating and oviposition were probably limited. A better rearing technique is necessary before the oviposition site can be found. Collyer (1953) observed that D. ruber (L.), a British species, oviposited deep into young apple wood. Southwood and Leston (1959) noted the eggs of D. lutescens (Schilling), another British species, are laid deep in the young wood of various trees. The eggs of D. fasciolus, a North American species, are inserted in the creases of apple twigs, often where the bark is incurved at the twig axils (Sanford, 1967). According to Westigard (1973), the eggs of D. brevis are laid singly

or in groups in pear leaf petioles. The eggs of D. nebulosus are oviposited singly or in pairs in the leaf mid-vein of apples and not in the leaf petioles or twigs (McCaffrey and Horsburgh, 1980).

No larvae or adults were collected in the sticky traps during the seven-week period the traps were on the tree boles. Sticky traps were placed on noble fir trees only on Marys Peak. Very few D. incertus were ever collected from noble fir. Only one larva and three adults of D. incertus were beaten off noble fir on Marys Peak.

No parasitoids of the larvae and adults of D. incertus were observed. No species of the genus was cited as a host of a hymenopteran parasite in the Catalog of Hymenoptera in America North of Mexico (Krombein et al., 1979). Leston (1961a) found one fifth instar larva of D. lutescens parasitized by a Braconidae. He listed no other Deraeocoris species as a host of Braconidae.

Hosts

Refer to the "Specimens examined" section for specific collection sites, dates and hosts.

I have collected larvae and adults of this species only on Abies procera. Razafimahatratra (1980) listed only conifers as known host-plants: Abies grandis, A. concolor, A. procera, A. magnifica var. shastensis Lemmon and Pseudotsuga menziesii. Razafimahatratra (1980) does not specify if larvae and/or adults were collected on these plant species. I have seen specimens also collected from Pinus contorta from three different localities. Extensive collecting of larvae and adults on these cited plants and other possible coniferous hosts must be conducted before a host-plant list can be completed. Such extensive collecting must be done for all eleven mirid species associated with noble fir. Host specificity varies with the different species of Deraeocoris. Adults(?) of D. brevis have been recorded from more than 30 taxonomically unrelated host-plant species. Deraeocoris incertus has been found on four genera of conifers (Abies, Picea, Pinus and Pseudotsuga) while D. diveni Knight has been collected only on Pinus contorta (Razafimahatratra, 1980).

Distribution

This species was rarely found on noble fir in the Coast Range in Oregon on Marys Peak and Grass Mountain. It was commonly collected in the HJA in Oregon in the Cascade Mountains and was also found in the Cascades around Mt. Hood, Oregon and in Washington at White Pass and Stevens Pass.

It is exclusively a western species known from the Coast Range, the Cascade Range, the Sierra Nevada, San Bernardino Mountains, San Jacinto Mountains and the Rocky Mountains in the following province and states: British Columbia, California, Idaho, Oregon, Utah and Washington (Razafimahatratra, 1980).

Periods of Occurrence

Despite 17 collecting trips to Marys Peak in 1979, no first, third, fourth or fifth instar larvae were collected on noble fir. One second instar larva was collected on June 28. One adult male was collected on July 25 and a single adult female was found on August 3 and 29.

One generation was observed in the Andrews Forest in 1979 (Figure 22); too few specimens were collected on Marys Peak to permit a conclusion to be made. Razafimahatratra (1980) suggested D. incertus may have one or two generations a year based on the records of all examined specimens. Most species of this genus have only one generation a year (Razafimahatratra, 1980). Westigard (1973) reported D. brevis piceatus had two generations a year in pear orchards in southern Oregon. Deraeocoris nebulosus was found to have three generations annually in an ornamental planting in central Pennsylvania (Wheeler et al., 1975). The number of generations per year may vary from one area to another. McMullen and Jong (1967) reported D. fasciolus had two generations annually in pear orchards in British Columbia while Razafimahatratra (1980) found the species had only one generation per year on a Corylus species in Oregon.

In the HJA, no first or second instar larvae were collected in 1979 despite 13 collecting trips to the noble fir sites. Third,

fourth and fifth instar larvae and adults were frequently collected on noble fir although never in large numbers. Third instar larvae were collected on June 13 and July 6, fourth instar larvae only on July 6 and fifth instar larvae on July 20 and 31 (Figure 22). Adult males were collected before females although only females were found late in the collecting season. Adult males were seen July 31 and August 5 while females were collected August 5 - October 9 (Figure 22).

Deraeocoris piceicola Knight

(Figure 1, adult; Figure 12, fifth instar larva)

Deraeocoris piceicola Knight, 1927b: 136; Carvalho 1957: 73; Razafimahatratra 1980: 168.

Adult

Mottled black and brown with yellow and red markings. Characteristically have tarsal claws swollen at base and scutellum only shallowly rugose-punctate. Male and female are distinctly different; hemelytra of male extend well beyond tip of abdomen while hemelytra of female barely reach or are shorter than tip of abdomen. Male is often darker in coloration than female.

Male. Length 6.71 - 7.70, width 2.74 - 3.28. Head. Width 1.15 - 1.31, vertex 0.54 - 0.63; frons black, often with yellow median line; clypeus yellow with two parallel black lines, or black; vertex black, frequently with yellow trapezoidal spot and often with yellow lines parallel to eye margins; jugum yellow, yellowish brown, brown or black; collum black. Rostrum. Length 2.56 - 2.92; segment I, 0.56 - 0.68; II, 0.61 - 0.77; III, 0.59 - 0.72; IV, 0.76 - 0.90. Antennae. Length of segment I, 0.54 - 0.68; II, 1.80 - 2.07; III, 0.68 - 0.81; IV, 0.50 - 0.59, all segments black. Pronotum. Length 1.13 - 1.37, anterior width 0.88 - 1.10, posterior width 2.20 - 2.57, coarsely punctate, black, rarely mottled brown and black; yellow, median, triangular spot along anterior margin, area anterior to calli often

yellow. Calli convex, black; posterior margin narrowly yellow. Collar black, brown, or yellowish brown; scutellum black, convex, shallowly rugulose-punctate, lateral angles, apex and often an apical portion of median line yellow or yellowish brown; mesoscutum black. Legs. Black or dark brown; large, median yellowish brown or brown spot with row of black spots; tibiae biannulate with yellow or yellowish brown; claws not cleft at base. Hemelytra. Mottled black and brown. Clavus light brown, black or mottled light brown and black, posterior tip black; corium black with light brown spots near anterior tip and middle, translucent spot along posterior margin; anterior half of cuneus red, reddish brown or brown, posterior half black. Venter. Black. Vestiture. Short, sparse, light brown setae; all antennal segments also with longer, erect, light brown setae; tibiae also with distinct brown, spinose setae. Specimens collected from Stevens Pass, King County, Washington have longer, denser number of setae than other examined specimens. Razafimahatratra (1980) found this setal difference in specimens from Whatcom and King Counties, Washington.

Female. Length 6.05 - 7.59, width 2.99 - 3.53. Head. 1.15 - 1.33, vertex 0.56 - 0.70. Rostrum. Length 2.54 - 3.08; segment I, 0.54 - 0.68; II, 0.58 - 0.77; III, 0.61 - 0.74; IV, 0.72 - 0.90. Antennae. Length of segment I, 0.56 - 0.65; II, 1.75 - 2.09; III, 0.72 - 0.85; IV, 0.50 - 0.63. Pronotum. Length 1.13 - 1.46, anterior width 0.92 - 1.13, posterior width 2.02 - 2.52. Basic coloration similar to male, except reduced black in cuneus, only posterior tip black; scutellum often has less black, more red or reddish brown; second antennal segment slender and brown, dark brown or black at base, gradually thickening toward black apex. See "Diagnosis" for hemelytral difference with male. Females from Stevens Pass, Washington have longer, denser number of setae and are noticeably smaller than females from other localities.

Description was based on the examination of 40 specimens (20 males) from noble fir.

Specimens examined. Two hundred and twelve specimens were examined from the following localities: Oregon. Clackamas Co.: Government Camp, 3900', Mt. Hood, on Pinus contorta Dougl., IX-5-79, G. Cooper and G. Stonedahl. Deschutes Co.: Three Creeks Meadow, 6500', on Picea sp. and Pinus contorta, IX-9-79, J. Lattin, G. Stonedahl and V. Razafimahatratra. Jackson Co.: Mt. Ashland, on Abies sp., IX-2-58, J. Lattin. Hood River Co.: Barlow Pass Summit, 4160', Mt. Hood, on Abies procera Rehd., IX-5-79, G. Cooper; 3.2 mis. N. Barlow Pass Summit, 4460', Mt. Hood, on Abies amabilis (Dougl.) and A. procera, IX-5-79, G. Cooper and G. Stonedahl, on Abies procera, VIII-2-80, G. Cooper; 4.4 mis. N. Cloud Cap, 4400', Mt. Hood, on Abies lasiocarpa (Hook.) Nutt., IX-5-79, G. Cooper. Lane-Linn Cos.: Carpenter Mtn., 4360', H.J. Andrews Expt. Forest, on Abies amabilis, VII-31-79, G. Stonedahl; Half-2.0 mis. N. Frissel Pt., 4750 - 4850', Andrews Forest, on Abies procera, many dates VII-20-79 to X-2-79, G. Cooper. Washington. King Co.: Stevens Pass, Old Stevens Pass Rd., 3200 and 3520', on Abies amabilis, A. procera and Tsuga mertensiana (Bong.) Carr., VIII-21-79, G. Cooper and G. Stonedahl. Yakima Co.: 3 mis. E. Dog Lake on Hwy 12, on Abies amabilis and A. procera, VIII-23-79, G. Stonedahl and G. Cooper.

Fifth instar larva

White, red and brown or dark brown with distinctive, dense, piliform setae. This species has largest larva of any mirid found on noble fir.

Male. Length 5.50 - 5.83, width 2.32 - 2.65. Head. Width 1.13 - 1.17, vertex 0.65 - 0.68; frons white with two parallel, thin red lines; clypeus brown, median line white. Rostrum. Length 2.12 - 2.32; segment I, 0.43 - 0.50; II, 0.56 - 0.59; III, 0.50 - 0.58; IV, 0.63 - 0.65. Antennae. Length of segment I, 0.47 - 0.50, brown or, light brown with distal tip tinged with red; II, 1.37 - 1.46, light brown or brown, distal tip darkening to brown or dark brown; III, 0.50 - 0.58, light brown or brown, distal tip often darker brown; IV, 0.47 - 0.56, reddish brown or brown. Pronotum. Length 0.77 - 0.86, anterior width

0.99 - 1.08, posterior width 1.51 - 1.62, white, white marked irregularly with brown, or brown. Legs. Femora reddish brown with distal tip white, or light brown with distal half brown, or brown with distal half reddish brown or dark brown; tibiae brown or dark brown biannulate with light brown; tarsi brown, dark brown, or light brown with distal tip dark brown. Wing pads. Extend to third or fourth abdominal segment, brown or dark brown with median white or light brown spot and white or light brown spots on median edges, or white marked with varying amounts of brown. Abdomen. Dorsal surface white tinged with red, median row of reddish brown or dark brown spots and two lateral rows of smaller, reddish brown or dark brown spots, except dark brown penultimate segment with median, white spot on proximal margin and dark brown last segment. Ventral surface white, two lateral rows of dark brown spots. Abdominal gland. Gland opening completely doubled as described for genus (Akingbohungbe, 1974), bordered by reddish brown or dark brown. Vestiture. Dense, light brown, piliform setae; all antennal segments also with longer, erect setae.

Female. Length 5.78 - 6.16, width 2.34 - 2.66. Head. Width 1.15 - 1.26, vertex 0.63 - 0.70. Rostrum. Length 2.21 - 2.45; segment I, 0.45 - 0.56; II, 0.52 - 0.63; III, 0.54 - 0.59; IV, 0.65 - 0.72. Antennae. Length of segment I, 0.45 - 0.54; II, 1.26 - 1.46; III, 0.63 - 0.72; IV, 0.50 - 0.54. Pronotum. Length 0.70 - 0.95, anterior width 1.04 - 1.12, posterior width 1.49 - 1.75. Female very similar to male in coloration; tend to be slightly larger than male.

Description was based on the examination of eleven specimens (three males) from noble fir.

Biology

For biological information on other species of Deraeocoris, refer to the "Biology" section of D. incertus.

Of all the mirids on noble fir, the larval stadia of Deraeocoris piceicola were the most frequently observed. All larvae were fed Cinara sp., Macrosiphum rosae (L.) and/or Myzus persicae (Sulzer)

aphids while in the laboratory. The third larval stadium was only two days based on the observation of one larva collected as a second instar larva and reared to a fifth instar larva. The fourth stadium was three to four days for one larva and three days for another. The fifth stadium was five to six days for two larvae and a third larva required six days to complete the fifth stadium. Refer to the "Biology" section of D. incertus for comparative results of other investigators. The results are similar except for the extremely short, third stadium of D. piceicola. More rearing experiments, especially in the field, are needed to better document the larval (and adult) stadia.

Carnivorous feeding by larvae and adults of D. piceicola were observed. One third instar larva was seen feeding on a live, second instar Deraeocoris incertus larva that was molting. This same D. piceicola larva was observed later feeding on a dead Macrosiphum rosae aphid. A single fourth instar larva also was seen feeding on a dead M. rosae aphid and one fifth instar larva fed on a live, immature Cinara sp. aphid. An adult fed on a live Cinara aphid while both were in the collecting jar in the field. Knight (1927b) found specimens of Deraeocoris piceicola only on Picea trees heavily infested with aphid galls. The implication was that D. piceicola was a predator of the aphids. Razafimahatratra (1980) found this species feeding on aphids and chermids in the field and in the laboratory. Cannibalism has been observed in the field for D. piceicola even when the prey populations were abundant (Razafimahatratra, 1980). Partial phytophagy was reported for this species by Razafimahatratra (1980). Fourth instar larvae of D. piceicola were reared by him to the adult stage when supplied with only spruce (Picea sp.) needles.

Attempts were made to observe the oviposition sites of D. piceicola. The adults did not die quickly like the adults of D. incertus, but after a careful search of the branchlets and seedlings, no eggs could be found. Three of the dead females were selected randomly and dissected to observe the stage of egg development. One female was full of eggs, one was half full and one was empty,

suggesting that the latter female had laid its eggs either before being collected on July 31 or in the laboratory where the eggs were not found.

No larvae or adults were collected in the sticky traps placed on the noble fir tree boles on Marys Peak but D. piceicola has not been found in the Coast Range.

No parasitoids were found on the larvae and adults of D. piceicola.

Hosts

Refer to the "Specimens examined" section for specific collection sites, dates and hosts.

I collected larvae and adults of this species only on Abies procera. Razafimahatratra (1980) listed only conifers as known hosts: Abies amabilis, A. procera, Picea engelmannii Parry and Pinus contorta. Razafimahatratra does not specify if larvae and/or adults were collected on these plants. I have collected or seen adults of D. piceicola from Abies lasiocarpa (Hook.) Nutt. and Tsuga mertensiana (Bong.) Carr.

Distribution

Deraeocoris piceicola has not been collected on noble fir in the Coast Range in Oregon on Marys Peak or Grass Mountain. It was collected abundantly in the HJA in Oregon in the Cascade Mountains and also abundantly in the Cascades around Mt. Hood, Oregon and in Washington at White Pass and Stevens Pass.

This western species is distributed throughout the range of Picea engelmannii: Arizona, Colorado, Montana, British Columbia, Washington and Oregon (Razafimahatratra, 1980).

Periods of Occurrence

One generation was observed in the H.J. Andrews Experimental Forest in 1979 (Figure 23). No first instar larvae were collected. Second instar larvae were seen on June 13 and nearly a month later on July 6 (Figure 23). The third instar larvae were collected June 13

and 26, fourth instar larvae June 26 - July 13 and fifth instar larvae July 6 - August 5. Adult males and females were initially collected on the same date, July 20, although males were last seen on August 31 and females were found until October 2.

GENUS DICHROOSCYTUS FIEBER, 1858

According to Kelton (1972b), the genus was proposed by Fieber (1858) to contain one European species, Lygaeus rufipennis Fallén. Kelton (1972c) reported 51 Nearctic species; 48 species from the United States and Canada and three species from Mexico. The majority of the North American species are confined to the western part of the continent with only six species occurring in eastern North America.

Distinctive generic characters include divergent arolia, body above lacking stout setiform bristles, posterior margins of the eyes somewhat flattened and the width of the head across the eyes distinctly less than the width of the pronotum across the base (Slater and Baranowski, 1978).

Many investigators have described a few North American species of Dichrooscytus: O. Heidemann, P.R. Uhler, O.M. Reuter, E.P. Van Duzee, H.H. Knight, B.P. Bliven and L.A. Kelton. Knight (1968) described 20 species from the western United States. Kelton (1972b,c) described 13 new species from North America and Kelton and Schaffner (1972) described four new species from New Mexico and Texas.

Kelton (1972b) stated that the overall color and pattern on the hemelytra were useful for separating species of Dichrooscytus but only if the specimens are mature adults. One of the most used characters for separating species of the genus is the absolute length of the rostrum (Kelton, 1972b). Kelton noted the male genital claspers were quite similar but the female vesicae show distinct differences between groups of species.

Species of Dichrooscytus are found and feed on conifers such as pines, spruce, fir, juniper and arbor-vitae (Kelton, 1972b,c). The biology of the species in this genus is generally unknown except for the biological information provided by Wheeler and Henry (1977) for two species: Dichrooscytus elegans Heidemann and D. repletus (Heidemann).

Dichrooscytus sp. A [nr abietis Bliven]

(Figure 2, adult; Figure 13, fifth instar larva)

Adult

Distinctively yellowish green and red. Species appears to have short head relative to remaining body and widely-spaced eyes relative to other noble fir mirids. Large variations in the length of body parts (e.g., total body, rostrum and antennal segments) of specimens from both Marys Peak and the HJA were observed. Specimens collected from the Andrews Forest had more extensive red markings on the hemelytra than the adults collected from Marys Peak or Grass Mountain, Benton County, Oregon. The basic coloration though was very similar. Rostrum lengths averaged 0.22 mm longer for adults (males and females) from Marys Peak than from the HJA. Twenty four adults were measured. No other morphological differences were found between the populations on noble fir on Marys Peak and in the HJA.

Bliven (1956) described a similar species of Dichrooscytus (D. abietis) from Abies concolor (Gord. and Glend.) Lindl. at Childs Meadows, Tehama County, California but gave no drawings of the genitalia. The description is unfortunately too general to be of value. I attempted to collect Dichrooscytus from Abies concolor at the type locality in 1980 but found none. Therefore, a species determination could not be made for Dichrooscytus sp. A.

Male. Length 4.95 - 5.40, width 1.84 - 1.98. Head. Width 1.30 - 1.33, vertex 0.65 - 0.72; frons yellowish green or green, often with dark green or brown markings; clypeus yellow or green. Rostrum. Length 2.63 - 2.95; segment I, 0.72 - 0.90; II, 0.84 - 0.96; III,

0.42 - 0.58; IV, 0.78 - 0.79. Antennae. Length of segment I, 0.40 - 0.54, varying shades of green; II, 1.76 - 2.07, light green, greenish brown or light brown; III, 0.99 - 1.08, light brown, brown or dark brown; IV, 0.54 - 0.72, light brown, brown or dark brown. Pronotum. Length 0.68 - 0.77, anterior width 0.99 - 1.12, posterior width 1.51 - 1.62, yellow, yellowish green or green with basal margin often darker; calli yellow, yellowish green or light green; collar yellow or light green. Scutellum yellow, yellowish green or light green, anterior margin may be dark green or bright yellow. Legs. Light green, yellowish green or yellow, except last tarsal segment dark brown. Hemelytra. Clavus light green tinged with red, or red with inner margin adjacent to apex of scutellum reddish black and posterior tip yellowish green; cuneus light green tinged with red, or pale red. Corium light green tinged with red, or red with inner margin adjacent to clavus yellowish green; reddish black band extends from middle to posterior edge increasing posteriorly in width. Venter. Yellowish green or green. Vestiture. Short, black setae on head, pronotum and scutellum; dark brown and light brown setae on hemelytra; dark brown setae on legs; brown setae on ventral surface of abdomen; nearly glabrous on ventral surface of thorax.

Female. Length 5.31 - 5.64, width 2.02 - 2.16. Head. Width 1.33 - 1.40, vertex 0.68 - 0.72. Rostrum. Length 2.74 - 3.15; segment I, 0.77 - 0.86; II, 0.90 - 1.01; III, 0.54 - 0.58; IV, 0.72 - 0.81. Antennae. Length of segment I, 0.41 - 0.52; II, 1.76 - 2.30; III, 0.99 - 1.19; IV, 0.72. Pronotum. Length 0.68 - 0.79, anterior width 1.04 - 1.13, posterior width 1.62 - 1.75. Female similar to male in coloration; body more robust, rostrum longer than those of male.

Description was based on the examination of 24 specimens (13 males) from noble fir.

Specimens examined. One hundred and forty four specimens were examined from the following localities: Oregon. Benton Co.: Grass Mtn., 3200 and 3550', on Abies procera, Rehd., VIII-14-80, G. Cooper; Marys Peak,

3250 - 3750', on Abies procera, many dates VI-28-79 to IX-4-79, VII-29-80, VIII-19-80, G. Cooper. Hood River Co.: 3.2 mi. N. Barlow Pass Summit, 4460', Mt. Hood, on Abies procera, VIII-2-80, G. Cooper, on Abies amabilis (Dougl.) Forbes, IX-5-79, G. Stonedahl. Lane-Linn Cos.: Carpenter Mtn., 4360', H.J. Andrews Expt. Forest, on Abies procera, many dates VII-6-79 to VII-31-79, G. Cooper; on Abies amabilis, VII-31-79, G. Stonedahl. Half-2.0 mis. N. Frissel Pt., 4750 - 4850', Andrews Forest, many dates VII-6-79 to VIII-31-79, G. Cooper and G. Stonedahl.

Fifth instar larva

Distinctly yellowish green and red. Short head, widely-spaced eyes and absence of external opening of abdominal gland are characteristic of species. General appearance similar to adult.

Male. Length 3.78 - 4.18, width 1.84 - 2.05. Head. Width 1.22 - 1.44, vertex 0.63 - 0.72; frons yellowish green; clypeus yellowish green, with two nearly glabrous triangular areas striated darker green. Rostrum. Length 2.39 - 2.54; segment I, 0.63 - 0.65; II, 0.72 - 0.81; III, 0.41 - 0.43; IV, 0.65. Antennae. Length of segment I, 0.32 - 0.34; II, 1.22 - 1.26; III, 0.90; IV, 0.68 - 0.77; all segments yellow. Pronotum. Length 0.50 - 0.59, anterior width 0.95 - 1.08, posterior width 1.21 - 1.26, yellowish green with random dark green spots. Legs. Yellowish green. Wing pads. Extend to third or fourth abdominal segment. Yellowish green, with one large red spot on each pad or two longitudinal spots, lateral spot nearly twice length of other and often forked at posterior end. Abdomen. Dorsal and ventral surfaces yellowish green. Abdominal gland. Gland lacks external opening; also no distinctive coloration where opening should be. Vestiture. Two types of short, black setae; one type twice as thick as other. Tibiae also with dark brown spines.

Female. Length 4.36 - 4.54, width 1.91 - 2.09. Head. Width 1.28 - 1.30, vertex 0.63 - 0.68. Rostrum. Length 2.39 - 2.52; segment I, 0.58 - 0.63; II, 0.72 - 0.74; III, 0.36 - 0.40; IV, 0.61 - 0.63. Antennae. Length of segment I, 0.36; II, 1.30 - 1.33; III,

0.95 - 0.99; IV, 0.72 - 0.77. Pronotum. Length 0.50 - 0.61, anterior width 1.08 - 1.13, posterior width 1.30 - 1.37. Very similar to male, only slightly larger body.

Description was based on the examination of 30 specimens (16 males) collected on noble fir.

Biology

Biological information on Dichrooscytus sp. A is limited. The vast majority of larvae and adults died in the collecting containers in the field or in the rearing chamber within two or three days. No other noble fir mirid species died as rapidly after collection. The two longest surviving Dichrooscytus sp. A were a fourth instar larva that was reared for nine days until it died in the molting process and a third instar larva that molted after five days in the laboratory and died three days later without another molt. No larval stadia could be determined.

Third, fourth and fifth instar larvae were observed probing and feeding on various parts of the noble fir branchlets in the covered petri dishes also containing immature Cinara aphids. The larvae were observed probing and feeding on the new growth of the branchlets and on the tip of older needles. Most feeding lasted two to three minutes before the proboscis was withdrawn. One fourth instar larva maintained its proboscis in a young needle for eight minutes. One third instar larva probed repeatedly the woody stem of last year's growth of a branchlet and later appeared to feed for three minutes. No adult feeding was observed.

The species appears to be phytophagous with no predaceous tendencies. Young Cinara larvae were added to the petri dishes but no feeding on live or dead aphids was observed. Butler (1923) stated that Scott (no reference given) noted green cones of Pinus sylvestris L. were attractive to Dichrooscytus rufipennis (Fallén). There are many records of host plants for Dichrooscytus species (e.g., Knight, 1968; Kelton, 1972b) although no feeding observations were recorded.

