THE HEMIPTERA:HETEROPTERA OF THE COLUMBIA RIVER BASIN, WESTERN UNITED STATES

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1. Biology, Systematics and Biogeography of the Hemiptera:Heteroptera of the Columbia River Basin

The Hemiptera:Heteroptera is a modest-sized taxon containing about 25,000 species world-wide and about 4000 species in Canada and the Continental United States. The 4000 species are placed in 677 genera and 45 families (Henry and Froeschner, 1988). There are about 648 species and 270 genera in the Pacific Northwest and about 307 species, 163 genera and 30 families of Hemiptera:Heteroptera in the Columbia River Basin (Lattin, unpublished). While there are other portions of the United States with more species, we do have a remarkably representative biota.

Although all of these insects have sucking mouthparts that normally confine their feeding to liquids (plant and animal) (a few Lygaeidae excepted) they are remarkably diverse in habit and in habitat occupied (Weber, 1930; Dolling, 1991). The majority of species are phytophagous, feeding on virtually every type of plant from mosses (Tingidae:*Acalypta*) to legumes (Miridae:*Lygus*) to conifers (Pentatomidae:*Dendrocoris*). Only a few species would be considered pests, chiefly species that have been introduced into North America (e.g., Miridae:*Leptopterna dolobrata* (L.)). There are native species of bugs that have become pests, virtually all on plants that have been introduced as crops or forage or as ornamentals (e.g. Miridae:*Labops hesperius* Uhler on crested wheatgrass or *Lygus* spp. on a variety of crops, especially legumes). Most species feed on various herbs, forbs, shrubs or trees where they are rarely considered pests. Their feeding is usually confined to high quality portions of the plant (i.e., growing tips, developing seeds or other reproductive parts) and thus may reduce reproduction in some plants.

Some of the species are predaceous in habit, feeding on a wide variety of small arthropods, including other insects. These predaceous species are a significant part of the predator complex many insects have to deal with. Since there is an interesting continuum of size class of the bugs, the selected prey often show a similar continuum in size. Small predatory species such as flower bugs (Anthocoridae) may feed on eggs and small-sized life stages; ***other*** species, such as stink bugs (Pentatomidae) may be able to feed on fully grown larvae or adults. There is a good representation of predatory Hemiptera:Heteroptera found throughout the Columbia River Basin in aquatic and terrestrial habitats (Lattin, unpublished).

The herbivorous habits of many bug species mean that their geographic range is often determined by the distribution of their host plant. Host specific bug species may only be found where the hosts are found assuming other factors do not preclude their presence. Knowledge of host associations is important and is a direct link to the distribution of the plant. The latter being a reasonable predictor for the range of the bug. Insects having a broader host range may feed on several hosts locally or change hosts in different parts of their range. These changes may be elevational in nature or due to other changes in plant associations. In general, we do not have adequate distributional knowledge on most species ***nor*** do we have adequate host plant data. We must rely more on extrapolation than solid data, not a desirable situation but one that can be improved upon by selecting key species for special attention for future work. Every effort has been made to select representative species , for this analyses based upon 40 years of work in the Pacific Northwest. While we do not know a great deal, we do know quite a bit that adds to the degree of confidence in our extrapolations. Similarly, we feel fairly confident about priority taxa that can be identified for future work that will yield quality data for future efforts. Clearly, with over 300 species in the Columbia River Basin, we must work with surrogate species as we gradually acquire a large-scale data base.

We have a reasonable knowledge of the general biogeographical distribution of the Hemiptera:Heteroptera fauna of the region based upon my personal experience of about 40 years in the area, combined with the holdings of the Systematic Entomology Laboratory at Oregon State University (about 2.6 million specimens), my large, personal library on the group (over 10,000 reprints), the holdings of the collections at Washington State University, University of Idaho, University of British Columbia, and the California Academy of Sciences (San Francisco). These holdings, and others, combined with some field work, would form the basis for future work to more accurately delimit the major geographical patterns within the region of concern. Representative species of Hemiptera:Heteroptera will be found in virtually every habitat examined. For that reason, species of this taxon are ideal biological probes for this broad endeavor.

2. Species of Special Concern

Five species of Hemiptera:Heteroptera are considered of special concern within the east-side region. It is certain that there are other such species but our knowledge base is simply inadequate to either recognize them or document their scarcity or sensitivity to disturbance.

Two of these species, *Micracanthia* ***fennica*** (Reuter) (Saldidae) and *Hebrus* ***buenui*** ***buenoi*** Drake and Harris (Hebridae) are known only from Harney Hot Springs, Oregon and in Idaho although both species have a wider range outside the east-side area (Polhemus, 1988; Polhemus and Polhemus, 1988). These isolated hot springs serve as refugia for a select group of insects and deserve special attention for protection and conservation. They are particularly vulnerable to disturbance.

Ambrysus ***mormon*** Montandon (Naucoridae) ranges widely over portions of western United States (Polhemus and Polhemus, 1988) but thus far, in our area, is found chiefly in run-off from thermal waters. In our area, the species is known from Idaho, Oregon, Nevada and Utah. One subspecies is known only from the thermal waters of Yellowstone National Park in Wyoming (Polhemus and Polhemus, 1988). As with the hot springs, thermal waters in general require special consideration because of the unique fauna normally associated with them.

Chorosoma sp. nov. (Rhopalidae) is an unusual component. The species was first collected near Bruneau Hot Springs, Idaho, later at Alvord Desert, southeastern Oregon, and later in Nevada. It is the sole representative of the genus in North America, all other species are found in the Old World. The distribution of Palearctic species extend from western Europe the Soviet Far East where a single species, ***Chorosoma*** *macilentum* Stal, occurs. Our species is found on Indian ***Rice grass*** (*Achnatherum* ***hymenoides (R&S)*** Barkworth), a grass species that is found on sand, adjacent to interior sand dunes. These sandy habitats are often subject to considerable disturbance from recreational vehicles. There are other cold-steppe Hemiptera:Heteroptera that display similar distribution patterns - that is, the extension of the range of a Palearctic genus into the colder, drier interior region of the Pacific Northwest (Schuh and Lattin, 1980). This distinct pattern is very poorly known thus far (Lattin, in press).

Boreostolus americanus (Wygoszinsky and Stys, 1970) (Enicocephalidae) is the final species considered as a potentially sensitive species. This is one of the most primitive species of the family Enicocephalidae and this family is considered to be the most primitive family within the Hemiptera:Heteroptera. Known as the unique-headed bugs, this group is usually found living in the litter/soil layer where the species are generalist predators on small organisms, including other insects (Wygodzinsky and Schmidt, 1991). ***Boreostolus americanus*** was described from western Oregon and is found also in Washington where it occurs at very scattered localities along streams coming from the Cascade Mountains. The single holotype male was collected in northern Colorado (Wygodzinsky and Stys, 1970). The only other species known was described from the Amur River region of the Soviet Far East by Wygodzinsky & Stys (1970), displaying a trans Behringian distribution pattern. The genus considered nearest to *Boreostolus* is *Gamostolus* with one of its species occurring in Tierra del Fuega, in southern Chile. Previously unknown from the Inter-mountain Region, a single specimen of ***B. aamericanus*** was collected from along the Twocannon River in southeastern Washington. This river runs out of the Blue Mountains. There is a high probability that the species will be taken from the riparian zone of other streams and rivers where it typically occurs under cobble-sized rocks partially imbedded in damp sand. There is a remote possibility that portions of its potential range may coincide with the flooding that resulted in channelled scablands of eastern Washington (Allen and Bums, 1986). This relictual species is of great evolutionary and biogeographical interest.

3. Model Information for Species of Concern

A. Key Environmental Factors

a. ***Micracanrhia fennica*** (Reuter). The key environmental factors for this species are: water (probably thermal water), riparian habitat with sparse cover, presence of small-sized arthropod prey items, absence of habitat disturbance.

b. *Hebrus buenoi* Drake and Harris. The comments above for ***M. fennica also*** apply to this species, also known only from Harney Hotsprings. **Both** of these are rare species at this location. No numerical samplings have been made. My estimate for both species would be no more than 100 individuals

of each species. Disturbance is certainly the most critical factor for both species, especially from cattle.

c. *Ambrysus mormon mormon* Montandon. Thus far, known only from Cow Lakes, Hamey County, from thermal waters. Key factors include: thermal water, aquatic prey items (small arthropods or other small animals, absence of contamination or disturbance. No estimate of population size presently available. Not possible to estimate at this time. Situation for this species should be better than species a and b above.

d. *Chorosoma* sp. nov. This as yet undescribed new species appears restricted to a single host plant, Indian Rice ***Grass, Achratherum hymenoides*** (R. & S.) Barkworth. Thus far, its known range includes a single site in southwest Idaho, one locality in southeast Oregon, and one locality in Nevada. Key environmental factors would include: presence of host plant, sand dune margins, lack of habitat disturbance where host occurs, no pesticide applications (e.g., grass hopper control). No information available on status of populations.

e. *Boreostolus americanus* Wygodzinsky and Stys. While known from four very local sites on the west side of the Oregon and Washington Cascades, only a single locality is known from the ease side (CRB), that being in the Twocannon River Valley in southeastern Washington. The key factors for this species include: riparian habitat, cobble/sand substrate, small arthropod prey, riparian habitat, lack of excessive disturbance (e.g., cattle). Population information not available. This is a rare, locally occurring species wherever it occurs.