Other authors have stated some Dichrooscytus species are phytophagous (e.g., D. rufipennis (Knight, 1941) and D. repletus (Wheeler and Henry, 1977)) although no feeding observations were mentioned. The feeding habits of the species of Dichrooscytus require future investigation.

Oviposition was not observed for Dichrooscytus sp. A. Wheeler and Henry (1977) observed the eggs of D. elegens within the scale-like foliage of juniper while D. repletus eggs were found in cedar rust galls.

Only one fifth instar larva and no adults of Dichrooscytus sp. A were found on the sticky traps during the seven weeks the traps were on the tree boles suggesting that the species remained on the foliage and branches.

One hymenopteran parasite was observed in a fifth instar larva of Dichrooscytus sp. A. A determination could not be made because of the extreme difficulty in identifying parasitic hymenopteran larvae but it appeared to be of the family Braconidae[1]. Loan (1974) observed the parasitism of Dichrooscytus tinctipennis Knight by the braconid parasite, Peristenus juniperinus Loan.

Hosts

Refer to the "Specimens examined" section for specific localities, dates and hosts.

Noble fir, Abies procera, presently is the only known host plant. The few adults of Dichrooscytus collected from Abies concolor appear similar to Dichrooscytus sp. A but a detailed examination of the male and female genitalia for both groups is required. None of the species of Dichrooscytus collected from Abies grandis (Dougl.) Lindl., Juniperus sp., Picea engelmannii Parry, Picea sitkensis (Bong.) Carr. and Pinus contorta Dougl. were Dichrooscytus sp. A.

[1] Personal communication with Dr. John D. Lattin, 1980.

Distribution

Dichrooscytus sp. A was collected in the Coast Range in Oregon on Marys Peak and Grass Mountain and in the Cascade Mountains in Oregon in the HJA and around Mt. Hood. No Dichrooscytus sp. A were found at Stevens Pass or White Pass in Washington but these areas were collected when intensive collecting on Marys Peak and in the HJA indicated few Dichrooscytus sp. A adults were still present on the trees.

Periods of Occurrence

On Marys Peak and in the HJA only one generation was found in 1979 (Figures 24 and 25). Certain populations of Dichrooscytus elegans and D. repletus were found to be bivoltine (Wheeler and Henry, 1977). Dichrooscytus sp. A is an early-occurring mirid species and would appear to have sufficient time for a second generation based on the 1979 data but early collections in 1980 showed that the cool, rainy spring and early summer had caused a two to three week delay in larval development. A second generation may not have survived in 1980 which could explain the absence of two generations per year. Generally, climatic conditions may not be favorable for two generations a year.

In 1979 on Marys Peak, first and second instar larvae of Dichrooscytus sp. A were observed May 19 - June 1, third instar larvae June 1-19, fourth instar larvae June 9 - July 11 and fifth instar larvae June 19 - July 11 (Figure 24). Adult males were collected June 28 - August 17 and females were seen July 11 - September 4. The males were collected earlier in the season than the females while the females were observed almost three weeks later than the last males.

Fewer larvae were collected in the HJA in 1979 than on Marys Peak so the periods of occurrence appear more restricted. No first instar larvae were found. Second and third instar larvae were collected only on June 13 (Figure 25). Fourth instar larve were observed June 13-26 and fifth instar larvae June 13 - July 13. Adult males and females were first collected on July 6. Males were last observed on August 5

while one female was seen on August 31. With the exception of this one late-occurring female, the periods of occurrence of both sexes were identical (Figure 25).

Most larval instars (i.e. second, third and fourth) and the adults appeared earlier on Marys Peak. The HJA sites averaged approximately 305 m (1000 ft.) higher in elevation which could be an important causal factor for the later periods of occurrence of this species in the HJA.

GENUS ORTHOTYLUS FIEBER, 1858
subgenus Melanotrichus Reuter

This large, poorly-defined genus contains approximately 110 species worldwide (Carvalho, 1958b) and 45 North American species excluding approximately 30 species of the subgenus Melanotrichus which occur north of Mexico and are predominantly western (Slater and Baranowski, 1978). Van Duzee (1916) provided the most recent key to the North American species of Orthotylus.

The genus is divided into three subgenera: Melanotrichus Reuter, Orthotylus Fieber and Pinocapsus Southwood (Southwood and Leston, 1959). Southwood (1953) had proposed that Melanotrichus and Orthotylus should be further divided into four subgenera: Orthotylus, Melanotrichus, Neomecomma Southwood and Pinocapsus based on a combination of characters including genitalia. Wagner and Weber (1964) retained the four subgenera proposed by Southwood.

Knight (1927c) raised Melanotrichus to generic status because the dorsum of Melanotrichus bears two types of pubescence and a left genital clasper with a simple curved hook. Species of Orthotylus are characterized by a simple pubescence and a left genital clasper that is bifurcate near the base. American authors have continued to classify species into the separate genera, Orthotylus and Melanotrichus. Southwood (1953) concluded that the generic separation

of Orthotylus and Melanotrichus based mostly on pubescence was not reliable and that a greater consideration of genital structures and other morphological characters supported the retention of Melanotrichus as a subgenus. The writer has retained Melanotrichus as a subgenus of Orthotylus.

Species of the subgenus Melanotrichus have convergent arolia, a dorsal surface bearing at least two types of pubescence (one type consists of erect bristle-like hairs) and an absence of prominently projecting plates or spines on the anterior margin of the male genital cavity (Slater and Baranowski, 1978).

Knight has described the majority of the North American species of Orthotylus and Melanotrichus. He described at least 14 species of Orthotylus (Knight 1923, 1925a, 1927d, 1941) and 21 species of Melanotrichus (Knight 1925c, 1968). Recently, Henry (1979) described three new species of Orthotylus from the eastern United States.

The characters used by Knight to separate Melanotrichus species in his final two major works (Knight 1941, 1968) included color of the scale-like setae, male genitalia, length of the rostrum relative to the hind coxae, the length of the second antennal segment and the color of the hemelytra and scutellum.

The majority of the species of the genus Orthotylus are found on trees and shrubs (Slater and Baranowski, 1978). The feeding habits and oviposition sites of the North American species of the genus Orthotylus and of the subgenus Melanotrichus, in particular, are relatively unknown although the biology of some European species of Orthotylus is partially known (Southwood and Leston, 1979).

Orthotylus subgenus Melanotrichus sp. A

(Figure 3, adult; Figure 14, fifth instar larva)

Adult

Greenish yellow, ovate-oblong species with distinctive black markings on the proximal end of the tibiae and distinctive, flattened, silvery setae. Males and females are very similar in size and appearance.

Male. Length 3.06 - 3.40, width 1.22 - 1.35. Head. Width 0.65 - 0.76, vertex 0.32 - 0.38; frons and clypeus yellowish green or light brown. Rostrum. Length 1.07 - 1.17; segment I, 0.22 - 0.29; II, 0.27 - 0.32; III, 0.22 - 0.32; IV, 0.25 - 0.31. Antennae. Length of segment I, 0.22 - 0.27, red, reddish brown, brown or dark brown; II, 0.80 - 0.94, brown, dark brown or black; III, 0.43 - 0.60, brown, dark brown, or black; IV, 0.29 - 0.36, dark brown or black. Pronotum. Length 0.43 - 0.50, posterior width 0.97 - 1.08, anterior angles broadly and evenly rounded when viewed from above; yellowish green, irregularly marked with brownish green. Calli and collar yellowish green, green or brownish green; scutellum and mesoscutum yellow, yellowish green, brownish green or brown, often irregularly marked with brownish green or brown. Legs. Yellow, yellowish brown or brown; proximal end of tibiae black; tarsi darken distally. Hemelytra. Yellow, greenish yellow, green or brownish green. Venter. Yellowish brown or brown. Vestiture. Setaceous, sub-erect, brown setae and flattened, recumbent, sericeous setae (parallel-sided, narrowing distally to fine point) on head, pronotum, mesoscutum, scutellum and hemelytra. Ventral surface, antennae, and legs with brown setae; tibiae also with black spines.

Female. Length 2.97 - 3.42, width 1.22 - 1.44. Head. Width 0.65 - 0.76, vertex 0.36 - 0.41. Rostrum. Length 1.07 - 1.16; segment I, 0.22 - 0.28; II, 0.27 - 0.36; III, 0.22 - 0.31; IV, 0.22 - 0.28. Antennae. Length of segment I, 0.22 - 0.30; II, 0.83 - 0.93; III, 0.45 - 0.61; IV, 0.28 - 0.37. Pronotum. Length 0.40 - 0.50, posterior width 0.92 - 1.08, anterior angles as in male. Very similar to male in all respects.

Description was based on the examination of 36 specimens (16 males) collected on noble fir.

Specimens examined. One hundred and fifty three specimens were examined from the following localities; California. Tehama Co.: Childs Meadow, on Abies concolor (Gord. and Glend.) Lindl., VIII-4-80,

G. Cooper. Oregon. Lane-Linn Cos.: Carpenter Mtn., 4360', H.J. Andrews Expt. Forest, on Abies procera Rehd., VII-31-79 and VIII-31-79, G. Cooper. Half - 2.0 mis. N. Frissel Pt., 4750 - 4850', Andrews Forest, on Abies procera, many dates VII-20-79 to X-16-79, G. Cooper. Josephine Co.: T41S, R7W, Sec2, on Abies concolor, VIII-9-79, G. Stonedahl.

Fifth instar larva

Yellowish green or green with long, black setae. Proximal end of the tibiae distinctively black. First and second antennal segments are red. Larvae appear bluish but lose the blue tinge once placed in alcohol. Collyer (1953) reported Orthotylus marginalis Reuter has a bluish tinge in the last two larval instars.

Male. Length 2.03 - 2.34, width 0.95 - 1.17. Head. Width 0.63 - 0.68, vertex 0.29 - 0.40; frons and clypeus yellow, reddish yellow, yellowish green, or brown. Rostrum. Length 0.89 - 0.98; segment I, 0.21 - 0.23; II, 0.22 - 0.25; III, 0.22 - 0.23; IV, 0.23 - 0.28. Antennae. Length of segment I, 0.18 - 0.22, red or reddish brown; II, 0.54 - 0.58; brown with red tinge, redder proximally; III, 0.41 - 0.48, light brown; IV, 0.32 - 0.36, light brown. Pronotum. Length 0.29 - 0.36, anterior width 0.50 - 0.58, posterior width 0.68 - 0.72; yellowish green or green. Legs. Yellowish green, green, or light brown; tarsi light brown or brown. Wing pads. Extend to third or fourth abdominal segment; yellowish green, green, brown or dark brown. Abdomen. Dorsal and ventral surfaces yellowish green, green or light brown. Abdominal gland. Gland has no apparent external opening and no distinctive coloration where opening should be. Collyer (1953) found Orthotylus marginalis has a prominent orange abdominal gland with very indistinct opening. Akingbohungbe (1974) reported Orthotylus ornatus Van Duzee has a simple opening with no tendency towards secondary doubling and no sclerotized bar above it. Vestiture. Long, black setae except short, thinner, black setae on antennae and ventral surface of abdomen.

Female. Length 2.25 - 2.34, width 1.12 - 1.22. Head. Width 0.63 - 0.72, vertex 0.32 - 0.38. Rostrum. Length 0.97 - 1.00; segment I, 0.20 - 0.24; II, 0.24 - 0.26; III, 0.22 - 0.27; IV, 0.24 - 0.29. Antennae. Length of segment I, 0.18 - 0.22; II, 0.55 - 0.58; III, 0.44 - 0.48; IV, 0.30 - 0.35. Pronotum. Length 0.28 - 0.36, anterior width 0.50 - 0.58, posterior width 0.67 - 0.76. Very similar to male.

Description was based on the examination of ten specimens (five males) collected from noble fir.

Biology

Larvae of this species were discovered in the alcohol collection about six months after the specimens were collected. This explains why no attempt was made to rear larvae of Orthotylus sp. A and the larval stadia could not be determined.

No observations were made of the feeding behavior of the species. Within the genus Orthotylus, phytophagy, carnivory or mixed feeding have been reported. The host-plants of many Orthotylus species have been reported: e.g. Scots pine, ash, oak, hazel, wych elm, willow, alder, apple, sycamore, birch, nettles, broom and chenopods. But, few direct feeding observations have been made. Orthotylus ericetorum (Fallén) attacks the flowers and leaves of heather and "cross-leaved heath" (Southwood and Leston, 1959). Heavy feeding by Orthotylus chlorionis (Say) on honeylocust apparently injures leaves and causes some discoloration (Burbutis, 1968).

Many Orthotylus species are at least partially predaceous on small insects, insect eggs, small arthropods and mites. Fryer and Petherbridge (1917) noted O. marginalis was phytophagous on apple leaves and fruits. Butler (1923) reported the young larvae of the same species pierced young flower and fruit buds or small, developing fruits causing malformations or death. Kullenberg (1946) regarded the species as both phytophagous and zoophagous but with a preference for the latter. Collyer (1953) reported O. marginalis exhibited cannibal-

ism and fed on red spider mites, aphids, and other small prey. Strawinski (1964) stated the species fed on Aphididae and Psyllidae as well as on plant sap. Southwood and Scudder (1956) stated Orthotylus ochrotrichus Fieber was partially predaceous on mites and aphids. Larvae and adults of Orthotylus tenellus (Fallén) feed on the sap of their host plants (ash, oak and hazel) and also on small insects such as aphids, whiteflies, small flies and eggs and larvae of beetles and moths (Puckov, 1961; Southwood and Leston, 1959; Strawinski, 1964). Orthotylus virescens (Douglas and Scott) larvae and adults are partial predators but also damage young broom leaves by causing numerous small white patches (Southwood and Leston, 1959). Dempster (1964) reported that O. adenocarpi (Perris), O. concolor (Kirschbaum) and O. virescens fed on broom, Sarothamnus scoparius (L.) Wimm., and to some extent all three species fed on eggs and larvae of psyllids, aphids and other mirids.

No oviposition was observed in the field or in the laboratory. Southwood and Leston (1959) reported the oviposition sites of six Orthotylus species: O. tenellus in young wood near the leaf base, O. marginalis and flavinervis (Kirschbaum) in young wood near the buds, O. ericetorum singly or in irregular rows in young shoots, O. flavosparsus often in rows in the stems of chenopods, and O. diaphanus (Kirschbaum) in willow wood. Waloff and Southwood (1960) found O. adenocarpi, O. concolor and O. virescens oviposited in the one- or two-year-old shoots of broom.

No larvae or adults were collected in the sticky traps during the seven-week period the traps were on the tree boles suggesting that the species remains on the foliage and branches.

No parasitoids of the larvae or adults of Orthotylus sp. A were observed. No North American species of the genus has been cited as a host of a hymenopteran parasite in the Catalog of Hymenoptera in America North of Mexico (Krombein et al., 1979). Leston (1959) recorded two Orthotylus species as hosts of Braconidae in Great Britain: Orthotylus marginalis and O. adenocarpi. Leston (1961a)

added four new Orthotylus hosts: O. concolor, O. ericetorum, O. tenellus and O. virescens.

Hosts

Refer to the "Specimens examined" section for specific collection sites, dates and hosts.

Larvae and adults of Orthotylus species A have been collected only on Abies procera. Although second, third, fourth and fifth instar larvae have been collected from noble fir, the number of larvae has not been large relative to the many adults collected. The larvae may utilize a part of the trees not sampled or the species may use another plant species as its principal host and noble fir is the secondary or accidental host. Also, the sampling procedure may not be efficient in collecting the larvae. A sufficient number of larvae was collected though to consider noble fir a host plant. Adult males and females were also collected on Abies concolor.

Distribution

This species was collected on noble fir in the Cascades in Oregon in the H.J. Andrews Forest and at three sites around Mt. Hood. No specimens were collected on Marys Peak or Grass Mountain in the Coast Range in Oregon. One adult female was collected on Abies concolor in Josephine County, Oregon (T41S, R7W, Sec2). Adults were collected on Abies concolor in the Sierra Nevada Mountains at Childs Meadow, California.

Periods of Occurrence

One generation was observed in the Andrews Forest in 1979 (Figure 26). Southwood and Leston (1959) reported Orthotylus flavosparsus has two generations a year and Orthotylus rubidus Fieber probably has two generations a year. Southwood and Leston (1959) implied that the other fifteen species of Orthotylus in the British Isles have one generation a year like Orthotylus sp. A. Waloff and Southwood (1960) observed one

generation annually for Orthotylus adenocarpi, O. concolor and O. virescens.

No larvae or adults were collected on Marys Peak. In the H.J. Andrews Forest, one second instar larva was collected on July 13 (Figure 26). Third instar larvae had a long period of occurrence: June 26 - July 31. Fourth instar larvae were observed July 6-31 and fifth instar larvae were found July 13-31. On July 13, second, third, fourth and fifth instar larvae were collected. This is a large number of larval instars for one date. Rarely more than two instars were observed on any collecting date for any mirid species collected on noble fir except this Orthotylus species and Plagiognathus species A. Adult males and females had the same period of occurrence: July 20 - October 2. More males than females were collected throughout this period. Adult males did not occur earlier than females nor were females more abundant later in the collecting season even though both occurrences were generally common for the noble fir mirids.

GENUS PARADACERLA CARVALHO AND USINGER, 1957

This western Northern American genus contains four species: two species from the western United States, one of the species also found in British Columbia, and two species known only from Mexico.

Carvalho and Usinger (1957) created the genus Paradacerla, separating it from Dacerla Signoret, 1881 based on the absence of a projection on the posterior margin of the pronotum. Extreme, consistent brachyptery in both sexes may be considered a generic character (Carvalho and Usinger, 1957). Kelton and Knight (1959) reported that the differences in the male and female genitalia appear no greater between a species of Dacerla and those of Paradacerla than between species of Paradacerla. They suggested that only a single genus may exist although they did not combine them. Future studies of other species of the tribe Herdoniini must be conducted before the value

of external characters such as brachyptery, projections on the pronotum and scutellum and pubescence can be evaluated (Kelton and Knight, 1959).

The genus is characterized by divergent arolia, a myrmecomorphic condition, width of the head across the eyes conspicuously greater than the width of the pronotum across the humeri and pronotum posteriorly lacking a spine-like projection (Slater and Baranowski, 1978).

Kelton and Knight (1959) presented a key to the species of Paradacerla. Characters used to separate the species included: color of the posterior margins of the hemelytra, shape of the second antennal segment (linear or swollen) and color of the posterior margin of the pronotum.

No biological information could be found for any species of Paradacerla or the closely related genus Dacerla. Host records are even limited for the four known species of Paradacerla.

Paradacerla formicina (Parshley)
(Figure 4, adult; Figure 15, fifth instar larva)

Dacerla formicina Parshley 1921: 18; Carvalho, 1959: 349.

Paradacerla formicina Kelton and Knight, 1959: 122.

Adult

Only ant-mimetic, brachypterous species collected from noble fir. Constricted thorax, brachytery and rounded abdomen give males and females a very distinct, ant-like appearance. Adult males and females have two color forms which occur in near equal proportions. Thorax and legs may be either black or various shades of brown: brown, dark brown, reddish brown or dark reddish brown. Dark reddish brown or dark brown color forms appear to be intermediates of two color extremes: light brown and black. Carvalho and Usinger (1957) suggested the "red" (or brown) form was teneral but

specimens with a brown thorax and legs do not appear teneral, i.e., body parts such as the third and fourth antennal segments have not shrivelled when dried.

Male. Length 4.95 - 5.78, body width across hemelytra 1.04 - 1.13. Head. Width 1.15 - 1.30, vertex 0.51 - 0.57; frons and clypeus black. Rostrum. Length 2.16 - 2.41; segment I, 0.49 - 0.58; II, 0.59 - 0.70; III, 0.40 - 0.50; IV, 0.59 - 0.72. Antennae. Length of segment I, 0.58 - 0.68, longer than vertex, brown or dark brown; II, 2.34 - 2.81, brown or dark brown, distal end black and swollen twice width of proximal end; III, 1.28 - 1.62, dark brown or black, proximal end often yellow, light brown, or brown; IV, 1.08 - 1.44, black. Pronotum. Length 0.94 - 1.08, anterior width 0.67 - 0.76, posterior width 0.65 - 0.72, black, reddish brown or brown tinged with black; scutellum red, reddish brown, reddish black or black. Legs. Reddish brown, dark brown, reddish black or black; distal tip of tarsi black. Hemelytra. Very short, reaching only to second abdominal segment; often lighter shades of brown than pronotum in brown color forms; black, reddish brown or dark reddish brown tinged with black. Abdomen. Width 1.76 - 2.16, black; ventral surface with large basal yellow or yellowish white spot and smaller spot at base of connexivum under hemelytra. Vestiture. Short, sub-depressed, silvery setae and short, sparse, erect, light brown setae; short, brown setae only on antennae and legs.

Female. Length 5.34 - 6.16, body width across hemelytra 1.08 - 1.30. Head. Width 1.26 - 1.31, vertex 0.54 - 0.67. Rostrum. Length 2.25 - 2.52; segment I, 0.49 - 0.58; II, 0.63 - 0.79; III, 0.40 - 0.52; IV, 0.63 - 0.76. Antennae. Length of segment I, 0.58 - 0.67; II, 2.48 - 2.81; III, 1.28 - 1.71; IV, 1.08 - 1.46. Pronotum. Length 0.99 - 1.12, anterior width 0.74 - 0.83, posterior width 0.67 - 0.74. Abdomen. Width 1.98 - 2.57. Female very similar to male but generally more robust.

Description was based on the examination of 34 specimens (12 males) from noble fir.

Specimens examined. Two hundred and two specimens were examined from the following localities: Idaho. Benewah Co.: 4 mis. W. Emida on Hwy. 6, on Abies grandis (Dougl.) Lindl., Pinus contorta Dougl. and Pseudotsuga menziesii (Mirb.) Franco., VII-9-79, G. Stonedahl; 4 mis. SW. Emida on Sanders Rd., on Vaccinium sp., VII-7-79, G. Stonedahl; 6.5 mis. SE. Emida on Palouse Divide Rd., on Ceanothus integerrimus Hook and Arn., VII-9-79, G. Stonedahl. Oregon. Benton Co.: Grass Mtn., 3200 and 3550', on Abies procera Rehd. and Pseudotsuga menziesii, IX-17-79, G. Stonedahl, VIII-14-80, G. Cooper and J. Lattin. Marys Peak, 1700', on blackberry, VI-24-70, P. Oman; 3250 - 3750', on Abies procera, many dates VII-18-79, to IX-4-79, G. Cooper. Clackamas Co.: Government Camp, 3900', Mt. Hood, on Pseudotsuga menziesii, G. Stonedahl. Deschutes Co.: Pioneer Ford FC Metolius River, VII-7-59, K. Fender. Hood River Co.: Cloud Cap, 6000', Mt. Hood, on Pinus contorta, IX-5-79, G. Stonedahl; 0.4 mi. N. Cooper Spur Ski Area, 3920', Mt. Hood, on Abies procera, IX-5-79, G. Cooper; 3.2 mis. N. Barlow Pass, 4460', Mt. Hood, on Abies procera, IX-5-79, G. Stonedahl. Josephine Co.: O'Brien, V-30-52, V. Roth; 7 mis. N. Grants Pass, VI-29-53, V. Roth; T41S, R6W, Sec7, on Abies concolor (Gord. and Glend.) Lindl., VIII-9-79, G. Stonedahl; T41S, R7W, Sec2, on Abies concolor and Abies magnifica A. Murr. (?), VIII-9-79, G. Stonedahl. Klamath Co.: 0.5 mi. E. Parker Summit on Hwy 66, on Castanopsis sp., VI-27-79, G. Stonedahl; 1 mi. E. Summit of Cascades on Hwy. 66, on Pinus ponderosa Laws., VI-26-79, G. Stonedahl. Lane Co.: 2.0 mis. W. Willamette Pass on Hwy. 58, on Ribes sp., VII-17-79, G. Stonedahl and J. Lattin. Lane-Linn Cos.: Carpenter Mtn., 4800', H.J. Andrews Expt. Forest, sweeping, VII-20-77 and VIII-2-77, Eulensen and Searles; on Holodiscus discolor (Pursh.) Maxim., VIII-13-80, G. Cooper; on Ribes sp., VIII-13-80, G. Cassis; sweeping flowers, VIII-13-80, K. Phillips. Carpenter Mtn., 4360', Andrews Forest, on Abies procera, VII-20-79 and VIII-19-79, G. Cooper; on Abies amabilis (Dougl.) Forbes, VII-31-79, G. Stonedahl. Access Rd. 1533 - 0.9 mi. N. Jct. 1533 - 1533J, Andrews Forest, on Alnus sp. and Ceanothus sp., VII-6-77, Eulensen and Searles. Half - 2.0 mis.

N. Frissel Pt., 4750 - 4850', Andrews Forest, on Abies procera, many dates VII-6-79 to VII-31-79, G. Cooper; on Pinus monticola Dougl., VIII-5-79, G. Stonedahl; on Penstemon sp., VII-23-80, G. Cooper and K. Phillips; on Tsuga mertensiana (Bong.) Carr., VIII-27-80, G. Cooper. Quarter mi. SE. ending of road 1506 - 350, 4650', Andrews Forest, on Holodiscus discolor, VIII-30-78, G. Stonedahl. T15S, R5E, Sec24, NW 1/4, 3500', Andrews Forest, on Ceanothus velutinus Dougl., VII-20-79, G. Cooper. T15S, R5E, Sec24, SE 1/4, 3300', Andrews Forest, Ceanothus velutinus and Ribes sp., VII-6-79, G. Cooper. T15S, R5E, Sec28, 1750', on Vaccinium parviflorum Smith and Salix sp., VI-13-79, G. Stonedahl. T15S, R5E, Sec34, SE 1/4, 3940', Andrews Forest, on Alnus sinuata (Reg.) Rydb., VII-23-80, G. Cooper. Watershed 1, 1500', Andrews Forest, on Alnus rubra Bong., VII-23-80 and VIII-27-80, G. Cooper and K. Phillips. Linn Co.: Summit N. Santiam Pass, VII-9-59, K. Fender. Multnomah Co.: 3 mis. W. Holbrook, 1100', on bracken, VII-16-59, J. Lattin. Yamhill Co.: Top of Bald Mtn., VII-4-58 and VII-13-58, K. Fender; Ball Mt., VII-28-57, K. Fender.

Fifth instar larva

Ant-mimetic larva. Distinguished by strongly myrmecomorphic condition, second antennal segment swollen at distal end, dorsal surface of first and second abdominal segments white with red band on second segment and wing pads that barely reach to first abdominal segment.

Male. Length 5.28, body width across hemelytral pads 0.92. Head. Width 1.08, vertex 0.52; clypeus reddish black, frons black, between and behind eyes dark reddish brown. Light red "Y" on head with lateral branches extending in front of eyes and short stalk in middle of head extending to pronotum and beyond to distal end of center of wing pads. Rostrum. Length 1.83; segment I, 0.43; II, 0.48; III, 0.38; IV, 0.54. Antennae. Length of segment I, 0.47, light brown; II, 1.66, red at both ends and reddish brown in center, slightly swollen at distal end; III, 1.21, light brown;

IV, 1.22, red except proximal end, light brown. Pronotum. Length 0.90, anterior width 0.70, posterior width 0.63; dark reddish brown with thin medial red line. Legs. Coxae, femora and tibiae reddish brown or red except distal end of tibiae brown; tarsi brown, distal tip of tarsi black. Wing pads. Extend to first abdominal segment; reddish brown with thin medial red line. Abdomen. Width 1.48; first and second segments as above; dorsal surface of other segments dark reddish brown, distal segments grayish brown; ventral surface white narrowing to point at middle of seventh or eight segment, remaining ventral surface dark reddish brown. Abdominal gland. Gland opening appears completely doubled, not bordered by distinctive coloration. Vestiture. Appears nearly glaborous; sparse, black hairs on antennae and legs; thin, silvery hairs also scattered on legs; tibiae also with brown spines.

Female. Length 5.50 - 5.78, body width across hemelytral pads 0.92 - 1.17. Head. Width 1.08 - 1.22, vertex 0.49 - 0.58, coloration like male between and behind eyes except dark reddish brown or black. Rostrum. Length 1.73 - 1.96; segment I, 0.39 - 0.48; II, 0.43 - 0.54; III, 0.38 - 0.43; IV, 0.45 - 0.55. Antennae. Length of segment I, 0.41 - 0.50, light brown or brown; II, 1.73 - 1.93; III, 1.17 - 1.31; IV, 1.21 - 1.40. Pronotum. Length 0.83 - 0.90, anterior width 0.74 - 0.85, posterior width 0.59 - 0.77, coloration like male except dark reddish brown or black. Abdomen. Width 1.44 - 1.85, coloration similar to male except dorsal surface of penultimate segment white except small, medial, dark brown triangular area. Female larger than male. General body coloration similar to that of male.

Description was based on the examination of nine specimens (only one male) from noble fir.

Biology

No field collected larvae were reared in covered petri dishes in the growth chamber so larval stadia remain unknown.

Feeding observations were limited to one fifth instar larva and two adults. Each was observed on separate dates sucking on a dead Cinara aphid. The two adults fed on the dead aphids while the Paradacerla adults and aphids were still in the live collecting vials in the field. The aphids were placed alive in the vials. Therefore, the aphids were either killed by the mirids or they had died shortly before being fed upon. The species appears to have predaceous tendencies although more observations are needed. The adults have been collected from many hosts by the author and his colleagues (see "Hosts" section) which indicate Paradacerla formicina may be a generalized predator. There are no known published observations on the feeding habits of this species nor of other species of the genus Paradacerla.

Oviposition by this species was not observed in the field or in the laboratory. There are no known recorded observations of the oviposition sites or behavior of any species of the genus.

No larvae or adults were collected in the sticky traps during the seven-week period the traps were on the tree trunks, suggesting that the species remains on the foliage and branches or the traps failed to capture larvae or adults because of the apparent low numbers found on noble fir.

Parasitoids were not observed of the larvae or adults of this mirid. The Catalog of Hymenoptera in America North of Mexico (Krombein et al., 1979) listed no Paradacerla species as a host of parasitic Hymenoptera.

Hosts

Refer to the "Specimens examined" section for specific collection sites, dates and hosts.

Parshley (1921) collected adults from Rubus nutkanus Moc. (synonomized now with Rubus parviflorus Nutt.). No other published host records were found.

I have collected both the larvae and adults of Paradacerla formicina only on Abies procera. There remains doubt if noble fir

should be considered a host of this mirid because the number of collected larvae was low. But since the number of adults collected was also low, noble fir is considered an infrequent host of P. formicina.

Adults only have been collected from many other plants: Abies amabilis, A. concolor, A. grandis, Alnus rubra, Alnus sinuata, Castanopsis sp., Ceanothus integerrimus, Ceanothus velutinus, Holodiscus discolor, Penstemon sp., Pinus contorta, P. monticola, P. ponderosa, Pseudotsuga menziesii, Pteridium sp., Ribes sp., Rubus sp., Salix sp., Tsuga mertensiana and Vaccinium parviflorum. Extensive collecting of both larvae and adults must be completed from these plant species and other possible hosts.

Distribution

I examined specimens from northern Idaho and western and central Oregon. It has been recorded previously from British Columbia, California, Idaho and Oregon (Kelton and Knight, 1959).

This mirid species was found at each locality where I collected on noble fir except in Washington at Stevens Pass and White Pass. It was found in the Coast Range in Oregon on Marys Peak and Grass Mountain and in the Cascade Mountains in Oregon in the HJA and two sites around Mt. Hood.

Periods of Occurrence

One generation was observed on Marys Peak and in the Andrews Forest during the 1979 collecting season (Figures 27 and 28). The number of generations per year was previously unrecorded for all species of Paradacerla.

Seventeen collecting trips were made to Marys Peak in 1979. No first instar larvae were collected, one second instar larva was collected on June 1, one third instar larva was collected on June 9 and two fourth instar larvae were collected on June 28 (Figure 27). Fifth instar larvae were collected July 11 and July 18. Adults were collected in low numbers (never more than one to three per date):

males July 18 - August 17 and females July 25 - September 4. A single male was collected one week before the first female was collected. The low abundance of adults precludes the conclusion that adult males of this species occur earlier than the females. Only adult females were present late in the collecting season.

Thirteen collecting trips were made to the noble fir sites in the HJA. No first, second or third instar larvae were collected. Two fourth instar larvae were seen on June 26 and fifth instar larvae were collected July 6-20 (Figure 28). Adult males were found only on July 20 while adult females were collected both earlier and later than the males on July 6 - August 19. Adults were collected in low numbers, i.e., one to three per collecting site, which also occurred on Marys Peak. The periods of occurrence for older larvae and adults on Marys Peak and in the HJA were very similar.

GENUS PHYTOCORIS FALLÉN, 1814

This cosmopolitan genus is one of the largest, most complex of all the North American mirid genera with 263 species worldwide (Carvalho, 1959) and approximately 150 species from western North America (Stonedahl, 1980). Species characteristically have arolia divergent at the apex, pseudoarolia present, second antennal segment linear or nearly so, hind femora long and flattened and extending considerably beyond the end of the abdomen, and general body color usually brown and black with yellow or white spots (Slater and Baranowski, 1978).

The majority of the North American species of Phytocoris were described by O. Heidemann, P.R. Uhler, O.M. Reuter, E.P. Van Duzee and H.H. Knight in the late 19th and early 20th centuries. Knight (1923) established several species groups for the eastern species of Phytocoris based on the color of the wing membrane, male genital

structures and the length and the color of the antennal segments. Species groups were established by Knight in 1968 for the western species of Phytocoris based primarily on antennal color patterns. Most of the North American species were treated by Knight in 1920, 1923, 1941, 1968 and 1974. Several additional species were described by Henry (1974, 1979) and Kelton (1979).

Morphological characters used to separate the species of Phytocoris include: shape, length and color of the first, second and third antennal segments; structure of the male genitalia; color of the scutellum, clavus, corium, cuneus, pronotum and femora; types of setae on various body parts; length of the rostrum; and width of the vertex (Knight 1941, 1968).

The biology of the majority of species of Phytocoris presently is, at best, only partially known. Many species appear to have predaceous tendencies both as larvae and adults (e.g., Knight, 1941; Southwood and Leston, 1959; Wheeler and Henry, 1977). No oviposition sites have been reported for any species of Phytocoris in North America. Southwood and Leston (1959) described the oviposition sites of several British species of Phytocoris. One generation per year is assumed for most species of Phytocoris although few direct observations have been reported.

Phytocoris neglectus Knight

(Figure 5, adult; Figure 16, fifth instar larva)

Phytocoris neglectus Knight, 1920: 54; Knight, 1941: 194; Carvalho, 1959: 207.

Adult

Mottled grayish, brown, dark brown or black and white or grayish white with distinctively long, hind legs. Tibiae triannulated, hind tibiae occasionally dark brown or black with white spots. Femora dark brown or black with many white or yellowish white spots. Males and females are very similar.

Male. Length 6.38 - 7.20, width 2.05 - 2.34. Head. Width 0.95 - 1.04, vertex 0.32 - 0.38; frons white, grayish white or white tinged with red, with dark brown or black striae; white spot often on posterior margin between eyes; clypeus black with varying size of median white spot; white or light brown spots at base of juga near antennal bases. Rostrum. Length 2.50 - 2.81; segment I, 0.56 - 0.67; II, 0.65 - 0.76; III, 0.54 - 0.67; IV, 0.72 - 0.85. Antennae. Length of segment I, 1.17 - 1.35, black or dark brown with white spots of varying sizes; II, 2.52 - 2.93, black or dark brown with proximal tip yellowish brown or white; III, 1.24 - 1.49, black, proximal tip yellowish brown or white; distal tip often yellowish brown or white; IV, 0.94 - 1.17, black. Pronotum. Length 0.72 - 0.90, anterior width 0.65 - 0.83, posterior width 1.62 - 1.82, grayish brown, brown, dark brown or black, often black or dark brown band near white posterior margin; calli white, light brown or grayish brown with varying amount of black marking; collar light or dark brown, or mottled white, grayish white or light brown and red, reddish brown, brown or dark brown; scutellum white, grayish white or grayish brown with two median black or dark brown lines, or mottled grayish brown and dark brown; mesoscutum like scutellum, also with lateral margins black or dark brown. Legs. Coxae white or yellowish white with few scattered dark brown or black spots; femora described in diagnosis; tibiae white or yellowish white with three black or dark brown bonds, hind tibiae occasionally dark brown or black with white or yellowish white spots. Hemelytra. Clavus mottled grayish brown, dark brown or black and grayish white or white; corium like clavus except with large white spot along posterior margin; anterior half of cuneus white, or mottled white and grayish brown, dark brown or black, posterior half grayish brown, dark brown or black with white or grayish white spots. Venter. Black, often large median white, grayish white or yellowish white spot on abdomen and near posterior end. Vestiture. Black setae and slightly flattened, sericeous setae on body, not appendages; cuneus also with short, light brown setae. Antennae with short, light brown setae, first antennal

segment also beset with longer, silvery setae. Legs with short, light brown setae, tibiae also with light brown spines.

Female. Length 6.05 - 7.04, width 2.07 - 2.47. Head. Width 0.94 - 1.03, vertex 0.38 - 0.41. Rostrum. Length 2.61 - 2.90; segment I, 0.58 - 0.72; II, 0.63 - 0.79; III, 0.56 - 0.68; IV, 0.76 - 0.83. Antennae. Length of segment I, 1.24 - 1.44; II, 2.54 - 3.06; III, 1.24 - 1.53; IV, 0.94 - 1.26. Pronotum. Length 0.72 - 0.90, anterior width 0.72 - 0.85, posterior width 1.64 - 1.89. Female very similar in all respects to male.

Description was based on examination of 35 specimens (15 males) from noble fir.

Specimens examined. One hundred and eighty specimens were examined from the following localities: Oregon. Benton Co.: Grass Mtn., 3200', on Castanopsis chrysophylla (Dougl.) A.D.C., IX-18-71, J. Lattin; Grass Mtn., 3200 and 3550', on Abies procera Rehd., IX-17-79, G. Stonedahl. Marys Peak, 3600', on Abies procera X-1-59, J. Lattin; 3350', IX-8-71, J. Lattin; summit, on Abies procera, IX-21-76, J. Lattin; 3750', on Abies procera, IX-14-77, J. Lattin; on Pseudotsuga menziesii (Mirb.) Franco, VIII-17-78 and IX-7-78 (3450'), J. Lattin; 3500 and 3600', on Abies procera, VIII-17-78, IX-1-78 and IX-24-78, J. Lattin and V. Razafimahatratra; 3250 - 3750', on Abies procera, many dates VII-25-79 to X-10-79, G. Cooper and G. Stonedahl; 2000', on Castanopsis chrysophylla, VIII-26-79, G. Cooper. Clackamas Co.: Government Camp, 3900', Mt. Hood, on Abies procera, IX-5-79, G. Cooper. Clatsop Co.: 14 mis. E. Seaside, Necanicum River, VIII-15-61, D. Smith. Curry Co.: Alfred A. Loeb State Park, on Myrica californica Cham., VIII-10-79, G. Stonedahl; Harris Beach, on Arctostaphylos sp., VIII-11-79, G. Stonedahl; Little Redwood Campground, on Lithocarpus densiflorus (Hook. and Arn.) Rehd., VIII-11-79, G. Stonedahl. Hood River Co.: 6 mis. SE. Parkdale, 3320', on Abies amabilis (Dougl.) Forbes, VIII-23-78, G. Stonedahl. Lane-Linn Cos.: Carpenter Mtn., 4360', H.J. Andrews Expt. Forest, on Abies procera, VII-27-79, G.

Cooper; 1.3 mis. N. Frissel Pt., Andrews Forest, on Abies procera, X-2-79, G. Cooper. Old-growth Douglas-fir stand, Andrews Forest, on Rhododendron sp., VIII-8-72, no collector; on plastic window trap, VII-12-72, W. Nagel. T15S, R5E, Sec33, NE 1/4, 3000', Andrews Forest, fifth instar larvae on Tsuga heterophylla (Raf.) Sarg. reared to adults, VII-30-80 (as larvae), G. Cooper. Washington. King Co.: Stevens Pass, Old Stevens Pass Rd., 3200 and 3520', on Abies procera and Tsuga mertensiana (Bong.) Carr., VIII-21-79, G. Cooper and G. Stonedahl. Whatcom Co.: Mt. Baker National Forest, on Tsuga heterophylla, IX-7-79, G. Stonedahl; 4 mis. NE. Welcome on North Fork Rd., on Acer macrophyllum Pursh, VII-22-79, G. Stonedahl.

Fifth instar larva

Mottled brown, red and white larva characterized by long hind legs, biannulate second and triannulate third antennal segments and triannulate tibiae. White spots found on first antennal segments, wing pads and femora.

Male. Length 3.60 - 4.68, width 1.42 - 1.98. Head. Width 0.83 - 0.95, vertex 0.43 - 0.49; frons white marked with red or dark brown; clypeus white, middle brown or dark brown. Rostrum. Length 1.89 - 2.24; segment I, 0.45 - 0.51; II, 0.51 - 0.57; III, 0.36 - 0.52; IV, 0.54 - 0.68. Antennae. Length of segment I, 0.81 - 0.94, brown tinged with red, row of large white spots; II, 1.82 - 2.16, brown, biannulate, proximal end and middle with white bands, distal tip often reddish brown; III, 1.17 - 1.35, brown, triannulate, proximal end, middle and distal tip with white bands; IV, 0.95 - 1.08, brown, proximal tip red. Pronotum. Length 0.47 - 0.54, anterior width 0.63 - 0.81, posterior width 0.90 - 1.17, white mottled with brown, grayish brown, reddish brown or red, lateral margins dark brown or black. Legs. Femora brown, grayish brown or dark brown with white spots of varying size, front and middle femora less brown, more white spots than hind femora; tibiae white, triannulate with brown or reddish brown; tarsi brown except middle of segment often white or

light brown. Wing pads. Extend to third or fourth abdominal segment; brown or grayish brown with white spots of varying size, median area black mottled with white. Abdomen. Dorsal surface white mottled with red, reddish brown or brown; ventral surface white, except lateral margins mottled white and red. Abdominal gland. Gland opening appears completely doubled as described for genus (Akingbohungbe, 1974), bordered by brown or reddish brown. Vestiture. Long, black setae; tibiae also with short, brown setae and brown spines. Brown setae only on last three antennal segments.

Female. Length 3.96 - 4.50, width 1.44 - 1.84. Head. Width 0.77 - 0.94, vertex 0.40 - 0.47. Rostrum. Length 2.08 - 2.27; segment I, 0.51 - 0.54; II, 0.54 - 0.60; III, 0.48 - 0.51; IV, 0.55 - 0.66. Antennae. Length of segment I, 0.79 - 0.94; II, 1.67 - 2.02; III, 1.17 - 1.26; IV, 0.99 - 1.12. Pronotum. Length 0.41 - 0.56, anterior width 0.72 - 0.83, posterior width 0.85 - 1.13. Female very similar to male.

Description was based on examination of nine specimens (five males) from noble fir.

Biology

Larvae of Phytocoris neglectus were reared at 24°C (75°F) and fed Cinara sp. and Macrosiphum rosae aphids. The late larval stadia were based on the observation of three third instar nymphs that were reared to the adult stage. The fourth larval stadium was three to four days and the fifth larval stadium was six to seven days. The larval stadia of other Phytocoris species have not been reported, which precludes any comparisons.

I observed a fifth instar larva feeding on a small, live dipteran larva in the laboratory. One adult of P. neglectus was seen feeding on a live Macrosiphum rosae aphid in the laboratory and another adult fed on a dead Cinara aphid also in the laboratory. These observations suggest the species has predaceous and possibly

scavenging tendencies. Knight (1920) reported that nymphs and adults of P. neglectus fed on psocids and he suggested that the species was probably predaceous on most soft-bodied insects found on the bark of host-plants. Turnock (1953) found P. neglectus feeding on larch sawfly eggs and newly hatched sawfly larvae. One second instar larva of P. neglectus was reared to the adult stage on spruce mites on branchlets of its host (Wheeler and Henry, 1977). They found a fourth instar larva on Irish juniper, Juniperus communis hibernica Gord., infested with Cinara aphids and a fifth instar nymph on Hetz juniper infested with juniper scales. The implication was that the larvae were feeding on the aphids and scales.

The feeding habits of most North American species of Phytocoris are relatively unknown. The majority of species are reported to be predators or possible predators. Knight (1941) reported that Phytocoris breviusculus Reuter was reared on apple branches heavily infested with San José scales. Knight (1920,1941) recorded that the following species were predaceous although no prey species were listed: Phytocoris arundinicola Knight, P. conspurcatus Knight, P. corticevivens Knight and P. erectus Van Duzee. Knight (1941) regarded many other species as probable predators: e.g., P. antennalis Reuter, P. albifacies Knight and P. canadensis Van Duzee. Knight reported only Phytocoris tricinctipes Knight as a predator in his 1968 review of the western North American species of Phytocoris. Martin (1966) reported Phytocoris eximius Reuter was predaceous and may have been a regulatory factor for populations of the aphid Schizolachnus pini-radiatae (Davidson) on Pinus resinosa Aiton. Ives (1967) reported an undetermined species of Phytocoris preyed on larch sawfly eggs. Wheeler and Henry (1977) observed that P. breviusculus was associated with the parts of host-plants heavily infested with scales and mites. They noted that adults fed readily on housefly eggs and early instar larvae in the laboratory. Adult longevity suggested predaceous tendencies when provided red cedar, mites and scales (15.3 days) versus water only (8.0 days), mites and scales only (8.7 days) or just red cedar (6.3 days) (Wheeler and Henry, 1977). The species may be at

least partially phytophagous since longevity nearly doubled when red cedar was added together with the insect prey although Wheeler and Henry did not suggest the possibility. They also observed the mirid often probing in and around the juniper needles. Partial phytophagy was recorded for Phytocoris ulmi (Linnaeus), a British species (Southwood and Leston, 1959). They stated that the species fed mainly on small insects like aphids and red spider mites but also on unripe fruits, buds and young leaves of various plants.

At least one North American species of Phytocoris has been suggested to be phytophagous: P. junipericola Knight (Knight, 1927). He found it on terminal twigs of red cedar and its hypodermal pigments were identical to those of the plant-feeding Parthenicus juniperi (Heidemann). Wheeler and Henry (1977) considered Phytocoris junipericola phytophagous although they reported no observations. Southwood and Leston (1959) reported that Phytocoris varipes Boheman, a British species, fed mostly on unripe fruits and flowers of various plants and probably on small animals.

The oviposition site of Phytocoris neglectus on noble fir was not observed in the field or in the laboratory. No reported oviposition sites could be found for any North American species of Phytocoris. Phytocoris tiliae (Fabricius), a British species, inserts its eggs in young apple wood (Collyer, 1953) and in the young wood of most deciduous trees such as oak, ash and lime (Southwood and Leston, 1959). Phytocoris ulmi oviposits in the bark of trees (especially hawthorn) and shrubs in the British Isles and P. varipes lays its eggs in the stems of host-plants in England, Wales and Ireland (Southwood and Leston, 1959).

No larvae or adults were collected in the sticky traps during the seven-week period the traps were on the tree boles but the traps were removed before the adults were present in large numbers on noble fir so no conclusion can be made regarding the movement of the adults of this species on the trees. Knight (1941) collected larvae and adults of Phytocoris neglectus on the bark of apple trees suggesting that this species may also inhabit the boles of the noble fir trees.

No parasitoids of the larvae or adults could be found. Loan (1974) reported one undetermined North American species of Phytocoris as a host of the braconid parasite, Peristenus dumestris Loan. No other species of Phytocoris was reported as a host of Braconidae in the Catalog of Hymenoptera in America North of Mexico (Krombein et al., 1979). John D. Lattin reared a Braconidae parasite from a larva of an undetermined species of Phytocoris collected at Tombstone Prairie, Linn County, Oregon[2]. Leston (1961a) listed Phytocoris reuteri Saund. and P. ulmi as hosts of Braconidae in Great Britain.

Hosts

Refer to the "Specimens examined" section for specific dates, localities and hosts.

I have collected larvae and adults of Phytocoris neglectus on Abies procera and Tsuga heterophylla which presently are the only known hosts.

My colleagues and I have collected adults only of this species on Abies amabilis, Acer macrophyllum, Arctostaphylos sp., Castanopsis chrysophylla, Lithocarpus densiflorus, Myrica californica, Pseudotsuga menziesii, Rhododendron sp., and Tsuga mertensiana. The adults of this species occur on a wide range of coniferous and deciduous plants.

Knight (1920) collected Phytocoris neglectus on the bark of apple trees. Wheeler and Henry (1977) reported that the mirid has been collected on deciduous hosts, particularly apple, Malus pumila Mill. Two adults were collected by them on eastern arbovitae (Thuja sp.). They also collected occasional nymphs on Chamaecyparis obtusa (Sieb. and Zucc.) Endl. Hinoki C., Juniperus communis hibernica Gord. and Hetz Juniper.

[2] Personal communication, 1980.

Distribution

Phytocoris neglectus was collected frequently in the Coast Range in Oregon: near Seaside in the north, Grass Mountain, Marys Peak and Alfred Loeb State Park in the south. The species was collected in the Cascade Mountains in Washington at Stevens Pass and in Oregon around Mt. Hood and in the Andrews Forest.

Phytocoris neglectus has an interesting distribution on noble fir in the Cascade Mountains. Only one adult was collected in the Andrews Forest on noble fir compared to approximately 100 adults collected from Marys Peak from a similar number of collecting trips when adults of the species were present. Only one adult was collected near Mt. Hood and no adults were seen at White Pass, Washington. Adults were collected commonly at Stevens Pass, which is the northernmost limit of noble fir. More collecting must be done on noble fir, but it appears the species is common on noble fir in the Coast Range and only at the northern limit of noble fir in the Cascades.