B. Key Functional Roles

a. ***Micracanthia fennica*** (Reuter): Predator in riparian area around hot springs, feeds on small arthropods in riparian zone, serves as food for other riparian arthropods, vertebrate predators.

b. *Hebrus* ***buenoi*** Drake and Harris: Very small-sized predator in riparian zone, also able to venture out on water surface, may serve as food for arthropod and vertebrate predators in riparian zone.

c. *Ambrysus* ***mormon mormon*** Montandon: Under water predator of arthropods, other invertebrates, and very small aquatic vertebrates, part of general aquatic predator complex.

d. *Chorosoma* sp. nov: A specialist herbivore on Indian Rice Grass along the margins of sand dunes, immature and adults plant feeding, provides food to vertebrate predators (and arthropod predators) in dune margin ecosystem

e. *Boreostolus* ***americanus*** Wygodzinsky and Stys: Riparian predator on small arthropods living under partially embedded rocks in sandy substrates, serves as prey for invertebrate and vertebrate predators in riparian system.

4. Functional Groups (Outline)

A. Predators

1. Aquatic
   a. In water
   b. Surface of water
   c. Riparian
2. Terrestrial
   a. Ground inhabiting
   b. Understory/herb and forb
   c. Shrub layer
   d. Trees
   e. Ectoparasites

B. Herbivores

1. Aquatic
2. Terrestrial
   a. Below ground
   b. Litter layer
   c. Understory/herb and forb

d. Shrub layer

e. Trees

Functional Groups

A. Predators

1. Aquatic

a. In Water

Belostomatedae: *Belostoma bakeri*

Notonectidae: *Notonecta kirbyi*

These insects are free swimming and predaceous. They are found in quiet waters (lakes, ponds, swamps, marshes) but may occur in backwaters of slow moving streams and rivers. They are major predators of other aquatic invertebrates and small vertebrates, chiefly small fish. They are winged and strong fliers and readily attracted to water. They will colonize water across the landscape. Thus, they tend to be rather ubiquitous within their normal range. They occur chiefly in the Basin/Range region and are not well known so far as their occurrence at higher elevations is concerned. They are likely to be rare under such conditions. They may be considered consumers of herbivorous arthropods and small vertebrates. Their departure from their pond or stream would result in transfer of energy from one aquatic habitat to another. These organisms would in turn be food for larger vertebrates including birds, amphibians, fish, small mammals. Occurring as they do in concentrations in a semi-arid environment, they may be targets for a higher level of predation than usual.

A. Predators

1. Aquatic

b. Surface of Water

Genidae *Gerris gillettei*

Veliidae ***Microvelia buenoi***

Veludae ***Rhagovelia*** *distincta*

These insects are free moving insects of very small to small size. They are found on the surface of water, including small seeps and ponds, streams and rivers, depending upon the species.

All of these species are predaceous in habit in both the immature and adult stages, feeding on small arthropods and some of the small animals that might be trapped in the surface film. The bugs do not go below the surface film.

These insects have special adaptations for moving on the surface film without breaking through, usually involving adaptations to the tarsi. Some of these insects (Gerridae) are able to detect the movement of potential prey on the surface of the water by special sensors and locate their position by water movement.

Rhagovelia disrincra Champion is found only on moving water, usually large rivers, and may occur in very large numbers. The distribution of this species is poorly known throughout the region chiefly because most people are unaware of its occurrence. Collecting is more likely to be effective from a boat since they may occur farther out from shore.

Microvelia buenoi Drake occurs throughout the United States and Canada and should occur throughout most of the east-side region as well. It is a small inconspicuous species found usually at the edge of the water, often where some emergent vegetation occurs. It is as commonly found on the moist substrate on shore as on the surface of the water. Its very small size permits it to venture onto the water without danger of falling through. It feeds on very small insects and other arthropods, including emerging aquatic insects, especially at the water/soil interface. It is a regular component of the predator complex in that region (Shore bugs - Saldidae, and toad bugs - Gelastocoridae being other Heteroptera predators on the surface of the waters edge (rarely on the water, Saldidae only).

Gerris gillettei Lithierry and Severin occurs throughout the western United States and into British Columbia. This is a moderate-sized water strider that is found on ponds and lakes throughout the east-side region. It is a surface predator, feeding on emerging aquatic insects and terrestrial species that might land on the water and become trapped in the water film. As indicated above, surface disturbances by potential prey is detected by the bug that is then guided to the location of the prey. These are effective surface predators with the front legs used to hold the prey and the curved beak used to penetrate the cuticle of the prey, inject saliva that will subdue the prey, and permit the fluid contents of the prey to be

withdrawn. Most bug predators have saliva that breaks down body contents with some extra oral digestion , allowing the liquid portion to be taken up as food.

There is a regular complex of these taxa. The three cited here are merely examples.

A. Predators

1. Aquatic

c. Riparian

These insects are free-living predators occurring along the edges of streams, ponds and lakes. Most species are found on the ground surface, but *Boreostolus americanus* (Wygodxinsky and Stys) (Enicocephalidae) occurs under partially buried rocks where they feed on small arthropods and other animals. This particular species has enlarged front legs that are modified to hold their prey and likely assist in moving through the soil as well. There is evidence that they are able to survive submergence when water levels rise. The insect becomes comatose, becoming active again when the water level lowers.

Members of the family Gelastocoridae (commonly called toad bugs), are surface predators commonly found in the riparian area. They are predaceous as adults and nymphs. Although there are a modest number of species in this family in the United States, only *Gelastocoris oculatus* (Fabricius) occurs in our area. There is some evidence that some toad bugs are able to survive flooding and may even burrow in soft sand near the edge of the water. These species may be collected by pushing quantities of sand into the water, the insects (other species as well) coming to the surface.

The mottled color pattern of the upper surface of the body makes these insects difficult to see until they move. They are active predators on a wide variety of small arthropods and other small animals. It is likely that they are particularly effective as predators of aquatic insects emerging from the water at the edge of the water.

The single species of Hebridae found in our ***area, Hebrus buenoi (Drake*** and Harris), is thus far known from one locality in Oregon, Hamey Hot Springs, just south of Hamey Lake, and has been reported from Idaho. Outside of this ‘area, it is found in California and is widely distributed in central and eastern United States (Polhemus and Polhemus, 1988).

These tiny insects are surface predators in the riparian zone and are small enough to venture onto the surface of the water. They feed ‘on very small organisms found in their habitat.

The small water striders, or Veliidae, are found in the riparian zone, close to or on the water. One common species is ***Microvelia buenoi*** Drake, a widespread species found throughout much of the United States and Canada. As ***with Hebrus buenoi,*** it too is a very small predator that feeds upon a wide variety of small organisms found along the water’s edge. In areas where water is in short supply (the drier east-side), these tiny predators may have an effect on the local aquatic community.

The family Saldidae; or shore bugs, are common inhabitants of the riparian zone, usually seen patrolling the shoreline where they feed on living and recently dead organisms--usually other arthropods, but sometimes very small worms. There are a number of species of Saldidae found within the east-side area. Five species are considered here. *Ioscytus politus* Reuter and ***Salda buenoi*** (McDunnough) are commonly found along the shores of saline or mineral waters (e.g., playa lakes and hot springs), especially ***I. politus***. ***Salda buenoi*** also occurs at scattered localities along the Oregon Coast in salt marshes, and at one locality in the Willamette Valley--A mineral spring. While *I. politus* is more common in more open situations, ***S. buenoi*** is more abundant among reeds and rushes. Both species are predaceous as adults and nymphs, being non-specialized predators of the arthropods living in the riparian habitat *Micracanthia fennica* (Reuter) is a Holartic species that occurs at scattered localities across the northern part of the United States and in Canada. It has been found in Oregon only at Harney Hot Springs where it occurs on the ground among the low vegetation around the spring complex. It is a predator on small organisms living in that habitat.

Many species of *Saldula* Van Duzee, occur within the region of concern. Two such species, ***S. explanata*** (Uhler) and ***S. nigrita*** Parshley, are considered here. *Saldula explanata* occurs commonly around lakes and streams in the higher elevations, usually in the coniferous zone. It is a common riparian predator of insects and other arthropods found in this widely occurring habitat. *Saldula* ***nigrita*** is most commonly found on rocky substrates along the edges of streams, and often on the rocks in the stream. It appears to feed on emerging insects that leave the water by crawling up on the rocks. Thus, the bug may be considered a

predator of the mature aquatic insects leaving the aquatic habitat. Several other species of *Saldula* have similar habits.

A. Predators

2. Terrestrial

a. Ground Inhabiting

There are three families commonly found as ground-inhabiting predators: Anthocoridae, Lygaeidae, and Nabidae. Occasionally, a predator from the vegetational layers above may drop to the ground but this is uncommon. The Anthocoridae, or minute pirate bugs, represents a small but interesting family of bugs. Thirty-six species are found in the Pacific Northwest and 10 are known from the CRB. Of these latter species, only two species may be found on the ground, usually in litter or in accumulations of dead grass. One species each from the genus *Lyctocoris* and the genus *Xylocoris* might be expected. Several more species of the latter genus may occur within the CRB but distributional information is sparse at present.