Phytocoris neglectus appears to be the only noble fir mirid species with a transcontinental distribution. The species has been recorded from New York, Massachusetts, Maine, Michigan and Minnesota (Knight, 1920) and also from Illinois, Iowa, Mississippi, New Hampshire, Ontario, South Carolina, South Dakota and Washington (Knight, 1941). Parshley (1921) observed the species in British Columbia. Turnock (1953) reported P. neglectus from the Prairie Provinces of Canada. Wheeler and Henry (1977) collected it from Pennsylvania.

Periods of Occurrence

Despite 13 collecting trips to the noble fir sites in the H.J. Andrews Experimental Forest, few larvae and adults of Phytocoris neglectus were collected on noble fir. A first instar larva was collected on July 9, 1980. A second instar larva was seen on July 6 and 13, 1979. No third or fourth instar larvae were collected. A single fifth instar nymph was found on July 20, 1979. One adult was

collected on October 2, 1979. The species was obviously uncommon on Abies procera in the HJA in 1979.

One generation was observed for Phytocoris neglectus on Marys Peak in 1979 (Figure 29). Knight (1920) reported two apparent generations in one season for P. neglectus. He recorded two generations per year for the species specifically in New York (Knight, 1941). One other North American species of Phytocoris has been suggested to have two generations a year: Phytocoris breviusculus in Missouri (Froeschner, 1949) and in Pennsylvania (Wheeler and Henry, 1977). The vast majority of the North American species of Phytocoris have no information on the number of generations annually. Collyer (1953) reported one generation a year for Phytocoris tiliae in England. Southwood and Leston (1959) implied that the nine species of Phytocoris found in Great Britain had only one generation a year.

On Marys Peak in 1979, first and second instar larvae were collected only on June 28 (Figure 29). Third instar larvae were seen June 28 - July 11, fourth instar larvae on July 3-25 and fifth instar larvae on July 11 - August 3 and on September 4. Adult males were seen August 3 - September 4 and on October 10. Females were observed August 17 - September 30. Adult males were collected earlier in the season than females. Females were not observed later in the collecting season than the males as is common for many noble fir mirids. Phytocoris neglectus first appeared as an adult later in the 1979 season than any other Miridae associated with Abies procera.

Phytocoris sp. A [nr abiesi Knight]

(Figure 6, adult; Figure 17, fifth instar larva)

Adult

Distinctively mottled white or yellowish white and black or dark brown mirid with long hind legs. Characteristic preapical white or yellowish white band on hind femora. Tibiae triannulate. Male with longer body length and more black or dark brown markings than female.

Male. Length 7.98 - 9.13, width 2.36 - 2.63. Head. Width 1.17 - 1.24, vertex 0.36 - 0.38; clypeus black; base of juga with yellowish white spot near antennal bases; frons black or dark brown with median, yellowish white spot; vertex yellowish white with median, dark brown or black, inverted "Y". Rostrum. Length 3.24 - 3.65; segment I, 0.74 - 0.85; II, 0.85 - 0.99; III, 0.67 - 0.81; IV, 0.92 - 1.10. Antennae. Length of segment I, 1.40 - 1.62, black or dark brown occasionally with small, white or yellowish white spots; II, 3.35 - 3.85, black or dark brown, proximal tip white or yellowish white; III, 1.80 - 2.09, black or dark brown; IV, 0.90 - 1.26, black or dark brown. Pronotum. Length 0.88 - 0.99, posterior width 1.82 - 2.02, anterior angles broadly and evenly rounded when viewed from above, yellowish white or white with lateral margins broadly dark brown or black, rarely with large, median dark brown or black spot; collar yellowish white, green or greenish white often marked with red or reddish brown, lateral margins narrowly dark brown or black; scutellum convex, black or dark brown with anterior angles, apex and median line yellowish white or white; mesoscutum black or dark brown with two lateral yellowish white spots often tinged with red. Legs. Coxae yellowish white, greenish yellow or yellow; femora dark brown, density of yellowish white or white spots increases apically, hind femora with preapical, transverse yellowish white or white band; tibiae dark brown, triannulate with yellowish white or white, apical band often mottled with dark brown; tarsi dark brown or black. Hemelytra. White mottled with varying amounts of brown or dark brown; anterior half of cuneus white or yellowish white, posterior tip or half dark brown or brown. Venter. Dark brown to black; yellowish white, greenish yellow or yellow spots along lateral margins at wing bases. Vestiture. Sub-erect, black setae intermixed with recumbent, silvery setae except on appendages. Antennae with silvery setae and scattered, erect, black setae also on first antennal segment; femora with sub-erect or recumbent black setae; tibiae with brown setae and black spines; tarsi densely covered with light brown setae.

Female. Length 6.98 - 7.70, width 2.11 - 2.56. Head. Width 1.08 - 1.17, vertex 0.40 - 0.49. Rostrum. Length 3.46 - 3.67; segment I, 0.79 - 0.86; II, 0.86 - 1.01; III, 0.72 - 0.83; IV, 1.01 - 1.08. Antennae. Length of segment I, 1.37 - 1.66; II, 3.24 - 3.78; III, 1.60 - 2.02; IV, 0.99 - 1.19. Pronotum. Length 0.81 - 0.92, posterior width 1.75 - 2.03, anterior angles as in male. Similar to male in color and pubescence except fewer brown or dark brown markings on pronotum, scutellum, mesoscutum and hemelytra. Female body length shorter, width of head smaller and vertex wider than in male.

Description was based on the examination of 21 specimens (nine males) collected from noble fir.

Specimens examined. Twenty one specimens were examined from the following localities: Oregon: Benton Co.: Marys Peak, 3500 - 3800', on Abies procera Rehd., VIII-6-75, J. Lattin; VII-25-79, VIII-3-79 and VIII-17-79, G. Cooper. Lane-Linn Cos. Carpenter Mt., 4360', H.J. Andrews Expt. Forest, on Abies amabilis (Dougl.) Forbes, VII-31-79, G. Stonedahl. Half - 2.0 mis. N. Frissel Pt., 4750 - 4850', Andrews Forest, on Abies procera, VII-20-79, VII-31-79 and VIII-13-80, G. Cooper and G. Stonedahl.

Fifth instar larva

Mottled brown, red and white or yellowish white larva characterized by long hind legs; large, median, white or yellowish white spots on mesoscutum and scutellum; and large, preapical, white or yellowish white band on hind femora. White spots found only on distal end of femora.

Male. Length 3.85 - 4.56, width 1.48 - 1.98. Head. Width 0.94 - 1.04, vertex 0.40 - 0.47; clypeus red or reddish brown with two lateral white spots, or brown tinged with red; frons white or yellowish white with brown or dark brown striae; vertex white or yellowish white with median, dark brown or black, inverted "V". Rostrum. Length 2.52 - 2.81; segment I, 0.54 - 0.63; II, 0.68 - 0.85;

III, 0.56; IV, 0.77. Antennae. Length of segment I, 0.94 - 1.08, reddish brown or brown; II, 2.25 - 2.61, yellowish white or brown; III, 1.06 - 1.67, yellowish white or brown; IV, 0.92 - 1.17, light brown or brown. Pronotum. Length 0.45 - 0.63, posterior width 1.01 - 1.28, anterior angles broadly and evenly rounded when viewed from above, white or yellowish white, laterally mottled red and white, or brown and yellowish white, lateral margins reddish black or black; mesoscutum and scutellum reddish brown or brown with large, white or yellowish white spot. Legs. Coxae white or yellowish white; proximal half of femora red or reddish brown, distal half with white or yellowish white spots; large, preapical, white or yellowish white band on hind femora. Front and middle tibiae white, triannulate with brown or dark brown; hind tibiae brown or dark brown, biannulate with white or yellowish white; tarsi brown. Wing pads. Extend to third or fourth abdominal segment, mottled brown or dark brown and yellowish white or white, posterior tips black. Abdomen. Mottled red and white or yellowish white. Abdominal gland. Gland opening with sinuate, sclerotized bar and tendency towards secondary doubling unlike double gland opening described for genus by Akingbohungbe (1974), opening bordered by brown. Venter. Mottled red and white or white with lateral margins red. Vestiture. Long, black setae on dorsum; except longer setae on first antennal segment, shorter setae on second and third antennal segments, and very short, fine setae on fourth antennal segment with few, scattered, longer setae at base of segment. Tibiae with long, black setae and black spines. Venter with only brown setae.

Female. No fifth instar females were collected.

Description based on examination of three males from noble fir.

Biology

For biological information on other species of Phytocoris, refer to the "Biology" section of P. neglectus.

Only two attempts were made to rear the larvae of Phytocoris sp. A because the few collected larvae were preserved in alcohol for possible

future larval instar descriptions. Two third instar larvae were reared and fed Cinara sp. and Macrosiphum rosae (L.) aphids. However, both larvae died molting to the fifth instar. The resultant fourth stadium was four to five days. No other complete larval stadium was observed.

No feeding by the larvae was observed in the rearing containers. Adults were so rare that no adults were placed in the rearing containers to observe feeding tendencies or oviposition sites.

One adult male of Phytocoris sp. A was collected on a sticky trap during the seven-week period the traps were on the tree boles. This usually would suggest very little about the movement of the species on noble fir but it was the rarest species found on noble fir: only 20 adults have been collected. Collecting one adult from the tree bole may suggest that this mirid species inhabits both the tree boles and the branches where the majority of species were collected. All of the adults were collected from old-growth noble firs which have the following common greenish white or grayish white lichens that cover the tree boles and branches: Ramalina sp. nr farinacea (L.) Ach. (the commonest species), Hypogymnia imshaugii Krog, Hypogymnia sp. and Usnea sp. nr subfloridana Stirt. The adults of Phytocoris sp. A would be easily camouflaged if found on the lichen. The lichen on the boles of various noble fir trees were vacuumed in a search for the adults of this mirid. None were found but the species was uncommon and the vacuuming was limited. More extensive collecting in the lichen is needed to determine if this mirid favors the lichen-covered branches and boles.

The larvae and adults of Phytocoris sp. A were examined externally for insect parasitism. No such parasitism was found for the larvae or adults.

Hosts

Refer to the "Material examined" section for specific dates, localities and hosts.

My colleagues and I have collected larvae and adults of Phytocoris sp. A on Abies amabilis and A. procera which presently are the only known hosts.

Distribution

Phytocoris sp. A was collected only in Oregon in the Coast Range on Marys Peak and in the Cascade Mountains in the H.J. Andrews Experimental Forest. No specimens were collected on Grass Mountain or around Mt. Hood in Oregon or at White Pass or Stevens Pass in Washington. This is an early-occurring Phytocoris relative to P. neglectus (see the periods of occurrence for both species) and other conifer-inhabiting Phytocoris. Trips to the sites with Abies procera where no specimens of this mirid were collected were probably after the disappearance of the adults of Phytocoris sp. A.

Periods of Occurrence

Phytocoris sp. A had one generation in 1979 on Marys Peak and in the Andrews Forest (Figures 30 and 31).

On Marys Peak, one first instar larva was collected on June 1 and one second instar larva was seen on June 9 (Figure 30). Third instar larvae were found on June 1 and 28 and July 3. No fourth or fifth instar larvae were collected. Adult females were collected on July 25 and August 3. Males were seen August 3 and 17.

In the HJA, no first or second instar larvae were collected. Third instar larvae were seen June 13 - July 6 while fourth and fifth instar larvae were found on July 6 and 13 (Figure 31). Adult females were collected on July 20 and 31 and males were found only on July 31. On both Marys Peak and in the Andrews Forest, females were collected before males and on Marys Peak, a single male was the last adult collected. Both occurrences were not typical of noble fir mirids but very few adults were collected. Any observations on the periods of occurrence of both sexes need to be supported by future collection data.

GENUS PINALITUS KELTON, 1955

The genus was proposed by Kelton (1955) to contain one North American species, Lygus approximatus (Stål). He stated the species resembled a Neotropical species of the genus Alda Reuter except for the shorter first antennal segment. Slater and Baranowski (1978) characterized the genus by the very elongate second antennal segment, twice or nearly twice as long as the head width across the eyes, pronotal collar narrower than or only as wide as the width of the second antennal segment and rostrum extending posteriorly to the fifth or sixth abdominal segment.

Knight (1968) added four new species from western United States and transferred Lygidea solivaga Van Duzee to the genus. Kelton (1977) revised the genus to include five species in North America and only one species outside of North America. The species, Pinalitus rubricatus (Fallén), is found throughout Europe, Siberia and northern Africa. Kelton (1977) used absolute lengths of the rostrum as the most important distinguishing character in his key to the species. He also used the color of the hemelytra and male genital structures.

All species are arboreal on conifers. Species have been collected on Picea spp., Pinus spp., Abies spp. and Pseudotsuga menziesii. Kelton (1977) refers to the host plant of two Pinalitus species but no one has described the feeding behavior of any species in the genus. Little biological information is known for the genus.

Pinalitus solivagus (Van Duzee)

(Figure 7, adult; Figure 18, fifth instar larva)

Lygidea solivaga Van Duzee 1921: 119.
Pinalitus solivagus Knight 1968: 188; Kelton, 1977: 1550.
Pinalitus brevirostris Knight 1968: 187.
Pinalitus utahensis Knight 1968: 188.

Adult

Varying color with a very elongate second antennal segment. General body color may be reddish orange or dark red marked with dark brown or black, or mottled light brown and brown. Butler (1923) noted Lygus rubricatus (Fallén) (now Pinalitus rubricatus) showed considerable color variability which was not due merely to varying degrees of hardening of the cuticle. Males have more extensive black markings than females on calli, posterior margin of the pronotum and on the head. Orange adults with no dark markings were occasionally collected from noble fir. Further collecting revealed that these adults were commonly on Pseudotsuga menziesii. An examination of the male genitalia of the orange adults and the red or brown adults commonly collected on noble fir indicated that the adults were all of the same species. It appears that the host-plant may affect the color form of the adults.

Male. Length 4.27 - 4.86, width 1.51 - 1.69. Head. Width 0.85 - 0.92, vertex 0.31 - 0.36; frons black or mottled with brown and red or light brown; clypeus black. Rostrum. Length 2.00 - 2.34; segment I, 0.54 - 0.58; II, 0.50 - 0.63; III, 0.38 - 0.49; IV, 0.54 - 0.65. Antennae. Length of segment I, 0.41 - 0.54, light brown, brown or black; II, 1.62 - 1.84, nearly twice width of head, light brown or brown darkening distally or whole segment black; III, 0.81 - 0.92, black; IV, 0.47 - 0.58, black. Pronotum. Length 0.56 - 0.65, anterior width 0.47 - 0.63, posterior width 1.30 - 1.40; punctate, mottled brown and light brown or black or red; calli black; posterior margin black; collar white. Scutellum light brown, proportion of black markings vary on anterior corners and center, often median line light brown. Legs. Femora mottled brown and red or light brown; tibiae brown or dark brown; tarsi brown, distal half of last tarsal segment black. Hemelytra. Mottled red and light brown; cuneus red, or inner margin only of cuneus red. Venter. Mottled red, brown and dark brown, or ventral surface brown, dark brown or orange. Vestiture. Light brown, semi-erect setae; tibiae also with black spines.

Female. Length 4.23 - 4.88, width 1.64 - 1.91. Head. Width 0.90 - 0.97, vertex 0.40 - 0.43. Rostrum. Length 2.34 - 2.57; segment I, 0.56 - 0.65; II, 0.54 - 0.72; III, 0.41 - 0.54; IV, 0.67 - 0.76. Antennae. Length of segment I, 0.40 - 0.50; II, 1.33 - 1.67; III, 0.72 - 0.94; IV, 0.47 - 0.58. Pronotum. Length 0.58 - 0.72, anterior width 0.54 - 0.68, posterior width 1.40 - 1.53. Female tends to be redder with black markings on head, pronotum and scutellum reduced. Calli rarely black, often mottled like pronotum. Vestiture similar to male. Female body and head wider than male. Second antennal segment shorter in female.

Description was based on the examination of 28 specimens (13 males) collected on noble fir.

Specimens examined. Six hundred and nine specimens were examined from the following localities: California. Shasta Co.: Mt. Shasta Ski Area, 8000', on Abies lasiocarpa (Hook.) Nutt., VIII-31-79, J. Lattin. Siskiyou Co.: Mt. Eddy, 9000', VII-28-1918, E.P. Van Duzee (male and female paratype of California Academy of Sciences). Oregon. Benton Co.: Grass Mtn., 3200 and 3550', on Abies procera Rehd. and Pseudotsuga menziesii (Mirb.) Franco., IX-17-79, G. Stonedahl; on Abies procera and Pseudotsuga menziesii, VIII-14-80, G. Cooper and J. Lattin. Marys Peak, 3250 - 3750', on Abies procera, X-14-75, J. Lattin; on Abies procera and Pseudotsuga menziesii, VIII-17-78, J. Lattin and V. Razafimahatratra; on Abies procera IX-1-78, IX-7-78 and X-3-78, J. Lattin; on Abies procera, many dates VII-18-79 to X-10-79, G. Cooper; on Pseudotsuga menziesii, IX-4-79, G. Stonedahl; on Abies procera VII-28-80 and VIII-19-80, G. Cooper. Hood River Co.: Cloud Cap, 6000', Mt. Hood, on Pinus contorta Dougl. and Pinus albicaulis Engelm., IX-5-79, G. Stonedahl. North 3.2 mis. of Barlow Pass, 4460', Mt. Hood, on Abies amabilis (Dougl.) Forbes, IX-5-79, G. Stonedahl; on Abies procera, IX-5-79, G. Cooper. Josephine Co.: T41S, R6W, Sec7, on Abies concolor (Gord. and Glend.) Lindl., VIII-9-79, G. Stonedahl. Lane-Linn Cos.: Carpenter Mtn., 4360', H.J. Andrews

Expt. Forest, on Abies amabilis, VII-31-79, G. Stonedahl. Half - 2.0 mis. N. Frissel Pt., 4750 - 4850', Andrews Forest, on Abies procera, many dates VII-20-79 to VIII-31-79, G. Cooper; on Pseudotsuga menziesii, VIII-31-79, G. Stonedahl, VIII-27-80, G. Cooper, G. Cassis, K. Phillips. Washington. King Co.: Stevens Pass, Old Stevens Pass Rd., 3200 and 3520', on Abies amabilis and A. procera, VIII-21-79, G. Cooper and G. Stonedahl. Whatcom Co.: Heather Meadows, on Abies amabilis, IX-7-79, G. Stonedahl; Mt. Baker National Forest, T39N, R9E, Sec16, on Abies amabilis, IX-7-79, G. Stonedahl. Yakima Co.: 3 mis. E. White Pass Summit, 4200', on Abies amabilis and A. procera, VIII-23-79, G. Cooper and G. Stonedahl.

Fifth instar larva

Body mottled light brown and orange or red with sparse, black setae. Wing pads similarly mottled, or brown with tips dark brown or black.

Male. Length 3.06 - 3.55, width 1.51 - 1.55. Head. Width 0.83 - 0.86, vertex 0.31 - 0.38; frons and clypeus brown or mottled light brown and orange or red. Rostrum. Length 1.78 - 2.07; segment I, 0.47 - 0.52; II, 0.45 - 0.56; III, 0.36 - 0.38; IV, 0.50 - 0.54; light brown except distal half of segment IV black. Antennae. Length of segment I, 0.31 - 0.36, light brown or mottled light brown and red; II, 1.03 - 1.13, light brown or mottled light brown and red with tip redder; III, 0.65 - 0.81, light brown; IV, 0.52 - 0.59, brown or reddish brown. Pronotum. Length 0.45 - 0.51, anterior width 0.68 - 0.74, posterior width 1.03 - 1.05; brown or mottled light brown and orange or red. Legs. Coxae, femora and tibiae mottled light brown and orange or red. Tarsi light brown except distal half of last segment black. Wing pads. Extend to fourth abdominal segment. Abdomen. Dorsal and ventral surfaces mottled light brown and orange or red. Abdominal gland. Single dorsal opening with sinuate, sclerotized bar and a distinct tendency towards secondary doubling; no distinctive coloration around opening. Vestiture. Sparse, short, black setae.

Female. Length 3.42 - 3.91, width 1.55 - 1.67. Head. Width 0.85 - 0.92, vertex 0.41 - 0.45. Rostrum. Length 1.96 - 2.14; segment I, 0.49 - 0.54; II, 0.45 - 0.58; III, 0.31 - 0.45; IV, 0.52 - 0.59. Antennae. Length of segment I, 0.34 - 0.40; II, 1.08 - 1.17; III, 0.70 - 0.81; IV, 0.50 - 0.61. Pronotum. Length 0.48 - 0.52, anterior width 0.72 - 0.81, posterior width 1.04 - 1.12. Very similar to male, only tends to be slightly larger.

Description was based on the examination of ten specimens (four males) collected on noble fir.

Biology

Many larvae were reared in covered petri dishes in the growth chamber but no larva survived more than one molt so the larval stadia could not be determined.

The feeding behavior of the species remains relatively unknown. The larvae and adults hid on the underside of noble fir needles which made feeding observations nearly impossible. Two different fifth instar larvae were observed beaking and sucking dead Cinara aphids suggesting the species has scavenging tendencies. Another fifth instar larva was seen feeding on a live aphid, Macrosiphum rosae (L.). No plant feeding by larvae or adults was observed. More observations must be made before a conclusion can be drawn on the feeding preference of this species.

Southwood and Leston (1959) cited spruce, firs and Scots pine as the host-plant for Orthops rubricatus (Fallén) (now Pinalitus rubricatus). Henry and Wheeler (1974) referred to Orthops rubricatus as a "conifer-feeding" mirid. Although this species is assumed to be phytophagous, no direct feeding observations from the field or the laboratory were described in either reference. Ives (1967) tested the predaceous tendencies of Pinalitus approximatus (Stål) larvae and adults on larch sawfly eggs. Unfortunately, the test results were inconclusive because of the small numbers tested.

Adult males and females were reared together in an attempt to observe the oviposition sites. After an intensive search of the branchlets, no eggs could be found. Southwood and Leston (1959) reported that Orthops rubricatus eggs were laid in young conifer needles.

No larvae or adults were collected in the sticky traps during the seven-week period the traps were on the tree boles suggesting the species remains exclusively on the foliage and branches.

Insect parasitism was not observed on any larvae or adults of this Pinalitus species. No species of the genus has been cited as a host of a hymenopteran parasite in the Catalog of Hymenoptera in America North of Mexico (Krombein et al., 1979).

Hosts

Refer to the "Specimens examined "section for specific collection sites, dates and hosts.

Adults and larvae of Pinalitus solivagus have been collected only on Abies procera. Adults only have been found on Abies amabilis, Pseudotsuga menziesii, Tsuga heterophylla and Tsuga mertensiana but in areas with noble fir. Collecting for larvae must be conducted on these tree species before any other trees should be considered hosts. Kelton (1977) reported that the mirid species has been collected on Abies lasiocarpa, Abies sp., Pseudotsuga menziesii and Picea engelmannii.

Distribution

I have collected this species on Marys Peak and Grass Mountain in the Coast Range in Oregon and various places in the Oregon and Washington Cascade Mountains: in the HJA, around Mt. Hood, White Pass summit, and Stevens Pass. The species' distribution appears to be extensive. It was described by Van Duzee from Mt. Eddy, California. Additional records are from Arizona, British Columbia, Colorado, New Mexico and Utah (Kelton, 1977).

Periods of Occurrence

One generation was found during the 1979 collecting season on Marys Peak and in the Andrews Forest (Figures 32 and 33).

On Marys Peak, no first instar larvae were seen while a single second instar larva was collected on June 9. Third instar larvae were collected June 9-28, fourth instar larvae June 19 - July 11 and fifth instar larvae June 28 - July 25 (Figure 32). Adult males and females were first collected on July 25. Males were found until September 4 while females were seen until October 10. The females were present a month longer than the males which was longer than usual for the noble fir mirid species. Pinalitus solivagus was one of only two noble fir mirids found so late in the season (October 10); the other species was Phytocoris neglectus.

Few larvae or adults were collected in the HJA. No first or second instar larvae were collected. Third instar larvae were seen June 13 - July 6, fourth instar larvae July 6-13 and fifth instar larvae July 13-20 (Figure 33). Adult males were collected July 20 - August 5 and females occurred later, July 31 - August 31. The periods of occurrence of the larvae or adults varied very little between Marys Peak and the Andrews Forest.

GENUS PLAGIOGNATHUS FIEBER, 1858

This is a large genus of small, more or less shining, oval or oblong species. The genus contains at least 99 species worldwide (Carvalho, 1958a) and 78 species north of Mexico (Slater and Baranowski, 1978). Species of the genus have a rostrum extending to or beyond the hind coxae, hind tibiae with dark or black spines usually with black spots at their bases, and head and pronotum covered with decumbent hairs or pubescence, without erect bristles (Slater and Baranowski, 1978).

Knight has described the vast majority of new species in North America. At least 28 new species of Plagiognathus were described by him (Knight 1923; 1925b; 1926; 1927a; 1941; 1968). Knight (1941) relied heavily on the color of many body parts (e.g., second antennal segment, cuneus, scutellum, pronotum and femora) to separate species of the genus. Other characters included the length of the second antennal segment relative to the width of the pronotum or the width of the head and the position of the rostrum relative to the middle coxae.

Species have been recorded from many different species of herbs, shrubs and trees (Knight, 1941). The biology of various North American species is at least partially known: e.g., Plagiognathus delicatus (Uhler) (Wheeler and Henry, 1976), P. politus Uhler (Wheeler, 1974) and P. vitellinus Scholtz (Henry and Wheeler, 1973).

Plagiognathus sp. A

(Figure 8, adult; Figure 19, fifth instar larva)

Adult

Oblong species varying from light to dark brown, occasionally black. Teneral adults are yellowish brown. Adults darken to brown or black; black adults appear to be the oldest specimens. No obvious, distinctive characters are found on this species. The absence of flattened, silvery setae separate this species from Psallus species A and B which are very similar to Plagiognathus species A. Males and females are very similar in size and appearance.

Male. Length 2.97 - 3.42, width 1.13 - 1.28. Head. Width 0.67 - 0.72, vertex 0.33 - 0.37; frons and clypeus brown, dark brown or black. Rostrum. Length 1.35 - 1.62; segment I, 0.32 - 0.42; II, 0.36 - 0.45; III, 0.29 - 0.36; IV, 0.33 - 0.46. Antennae. Length of segment I, 0.20 - 0.27; II, 0.78 - 0.90; III, 0.48 - 0.59; IV, 0.32 - 0.39; all segments dark brown or black. Pronotum. Length 0.37 - 0.49, posterior width 0.92 - 1.04, anterior angles broadly and evenly rounded when viewed from above; brown, dark brown or black; calli and collar dark brown or black. Scutellum and mesoscutum brown, dark brown or black.

Legs. Coxae dark brown or black; femora yellowish brown, brown or dark brown with black spots or black only, distal tip often yellow; tibiae yellow, brown or dark brown with black spots at bases of black spines; tarsi brown, dark brown or black. Hemelytra. Brown, dark brown or black. Venter. Brown, dark brown or black. Vestiture. Setaceous, decumbent, light brown setae.

Female. Length 2.97 - 3.42, width 1.22 - 1.44. Head. Width 0.66 - 0.72, vertex 0.33 - 0.39. Rostrum. Length 1.47 - 1.56; segment I, 0.31 - 0.36; II, 0.36 - 0.43; III, 0.29 - 0.36; IV, 0.36 - 0.46. Antennae. Length of segment I, 0.23 - 0.27; II, 0.74 - 0.88; III, 0.48 - 0.54; IV, 0.32 - 0.39. Pronotum. Length 0.39 - 0.46, posterior width 0.93 - 1.04, anterior angles as in male.

Females have wider bodies than males, very similar in other respects.

Description was based on the examination of 48 specimens (24 males) from noble fir.

Specimens examined. Six hundred and seventy specimens were examined from the following localities: Oregon. Benton Co.: Grass Mtn., 3200 and 3550', on Abies procera Rehd., IX-17-79, G. Stonedahl; on Abies procera, VIII-14-80, G. Cooper and J. Lattin. Marys Peak, 3250 - 3750', on Pseudotsuga menziesii (Mirb.) Franco., VIII-17-78, J. Lattin; on Abies procera, IX-1-78 and IX-7-78, J. Lattin; on Abies procera, many dates, VII-18-79 to X-10-79, VIII-19-80, G. Cooper. Clackamas Co.: Government Camp, 3900', Mt. Hood, on Abies procera, IX-5-79, G. Cooper. Hood River Co.: Barlow Pass Summit, 4160', Mt. Hood, on Abies procera, IX-5-79, G. Cooper; 3.2 mis. N. Barlow Pass Summit, 4460', Mt. Hood, on Abies procera, IX-5-79, G. Cooper and G. Stonedahl; on Abies procera, VIII-2-80, G. Cooper. Lane-Linn Cos.: Carpenter Mtn., 4360', H.J. Andrews Expt. Forest, on Abies procera, many dates VII-31-79 to X-9-79, G. Cooper. Half - 2.0 mis. N. Frissel Pt., 4750 - 4850', Andrews Forest, on Abies procera, many dates VII-20-79 to X-9-79,

G. Cooper. Washington. King Co.: Stevens Pass Summit, 3250', on Abies amabilis (Dougl.) Forbes VIII-21-79, G. Stonedahl; on Abies procera, VIII-21-79, G. Cooper. Yakima Co.: 3 mis. E. White Pass Summit, 4200', on Abies amabilis, VIII-23-79, G. Stonedahl; on Abies procera, VIII-23-79, G. Cooper and G. Stonedahl.

Fifth instar larva

Yellowish green or green larva with no obvious distinguishing characters. Wing pads yellow in recently molted fifth instar larvae but darkening to green then dark green. Wing pads are dark brown immediately prior to ecdysis.

Male. Length 2.12 - 2.75, width 1.08 - 1.31. Head. Width 0.63 - 0.68, vertex 0.29 - 0.40; frons and clypeus yellow, yellowish green, green or brownish green. Rostrum. Length 1.15 - 1.31; segment I, 0.24 - 0.32; II, 0.29 - 0.39; III, 0.19 - 0.27; IV, 0.34 - 0.39. Antennae. Length of segment I, 0.18 - 0.23; II, 0.54 - 0.72; III, 0.40 - 0.51; IV, 0.31 - 0.41; all segments greenish brown, light brown or brown. Pronotum. Length 0.27 - 0.36, anterior width 0.54 - 0.63, posterior width 0.68 - 0.77; yellowish green or green. Legs. Yellowish green, green or brownish green, distal tip of tarsi brown. Wing pads. Extend to third or fourth abdominal segment; yellow, green, brown or dark brown. Abdomen. Dorsal and ventral surfaces yellowish green, green or brownish green. Abdominal gland. Opening with a sinuate sclerotized bar and distinct tendency towards secondary opening as described for genus (Akingbohungbe, 1974); not bordered by distinctive coloration. Vestiture. Black, setaceous setae except thinner setae on antennae.

Female. Length 2.34 - 2.88, width 1.10 - 1.24. Head. Width 0.63 - 0.70, vertex 0.27 - 0.39. Rostrum. Length 1.18 - 1.27; segment I, 0.26 - 0.32; II, 0.32 - 0.36; III, 0.22 - 0.27; IV, 0.30 - 0.38. Antennae. Length of segment I, 0.18 - 0.25; II, 0.59 - 0.72; III, 0.44 - 0.53; IV, 0.36 - 0.40. Pronotum. Length 0.28 - 0.35, anterior width 0.53 - 0.63, posterior width 0.68 - 0.75. Very similar to male.

Description was based on the examination of 20 specimens (eleven males) collected on noble fir.

Biology

Many field-collected larvae were reared in covered petri dishes in a growth chamber but few survived more than one molt so data on the larval stadia are limited. The fourth stadium was about four days and the fifth stadium was four to five days based on the observation under laboratory conditions of two and three larvae, respectively. One field-collected fifth instar larva did not molt to an adult until eleven days had passed.

Feeding observations are limited for this species. No larvae were observed feeding on plant or animal tissue. One adult was seen feeding on a live Myzus persicae (Sulzer) aphid and another adult fed on a dead fifth instar larva of Plagiognathus species A. The feeding habits of this species are in need of future research.

Phytophagy, carnivory or mixed feeding have been recorded for species in this genus. Plagiognathus vitellinus, collected on conifers like Plagiognathus species A, feeds at the base of needles on the new growth of spruces, larch and Douglas-fir (Henry and Wheeler, 1973). Plagiognathus albatus (Van Duzee) is phytophagous on sycamore (McClure, 1974). Wheeler and Henry (1976) reported Plagiognathus delicatus feeds only on the flowers of ornamental honeylocust, Gleditsia triacanthos L. Plagiognathus medicagus Arrand was reported a pest of alfalfa (Arrand, 1958). Wheeler (1974) observed P. chrysanthemi (Wolff) feeding on the buds and blossoms of alfalfa. This species also has been reported to have scavenging tendencies since adults were observed feeding on a dead aphid (Goddard, 1935) and on dead Hylemya flies (Wheeler, 1971). Larvae fed on dead larvae of their own species in the laboratory and once fed on a very small fly trapped in a water droplet (Guppy, 1963). Plagiognathus politus also has phytophagous and predaceous tendencies. Dorsey (1967) recorded P. politus as a minor pest of alfalfa and Shure (1973) classified it as a major ragweed (Ambrosia

spp.) herbivore. Stear (1925) observed predation by P. politus on the rose leafhopper, Edwardsiana rosae (L.). Wheeler et al. (1968) found P. politus adults feeding on the hymenopteran parasites, Aphidus spp., within mummified pea aphids and Wheeler (1971) reported the same species scavenging on fungus-killed Hylemya flies. Turnock (1953) listed Plagiognathus repeticus Knight as a predator of larch sawfly eggs and newly hatched larvae. Ives (1967) listed P. laricicola Knight as another predator of larch sawfly eggs. Plagiognathus obscurus Uhler was listed as a predator in apple orchards (MacLellan, 1977). Kullenberg (1946) found that P. arbustorum (Fabricius) was completely phytophagous in Sweden. Collyer (1953) found the same species in Great Britain was partially phytophagous but did not survive on plant material alone. It is essentially carnivorous and feeds mainly on red spider mites.

No oviposition by Plagiognathus sp. A was observed in the field or in the laboratory. Abraham (1937) observed the oviposition of Plagiognathus arbustorum on currant shoots in the laboratory. He found eggs laid in batches in damaged areas of the shoots. Collyer (1953) stated P. arbustorum readily oviposited in apple wood, preferably in young apple shoots. Eggs were laid singly or more rarely in pairs, but seldom in wounded tissue. Southwood and Leston (1959) recorded that P. chrysanthemi oviposited in the stems of plants. Wheeler and Henry (1976) noted P. delicatus inserted eggs at an angle, singly or in groups of two to four, in the lenticels of two to three-year-old twigs of ornamental honeylocust. They included photographs of P. delicatus eggs in a lenticel and the hatching of a larva from an egg inserted in a lenticel.

No larvae or adults were collected in the sticky traps during the seven-week period the traps were on the tree trunks suggesting that the species remains on the foliage and branches.

Parasitoids of the larvae or adults of this species were not observed. The Catalog of Hymenoptera in America North of Mexico (Krombein et al., 1979) lists at least three Plagiognathus species

as hosts of two Braconidae species: Plagiognathus albonotatus Knight and P. cornicola Knight were listed as hosts of Peristenus plagiognathi (Loan) (Loan, 1966) and Plagiognathus nigronitens (Knight) and Plagiognathus sp. were hosts of Peristenus reidi Loan (Loan, 1974). Leston (1959) listed Plagiognathus arbustorum as a host of Braconidae in Great Britain. Leston (1961a) added P. albipennis (Fallén) as another host.

Hosts

Refer to the "Specimens examined" section for specific collection sites, dates and hosts.

My colleagues and I have collected the larvae and adults of Plagiognathus sp. A on Abies procera only.

Distribution

This species was found at every locality the author collected on noble fir: in Oregon in the Coast Range on Marys Peak and Grass Mountain and in the Cascade Mountains in the HJA and around Mt. Hood at three sites and in Washington at White Pass and Stevens Pass.

Periods of Occurrence

One generation was observed on Marys Peak and in the H.J. Andrews Forest during the 1979 season (Figures 34 and 35). Some species of the genus have been reported to have one generation a year: e.g., Plagiognathus arbustorum (Southwood and Leston, 1959), P. vitellinus (Henry and Wheeler, 1973) and P. chrysanthemi (Wheeler, 1974). Other species have two generations annually: e.g., Plagiognathus albipennis (Southwood and Leston, 1959), P. politus (Wheeler, 1974) and P. cuneatus Knight (Messina, 1978).

On Marys Peak, first instar larvae were collected on June 9 and 28 with all but one larva collected on June 9 (Figure 34). Second instar larvae were found June 9 - July 3, third instar larvae June 9 - July 11, fourth instar larvae June 9 - July 25 and fifth instar larvae

June 28 - August 17. On June 9, first, second, third and fourth instar larvae were collected which is a large number of larval instars for one date. No more than two or three larval instars regularly were collected on any date for any mirid species except this species and Orthotylus species A. Adult males and females were first collected on July 18. Males were collected until September 4 while females were seen until September 30.

In the HJA, only one first instar larva was collected on June 13 (Figure 35). Second instar larvae were seen June 26 - July 13, third instar larvae July 6-13, fourth instar larvae July 6-31 and fifth instar larvae July 20 - August 5. Female adults were collected July 20 - October 9. If the one female collected on July 20 and October 9 are disregarded, the adult males and females had the same period of occurrence: July 31 - August 31.

The larval instars commenced almost a month earlier on Marys Peak than in the HJA although the instars disappeared at about the same time. Adults were collected about two weeks earlier on Marys Peak with the exception of only one early adult female collected in the Andrews Forest. Therefore, the larval instars and the adult stage generally began earlier on Marys Peak than in the HJA.

GENUS PSALLUS FIEBER, 1858

Psallus is a large, poorly defined genus containing approximately 149 species worldwide (Carvalho, 1958a) and 34 North American species (Slater and Baranowski, 1978). The majority of North American species of Psallus were described by Knight (1923,1925a,1927a,1930,1968). He described at least 21 new species. Distinctive generic characters include sericeous hemelytral pubescence, presence of evident pulvilli and antennal segment two lacking conspicuous black spots and as long as or longer than the basal width of the pronotum (Slater and Baranowski, 1978).

The limits of the genus and its near relatives are not well-defined because the male genital structures of the species within the group have not been examined; the genitalia have been studied only at the species level for a part of the European fauna (Woodroffe, 1957). Within the genus, Wagner (1952) used the differences in the shape and structure of the claws to separate Psallus species. Woodroffe (1957) and Southwood and Leston (1959) relied on the width of the pronotal base, head width, vertex width and the proportionate length of the antennal segments. Knight (1941) separated the species of Psallus by the color of the antennae, femora, scutellum and legs and the length of the second antennal segment, rostrum and body.

Many Psallus species occur on trees as well as on herbaceous plants (Slater and Baranowski, 1978). The biology of the North American species is relatively undescribed although the biology of a few European species has been studied extensively (e.g., Psallus ambiguus (Fallén)).

Psallus sp. A [nr Kolenatii (Flor)][3]

(Figure 9, adult; Figure 20A, fifth instar larva)

Adult

Black, ovate species with distinctive flattened, silvery setae. Vestiture easily lost so some specimens appear nearly glabrous. Eyes prominent. Dorsal and ventral surfaces black; antennae and legs vary in color. Psallus species A differs from Psallus species B in following characters: lora and juga not protruding forward beyond antennal bases so lateral head profile not conical (Figure 20B), rostrum not extending beyond hind coxae, and male hemelytra not extending well beyond end of abdomen as in species B. Vertex wider and femora distinctively swollen in species A.

[3] Personal communication with T.J. Henry, 1979.

Male. Length 3.06 - 3.51, width 1.30 - 1.33. Head. Width 0.68 - 0.77, vertex 0.32 - 0.36; frons black; clypeus black. Rostrum. Length 1.22 - 1.26; segment I, 0.27 - 0.31; II, 0.32 - 0.36; III, 0.20 - 0.28; IV, 0.34 - 0.40. Antennae. Length of segment I, 0.18 - 0.21; II, 0.75 - 0.81, about twice as wide as segment III; III, 0.43 - 0.50; IV, 0.36 - 0.40; all segments yellow, shades of brown or black. Pronotum. Length 0.45 - 0.54, anterior width 0.32 - 0.45, posterior width 0.99 - 1.08, black; collar black. Scutellum black. Legs. Coxae black and swollen, femora black or black, with distal end yellow, usually 5 to 7 times wider than tibiae; tibiae yellow or black; tarsal segments yellow or black, darkening distally. Hemelytra. Black. Venter. Black. Vestiture. Setaceous, sub-erect, black setae and flattened, recumbent, sericeous setae (parallel-sided, narrowing distally to fine point) on head, pronotum, scutellum and hemelytra; ventral surface with same sericeous setae and brown setae; legs with brown setae, tibiae also with black spines; antennae with brown setae.

Female. Length 3.06 - 3.42, width 1.40 - 1.53. Head. Width 0.74 - 0.81, vertex 0.40 - 0.45. Rostrum. Length 1.17 - 1.30; segment I, 0.27 - 0.32; II, 0.27 - 0.36; III, 0.27 - 0.32; IV, 0.32 - 0.36. Antennae. Length of segment I, 0.18 - 0.25; II, 0.76 - 0.86; III, 0.41 - 0.48; IV, 0.32 - 0.40. Pronotum. Length 0.50 - 0.55, anterior width 0.45 - 0.54, posterior width 1.06 - 1.17. Coloration, vestiture and body length like male though body width of female is greater; second antennal segment not twice width of third segment as in male though usually wider.

Description was based on the examination of 30 specimens (twelve males) collected on noble fir.

Specimens examined. Two hundred and twenty eight specimens were examined from the following localities: Oregon. Benton Co.: Grass Mtn., 3200 and 3550', on Abies procera Rehd., IX-17-79, G. Stonedahl, VIII-14-80, G. Cooper; on Pseudotsuga menziesii (Mirb.) Franco., VIII-

14-80, J. Lattin. Marys Peak, 3250 - 3750', on Abies procera, X-14-75, J. Lattin; on Pseudotsuga menziesii, VIII-17-78, J. Lattin; on Abies procera, IX-1-78, J. Lattin; on Abies procera, many dates VI-28-79 to IX-4-79, VII-29-80, G. Cooper; on Tsuga heterophylla (Raf.) Sarg., VIII-19-80, G. Cooper. Clackamas Co.: Government Camp, Mt. Hood, 3900', on Abies procera, IX-5-79, G. Cooper. Hood River Co. 3.2 mis. N. Barlow Pass Summit, 4460', Mt. Hood, on Abies procera, IX-5-79, VIII-2-80, G. Cooper. Lane-Linn Cos.: Carpenter Mtn., 4360', H.J. Andrews Expt. Forest, on Abies procera, many dates VII-13-79 to VIII-19-79, G. Cooper. Half - 2.0 mis. N. Frissel Pt., 4750 -4850', Andrews Forest, on Abies procera, many dates VII-6-79 to VIII-19-79, G. Cooper. Washington. King Co.: Stevens Pass, Old Stevens Pass Rd., 3200', on Abies amabilis (Dougl.) Forbes, VIII-22-79, G. Stonedahl. Yakima Co.: 3 mis. E. White Pass Summit, 4200', on Abies procera and Pseudotsuga menziesii, VIII-23-79, G. Stonedahl.

Fifth instar larva

Red body with black setae and brown to dark brown wing pads. Abdomen uniformly red not color-banded as in larvae of Psallus sp. B. Lora and juga do not protrude forward between antennal bases; lateral head profile not conical as in larvae of Psallus species B (Figure 20B).

Male. Length 2.34 - 2.70, width 1.17 - 1.38. Head. Width 0.74 - 0.76, vertex 0.32 - 0.36; frons and clypeus red, reddish brown, brown, or dark brown. Rostrum. Length 0.90 - 1.20; segment I, 0.22 - 0.29; II, 0.25 - 0.32; III, 0.18 - 0.27; IV, 0.23 - 0.32. Antennae. Length of segment I, 0.14 - 0.18, red or reddish brown; II, 0.54 - 0.63, red or reddish brown; III, 0.40 - 0.45, light brown or brown; IV, 0.32 - 0.39, light brown or light brown with red tinge. Pronotum. Length 0.32 - 0.36, anterior width 0.32 - 0.38, posterior width 0.77 - 0.85; red, reddish brown, brown or dark brown. Legs. Coxae and femora red or reddish brown, tibiae and tarsi light brown, brown or dark brown. Wing pads. Extend to third or fourth abdominal segment. Abdomen. Dorsal and ventral surfaces uniformly red. Abdominal gland. Single dorsal opening with sinuate, sclerotized bar and distinct tendency

towards secondary doubling as described for genus (Akingbohungbe, 1974), no distinctive coloration bordering the opening. Vestiture. Thick, black setae; ventral surface of abdomen with shorter, black setae. Antennae and legs with finer, brown setae; tibiae also with black spines.

Female. Length 2.34 - 2.65, width 1.17 - 1.40. Head. Width 0.72 - 0.76, vertex 0.32 - 0.36. Rostrum. Length 0.90 - 0.99; segment I, 0.21 - 0.24; II, 0.22 - 0.30; III, 0.18 - 0.22; IV, 0.22 - 0.27. Antennae. Length of segment I, 0.14 - 0.18; II, 0.52 - 0.58; III, 0.36 - 0.43; IV, 0.32 - 0.39. Pronotum. Length 0.29 - 0.38, anterior width 0.36 - 0.37, posterior width 0.76 - 0.84. Very similar to male.

Description was based on the examination of 18 specimens (eight males) from noble fir.

Biology

Many larvae were reared in the growth chamber but few survived more than one molt which limited the data on the larval stadia. Four Psallus sp. A specimens did survive three molts indicating the fourth stadium was three to four days and the fifth stadium was four to five days under the given laboratory conditions.

Wagner and Weber (1964) reported Psallus kolenatii (Flor) was phytophagous but Psallus sp. A has strong predaceous and scavenging tendencies. Fourth and fifth instar lavae and adults frequently were observed feeding on live and dead aphids (Cinara sp. and Macrosiphum rosae (L.)) and mirid larvae in the growth chamber. A fourth instar larva was observed feeding on a live third instar Pinalitus solivagus larva (Miridae). Another fourth instar larva fed on a live rose aphid (Macrosiphum rosae) and many fourth instar larvae were seen feeding on dead aphids. Fifth instar larvae and adults fed on live and dead Cinara sp. and Macrosiphum rosae aphids. One adult was observed "beaking" (or probing) and feeding on a live fifth instar

Plagiognathus sp. A larva (Miridae). No larvae or adults were seen feeding on the noble fir branchlets placed in the growth chambers.

Within the genus Psallus, phytophagy, carnivory or mixed feeding have been reported. The biology of the European species, Psallus ambiguus (Fallén) appears to be the best known. Many of the recent biological studies on species in this genus have been conducted and published in East European countries (e.g., Byazdenka et al., 1975). Butler (1923) observed P. ambiguus feeding on apple branches although no obvious injury to the tree was produced. Collyer (1953) reported that most authors have recorded the species as at least partially carnivorous. She found it predaceous on all stages of the red spider mite, other mite species and small insects and stated that it will feed on plant tissue but is unable to live on plant material alone. Southwood and Leston (1959) reported that the species feeds on aphids and other small insects as well as on the host trees. Niemczyk (1966) reported that the preferred food of Psallus ambiguus were small, slow-moving insects with soft skin. He listed the aphids, Aphis pomi DeG., Rhopalosiphum incertum WlK. and Brachycaudus helichrysi (Klt.), and the larvae of Psylla mali (Schm.) as essential food that allowed the complete development of the predator. In the field, he found females sucked large numbers of Panonychus ulmi (Koch) aphids as an alternative but not essential food source because when reared on this prey, P. ambiguus did not produce eggs. Larvae of P. ambiguus died after several days when fed only apple leaves and adult females fed only apple juices did not produce eggs. He concluded the species was carnivorous.

The feeding habits of other Psallus species have been observed. Butler (1923) saw Psallus variabilis (Fallén), P. varians (Herrich-Schaeffer) and P. diminutus (Kirschbaum) sucking a butterfly larva. He reported that P. fallenii Reuter and P. betuleti were phytophagous. Knight (1941) reported only phytophagous species. He stated Picea sp. was the "food plant" of P. piceicola Kngt. and Pinus strobus the "food plant" of Psallus strobicola Kngt. Knight also listed the

"food plants" of P. amorphae Kngt., P. bakeri (Bergroth) and P. parsheyi Kngt. Brown and Clark (1956) reported that Psallus piceicola Knight feeding on an adelgid on larch, Larix laricina (Du Roi) K. Koch, and could be reared on Adelges piceae (Ratzeburg). Wheeler and Henry (1977) suggested that Brown and Clark may have observed Plagiognathus laricicola Knight, a species similar to Psallus piceicola. Psallus betuleti (Fallén) adults and larvae are partially phytophagous (host-plants, Betula spp.) but will feed on greenflies and other small insects (Southwood and Leston, 1959). Southwood and Leston (1959) recorded that Psallus salicellus (Herrich-Schaeffer) was partially predaceous, feeding on mites and other small animals.

Adult males and females were reared together in an attempt to observe the oviposition sites. After an intensive search of the branchlets, no eggs could be found. Abraham (1937) noted the oviposition of Psallus ambiguus eggs in young currant wood and Collyer (1953) found P. ambiguus eggs laid, usually singly, in young apple wood. Southwood and Leston (1959) recorded that Psallus ambiguus, P. betuleti and P. roseus oviposit in the young wood of their respective hosts. Psallus perrisi Wagner lays eggs in the cracks of the bark of year-old oak wood.