These small bugs are virtually all predators, a few are known to also feed on pollen (e.g., *Orius* sp.). Anthocorids are part of the general predator complex found in many habitats where they feed on a variety of small insects and other arthropods. In the litter layer, they feed on the many different small arthropods that feed on the decomposing organic matter. Both of the species reported here are sometimes found in stored products in or around granaries and are considered to be beneficial in reducing the populations of stored-grain pests.

A. Predators

2. Terrestrial

b. Understory/herb and forb

Representatives of five families of Hemiptera:Heteroptera are found commonly in the understory/herb and forb layer in the CRB. These include the Anthocoridae, Nabidae, Pentatomidae, Phymatidae, and Reduviidae, representing a body-size gradient from small

(Anthocoridae) to large (Pentatomidae). The prey they feed upon as immature stages and adults includes a wide variety of insects in all life stages. Most of the species in these families are generalist predators (e.g.;, *Orius* (Anthocoridae), *Nabis* (Nabidae), *Sinea* (Reduviidae), and *Phymata* (Phymatidae), but a few are specialists, feeding on only one or two prey species (e.g., *Perillus* (Pentatomidae).

Representative species of these families can be expected to occur widely throughout most of the habitats of the CRB, but especially in the open shrub-steppe regions dominated by sagebrush, bitterbrush, and grasses as well as open stands of juniper and ponderosa pine. They are less abundant in dense, closed canopy forests but would be present during the early seral stages of these forests.

Most species of these families have good dispersal characteristics and thus may be expected to occur in most available habitats. Their feeding habits are such that they are likely to be less effected by disturbances, assuming some insects are available as prey. Areas that have been seeded with crested wheatgrass, for example, often have outbreaks of several native plant bugs (***Labops*** and ***Zrbisia*** (Miridae)). Common predators of these herbivorous bugs are the damsel bugs (Nabidae) and assassin bugs (Reduviidae). While the prey species diversity may be low in such instances, the numbers of individuals are high, providing ample food for these generalist predators.

A. Predators

1. Terrestrial

c. Shrub layer

All of the families included in the understory/herb and forb layer also occur in the shrub layer (i.e., Anthocoridae, Nabidae, Pentatomidae, Phymatidae, and Reduviidae) as well as representatives of the plant bug family, Miridae. While most of the five families mentioned have rather few species (except the Pentatomidae), the family Miridae is the largest family of the Hemiptera:Heteroptera throughout the world. The CRB is no exception to this statement; at least 110 species are known, and this figure is certainly low for the area simply has been poorly collected and studied. I would estimate that over 200 species might be found there, likely more. The only other family that would approach this number would

be the Lygaeidae, but only 25 species are known in the CRB and only 75 species known from the entire Pacific Northwest.

While the majority of species of Miridae are herbivorous, a well-defined group are either entirely predaceous (e.g., *Deraeocoris*) or at least partially predaceous (e.g., *Atractotomus* and *Parthenicus*). Combined with species from the other five families mentioned, the Hemiptera:Heteroptera comprise an important group of predators in the shrub system. As with the herb and forb understory system, the shrub species of bugs tend to be widely distributed throughout the CRB, and thus may be expected to occur virtually wherever this vegetational association is found.

One important difference should be mentioned, while most of the Anthocoridae, Nabidae, 'Pentatomidae, Phtymatidae, and Reduviidae are few in numbers of species and are generalist predators, the Miridae is a speciose taxon with many different species throughout the CRB. Therefore, one might expect to find Miridae wherever you sample, one would also expect to find different assemblages of species in different subsets of the shrub habitat. It is highly likely that a closer study of this phenomenon would yield information of considerable value in developing models for different portions of the CRB. We know just enough to know it is a very promising avenue of study, it simply has not been investigated thoroughly enough.

A. Predators

2. Terrestrial

d. Trees

The different families, genera, and species found in trees at various seral stages. represents a more specialized subset of four of the families of bugs already mentioned (i.e., Anthocoridae, Miridae, Pentatomidae, and Reduviidae). The families Lygaeidae, Nabidae, and Phymatidae rarely are found on trees; occasionally on very small seedlings among the shrubs and herbs. The genera and species of the four families that do occur on trees contain genera and species more typically tree-dwellers. This is especially true for the Anthocoridae (Lattin and Stanton, 1993) and the Miridae (Stonedahl, 1988; Schuh and Schwartz, 1988).

Only six predaceous species of Pentatomidae are found in the CRB on trees and less than that for the family Reduviidae.

While the family Anthocoridae is modest in size in the Pacific Northwest (12 genera and 35 species), at least six genera and 10 species are found in the CRB, chiefly on trees where they are important predators of Homoptera, Lepidoptera, Hymenoptera, and Coleoptera. A few species are generalist predators but most specialize on aphids, scales, and bark beetles, thus they are important components of the predator trophic level.

Only a few genera and species of Pentatomidae contain predaceous species (*Apateticus* and *Podisus*) found on, trees, but they may be important predators, especially of larval Lepidoptera and Hymenoptera (sawflies). The various immature stages feed on different-sized prey. The adults are large and able to handle the larvae of most sawflies and caterpillars.

There are many species of predaceous Miridae, chiefly in the genera ***Phytocoris,*** *Pilophorus*, and ***Deraeocoris.*** ***Pilophorus*** is a rather small genus nation-wide but with some species in the CRB. Most species are aphid predators, especially on members of the genus ***Cinara.*** Sixteen species of ***Deraeocoris are*** found in the Pacific Northwest, with at least six species occurring in the CRB. They are commonly found on trees where they feed on various Homoptera, and likely smaller-sized caterpillars and sawflies. Some species show a remarkable fidelity to a given host plant even though they are predators. The same is true for the plant bug genus ***Phyrocoris.*** Over 200 species occur in western North America (Stonedahl, 1988), many in the CRB, chiefly on trees and shrubs. ***Phyrocoris*** is the largest genus in the family Miridae worldwide and in America north of Mexico. Although largely predaceous, they too show remarkable host-specific associations. For that reason, species of this genus would be useful taxa to incorporate into models when adequate sampling has been done across representative plant associations in the CRB.

A. Predator

2. Terrestrial

e. Ecto Parasite

Cimicidae

Cimex pilosellus (Horvath) was originally described from Okanagan Landing, British Columbia from *Myotis longicrus* ***(True).*** The species is known from British Columbia, Washington, Idaho, Montana, and California. Recorded host bats include ***Eptesicus fuscus*** (Palisot de Beauvois), *Pipistrellus hesperus merriami* (Richardson), ***Antrozous pallidus*** (Le Conte), *Myotis* ***yumaneusis*** (H. Allen), *Myotis* ***califomicus*** (A.J. Beck), *Myotis* ***yumaneusis sociabilis*** (C.B. Phillip). Thus far, the bug is not known from Oregon, the Oregon species being *Cimex latipennis* Usinger and Ueshima whose host is *Myotis* ***thysarwdes*** (Miller) in California and a species of *Myotis* in Oregon.

These bat bugs are found more commonly in the roosts of bats rather than on the bats. They are ectoparasites of the bats, feeding on the blood of the animal as adults and nymphs (Usinger, 1966). Other species of Cimicidae occur in the region, found on birds rather than bats (i.e., *Oeciacus vicarius* Horvath and ***Hesperocimex*** *coloradensis* List).

B. Herbivores

1. Aquatic

The only aquatic herbivore represented by the Hemiptera:Heteroptera are the water boatman (Corixidae). These winged insects are found in a wide variety of still waters from fresh to saline, from ponds and lakes, to quiet pools in streams or rivers. They have unusual mouth parts that are adapted to feed on fine organic matter on the bottom or on filamentous algae where they remove the chloroplasts (Hunger-ford, 1920). These insects are excellent dispersers, often responding to shiny surfaces (car tops) far from water. Any impoundment will soon be colonized by some of the widespread species. Several such species are included in this review that are typically found in still waters throughout the CRB (Stonedahl and Lattin, 1986).

A. Herbivores

2. Terrestrial

a. Below-Ground

The only below-ground herbivores in the Hemiptera:Heteroptera belong to the family Cydnidae, or burrowing bugs. Six species of Cydnidae are found in the Pacific Northwest and all of them are likely to occur in the CRB. This is a poorly known group in the PNW, partly because most of the species are found on the east side where much less collecting has occurred. Far more species of Cydnidae in North America are found to the south and east of the PNW. We are at the edge of the range of the family. It is a group that is more abundant in warmer climates. Little is known about the specific habits of our species except that, so far as known, all species feed on plants, mostly underground. This means that most species feed on the roots of plants within the range of the species. We do not have any information on the specificity of host plant relations. The various species of this family have the front legs'modified for digging in the soil, allowing them to move around below-ground and seek appropriate food plants. Specimens have been found in surface samples from the litter layer in west-side forests, suggesting that'there is some movement in the litter layer as well. Adults do occur on the surface of the soil during specific times of the year, perhaps for dispersal and/or mating. In other parts of the country, adults are readily attracted to lights. There is no reason not to assume the same should be true for our species.