Four adult Psallus sp. A were found on sticky traps during the seven-week period the traps were on the tree boles suggesting that the species remains on the foliage and branches although occasionally may be found on the boles.

Three hymenopteran parasites were observed on three fifth instar larvae of Psallus sp. A. A determination could not be made because of the extreme difficulty in identifying parasitic hymenopteran larvae but they appear to be of the family Braconidae[4]. The Catalog of Hymenoptera in America North of Mexico (Krombein et al., 1979) listed no hymenopteran parasites of the larvae or adults of the species of Psallus; only egg parasites were listed. Morley (1904) described parasitism of Psallus variabilis Fallén, a European species, and was certain the parasite was a dipteran. Leston (1959)

[4] Personal communication with Dr. John D. Lattin, 1980.

reported Psallus ambiguus, P. lepidus Fieber, and P. varians as hosts of braconid parasites. Leston (1961a) included P. perrisi Wagner and P. roseus (Fallén) to his list of mirid hosts of the family Braconidae.

Hosts

Refer to the "Specimens examined section for specific collection sites, dates and hosts.

Noble fir, Abies procera, presently is the only known host plant. Psallus sp. A adults were collected from Abies amabilis and Pseudotsuga menziesii from collecting sites with noble fir present. Larvae would have to be collected from these tree species to verify if they are true hosts of this Psallus species. One adult similar to Psallus sp. A was collected from Abies grandis (Dougl.) Lindl. but further collections of Abies grandis should be conducted to determine if the two Psallus are the same species and if grand fir is a host of the mirid.

Distribution

This species was collected in the Coast Range in Oregon on both Marys Peak and Grass Mountain. Psallus sp. A appears to be widespread in the Cascade Mountains. It was collected in Oregon in the Andrews Forest, at two sites around Mt. Hood and in Washington at White Pass.

Periods of Occurrence

Only one generation was found during the 1979 collecting season on Marys Peak and in the HJA (Figures 36 and 37). Southwood and Leston (1959) recorded one generation annually for 18 of the 19 Psallus species in their book. Only Psallus lepidus Fieber may have two generations a year.

On Marys Peak, first instar larvae were found only on May 19, second instar larvae were found May 19 - June 1, third instar larvae June 1-9, fourth instar larvae June 1-28 and fifth instar larvae June 1 - July 11 (Figure 36). Adults were collected June 28 - September 4; the majority were collected July 25 - August 29 with

males more abundant than females earlier in the season, June 28 - July 3 (Figure 36). All specimens from August 17 - September 4 were females with the exception of one male collected August 29.

Very few larvae or adults were collected in the HJA. No first or second instar larvae were collected. June 13 was the only collecting date for the third and fourth instar larvae (Figure 37). Fifth instar larvae were seen only on July 6. Adult males were collected on July 6 and August 19 while females were found from July 6 to August 19.

Psallus sp. A and Dichrooscytus sp. A were the first two noble fir mirid species to appear on the fir as adults on Marys Peak and in the HJA. Collyer (1953) noted that Psallus ambiguus appeared earlier than any other mirid predator on apple. This agrees with the early occurrence of Psallus sp. A.

Psallus sp. B [nr Kolenatii (Flor)]

(Figure 10, adult; Figure 21A, fifth instar larva)

Adult

Dark brown to black, ovate species with distinctive, flattened, silvery setae. Vestiture easily lost so some specimens appear nearly glabrous. Eyes prominent, facets prominently rounded ("berry-like" appearance) in males. Dorsal and ventral surfaces dark brown to black; antennae and legs dark brown to black. Distinctive characters include: lora and juga protrude forward beyond antennal bases so lateral head profile conical (Figure 21B), rostrum extends beyond hind coxae, and male hemelytra extend well beyond end of abdomen.

Male. Length 3.42 - 3.83, width 1.28 - 1.40. Head. Width 0.62 - 0.74, vertex 0.25 - 0.27; frons and clypeus dark brown to black. Rostrum. Length 1.53 - 1.62; segment I, 0.30 - 0.36; II, 0.40 - 0.45; III, 0.36 - 0.40; IV, 0.36 - 0.45. Antennae. Length of segment I, 0.21 - 0.24; II, 0.90 - 1.05, two to two and a half times wider than segment III; III, 0.49 - 0.54; IV, 0.36; all segments dark brown to black. Pronotum. Length 0.45 - 0.49, anterior width 0.21 - 0.32,

posterior width 0.98 - 1.06, dark brown to black; collar dark brown to black. Scutellum dark brown to black. Legs. Dark brown to black; femora not distinctively swollen as in species A. Hemelytra. Dark brown to black. Venter. Dark brown to black. Vestiture. Setaceous, sub-erect, black setae and flattened, recumbent, sericeous setae (parallel-sided, narrowing distally to fine point) on head, pronotum, scutellum and hemelytra; ventral surface with same sericeous setae and brown setae; legs with brown setae, tibiae also with black spines; antennae with silvery setae and longer, black setae; second antennal segment of female lacks silvery setae.

Female. Length 2.74 - 3.01, width 1.17 - 1.30. Head. Width 0.65 - 0.70, vertex 0.29 - 0.32. Rostrum. Length 1.53 - 1.65; segment I, 0.30 - 0.39; II, 0.40 - 0.50; III, 0.35 - 0.39; IV, 0.36 - 0.41. Antennae. Length of segment I, 0.18 - 0.22; II, 0.66 - 0.77, widens distally; III, 0.40 - 0.50; IV, 0.31 - 0.38. Pronotum. Length 0.37 - 0.45, anterior width 0.27 - 0.36, posterior width 0.89 - 1.02. Coloration and vestiture like male. Body size to tip of abdomen similar to male. Hemelytra not greatly extended beyond tip of abdomen, second antennal segment wider than third segment but not swollen as in male.

Description was based on the examination of 24 specimens (eleven males) collected from noble fir.

Specimens examined. One hundred and sixteen specimens were examined from the following localities: Oregon. Benton Co.: Grass Mtn., 3200 and 3550', on Abies procera Rehd., IX-17-79, G. Stonedahl. Marys Peak, 3250 - 3750', on Abies procera, X-4-77, J. Lattin; on Pseudotsuga menziesii (Mirb.) Franco., VIII-17-78, J. Lattin; on Abies procera IX-7-78, J. Lattin; on Abies procera, many dates VII-25-79 to X-10-79, G. Cooper; on Tsuga heterophylla (Raf.) Sarg.; 4460', Mt. Hood, on Abies procera, IX-5-79, G. Stonedahl. Lane-Linn Cos. Half - 2.0 mis. N. Frissel Pt., 4750 - 4850', H.J. Andrews Expt. Forest, many dates VII-31-79 to VIII-31-79, G. Cooper.

Fifth instar larva

Body red or reddish brown with black setae and brown to black wing pads. Abdomen banded with white or light brown and red or orange. Lora and juga protrude forward between antennal bases so lateral head profile conical (Figure 21B).

Male. Length 2.43 - 2.70, width 1.04 - 1.26. Head. Width 0.66 - 0.74, vertex 0.25 - 0.32; frons and clypeus red, reddish brown, brown or dark brown. Rostrum. Length 1.26 - 1.40; segment I, 0.27 - 0.32; II, 0.32 - 0.38; III, 0.29 - 0.36; IV, 0.30 - 0.37. Antennae. Length of segment I, 0.19 - 0.22; II, 0.54 - 0.66; III, 0.39 - 0.45; IV, 0.31 - 0.36; all segments red, reddish brown, brown, or dark brown. Pronotum. Length 0.32 - 0.37, anterior width 0.25 - 0.27, posterior width 0.66 - 0.77; red, reddish brown, brown, or dark brown. Legs. Red, reddish brown, or brown. Wing pads. Extend to third or fourth abdominal segment. Abdomen. Dorsal and ventral surfaces of each segment orangish red, light brown or white, anterior and posterior edges red or orange; lateral margins of ventral surface often with light brown spots. Abdominal gland. Single dorsal opening with sinuate, sclerotized bar and distinctive tendency towards secondary doubling (Akingbohungbe, 1974); opening not bordered by distinctive coloration. Vestiture. Thick, black setae; tibiae also with black spines.

Female. Length 2.25 - 2.34, width 0.99 - 1.12. Head. Width 0.59 - 0.66, vertex 0.28 - 0.32. Rostrum. Length 1.29 - 1.35; segment I, 0.27 - 0.32; II, 0.34 - 0.36; III, 0.29 - 0.32; IV, 0.35 - 0.36. Antennae. Length of segment I, 0.18 - 0.20; II, 0.50 - 0.54; III, 0.36 - 0.39; IV, 0.29 - 0.36. Pronotum. Length 0.30 - 0.32, anterior width 0.27 - 0.32, posterior width 0.68 - 0.72. Very similar to male.

Description was based on the examination of 13 specimens (eight males) from noble fir.

Biology

Due to the similarity in appearance between the larvae or adults of Psallus spp. A and B, this species was not identified until the collecting season had ended so no biological information was obtained for Psallus sp. B.

Hosts

Refer to the "Specimens examined" section for specific collection sites, dates and hosts.

No first, second or third instar larvae were collected from noble fir, suggesting that the fir may not be a true host of this mirid species. The early instar larvae may have been overlooked because of their very small size. Regular collections of the fourth and fifth instar larvae and the adults indicates that noble fir should be considered a host.

Distribution

Psallus sp. B was collected in the Coast Range in Oregon on Marys Peak and Grass Mountain. The species appears widespread in the Cascade Mountains: in Oregon in the HJA and at two sites near Mt. Hood and in Washington at Stevens Pass.

Periods of Occurrence

Only one generation was found on Marys Peak or in the HJA (Figures 38 and 39).

On Marys Peak, no first, second, or third instar larvae were collected despite 17 different collecting trips to the Peak. Fourth instar larvae were collected July 11-25 and fifth instar larvae July 18 - August 17 (Figure 38). Adult males were collected before females: July 25 - September 4 for males and August 17 - September 4 for females.

First, second or third instar larvae also were not observed in the HJA. Fourth instar larvae were collected July 13 and 20 and fifth instar larvae were observed July 13-31 (Figure 39). Adult males were

collected on July 31 and August 31 while females were found August 5 - 31.

The adults of Psallus sp. B appeared about a week sooner on Marys Peak than in the Andrews Forest. More collections would verify if this is a common occurrence for this mirid species.

DISCUSSION

Thirty six species of the Miridae were collected from noble fir, Abies procera Rehd., in 1979. These species were represented by either adults and larvae or adults only. Undetermined larvae were collected infrequently but only the species represented with adults are included in the total of 36 species. It was concluded that eleven mirid species were associated with noble fir (and called "noble fir mirids"). Refer to Appendix A for a list of the "visitor" species collected on noble fir. Most "visitor" species could be eliminated by the complete absence of their larvae from noble fir or by the presence of only fifth instar larvae. Deraeocoris brevis (Uhler) was considered a "visitor" because many adults were collected (over 100 adults) but only one second instar and one fourth instar larva were collected. Only one mirid species listed as Dichaetocoris in Appendix A was eliminated questionably from inclusion as a noble fir mirid. One third instar, two fourth instar and nine fifth instar larvae and 128 adults were collected but the species was not included because the number of larvae was too low relative to the number of collected adults. Possibly, the larvae normally are found higher on the trees than the writer could reach but without such evidence, the species was considered a "visitor". Interestingly, two copulating pairs of this mirid species were collected from noble fir. No copulating pairs of any other mirid species were collected. Therefore, eleven mirid species are associated with noble fir.

References to the mirid fauna of specific North American conifers are listed in the major works of Knight (1941,1968). From the western United States, Knight (1968) listed the records of 14 mirid species from Pinus monophylla Torr. and Frém., the North American conifer with the largest mirid fauna. He listed eight species from Juniperus osteosperma (Torr.) Little and seven mirids from Pinus edulis Engelm. From eastern conifers, Knight (1941) collected eight mirid species from Pinus strobus L. and Taxodium distichum (L.) Richard and seven mirids from Pinus virginiana Mill. Southwood and Leston (1959) reported only three mirid species from the Abies spp. of the British Isles but found ten mirids from Pinus sylvestris L.

Various explanations have been proposed to explain observed differences in the number of insect species associated with selected species of plants. Plant species with larger geographical ranges generally support more insect species than rarer species of plants. Southwood (1960,1961) suggested that the number of insect species associated with various trees was a function of their abundance in the geologic record. Strong (1974), Opler (1974) and Lawton (1978) demonstrated the operation of a species-area effect in current time not over geologic time. Lawton (1978) concluded that plant architecture may also influence insect species diversity. More structurally complex plants permit greater niche diversification which reduces competition and aids the avoidance of generalized predators and parasitoids. He suggested that plant chemistry may be of only minor importance in determining the total number of insect species on particular species of plants. Southwood (1961, 1973) suggested that plant chemistry might be the cause that several British trees (e.g. holly, Ilex and yew, Taxus) have smaller numbers of insects associated with them than would be expected from their abundance. Whether geographical range, plant architecture, and/or plant chemistry of noble fir contribute to the large mirid fauna on this fir should be investigated.

Data on the larval stadia for the eleven mirid species associated with noble fir were limited by the many rearing problems encountered during this study. Five different species had a three to four-day fourth stadium and four species had a four to six-day fifth stadium. These species were from four genera in three subfamilies of the Miridae: Deraeocoris piceicola, Phytocoris neglectus, Phytocoris sp. A (fourth stadium only), Plagiognathus sp. A and Psallus sp. A. The species were not closely related yet the variability of the late larval stadia was small.

Feeding observations were recorded for eight of the eleven species. Only feeding by specimens of Orthotylus sp. A, Phytocoris sp. A and Psallus sp. B were not observed. Of the eight observed species, seven species were observed feeding on live and/or dead aphids: Deraeocoris incertus, D. piceicola, Paradacerla formicina, Phytocoris neglectus, Pinalitus solivagus, Plagiognathus sp. A and Psallus sp. A. Only Dichrooscytus sp. A was seen feeding repeatedly on the young growth of the noble fir branchlets. One could not conclude seven mirid species are predators and/or scavengers and one species is a herbivore for two reasons. First, the observations were limited and under unnatural, laboratory conditions. Second, many mirids are "mixed feeders", partially predaceous and phytophagous (Lilly, 1958; Wheeler, 1974). Phytophagous feeding may have been overlooked for some or all of the seven species. It can be concluded though that the seven species have predaceous and/or scavenging tendencies.

The sticky traps placed on the boles of noble fir trees captured very few mirid larvae and adults: one fifth instar Dichrooscytus sp. A larva, one adult of Phytocoris sp. A, two fifth instar larvae of Pinalitus sp. A (a "visitor" species) and four Psallus sp. A adults. The low numbers collected in the traps relative to the much higher abundances on the foliage suggested that the vast majority of individuals of the noble fir mirids remained on the foliage. Phytocoris sp. A was collected in very low numbers on the foliage suggesting that the species may be bark-inhabiting like

many Phytocoris species (Knight, 1941). Collecting one adult of this species in a sticky trap supports this possibility.

Braconid parasites were observed only in one fifth instar larva of Dichrooscytus sp. A and three fifth instar larvae of Psallus sp. A. These two species were the earliest two species to appear as larvae and adults. Larval parasites of mirids attack the early mirid larval instars (Loan, 1966; Waloff, 1967). The larvae of the other mirid species may be present too late for attack by the braconid parasites.

Few generalizations can be made regarding the host specificity of the noble fir mirids. Some species may be host specific to Abies procera while other species are apparently found on many other conifers. When discussing the other host-plants of the noble fir mirid species, one must remember that other investigators have based their host-plant lists usually only on the adults collected and rarely have considered the larvae. Adult mobility makes accidental host records quite possible. Only the careful collection and association of larvae with the adults will provide the data necessary to make accurate host-plant lists for the noble fir mirids.

Five of the noble fir mirids were known only from Abies procera: Dichrooscytus sp. A, Orthotylus sp. A, Plagiognathus sp. A and Psallus spp. A and B. This may be due to the difficulty in the species determinations of these genera so reported hosts of the same species were not included or these mirid species are specific or nearly specific to Abies procera. The larvae and adults of Phytocoris sp. A were collected from two hosts: Abies amabilis and A. procera while the adults of Phytocoris neglectus have been recorded by various investigators from many deciduous and coniferous species. The adults of Deraeocoris incertus and D. piceicola are known from at least six conifers (Razafimahatratra, 1980) and the adults of Pinalitus solivagus have been seen by this writer and other researchers from seven conifers. Paradacerla formicina is the least host specific mirid associated with noble fir, adults having been collected from

18 deciduous and coniferous plant species. The past, present and future collection of Pacific Northwest conifers by Dr. John D. Lattin and his students (in particular, G. Stonedahl) will be instrumental in determining any other host-plants of the noble fir mirids.

Mirids were collected from three different age groups of noble fir in the HJA to observe the influence that stand age of the host-plant may have on the presence or absence and abundance of the mirid species associated with noble fir. The 1977 planting on noble fir had approximately 5-year-old saplings (0.6 m. to 0.9 m. or 2 to 3 ft. tall). Of the eleven mirids associated with mid-growth or old-growth noble fir, only one fifth instar larva of Plagiognathus sp. A and one adult of Paradacerla formicina were collected from the site. Paradacerla formicina is a generalized predator also found on the Ceanothus velutinus Dougl. and Ribes sp. near the saplings which would explain its appearance on the young fir saplings. Plagiognathus sp. A may be one of the first mirids to colonize young noble fir. The site on Carpenter Mountain had noble fir approximately 15-18 years old (1.5 to 2.7 m. or 5 to 9 ft. tall). All eleven noble fir mirids were collected from this site although only Dichrooscytus sp. A and Plagiognathus sp. A were collected commonly. These two species are probably the first two mirid species associated with mature noble fir to colonize young noble fir. It is interesting to note that no mirid species were specific to the sapling stages of the tree and once the trees were only 15-18 years old, all eleven mirid species associated with mature Abies procera were present. The site 0.5 mi. north of Frissel Point had mid-growth and old-growth noble fir approximately 150-200 years old (23 to 46 m. or 75-150 ft. tall). The eleven noble fir mirid species found on mature noble fir trees were collected at this site.

The species richness (the number of species present) of the mirids associated with noble fir varied between Marys Peak and the HJA although the difference was not large. Seven mirid species were

collected regularly in both areas: Dichrooscytus sp. A, Paradacerla formicina, Phytocoris sp. A, Pinalitus solivagus, Plagiognathus sp. A and Psallus spp. A and B. Eight species were regularly collected from noble fir on Marys Peak. Phytocoris neglectus was common on Marys Peak but not in the HJA. Only two adults and no larvae of Deraeocoris incertus were collected; the species is obviously rare on noble fir on Marys Peak. Orthotylus sp. A and Deraeocoris piceicola were never collected on Marys Peak. In the HJA, ten mirid species were regularly collected; only one second instar and one fifth instar larva and one adult of Phytocoris neglectus were observed. The near absence of Phytocoris neglectus in the HJA may have reflected the large population of Deraeocoris piceicola on noble fir. The periods of occurrence of the larvae and adults of D. piceicola in the HJA (Figure 23) were three to four weeks before similar periods of occurrence of Phytocoris neglectus on Marys Peak (Figure 29). If one adds a possible one week delay in the phenology of P. neglectus, if it was common in the HJA, larvae and adults of D. piceicola would be present at least a month before comparative larvae and adults of P. neglectus. The two mirid species are predators. If both species utilize the same prey, the Deraeocoris species may outcompete the Phytocoris for food with its older, larger individuals or D. piceicola may feed on the earlier instar larvae of P. neglectus. On Marys Peak, there was no Deraeocoris piceicola and very rarely D. incertus yet Phytocoris neglectus was very abundant on Marys Peak. Conditions may be more favorable on Marys Peak for Phytocoris neglectus to outcompete Deraeocoris incertus. Deraeocoris piceicola has never been reported from the Coast Ranges of Oregon and Washington so possibly Phytocoris neglectus fills a "niche" on Marys Peak that D. piceicola has never occupied.

There was a very obvious difference between Marys Peak and the Andrews Forest in the populations of each species common to both areas. Mirids were much more abundant on noble fir on Marys Peak than in the HJA. Collecting during this investigation was not standardized between the areas but the writer made approximately the same "effort" (i.e., time spent beating branches) at sites in both

areas. In the HJA, only Deraeocoris piceicola and Orthotylus sp. A were abundant although Plagiognathus sp. A was commonly collected but in numbers half or less of the quantity collected on Marys Peak. Interestingly, the two abundant mirid species from the HJA were absent from Marys Peak.

To explain this apparent difference in the mirid species richness and the number of individuals collected from the two areas, one may suggest various possible causal factors. Larval predation of the other mirid species by the larvae and adults of Deraeocoris piceicola may help to explain the absence of some mirid species and low populations of other species on noble fir in the HJA. Deraeocoris piceicola was the most abundant predator collected from noble fir by a large margin. Phytocoris neglectus was a very abundant predator on Marys Peak but its larval and adult periods of occurrence (unlike those of D. piceicola) were later than the majority of mirid species on noble fir. The larvae and adults of the other mirids may be able to escape predation by Phytocoris neglectus. This argument obviously neglects the other predators found on noble fir trees but I am only suggesting one of many possible causal factors.

The climate of Marys Peak is milder than in the HJA due to the moderating effect of the ocean only about 40 km. (25 mis.) to the west. The elevation where noble fir grows is lower on Marys Peak which should also mean a milder climate. The climatic requirements of the noble fir mirids are unknown so the effect of climate on the distribution and abundance of these mirids remains unknown.

Noble fir grows in a nearly pure stand around the top of Marys Peak so the host-plant of these mirids is concentrated in a relatively small area. The collection sites of naturally occurring noble fir (as opposed to the plantings) in the HJA were intermixed with Abies amabilis, A. lasiocarpa (Hook.) Nutt., Libocedrus decurrens Torr., Pinus concorta, Pseudotsuga menziesii and Tsuga mertensiana. The effect of resource concentration has been investigated for collards (Brassica oleracea L.). Tahvanainen and Root (1972) and Root (1973)

demonstrated by planting collards in large patches and in single rows among meadow vegetation that large, concentrated stands had a greater herbivore populations and lower species richness. Tahvanainen and Root (1972) suggested that the non-host plants in a floristically diverse environment may protect the host-plant species by interfering with the olfactory senses of the herbivores, possibly causing direct repulsion of the herbivores from the host-plant. Root (1973,1975) proposed that the increased number of herbivores, particularly specialists, in the larger patches was due to the increased ability to find and remain in these stands. Collards planted in mixed vegetation had reduced herbivore populations because the intermixed plants possess an "associational resistance" which prevents the dominance of specialists (Root, 1975). Investigation of the effects of resource concentration on dominant, larger plants like trees appears to be lacking although Root (1975) suggested that the herbivore fauna on dominant plants may be larger, less specialized and less responsive to resource concentration effects than the fauna on herbs like collards that grow in small, scattered patches. Therefore, the mirid fauna on noble fir may be responding little to the differences in the concentration of noble fir between Marys Peak and the HJA. The host specificity of all the mirids on noble fir must be determined before initiating a study of the effects of noble fir concentration on these mirid species. Only mirids specific to noble fir should be studied. Generalist species would be less affected by the concentration of noble fir if other host-plant species were present. Also, the study sites of varying densities of noble fir should be selected from the same general area to eliminate any geographical or climatic effects.

On Marys Peak, noble fir generally grows as an "island" or patch surrounded by a "sea" of Pseudotsuga menziesii and Tsuga heterophylla. The naturally growing noble fir in the Andrews Forest also grows in patches but of varying sizes. The size of the patches that were collected were not measured but are thought to be much larger in the HJA than the noble fir "island" on Marys Peak. The size of the

patches may play an important role in the local insect diversity on a host-plant. If patches of a host-plant behave as ecological islands, large patches should be utilized by a greater number of herbivore species than small patches (MacArthur and Wilson, 1967; Seifert, 1975). Lawton (1978) found the local insect diversity on bracken fern, Pteridium aquilinum, was determined mainly by the size of the patches. Small patches had a lower species richness. A typical bracken fern island did not contain all the species in the study area until a certain size was reached. Ward and Lakhani (1977) similarly found a patch of juniper (Juniperus communis L.) must have contained at least 3000 bushes to have a reasonable chance of supporting the 15 common native insect species present in the regional pool. On the other hand, Raupp and Denno (1979) found that the number of sap-feeding insects of the grass, Spartina patens (Ait.) Muhl., in large and small patches were the same but small patches supported lower densities of sap-feeders because the immigration rates were probably lower and the removal rates were higher than in large patches. The larger patches sampled were in the HJA and had a slightly greater richness of species than on Marys Peak (ten versus eight species, respectively) which might support Lawton and Ward et al. The higher densities of mirids on Marys Peak would contradict Raupp and Denno's (1979) observation of lower densities in smaller patches. It must be noted that any direct comparison to the other studies would be valid only if all factors were equal except for the species involved. All factors are not equal. The patches studied by these other investigators were very small relative to the patches of noble fir which I sampled. Also, their patches were from the same area. Noble fir on Marys Peak and in the HJA are not from the same region so any comparison to the other studies would be hard to make. The other investigators worked with pure patches of the studied host-plant. The patches were not pure noble fir in the HJA which added a complicating variable to any comparison with the other studies. To understand the effect of noble fir stand size on the richness of mirid species and the abundance of these species, one should

deal with pure stands of noble fir from the same region and with mirids specific to noble fir while determining what factors regulate the immigration rates and extinction or removal rates of the patches.