Below-ground herbivory by insects is a topic that has been little investigated in a systematic way. There are many different groups whose larvae are important pests of crops that feed on plant roots (e.g., wireworms and white grubs), but the true-bugs are poorly known in this role. My only personal knowledge of such a case was in California where I found a species of Cydnidae feeding upon the roots of commercially grown strawberries. A thorough search of the literature on the family at the time (mid 1950's) revealed virtually no sound information. In our region (CRB), the various species should be considered a typical member of belowground herbivores in the range-basin region.

B. Herbivores

2. Terrestrial

b. Litter Layer

There is one major family of true bugs typically found in the litter layer, the Lygaeidae, or seed bugs. Several other families have some representatives that occur there,

feeding on surface growing plants, exposed roots, or mosses. The family Tingidae, or lace bugs, contains at least one genus, *Acalypta*, whose species feed on mosses growing on the ground or on fallen coarse woody debris. While normally most common in the more mesic forests of the west side, there is a species that is found in the Range-Basin region where it feeds upon a moss growing at the base of sagebrush and other such shrubs. While known from only a few specimens thus far, it is widely distributed throughout the Great Basin Region and has been reported from the Steppe Region of the Soviet Far East. It is a member of a small, but quite distinct cold steppe fauna that we have within the CRB.

Several genera of Pentatomidae are found in the litter layer in the CRB where they feed at the base of grasses and other plants. They are poorly represented in collections because of their rather secretive habits. When more work is done within the CRB, these species will certainly be found to be quite widespread. The family Scutelleridae, a close relative of the Pentatomidae, contains several genera whose species also are found at the bases of plants, especially grasses, where they feed on the stems. As with the Pentatomidae, these insects are poorly known but are known to have wide distribution within the CRB.

The Lygaeidae, or seed bugs, are the most typical of the litter herbivores found throughout the CRB. This is one of the largest families within the PNW with at least 75 species. At least 25 species are found within the CRB and most certainly more occur there. While some species of Ltygaeidae occur on herbs, forbs, shrubs and trees, the great majority of species in our area occur on the ground where they feed on seeds found in the litter layer. It is of special interest that these seed bugs are able to use their sucking mouthparts to feed upon seeds. They use their enlarged front legs to hold the seed, puncture the seed, inject saliva into the seed where extra-oral digestion occurs and the resulting liquids sucked back into the bug as a food source. This is a remarkable adaptation to utilize an abundant but obscure resource - fallen seeds. This is a common and widespread group of species within the CRB and should be included in any construction of life tables for plants in the drier regions where they function as functional counterparts to harvester ants and other seed-feeding insects. There are counterparts that feed on the seeds of conifers in the Lygaeidae (*Gastrodes*) and Coreidae (*Leptoglossus*) that will be discussed later.

B. Herbivore

2. Terrestrial

c. Understory/herb and forb

Ten families of the true bugs have representatives found in the understory layer where they occur on grasses, herbs and forbs. These families are: Alydidae, Berytidae, Coreidae, Lygaeidae, Miridae, Pentatomidae, Rhopalidae, Scutelleridae, Thyreocoridae, and Tingidae. By far the most abundant genera and species encountered in this habitat belong to the plant bug family, or Miridae. This comes as no surprise since it is the largest family in number of species and most of its members are phytophagous.

The Alydidae, or broad-headed bugs are represented by three species in the CRB, one each for the three genera occurring in the area. According to Schaefer (1980) and Schaefer and Mitchell (1983), members of this family feed largely on grasses and legumes. The immature stages are often found on the ground where. the action and appearance resemble ants. Adults fly readily when disturbed. The color is quickly obscured when they land and the front wings cover them up. Adults appear towards the end of summer.

The Berytidae, or stilt bugs, is a small family of bugs; only seven genera and 12 species are found in Canada and the United States. Three genera and four species are found in the CRB. These slender, distinctive insects, with their knobbed antennae are familiar insects throughout the region. They are mainly plant feeding but have been reported to be partially predaceous on small insects and insect eggs. Wheeler and Schaefer (1982) review the food plants for this family. ***Neides muticus*** (Say) and ***Jalysus wickhami*** Van Dozee are widely distributed in western North ‘America. They may have several generations per year. The Coreidae, or coreid bugs, is primarily a warm temperate and tropical group with only five genera and nine species found in the Pacific Northwest. All of the genera and eight of the species occur within the CRB. ***The*** genus ***Leptoglossus*** occurs on trees, the other genera and species are found on plants in the understory. Species of the genus ***Chelinidea*** are found on species of ***cacti,*** especially ***Opuntia,*** while species of the genus ***Anasa*** feed on a variety of plants,including squash.

While species of the family Lygaeidae are abundant in the CRB (20 genera and 25 species), as mentioned previously, most are seed feeders, chiefly on the ground, but a few

species feed on low plants. Species of *Lygaeus* are associated with species of ***Asclepias*** while species of *Nysius* are found on many different plants, often in considerable numbers. They will be widely distributed throughout the CRB. Species of *Blissus* feed on grasses and sedges as do species of *Cymus*. Although more commonly associated with shrubs, there are several species of Pentatomidae (stink bugs) found on plants in the understory layer. Representatives of the genera ***Chlorochroa, Codophila, Cosmopepla,*** *Euschistus*, ***Neotiglossa,*** and *Thyanta* will be found throughout the CRB. Detailed information on host association is scarce but could be obtained through surveys. Some species would be useful indicators once host-plant relationships are established.

The family Rhopalidae is represented by five genera and seven species in the CRB. They are often abundant, on many plants, especially towards the end of the season. Although difficult taxonomically, they are abundant enough to be of potential value as indicators once host relationships are established. Species of the family Scutelleridae (4 genera and seven species in the CRB) are a more inconspicuous component of the Hemiptera:Heteroptera fauna except for species of the genus *Eurygaster* and *Homaemus* species of both genera are associated with grasses throughout the CRB. Three genera with one species each of the Thyreocoridae occur in the region. Host data is limited at present but suggest that species of the Scrophulareaceae may be the hosts. The family Tingidae, or lace bugs, is reasonably well represented in the CRB on a variety of herbs and forbs. Species of ***the*** genus ***Corythucha are*** often abundant on certain plants. Like so many bug taxa, this genus would be an ideal group to survey to obtain accurate host and distributional information. There are some taxonomic difficulties but they can be resolved with study.

The family Miridae, or plant bugs, is the largest taxon of the suborder Heteroptera and is well represented throughout the CRB by at least 46 genera and 110 species. While some of the species are predaceous, most are herbivorous on a wide variety of plants in all of the different habitats. They are well represented in the category under discussion. The abundance of genera and species and their general host-plant specificity, make them ideal taxa to be used in reflecting different vegetative assemblages. Some groups are still imperfectly known but a thorough survey of bugs or major plant taxa throughout the CRB would yield useful information. There are genera that feed on grasses ***(e.g., Labops, Irbisia;*** *Leptopterna*, *Litomirus*, ***Stenodema*** and *Trigonotylus*) while other genera feed on .

non-gramminoid hosts (e.g., *Lygus*, *Polymerus*, ***Labopidea,*** *Lopidea*, *Slaterocoris*, *Plagiognathus*, and *Psallus*). Of the genera cited above, we know the most about ***Labops, Irbisia, Leptopterna, Stenodema, Lygus*** and *Lopidea*, with some reasonable host data available combined with good taxonomic knowledge. Species of several of these genera are important pests in certain situations (e.g., ***Labops*** and ***Zrbisia*** on crested wheatgrass plantings (Lattin, Christie, and Schwartz, 1993). Some species of the genus *Lygus* ***are*** often pests of alfalfa and beans in many parts of the CRB, but the taxonomy is under study at present. The wide distribution, abundance of species and individuals, and the general host specificity make the Miridae a potentially useful group for further work and analyses.

B. Herbivores

2. Terrestrial

d. Shrubs

There is a rich herbivorous fauna in the shrub layer, although not as rich as that found in the understory/herb and forb layer. Ultimately, the fauna of the shrub layer may prove to be greater considering how widespread some of the plant species are within the CRB. More precise host information on the insects is required. There is a hypothesis that plants with greater geographical range support more species at a given site compared to a plant species with a more restricted range. Currently, there is little work being done to prove or disprove such a suggestion. Our work on Miridae on the various subspecies of *Pinus contorta* seems to support the hypothesis but much additional work is required (Lattin, unpublished; Lattin and Stanton, in press). While many species of Hemiptera:Heteroptera are known to occur on such shrubs ***as Artemesia,*** the failure to record the species of sage-brush blurs the true host specificity of the bugs. Compounding the problem is the fact that many of the genera of bugs are poorly known taxonomically. However, these problems are tractable with appropriate field and laboratory work. The results are sure to help understand the true nature of the biodiversity of the biota within the CRB.

The dominate family of herbivorous Hemiptera:Heteroptera found on shrubs throughout the CRB is the Miridae, or plant bugs. As mentioned previously, this is the largest family in the order. Most of the species are plant feeders, thus the common name - plant bugs. There

are predaceous species and some .of these have been discussed earlier in this report. Shrub-inhabiting, herbivorous Miridae tend to be host plant specific and for that reason provide useful links between plants and consumers. Due to relatively little comprehensive study, extensive detailed information on the distribution of species is largely lacking but that void could be filled with some effort and would surely be productive. One area of particular interest would be. to select a suite of widespread shrubs ***(e.g., Purshia, Artemesia*** spp., *Sarcobatus*, ***Ceanothus,*** *Cercocarpus* and *Chrysothamnus* spp.) and examine the changes in associated plant bug species across the landscape. Comparing the results of such a study with similar work on selected host plants of more limited distribution should allow the testing of the hypothesis that widespread plants support a greater fauna at any given site than do plants with a more limited range. GIS analysis would of course be a natural means of examining this question.

B. Herbivores

2. Terrestrial

e. Trees

At least six families of Hemiptera:Heteroptera have species known to occur on trees. These families are: Aradidae, Coreidae, Lygaeidae, Miridae, Pentatomidae, and Scutelleridae. Three genera and ten species of Aradidae, or flat bugs, occur on trees. Virtually all known species feed upon fungus associated with different tree species. Some appear to be fairly host tree specific. One species, *Aradus kormilevi* Heiss, is likely to feed directly on trees, especially young trees. Its Old World counterpart, ***A.*** *cinnamomeus* Panzer, is a known pest of conifers, especially young *Pinus sylvestris* L. At least one species of Coreidae is known to occur on trees within the CRB, *Leptoglossus occidentalis* Heidemann, a species that is sometimes considered a pest because it feeds on the developing cones of conifers, especially ***Pinus ponderosa.*** Feeding may cause a reduction in seed set, thereby reducing the reproductive capacity.

While there are a number of Lygaeidae found within the CRB, only a few genera and species show any relationship with trees. Specimens of several species of the genus *Crophius* are sometimes beaten from conifers; especially ***Pinus ponderosa*** (Lattin, unpublished). Little

is known about the details of this relationship. Other species of ***Crophius*** are found in the understory. Species of the genus ***Gastrodes*** are confined to conifers where they feed on the seeds. They have enlarged front legs that apparently are used to hold the seeds during feeding. The family Pentatomidae, or stink bugs, contains at least three genera found on ***trees*** in the CRB. ***The*** genus ***Brochymena*** seemingly found on deciduous ***trees*** while *Banasa* and ***Dendrocoris*** are found chiefly on conifers. Many species of ***Banasa are*** found on trees of the family Cupressaceae (especially ***Juniper-us, Cupressus,*** and *Thuja*) while ***Dendrocoris*** occurs on Pinaceae (especially *Pinus*). Exact host information is lacking for many of these species although it would not be impossible to obtain with some field work. There is some information on the biologies of some species outside our region. The family Scutelleridae has one species in our region that is found on *Juniperus*, ***Tetyra*** *robusta* Uhler. Another species of ***Tetyra, T. bipunctata*** is a pest of pines in the eastern United States.

The family Miridae is well represented on trees of all types throughout the CRB. Of the 110 species known from that area, at least 25% occur on trees--deciduous and coniferous. At least 12 genera are represented, very likely more. Several genera are quite well represented on deciduous trees including *Orthotylus*, ***Tropidosteptes, Chlamydatus, Plagiognathus, Lepidopsallus*** and ***Psallus.*** Conifers support other genera, usually confined to conifers such ***as*** *Platylygus*, ***Bolteria, Dichrooscytus,*** and several species groups of ***Plagiognarhus.*** Considerable host specificity is often involved. There are taxonomic problems with the species of some genera but they can be solved. One genus is of special interest - ***Neoborella.*** All known species feed upon dwarf mistletoe - ***Arceuthobium*** spp. One of the few insects know to do so.

5. Model Information for Functional Groups

A. GIS Attributes

It is a reasonable expectation that the functional groups of the Hemiptera:Heteroptera discussed in Section 4 will be found in essentially all of the major plant associations. The diversity of the members of this group of insects is such that they will be present, but in different species assemblages; somewhat more restrictive will be more bugs associated with aquatic habitats since water is either present or not. If it is present, and if it is either

standing or running, then these functional groups will normally be present too. Isolated hot springs represent a special case because they may provide refugia for species normally found far to the south. We do have a data base on most insects known to occur in or around all Oregon hot springs.

B. Representative Species for Functional Groups

Examples are given of representative genera and/or species for each functional group established and discussed in Section 4. These are representative only since in some cases (e.g. Miridae), there may be many species found in the different functional categories. This phenomenon simply underscores the utility of including insects and other arthropods in environmental studies. They will provide a high resolution image of many of the different variables under consideration.

C. Key Environmental Factors

As discussed under a similar subheading in Section 3 for Species of Concern, key environmental factors will of course vary between the different taxa depending upon their particular functional role. There are however some broad, general factors of importance. The Hemiptera:Heteroptera are insects, and as such, they are cold-blooded and influenced by temperatures - air temperature, water temperature, and soil temperature. One graphic example would be bugs found around hot springs, because of the thermal characteristics of hot springs, insects are able to be active without temperature regimes that would render ordinary insects immobile. Of course the upper temperatures of the water of hot springs often exceed the thermal death point of the species and thus the insects must select an optimal water temperature in the run-off zone, where cooling usually occurs. Similarly, excessively high air temperatures on or near the soil level will cause Saldidae (shore bugs) to cease activity in the riparian zone.

As mentioned previously, aquatic insects require water (obvious but often over-looked). Some riparian species time their periods of activity to the presence of water (and food items) in stretches of streams whose flow will be interrupted. Similarly, temporary ponds and pools are usually colonized by more mobile species that have good dispersal abilities (e.g., Notonectidae, corixidae). Species of water surface predators usually require water surfaces

to function (e.g., Gerridae), but some are able to find their food items on shore as well (e.g, Hebridae, Veliidae).

Many of the Hemiptera:Heteroptera that are terrestrial predators are generalists and less tied to specific host plants than they seem to be associated with different habitat types (e.g., ground, herb and forb layer, shrub, and tree). Some predators do have specific prey taxa, for example, certain Anthocoridae that specialize as predators of bark beetles in their galleries or others that specialize on certain scale insects (*Matsucoccus*) or aphids ***(Cinara).*** Such specialization seems to be most commonly found among tree inhabiting predatory Hemiptera:Heteroptera. Ectoparasites are a special case (e.g., Cimicidae) for they are usually host-specific (e.g., bats, or birds). An example is included under that functional group discussion in Section 4.

In general, herbivorous Hemiptera:Heteroptera tend to be more host plant specific and further, show greater number of species in any given situation than do predatory taxa. There are exceptions of course for species of the Miridae genus ***Phytocoris,*** the largest genus in the family and possibly the largest genus in the Hemiptera:Heteroptera (over 200 species occur in western North America) are largely predaceous and show remarkable fidelity to different host plants. The only aquatic herbivore family among the bugs is the family Corixidae whose feeding habits are specialized in the sense that they often feed on the particulate organic matter on the bottom but also may remove chloroplasts from filamentous algae. Apparently, they do not feed directly upon higher aquatic plants.

The below ground Cydnidae (burrowing bugs) feed upon roots. They appear to be more abundant where soils are drier and more porous because they have to dig through the. soil with specialized front legs. The heavy, wet, clay soils of the Willamette soils for example, would be most unsuitable for this group. This fact likely explains why most of our species occur on the east side and to the south. Below ground herbivory is a poorly studied phenomena.

Obviously, if you are a herbivore that requires a particular type or species of plant for food, then the presence of that plant is of major importance. Some species are polyphagous and may feed on several hosts (e.g., many species of the mirid genus ***Lygus,*** or such grass feeding Miridae as ***Labops, Irbisia, Stenodema,*** or *Trigonotylus*). Grass-feeding

Hemiptera:Heteroptera seem to show less host specificity (except that it must be a grass) than do species feeding on herbs, forbs, shrubs and trees.

Litter-layer inhabiting species (mostly Lygaeidae) also seem less host specific and may be able to use a variety of fallen seeds as food. Some degree of specificity does occur. There is a species of Lygaeidae ***(Thylochromus nitidulus*** Barber) that apparently feeds only the ***seeds*** of ***Arctostaphylos.*** Another species is reported to feed only on the seeds of hemlock *(Tsuga)*. Considering that our detailed knowledge about the particular habits of most species is at such a low level, I expect we will learn a great deal as we pay more attention to such detail.

Bug species that do have very specific host plant requirements obviously require that host for survival. Thus, the dynamics and health of the host plant is of major importance and thus the trophic levels are connected. There are some extremely important questions that need to be addressed. Of particular interest would be the study of the insect fauna associated with widespread host plants such as those of the genera ***Artemesia, Purshia, Chrysothamnus,*** *Sarcobatus*, *Ceanothus*, ***Arctostaphylos.*** As mentioned previously, one hypothesis suggests that widespread hosts have more species at any given locality than hosts that have a more limited range but there is little direct evidence that this is true except for the study by Opler on leaf-mining Lepidoptera on California oaks. Any of the plant groups cited above would make ideal vehicles to test this hypothesis, or the idea that the range of the entire genus may be important,especially if species level specificity connections are weak. The shrub genus ***Anemesia*** would be an ideal biological metric--contrasting it to ***Purshia tridentata*** for example, or ***Chrysothamnus.*** Concurrent chemical studies of these plants might well shed valuable insights into the nature of herbivory at different spatial scales.