All eleven noble fir mirid species were found to have one generation per year on Marys Peak and in the Andrews Forest. Any differences between these two areas in the periods of occurrence of the larvae and adults of the mirid species associated with noble fir were recorded. When reporting the phenological differences between the two areas of specific mirid species, one must remember that the one to two week-time interval between the collections may have exaggerated any phenological difference between the two regions. For example, the adults of one species might have been collected on June 30 on Marys Peak but were absent on July 1 in the HJA. The adults were present by July 3 in the HJA but the writer did not return to the Andrews Forest until July 11 when the adults were observed. The reported difference in appearance of the adults between the areas would have been inaccurate. The larvae and adults of Dichrooscytus sp. A, Pinalitus solivagus, Plagiognathus sp. A and Psallus spp. A and B appeared earlier on Marys Peak than in the HJA. The difference varied from two days for the adults of Pinalitus solivagus to nearly two weeks for the fourth instar larvae of P. solivagus. The larvae and adults of these species more commonly appeared approximately five to seven days earlier on Marys Peak. Yet, the adults of Paradacerla formicina and Phytocoris sp. A appeared one to five days sooner in the Andrews Forest. The number of specimens collected of the noble fir mirids was very low and the areas were not collected extensively so no conclusion should be made. Collections at shorter intervals and more extensive collecting of both areas should be conducted to observe if the periods of occurrence of the noble fir mirids differ between the two areas.

Two species of Deraeocoris were collected in the HJA, two species of Phytocoris on Marys Peak and two species of Psallus were seen on Marys Peak and in the HJA. The vast majority of the species of the genera Deraeocoris and Phytocoris are predaceous. One can only

assume the two species of each genus feed on the same prey on noble fir. The larvae and adults of Deraeocoris incertus and D. piceicola occurred concurrently on noble fir in the HJA while the larvae of Phytocoris sp. A were collected earlier than the larvae of P. neglectus. Refer to the figures of the periods of occurrence of the appropriate species. The adults were collected together although the majority of the adults of Phytocoris neglectus were collected after the adults of Phytocoris sp. A had disappeared. The feeding habits of the two Psallus species remain unknown; the existence of possible competition for food is unknown. The periods of occurrence of the larvae of Psallus spp. A and B were quite separated on Marys Peak or in the HJA. The larval instars of Psallus sp. A were observed earlier than the larvae of Psallus sp. B. The adults of Psallus sp. A at both sites appeared three to four weeks before the adults of Psallus sp. B and the majority of the adults of Psallus sp. B were seen as the number of Psallus sp. A adults declined later in the collecting season. The two species of Deraeocoris were not temporally isolated while the two species of Phytocoris or Psallus were nearly temporally separated from each other on noble fir.

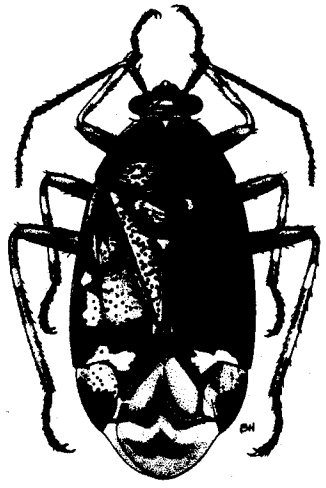
The adult males were frequently collected earlier than the females or if initially collected together then males were more abundant. Seven of the eleven noble fir mirid species supported this observation: Deraeocoris incertus, Dichrooscytus sp. A, Orthotylus sp. A, Paradacerla formicina, Phytocoris neglectus, and Psallus spp. A and B. The adult females were commonly collected later in the season than the males of seven noble fir mirids: Deraeocoris incertus, D. piceicola, Dichrooscytus sp. A, Paradacerla formicina, Pinalitus solivagus, Plagiognathus sp. A and Psallus sp. A.

Future investigations should include biological, distributional and host determination studies of the eleven mirid species associated with Abies procera. More feeding observations and the determination of the oviposition sites of the eleven species should be conducted. Biological observations in the field would be preferrable to laboratory conditions but the distance to a noble fir site is a deterrant.

Rearing the mirids outside in cages in the Willamette Valley would pose problems of climatic differences. There is a real need to devise an efficient rearing procedure for mirid species in the laboratory. More intensive collecting of the larvae and adults of these eleven species must be conducted to determine any other host-plants of these mirids. Distributional data should be detailed by collections at the Willapa Hills in southwestern Washington and other areas within the range of noble fir. Further investigations to explain the large diversity of mirid species on Abies procera should be conducted. Finally, a study of the causal factors for the differences in the species richness and the abundance of the species between Marys Peak and the HJA would be valuable. Other study sites should be established in both the Coast Range and the Cascade Mountains to observe if the differences were unique to Marys Peak and the Andrews Forest.

Figures 1-5. Dorsal view of adult male.

1. Deraeocoris piceicola.
2. Dichrooscytus sp. A.
3. Orthotylus sp. A.
4. Paradacerla formicina.
5. Phytocoris neglectus.



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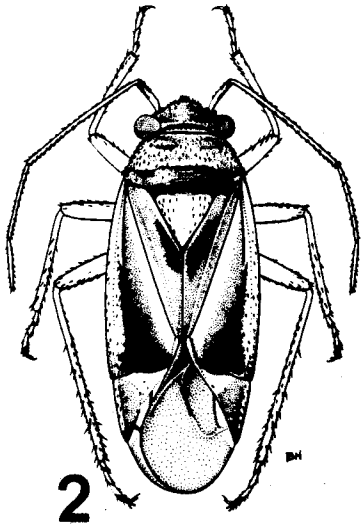

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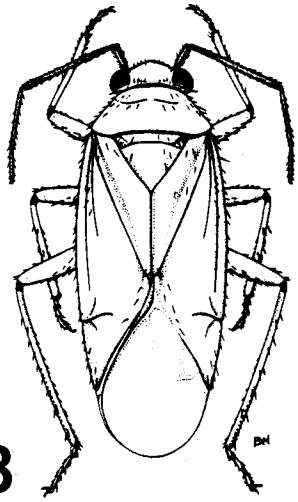

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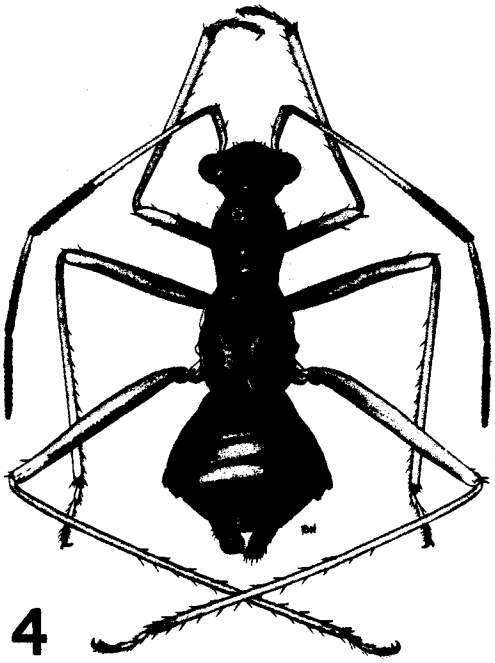

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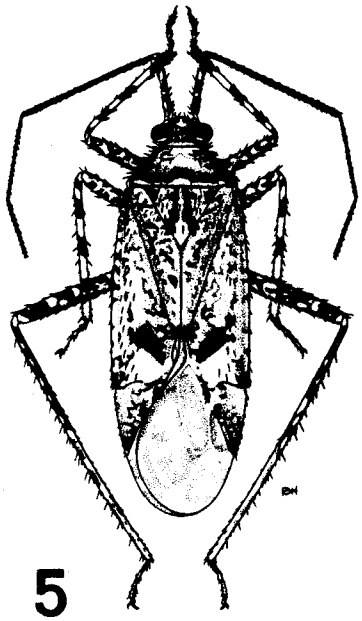
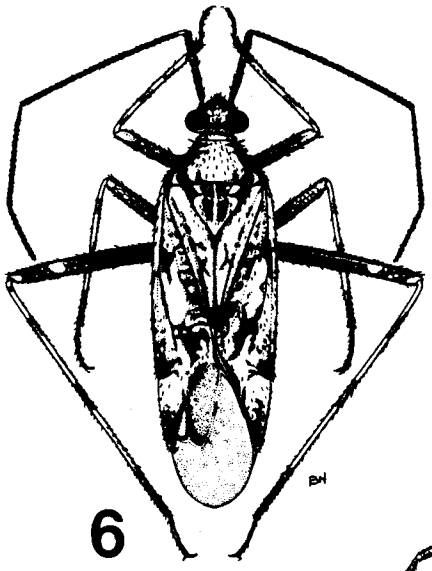


5

Figures 6-10. Dorsal view of adult male.

6. Phytocoris sp. A.
7. Pinalitus solivagus.
8. Plagiognathus sp. A.
9. Psallus sp. A.
10. Psallus sp. B.



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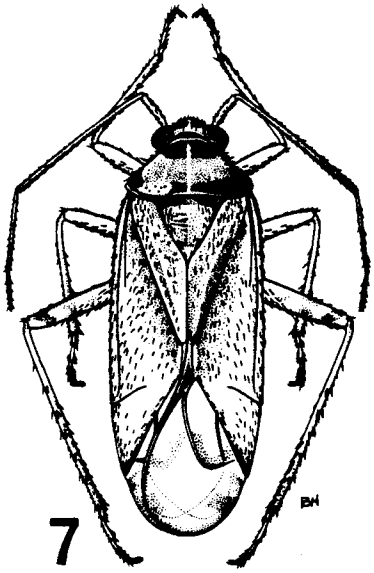

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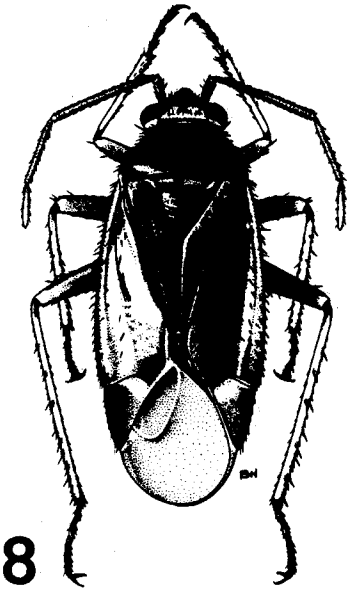

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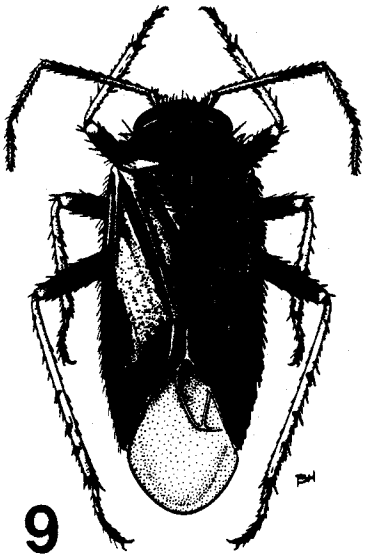
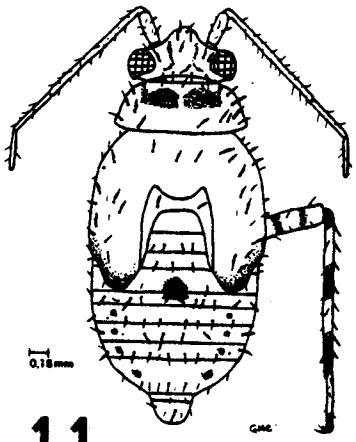


9

10

Figures 11-14. Dorsal view of male fifth instar larva.

11. Deraeocoris incertus.
12. Deraeocoris piceicola.
13. Dichrooscytus sp. A.
14. Orthotylus sp. A.



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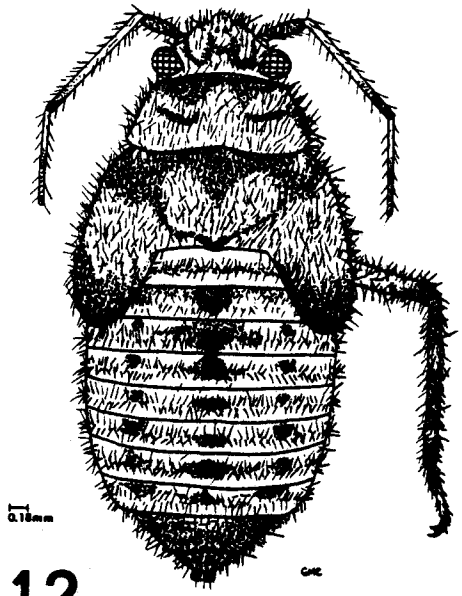

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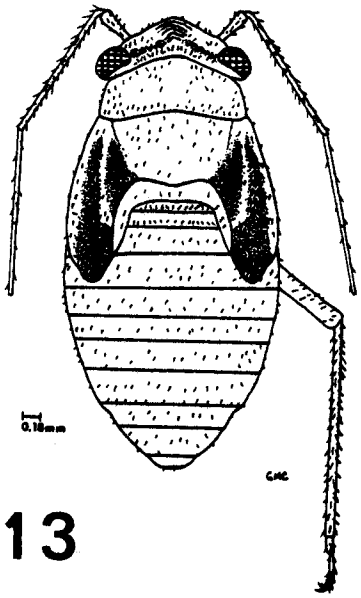

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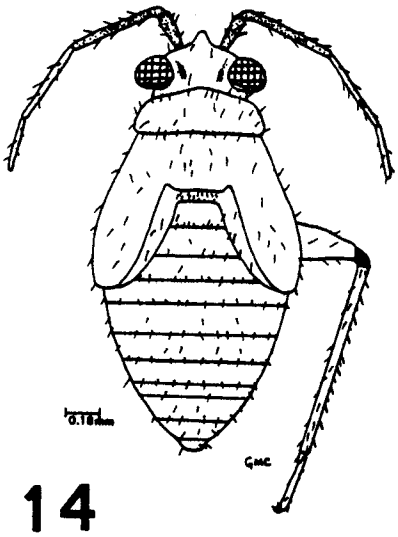
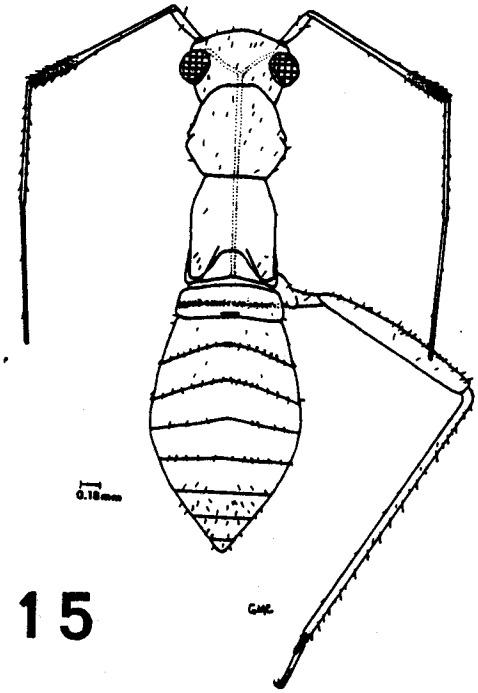


14

Figures 15-17. Dorsal view of male fifth instar larva.

15. Paradacerla formicina.
16. Phytocoris neglectus, coloration shown for antennae and hind leg only.
17. Phytocoris sp. A, coloration shown for hind leg only.



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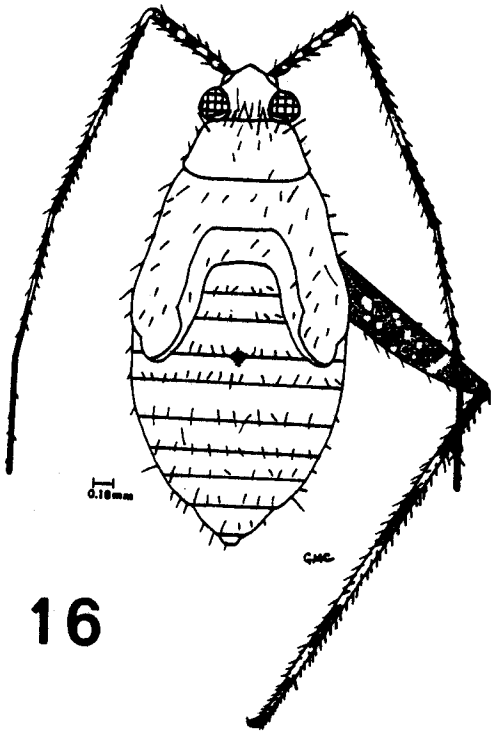

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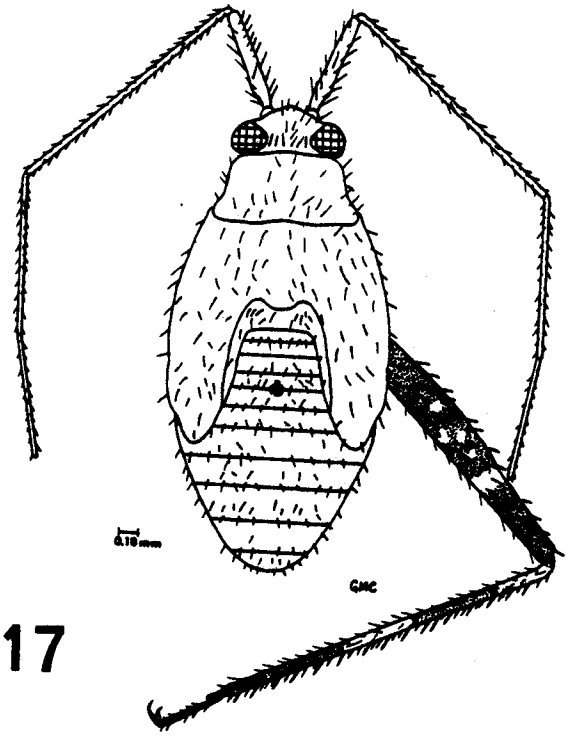


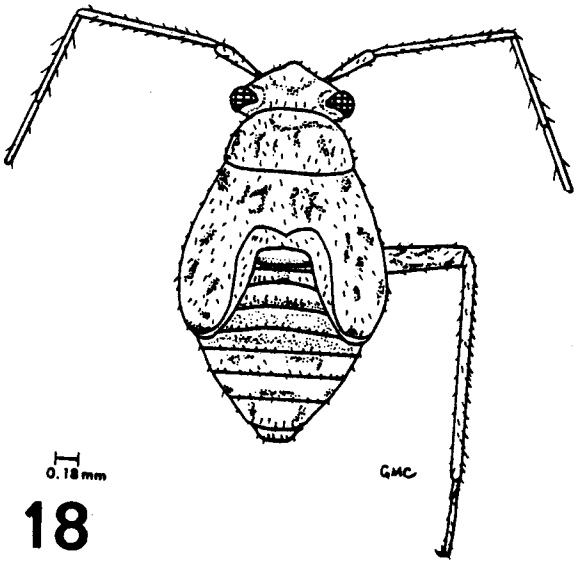
17

Figures 18 and 19. Dorsal view of male fifth instar larva.

18. Pinalitus solivagus.
19. Plagiognathus sp. A.

Figures 20 and 21. A. Dorsal view of body and, B. Lateral view of head of male fifth instar larva.

20. Psallus sp. A.
21. Psallus sp. B.



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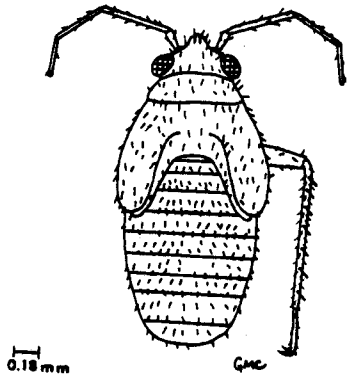

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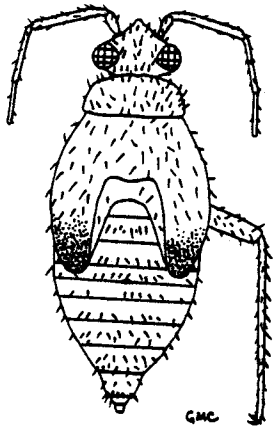
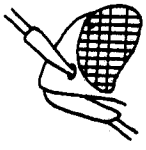
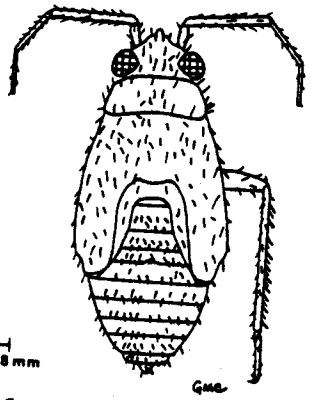


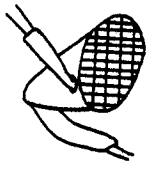
20 A



B



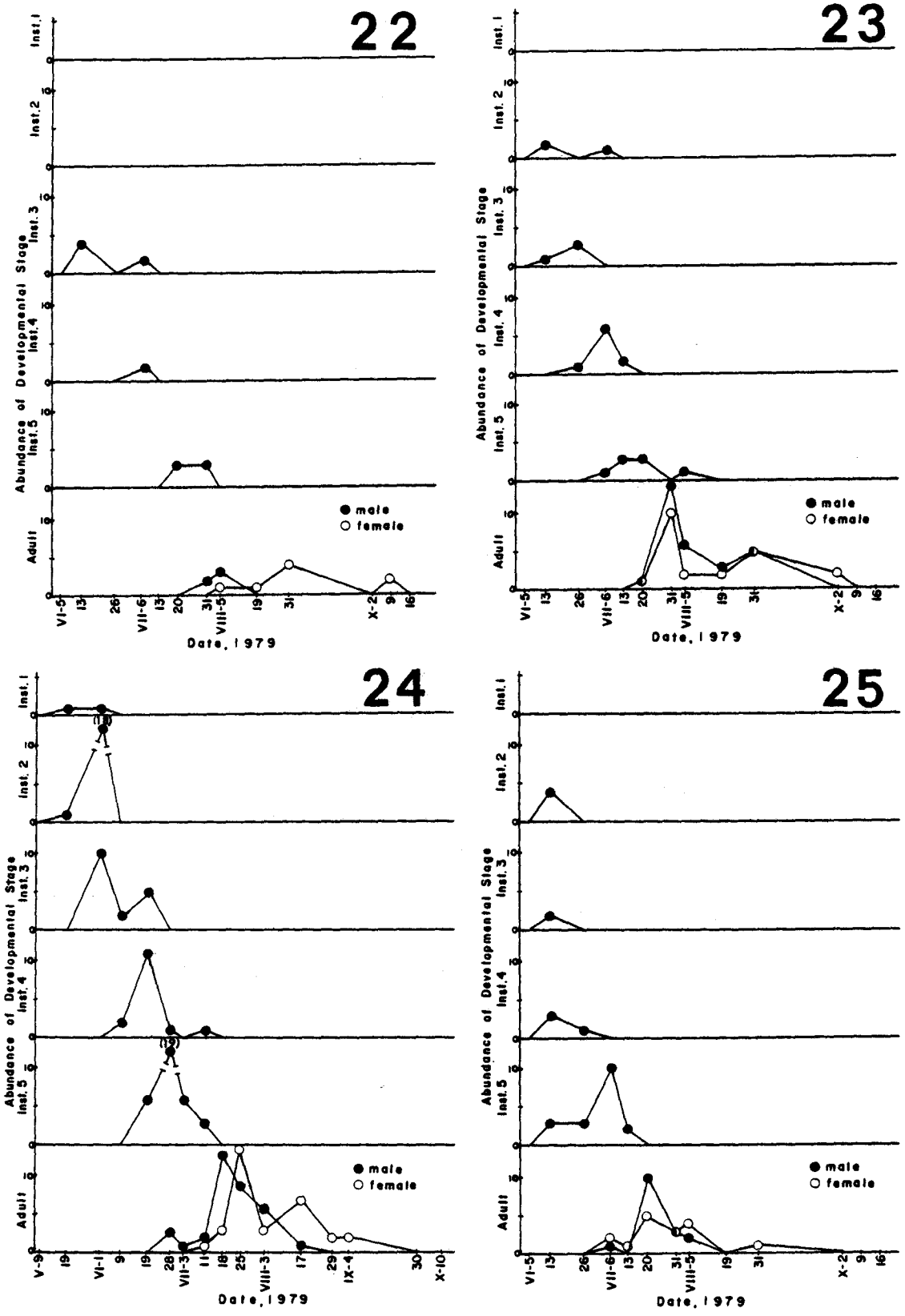
21 A



B

Figures 22-25. Periods of occurrence and abundance of five larval instars and adult males and females.