Our knowledge of the tree-inhabiting Hemiptera:Heteroptera is improving and we can make some statements about host associations across the landscape for a few host species. more systematic sampling program throughout the CRB would be profitable and greatly improve our detailed knowledge of these host associations. In general, many of the taxonomic problems have been resolved for key taxa ***(e.g.,*** *Phytocoris*, *Pilophorus* and *Platylygus*), but others remain (e.g., ***Neoborella, Dichrooscytus, Dichaetocoris).*** We do know enough to know that the Hemiptera:Heteroptera would make ideal biological probes for some of these phenomena with additional work.

D. Key Functional Roles

The key functional roles of different members of the Hemiptera:Heteroptera have. been discussed in detail in Section 4. In review, there are predatory taxa that are found in and on the water and at the edge (riparian). In these habitats, they are a part of the predator complex feeding upon small organisms, usually other invertebrates. The predators too are preyed upon by secondary consumers of all types including invertebrates and vertebrates. In some systems (e.g., hot springs) where the biota may be rather condensed and specialized, they likely play major roles both as predators and as prey items.

Only a single family (Corixidae) are known to be aquatic herbivores. Their habits have been, discussed previously. They too may be prey of larger invertebrates and vertebrates. Most of the terrestrial Hemiptera:Heteroptera are herbivorous, feeding on a wide variety of plants and parts of plants. As such, they should be included in virtually all assemblages of herbivorous organisms under most situations. In various habitats or plant associations, plant-feeding Hemiptera:Heteroptera will be present. The degree of host specificity will depend upon the bug group and the plants involved (i.e., grasses - low specificity and trees - other high host specificity).

The sucking mouthparts possessed by the bugs precludes certain food materials (most solids) and habits (e.g., woodboring). Thus, it may be somewhat easier to assign functional roles to most bugs once feeding habits have been determined.

6. Defined Vegetation Habitats

A. Functional Groups and Representative Species of Hemiptera:Heteroptera

I. Predators

a. Aquatic

1. In Water

Notonectidae

Notonecta kirbyi Hunger-ford

2. Water Surface

Gerridae

Gerris gillettei Lethierry and Severin

Veliidae

Microvelia buenoi Drake

3. Riparian

Gelastocoridae

Gelastocoris oculatus (Fabricius)

Saldidae

Ioscytus politus Uhler

Saldula explanata (Uhler)

Saldula nigrita Parshley

Veliidae

Microvelia buenoi Drake

b. Terrestrial

1. Ground Dwelling

Lygaeidae

Geocoris ***bullatus*** (Say)

2. Understory/Herb and Forb Layer

Anthocoridae

Orius tristicolor (White)

Nabidae

Nabicula *vanduzeei* (Kirkaldy)

Nabis alternata Parshley

Phymatidae

Phymata americana Melin

3. Shrub Layer

Anthocoridae

Orius tristicolor (White)

Miridae

Deraeocoris ***brevis*** (Uhler)

Phytocoris *nigrolineatus* Knight

Phytocoris laevis (Uhler)

Nabidae

Nabis alternatus Parshley

Pentatomidae

Zicrona caerulea (L.)

Phymatidae .

Phymata americana Melin

Reduviidae

Sinea diadema (Fabricius)

4. Trees

Anthocckidae

Tetraphleps latipennis Van Duzee

Miridae

Dcraeocoris brevis (Uhler)

Dichaetocoris spp.

Phytocoris juniperanus Knight

Phytocoris lattini S tonedahl

Phytocoris *stellatus* Van duzee

Phytocoris *yollabollae* Bliven

Pilophorus tibialis Van Duzee

5. Ectoparasite

Cimicidae

Cimex ***latipennis*** Usinger and Ueshima

II. Herbivores

a. Aquatic

Corixidae

Callicorixa *audeni* Hunger-ford

Corisella decolor (Uhler)

b. Terrestrial

1. Below Ground

Cydnidae

Microporus obliquus Uhler

2. Litter Layer

Lygaeidae

Malezonotus *angustatus* (Van Duzee)

Tingidae

Acalypta cooieyi Drake

3. Understory/Herb and Forb

Berytidae

Jalysus wickhami Van Duzee

Coreidae

Chelinidea vittiger Uhler

Lygaeidae

Lygaeus kalmii (Stal)

Mindae

Adelphocoris *superbus* (Uhler)

Irbisia *pacifica* (Uhler)

Labops hesperius Uhler

Myrmecophyes oregonensis Schuh and Lattin

Lopidea ***nigridia*** Uhler

Pentatomidae

Chlorochroa opuntiae Esselbaugh

Codophila remora (Horvath)

Scutelleridae

Homaemus *bijugis* Uhler

Thyreocoridae

Corimelaena *extensa* Uhler

Tingidae

Coryrhucha *immaculata* Osbom and Drake

4. Shrub Layer

Berytidae

Jalysus wickhami Van Duzee

Miridae

Atractotomtis *balli* Knight

Europiella rubricomis Knight

Lygus ***elisus*** Van Duzee

Pentatomidae

Codophila remota (Horvath)

Piesmatidae

Piesma ***cinereum*** (Say)

5. Trees

Aradidae

Aradus kormilevi Hess

Coreidae

Leptoglossus occidentalis Heidemann

Lygaeidae

Gastrodes pacificus (Provancher)

Miridae

Neoborella xanthencs Herring

Platylygus rubripes Knight

Rhopalidae

Boisea rubrolineata (Barber)

Scutelleridae

Tetyra robusta Uhler

Tingidae

Corythucha ***mollicula*** Osbom and Drake

B. Taxonomic Categories of Hemiptera:Heteroptera Representatives

Anthocoridae

Orius tristicolor (White)

Tetraphleps latipennis Van Duzee

A r a d i d a e

Aradus kormilevi Hess

Berytidae

Jalysus wickhami Van Duzee

Cimicidae

Cimex ***latipennis*** Usinger and Ueshima

Coreidae

***Cheiinidea** vittiger* Uhler

Leptoglossus ***occidentalis*** Heidemann

Corixidae

Callicorixa ***audeni*** Hungerford

Corisella decolor (Uhler)

C ydnidae

***Microporus** obiquus* Uhler

Gelastocoridae

Gelastocoris oculatus (Fabricius)

Genidae

Gerris ***gillettei*** Lethierry and Severin

L y g a e i d a e

***Geocoris** bullatus* (Say)

Lygaeus kalmii ***Stal***

Gastrodes pacificus (Provancher)

Malezonotus angustatus (Van Duzee)

Miridae

Deraeocoris ***brevis*** (Uhler)

Adelphocoris superbus (Uhler)

***Irbisia** pacifica* (Uhler)

***Lygus** elisus* Van Duzee

Neoborella ***xanthenes*** Herring

Phytocoris juniperanus Knight

Phytocoris laevis (Uhler)

Phytocoris lattini S tonedahl

***Phytocoris** nigrolineatus* Knight

***Phytocoris** stellatus* Van Duzee

***Phytocoris** yollabollae* Bliven

Platylygus ***rubripes*** Knight

Labops ***hesperius*** Uhler

Myrmecophyes oregonensis Schuh and Lattin

Lopidea ***nigridia*** Uhler

Atractotomus balli Knight

Europiella rubricornis Knight

Pilophotus tibialis Van Duzee

Nabidae

Nabicula *vanduzeei* (Kirkaldy)

Nabis alternatus Parshley

Notonectidae

Notonecta *kirbyi* Hungerford

Pentatomidae

Zicrona caerulea (L.)

Chlorochroa opuntiae Esseibaugh

Codophila remota (Horvath)

Phymatidae

Phymata americana Melin

Piesmatidae

Piesma ***cinereum*** (Say)

Reduviidae

Sinea diadema (Fabricius)

Rhopaiidae

Boisea ***rubrolineata*** (Barber)

Saldidae

Ioscytus *politus* Uhler

Saldula explanata (Uhler)

Saldula nigrita Parshley

Scutelleridae

Homaemus bijugis Uhler

Tetyra *robusta* Uhler

Tingidae

Acalypta cooleyi Drake

Corythucha immaculata Osborn and Drake

Coryshucha mollicula Osbom and Drake

Veliidae

Microvelia buenoi Drake

C. GIS Attributes

I. Forest Vegetation Cover Types

A. Western Juniper

a. Representative Hemiptera:Heteroptera

Predators

Phytocoris juniperanus Knight

Herbivores

Dichaetocoris spp.

Tetyra robusta Uhler

b. Habitat Requirements, Sensitivity to Disturbance, Populations Trends

Species diversity of bugs on juniper is far below that found on trees of the family Pinaceae. While the, host plant may be widespread and common, the insects found on the trees are often clumped rather than evenly spread across a group of trees (Lattin, personal observation). No population trend information available.

c. Key Environmental Factors

Since these are very host specific bugs, host presence is all important; general distribution and abundance of the host tree is also important, since populations seem clumped on individual trees, perhaps there is a minimal number of trees that must be present (patch size; on juniper). We know little about the chemical ecology of both the bugs and the trees. This is a promising area for investigation. No information on population trends available.

d. Key Functional roles

Key functional roles would be as a predator in a rather circumscribed community and as a herbivore in the same system; they also serve as food for other invertebrate and vertebrate predators. Both species of members of a small insect community, it would be useful to know the range of these species compared to the range of the host plant.

E. Cottonwood/Willow

a. Representative Hemiptera:Heteroptera .

Predators

Phytocoris lattini S tonedahl

Herbivores

Boisea rubrolineata (Barber)

Corythucha mollicula Osbom and Drake

b. Habitat Requirements, Sensitivity to Disturbance, Population Trends

Both predators and herbivores listed above require presence of host trees. Willow especially has a large insect fauna; sensitive to habitat destruction and modification in riparian zone; will profit from riparian management proposals. No good information on population trends available.

C. Key Environmental Factors

Maintain adequate riparian vegetation across the landscape, especially critical in more arid regions where riparian zone is subject to considerable degradation; will likely respond to restoration efforts--needs monitoring to see if this is really true.

d. Key Functional Roles

As predators and herbivores in riparian system. Likely to be quite important in providing food for vertebrate predators, especially birds. Concentrated habitat means concentrated

feeding by larger predators. Mobility of bugs important to maintain viable populations in a fragmented system.

B. Interior Ponderosa Pine

a. Representative Hemiptera: Heteroptera

Predators

Tetraphleps latipennis Van Duzee

Deraeocoris brevis (Uhler)

Phytocoris stellatus Van Duzee

Pilophorus tibialis Van Duzee

Herbivores

Aradus ***kormilevi*** Hess

Leptoglossus occidentalis Heidemann

Neoborella xanthenes Herring

b. Habitat Requirements, Sensitivity to Disturbance, Population Trends

The predators require prey items scaled to their size in sufficient abundance to maintain population levels; both predators and herbivores are specialists on conifers, chiefly pines; any disturbance that would impact their host trees would impact them. We know little about population trends. ***Neoborella xanthenes*** is an unusual species, it feeds only on dwarf mistletoe ***(Arceuthobium*** spp.) growing on the trees. No population trend information available at present.

c. Key Environmental Factors

Presence of proper host tree; adequate tree populations; adequate prey to sustain populations of bugs; possible problems with widespread chemical sprays against pests of trees.

d. Key Functional Roles

Roles as predators or herbivores on specific tree species (conifers only); serve as food for other predators; part of predator and herbivore guild on trees.

C. Lodgepole Pine

a. Representative Hemiptera: Heteroptera

Predators

Tetraphleps latipennis Van Duzee

Dereocoris brevis (Uhler)

Phytocoris stellatus Van Duzee

Pilophorus tibialis Van Duzee

Herbivores

Aradus ***kormilevi*** Hess

Neoborella xanthenes Herring

Platylygus ***rubripes*** Knight

b. Habitat Requirements, Sensitivity to Disturbance, Population Trends

Species normally require this host but predators may be found on other related hosts; *Playtylygus* feeds on developing female cones, ***Neoborella*** feeds on dwarf mistletoe; all species may be sensitive to widespread disturbance (fire, pesticide spraying). No population information available.

c. Key Environmental Factors

Presence of proper tree species to provide prey items, plant food,adequate prey populations for predators to maintain viable populations.

d. Key Functional Roles

As predators of specific prey scaled to size of predator (aphids and relatives), help regulate populations of prey; both predators and herbivores serve as food for other predators--invertebrate and vertebrate alike.

D. Interior Douglas Fir

a. Representative Hemiptera:Heteroptera

Predators

Pilophorus ***tibialis*** Van Duzee

Phytocoris yollabollae Bliven

Herbivores

Gastrodes *pacificus* (Provancher)

b. Habitat Requirements, Sensitivity to Disturbance, Population Trends

Both predator and herbivore require the presence of the proper host plant. The predators will be feeding chiefly on aphids and other small-

bodied arthropods. ***Gastrodes*** feeds on the seeds of Douglas-fir and thus requires trees old enough to bear cones. Both groups are sensitive to stand replacement disturbances such as tires. They may be affected by widespread spray activities. No solid information on population trends available.

c. Key Environmental Factors

Presence of proper prey and proper host plant; adequate host plant material to support viable insect populations; these predators are widespread suggesting the value of alternate hosts to maintain populations.

d. Key Functional Roles

Predatory habits and herbivorous habits of the two groups of species are main functional roles; both groups also serve as food for other invertebrate and vertebrate predators; some groups of bugs are part of the natural fauna associated with this host tree throughout much of its range.

II. Nonforest Vegetation Cover Types

A. Steppe Shrub and Grassland

1. Shrub/herb stage

a. Representative Hemiptera:Heteroptera

Predators

Orius tristicolor (White)

Deraeocoris brevis (Uhler)

Phytocoris laevis (Uhler)

Phytocoris nigrolineatus Knight

Nabis alternatus Parshley

Zicrona caerulea (L.)

Phymata americana Melin

Sinea diadema (Fabricius)

Herbivores

Jalysus wickhami Van Duzee

Atractotomus balli Knight

Europiella rubricomis Knight

Codophila remota (Horvath)

Piesma ***cincreum*** (Say)

b. Habitat Requirements, Sensitivity to Disturbance, Population Trends

The predators may be generalists on a wide variety of small insects and other arthropods. Normally they are not associated with a specific host. Severe habitat disturbance would disrupt the populations (e.g., fire, habitat modification). No information on population trends available.

c. Key Environmental Factors

Several key factors would be the distribution and abundance of host plants forming habitats; the health of the dominant shrub/herbs; the abundance of predators- invertebrate and vertebrate; the mobility of the insect species that influences dispersal.

d. Key Functional Roles

Key functional roles would be as a predator; population regulator of other insects present; predator and herbivore; potential colonizer of disturbed habitats or habitats under restoration; food for other invertebrate and vertebrate predators.

2. Native Perennial Herb Stage

a. Representative Hemiptera:Heteroptera

Predators

Geocoris *bullatus* (Say)

Orius tristicolor (White)

Nabicula *vanduzeei* (Kirkaldy)

Nabis ***alternata*** Parshley

Phymata americana Melin

Herbivores

Malezonatus angustatus ***(Van*** Duzee) (seeds)

Acalypta cooleyi Drake (moss)

Microporus obliquus Uhler (roots)

Jalysus wickhami Van Duzee

Chelinidea vittiger Uhler

Lygaeus ***kalmii*** (Stal)

Adelphocoris *superbus* (Uhler)

Irbisia *pacifica* (Uhler)

Labops hesperius Uhler

Myrmecophyes oregonensis Schuh and Lattin

Lopidea ***nigridia*** Uhler

Chlorochroa opuntiae Esselbaugh

Codophila remota (Horvath)

Homaemus ***bijugis*** Uhler

Corimelaena *extensa* Uhler

Corythucha immaculata Osborn and Drake

b. Habitat Requirements, Sensitivity to Disturbance, Population Trends

Because these are herbivores, there will be a greater fidelity to individual host plants. This host specificity will be greater with the Hemiptera found on herbs and forbs than on grasses. Certain grass genera and species are known hosts of some bugs ***(e.g.,*** *Elymus* for ***Irbisia*** *pacifica*; ***Agropyron*** *destertorum* for ***Labops hesperius*** [Lattin, Christie, and Schwartz, 1994, 19951). Accordingly, the deployment of the host plants across the landscape will be of greater importance to those bug species found on specific host plants. As with the predators, the herbivorous bugs will be sensitive to disturbance, especially fire, habitat modification, or diseases affecting key host plants or even heavy pest infestations by other insects (e.g., grasshoppers). No information available on population trends available.

c. Key Environmental Factors

Key factors include presence and distribution of critical host plants; host plant health, competition with other herbivores; predation by other invertebrate and vertebrate predators; natural and anthropogenic disturbance factors (e.g., extended drought on moss host of ***Acalypra cooleyi*** Drake); host plant abundance would be important.

d. Key Functional Roles

Key roles would be as herbivore on host; prey for invertebrate and vertebrate predators, possible plant population regulation ***(e.g., Labops hesperius*** Uhler as a pest of exotic crested wheatgrasses).

3. Exotic Species

Herbivores

Irbisia pacifica ('Uhler)

Labops hesperius Uhler

Note: These two species, especially ***Labops hesperius*** have been major pests of the introduced crested wheatgrasses ***(Agropyron*** spp.); especially where habitat alteration has resulted in virtual monocultures of the grasses. These are native bugs that have expanded their feeding to include these exotic grasses (Lattin, Christie, and Schwartz, 1994; 1995). There is evidence that other native'species of Miridae (especially *Lygus*) ***are*** becoming pests of another introduced range improvement plant, ***Kochia,*** also from the former USSR (Lattin, Christie, and Schwartz, in prep.).