22. Deraeocoris incertus, H.J. Andrews Exp. Forest.
23. Deraeocoris piceicola, H.J. Andrews Exp. Forest.
24. Dichrooscytus sp. A, Marys Peak.
25. Dichrooscytus sp. A, H.J. Andrews Exp. Forest.


22
23
24
25
Inst. 1
Inst. 2
Inst. 3
Inst. 4
Inst. 5
Adult
Abundance of Developmental Stage
male
female
VI-5
13
26
VII-6
13
20
31
VIII-5
19
31
X-2
9
16
Date, 1979
V-9
19
VI-1
9
19
28
VII-3
11
18
25
VIII-3
17
29
IX-4
30
X-10

Figures 26-29. Periods of occurrence and abundance of five larval instars and adult males and females.

26. Orthotylus sp. A, H.J. Andrews Exp. Forest.
27. Paradacerla formicina, Marys Peak.
28. Paradacerla formicina, H.J. Andrews Exp. Forest.
29. Phytocoris neglectus, Marys Peak.

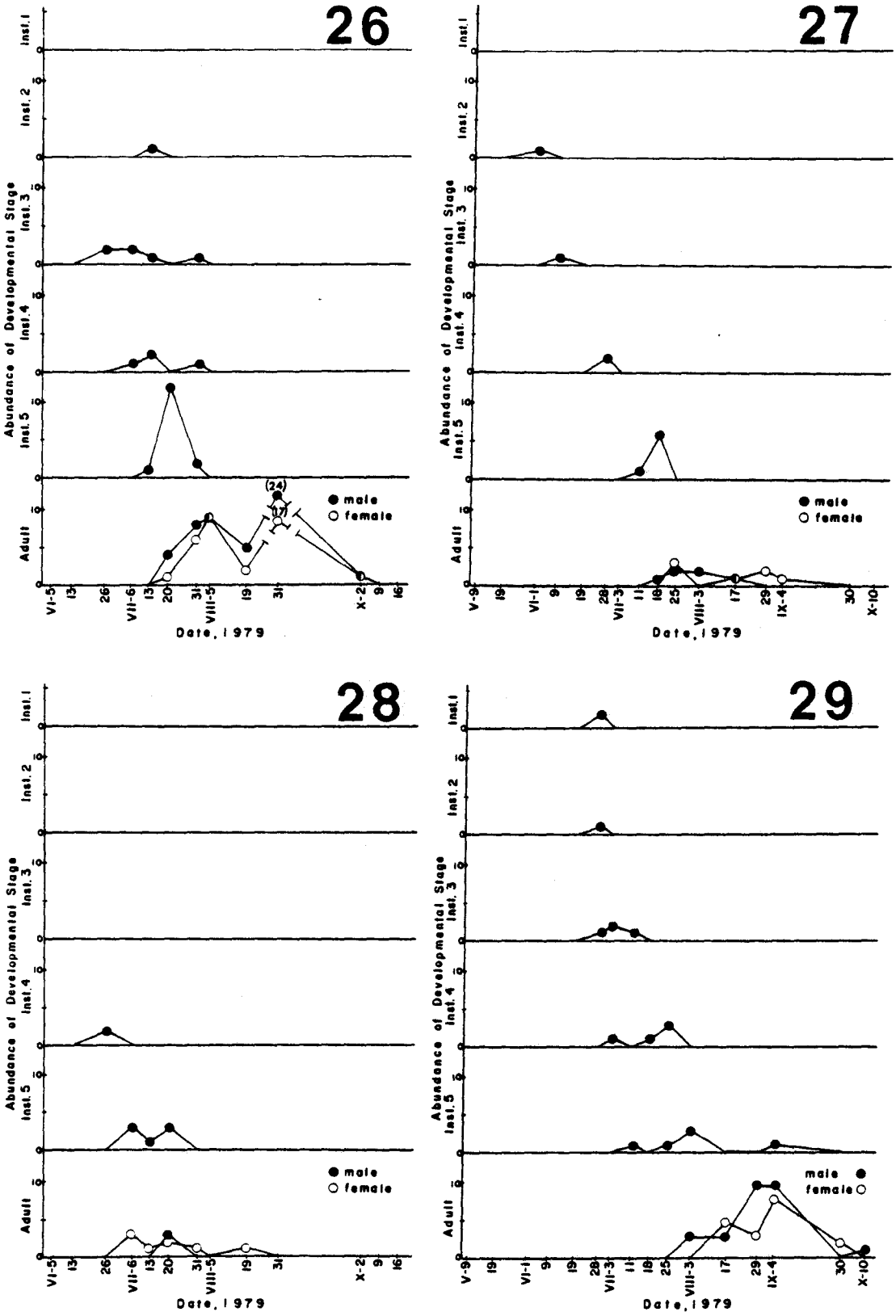
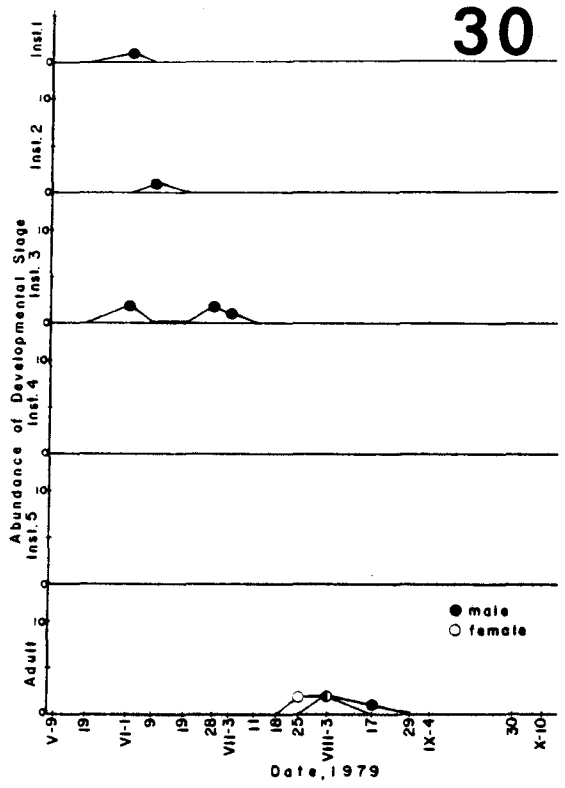
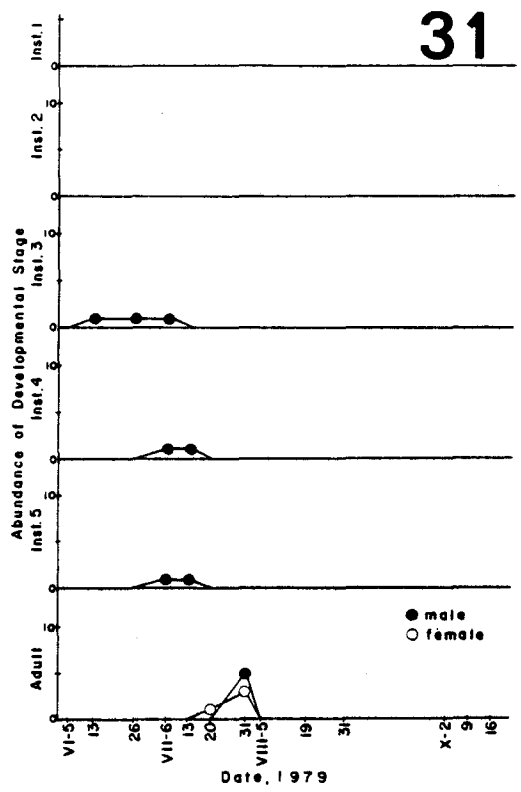
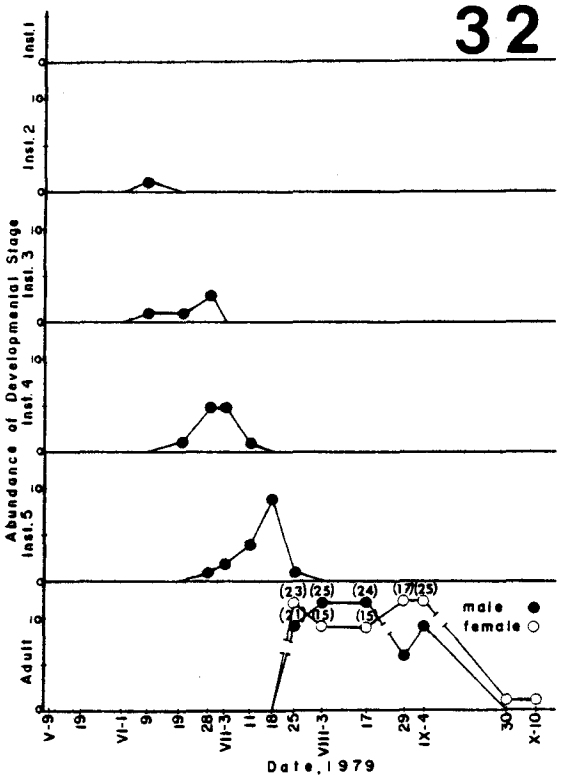

26
27
28
29
Abundance of Developmental Stage
Inst. 1
Inst. 2
Inst. 3
Inst. 4
Inst. 5
Adult
male
female
(24)
(17)
Date, 1979
VI-5
13
26
VII-6
13
20
31
VIII-5
19
31
X-2
9
16
V-9
19
VI-1
9
19
28
VII-3
11
18
25
VIII-3
17
29
IX-4
30
X-10

Figure 30-33. Periods of occurrence and abundance of five larval instars and adult males and females.

30. Phytocoris sp. A, Marys Peak.
31. Phytocoris sp. A, H.J. Andrews Exp. Forest.
32. Pinalitus solivagus, Marys Peak.
33. Pinalitus solivagus, H.J. Andrews Exp. Forest.


30
Inst.1
Inst.2
Inst.3
Inst.4
Inst.5
Adult
Abundance of Developmental Stage
male
female
V-9
19
VI-1
9
19
28
VII-3
11
18
25
VIII-3
17
29
IX-4
30
X-10
Date, 1979


31
Inst.1
Inst.2
Inst.3
Inst.4
Inst.5
Adult
Abundance of Developmental Stage
male
female
VI-5
13
26
VII-6
13
20
31
VIII-5
19
31
X-2
9
16
Date, 1979


32
Inst.1
Inst.2
Inst.3
Inst.4
Inst.5
Adult
Abundance of Developmental Stage
(23)
(25)
(24)
(17)
(25)
(21)
(15)
(15)
male
female
V-9
19
VI-1
9
19
28
VII-3
11
18
25
VIII-3
17
29
IX-4
30
X-10
Date, 1979

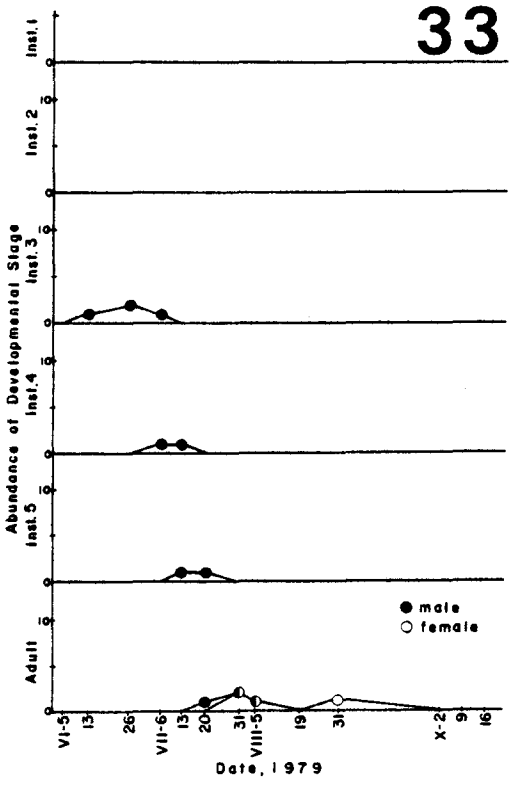
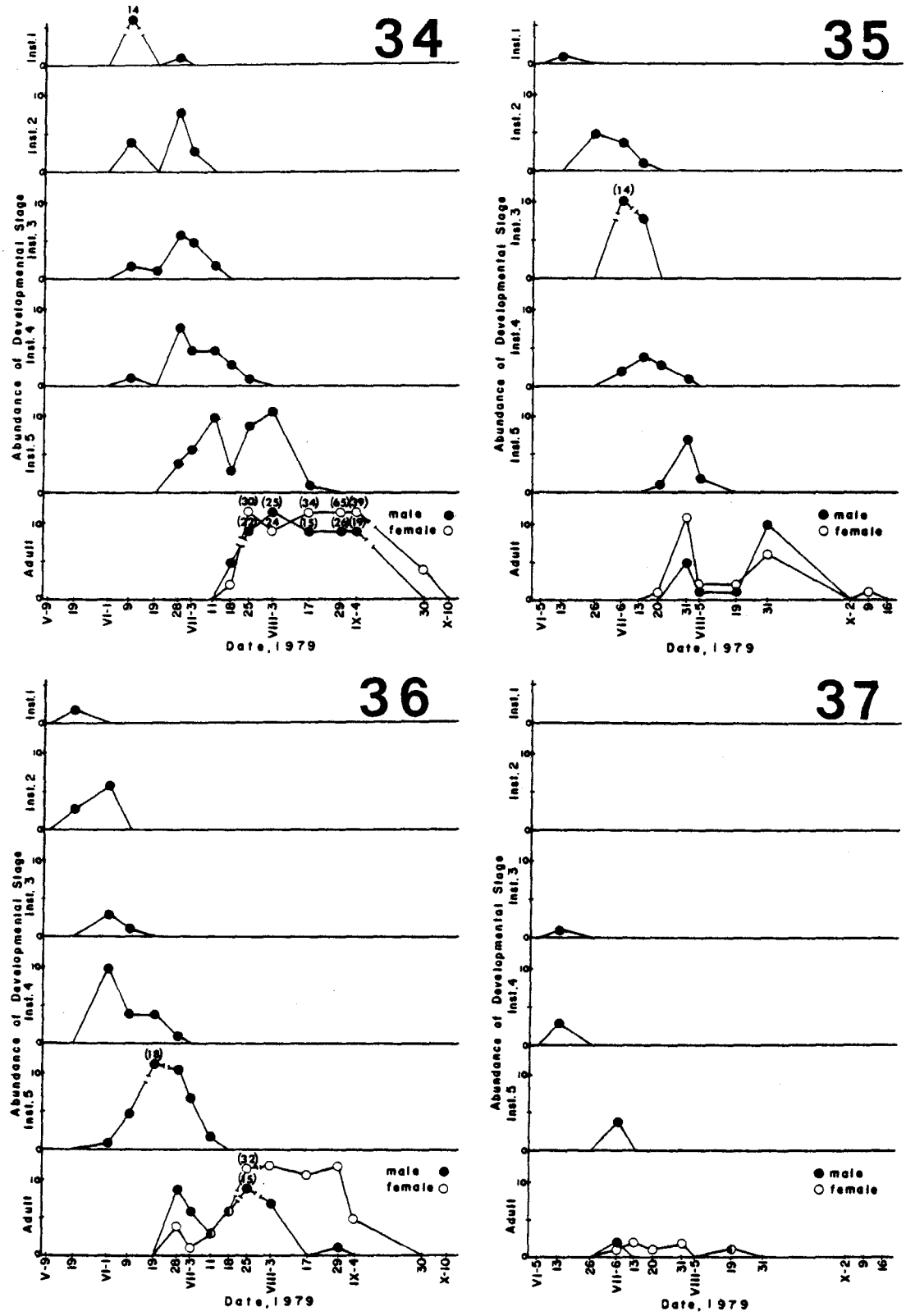

33
Inst.1
Inst.2
Inst.3
Inst.4
Inst.5
Adult
Abundance of Developmental Stage
male
female
VI-5
13
26
VII-6
13
20
31
VIII-5
19
31
X-2
9
16
Date, 1979

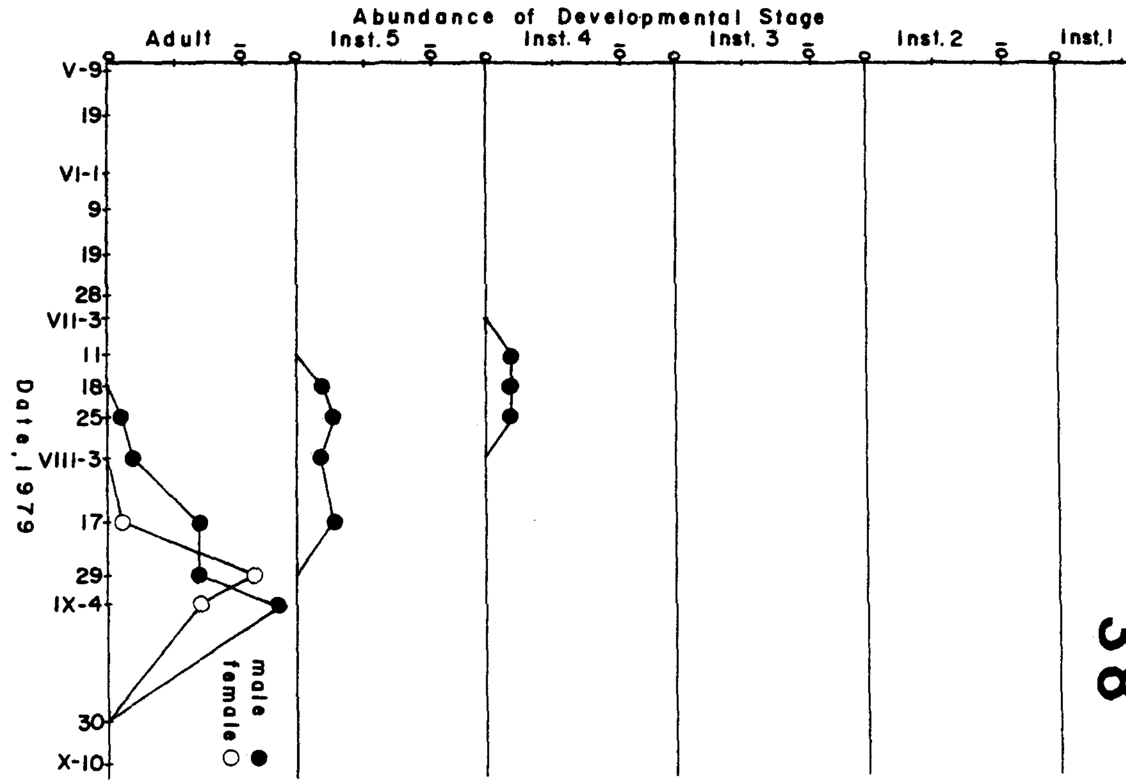
Figure 34-37. Periods of occurrence and abundance of five larval instars and adult males and females.

34. Plagiognathus sp. A, Marys Peak.
35. Plagiognathus sp. A, H.J. Andrews Exp. Forest.
36. Psallus sp. A, Marys Peak.
37. Psallus sp. A, H.J. Andrews Exp. Forest.

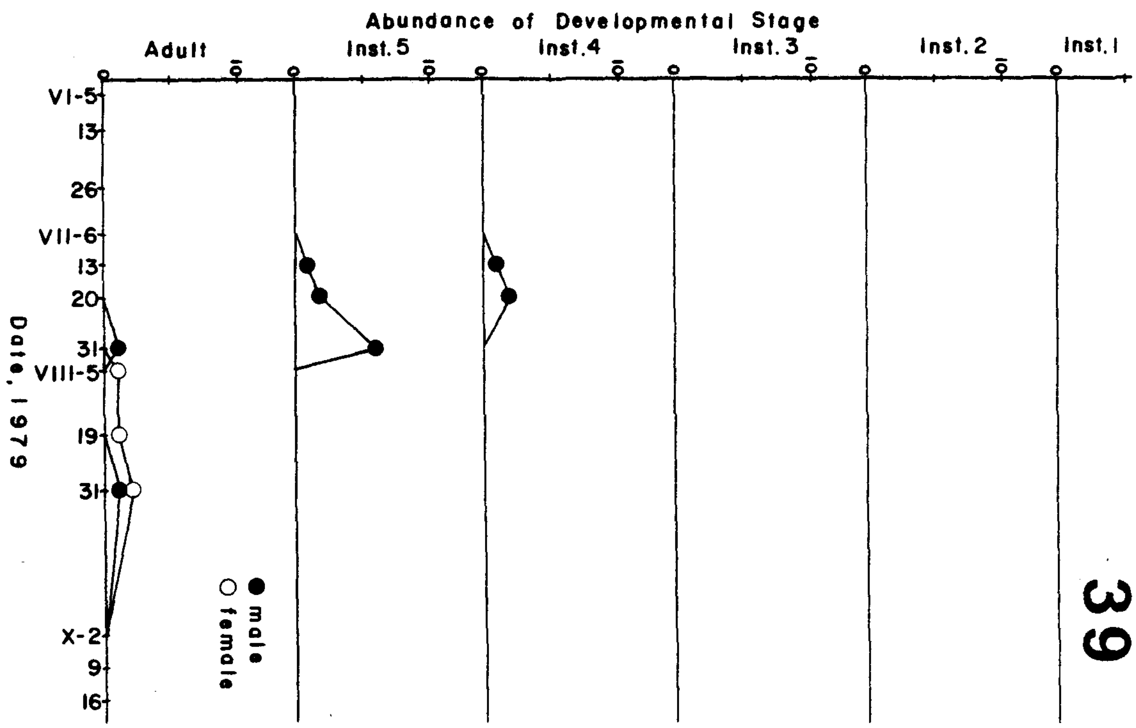

34
35
36
37
Abundance of Developmental Stage
Inst.1
Inst.2
Inst.3
Inst.4
Inst.5
Adult
male
female
Date, 1979

Figures 38 and 39. Periods of occurrence and abundance of five larval instars and adult males and females.

38. Psallus sp. B, Marys Peak.
39. Psallus sp. B, H.J. Andrews Exp. Forest.



Abundance of Developmental Stage
Adult
Inst. 5
Inst. 4
Inst. 3
Inst. 2
Inst. 1
Date, 1979
V-9
19
VI-1
9
19
28
VII-3
11
18
25
VIII-3
17
29
IX-4
30
X-10
● male
○ female
38



Abundance of Developmental Stage
Adult
Inst. 5
Inst. 4
Inst. 3
Inst. 2
Inst. 1
Date, 1979
VI-5
13
26
VII-6
13
20
31
VIII-5
19
31
X-2
9
16
● male
○ female
39

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APPENDIX

Appendix A. The "visitor" species of the Miridae collected from noble fir, Abies procera Rehd., the collection frequency of the adults of each species and field observations on various species.

Species	Frequency	Observations
Allorhinocoris flavus J. Sahlbg.	O	
Ceratocapsus nr apicatus Van Duzee	R	collected one adult
Deraeocoris brevis (Uhler)	F	collected one second instar and one fourth instar larva
D. rubroclarus Knight	R	fifth instar larvae occasionally and adults frequently collected on Grass Mtn., Benton Co., Ore.
Dichaetocoris n. sp.	A	one third instar, two fourth instar and nine fifth instar larvae and 128 adults collected.
Dicyphus nr elongatus Van Duzee	R	
Dicyphus sp.	R	one adult collected
Heterotoma meriopterum (Scopoli)	O	introduced Palearctic predator
Irbisia inurbana Bliven	R	grass-inhabiting
I. serrata Bliven	F	grass-inhabiting; rarely collected fifth instar larvae
Lopidea sp.	R	one adult collected
Lygus striatus Knight	F	hosts: lupines, Lupinus spp.
L. varians Knight	F	many non-coniferous hosts
Mecomma gilvipes (Stål)	O	meadow-inhabiting; rarely collected fifth instar larvae
Megaloceroae recticornis (Geoff.)	R	grass-inhabiting, collected one adult

Appendix A. (cont'd.)

Species	Frequency	Observations
Neoborella n. sp.	O	host, hemlock dwarf mistletoe, Arceuthobium tsugense (Rosendahl), found on noble fir on Marys Peak, Benton Co., Ore.
Orthops scutellatus (Uhler)	F	host, a species of the Umbelliferae; fifth instar larvae occasionally seen
Phytocoris interspersus Uhler	O	
Phytocoris nr montanae Knight	R	
Pinalitus nr approximatus (Stål)	O	hosts, Tsuga heterophylla (Raf.) Sarg. and T. mertensiana (Bong.) Carr.; two fifth instar larvae collected on sticky traps on noble fir tree boles
Pithanus maerkelii (H.S.)	R	grass inhabiting; one adult collected
Platylygus pseudotsugae Kelton	O	host, Pseudotsuga menziesii (Mirb.) Franco.; rarely collected fourth and fifth instar larvae
Psallus piceicola Knight	O	rarely collected fifth instar larvae; adults collected from noble fir cones by J. Scurlock, and on foliage.
Psallus sp. (like P. sp. B but second antennal segment not thickened and vertex wider)	R	
Stenodema vicinum (Provancher)	F	grass-inhabiting; rarely collected fifth instar larvae

Symbols

R = Rare, total collection of adults on noble fir during the 1979 collecting season was only 1-5.

O = Occasional, 5-20 adults collected.

F = Frequent, 21-50 adults

A = Abundant, more than 50 adults.