B. Mountain Shrubs

Many of the same insects discussed above will follow the same hosts into higher elevations but we do not have good information on the within range distribution of a host plant and its insect fauna. Generalist predators are likely to be less affected than herbivores.

C. Riparian Bottomlands

1. Multi-layer shrub stage

a. Representative Hemiptera:Heteroptera

Predators

Orius tristicolor (White)

Nabis alternata Parshley

Sinea diadema (Fabricius)

Herbivores

Jalysus wickhami Van Duzee .

Adelphocoris superbus (Uhler)

Lopidea nigridia Uhler

Codophila remota (Horvath)

Corythucha mollicula Osborn and Drake

Boisea rubrolineara (Barber)

b. Habitat Requirements, Sensitivity to Disturbance, Population Trends

The predators will most likely be generalists that also occur outside the riparian bottomiands. The herbivores would be more sensitive to host plants. some such host plants would also occur outside the riparian bottomlands while others, especially the trees, are more likely to occur only there. This means that host specific herbivorous bugs are likely to occur only in this habitat on willow, alder, maple and others. All species of insects would be impacted by habitat disturbance, especially those disturbances that reduce or eliminate the hosts (e.g., from extensive grazing). No population information available.

C. Key Environmental Factors

Such factors include habitat disturbance, long-term droughts that might impact water flow, fire, stream alteration, pesticide treatments.

d. Key Functional Roles

Key roles are as predators and herbivores in this system; bugs provide a source of food to other invertebrate and vertebrate hosts. Predators could provide some population control to herbivores.

2. Single layer Shrub Stage

Remarks above would also cover this habitat stage. We do not know enough to distinguish between the two at present.

III. Aquatic Habitats

A. Streams and rivers

a. Representative Hemiptera:Heteroptera

Predators

Gerris gillettei Lethierry and Severin

Microvelia buenoi Drake

Gelastocoris oculatus (Fabricius)

Saldula ***nigrita*** Parshley

Microvelia buenoi Drake

Herbivores

Callicorixa audeni Hunger-ford

b. Habitat Requirements, Sensitivity to Disturbance, Population Trends

Aquatic habitat, running at least part of the time, can survive when reduced to pools. These are chiefly surface or riparian predators (except ***Callicorixa);*** require small arthropods. as food source; most of these are fairly mobile, being fully winged in some species; ***Microvelia*** usually wingless, thus dispersal is impaired. Sensitive to habitat disturbance, especially of riparian zone. Population trends unknown.

c. Key Environmental Factors

Water, usually moving water; prey items available, extensive riparian zone; *Saldula* ***nigrita*** prefers large rivers

with abundant stones rather than fine textured substrate. Corixidae require quiet waters, organic ooze containing diatoms.

d. Key Functional Roles

Predators on small insects and other organisms in habitat or underwater herbivore feeding on algae or diatoms in bottom "ooze;" predators may serve as prey for other invertebrate and vertebrate predators; herbivore more likely to be prey of vertebrate predators (fish).

B. Ponds and Lakes

a. Representative Hemiptera:Heteroptera

Predators

Notonecta kirbyi Hungerford

Gerris gillettei Lethierry and Severin

Microvelia buenoi Drake

Gelastocoris oculatus (Fabricius)

Ioscytus politus Uhler

Saldula explanata (Uhler)

Herbivores

'Corisella decolor (Uhler)

b. Habitat Requirements, Sensitivity to Disturbance, Populations Trends

Standing water, pond or lake predators listed above are riparian or water surface predators, thus require riparian zone; also require small prey items (other insects or small organisms). Corixidae, underwater herbivore, prefers standing or slow moving water. Feeds on algae/diatoms. Sensitive to riparian disturbance and destruction or water pollution. Population trends unknown.

c. Key Environmental Factors

Still water, riparian zone, abundant prey scaled to size of bug; some degree of permanence of habitat although some

species quite mobile (e.g., Corixidae). *Microvelia* may be more restricted since most adults are wingless.

d. Key Functional Roles

Predators feed on small insects and other small organisms found in riparian zone; Notonectidae are under water predators on small organisms found in the water, including small fish. Herbivore feeds on algae/diatoms under water. Riparian species are preyed upon by other arthropod and vertebrate predators. Aquatic species most likely will be fed upon by vertebrate predators (fish).

C. 'Hot Springs

a. Representative Hemiptera:Heteroptera

Predators

Ambrysus mormon Montandon

Hebrus buenoi Drake and Harris

Micracanthia fennica (Reuter)

H e r b i v o r e s

None yet known

b. Habitat Requirements, Sensitivity to Disturbance, Population Trends

In our area, hot springs seem essential for ***H. buenoi*** and ***M. fennica***. All species occur outside of the CRB. Other localities likely to be found, including non-hot spring localities, very sensitive to riparian disturbances, especially trampling of narrow riparian zone around spring. *Ambrysus mormon* occurs in the water where hot water enters cooler waters. Not subject to same impact from disturbance as riparian species. Lowering water temperatures might render water unsuitable for insect. Population information not available, but not abundant.

C. Key Environmental Factors

Habitat protection for riparian species to avoid trampling; water temperature requirements likely critical at these latitudes. Temperature reduction likely to eliminate species.

d. Key Functional Roles

As predators of a variety of small organisms. Also serve as prey for larger predators--invertebrate and vertebrate alike.

IV. Other Categories

A. Ectoparasites

a. Representative Hemiptera:Heteroptera

Cimex laripennis Usinger and Ueshima

b. Habitat requirements, Sensitivity to Disturbance, Population Trends

Associated with bats, usually found at roosting site rather than on the bat itself. Described from near Klamath Lake, Oregon,it occurs chiefly in central Oregon but is also known from Marisposa and Fresno County, California. (Usinger and Ueshima only report *Myotis rhysanodes* Miller as a host (Fresno County, California). Sensitivity to any disturbance that would affect bat host. Populations trends unknown.

c. Key Environmental Factors

Distribution and abundance of host animal; this is a flightless insects and thus dependent upon host for movement from place to place; roosting sites for the bats would be critical for survival. An epizootic might reduce or eliminate host locally.

d. Key Functional Roles

As ectoparasite of bat, not known to vector diseases but high density of bugs might impact small populations of bats. Blood sucking from host. Adult and immature stages with similar feeding habits.

7. Special Habitats

Within the vast area of the CRB, there are many special habitats for insects, including the Hemiptera:Heteroptera. The small. size of an insect makes it possible to utilize small scale resources. Since so many insects are herbivores, any plant with very restricted distribution or widely separated populations would impact the populations of any insect associated with that plant, especially if that insect is host-specific. While most insects have functional wings, some are flightless due to the reduction of the wings or their complete absence (e.g., lice and fleas). Thus, the combination of poor dispersal capabilities, restricted habitats or widely scattered host populations combined with a variety of different disturbances might well place certain insects in jeopardy. One might envision the impact of widespread chemical spraying for grasshopper control, for example, on highly localized populations of rare insect species. Massive range fires or forest fires might easily destroy the restricted habitats and their insect associates. Widescale conversion of rangeland to a few non-indigenous plants (e.g., wheatgrasses to increase carrying capacity) might impact highly localized habitats too (Lattin, Christie, and Schwartz, 1994; 1995).

For the purposes of this report on the CRB, I have selected hot springs as the special habitat requiring special attention by land managers. They are few in number, widely separated spatially, often (usually) modified for and by human use and often heavily impacted by such activities as grazing. The thermal waters contain many highly specialized organisms, plant and animal, able to adjust to selected temperature levels. Further, run-off waters usually over temperature gradients that allow a species to select a very narrow (or not) range most suited to their physiological needs. Finally, the riparian region surrounding such springs provides an unusually warm substrate that remains so throughout most of the year. This permits some species to be active virtually year round--in a greater environment that may be in the grips of winter.

These unusual aquatic habitats frequently serve as refugia for organisms whose geographical range is far to the south. Thus, for our region, some unusual species may be found well outside their normal range (e.g., *Ambrysus mormon* from the main range of the other species of *Ambrysus*). There are many other insects and arthropods besides the Hemiptera:Heteroptera that are associated with hot springs throughout the CRB, including flies, beetles and mites. The bugs of special concern that are found around hot springs

include *Micracanthia fennica* (Reuter) (Saldidae), and *Hebrus buenoi* Drake and Harris (Hebridae). These two species are so far known only from Haney Hot springs, Oregon where they occur around the edge of the spring, feeding on small arthropods. The destruction of such sites as this from the impact of cattle is so high that they may have been extirpated already.

The creeping water bugs, *Ambrysus mormon* Montandon, are underwater predators that occur at a few thermal water sites including Cow Lakes, Oregon and 'Bruneau Hot Springs, Idaho. One subspecies of ***A. mormon, A. mormon heidemanni*** Montandon, is know only from the thermal waters in Yellowstone National Park in northwestern Wyoming (Polhemus and Polhemus, 1988). The occurrence of these interesting insects and these habitats deserve special attention within the CRB for they are of great biological interest. Other species of Naucoridae are known from thermal waters in southwestern United States (Polhemus and Polhemus, 1988).

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