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The Corixidae of Oregon and Washington (Hemiptera: Heteroptera)

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ABSTRACT

Seven genera and 26 species of Corixidae are reported from Oregon and Washington. The literature of the family is reviewed, and diagnostic keys for the identification of genera and species are given. Diagnoses, habitat information, illustrations of morphological structures, and distribution maps are provided for all species.

Introduction

The Corixidae is the largest family of aquatic Hemiptera. It is comprised of approximately 30 genera distributed among six subfamilies, and contains well over 500 species on a worldwide basis. They are familiar insects in most aquatic habitats, and in general are adaptable to a wide range of environmental conditions. The high dispersal potential of this group allows the insects to use many unstable and temporary habitats. Corixids, or water boatmen, are strong and agile swimmers; their large, flattened, oarlike hind legs are well adapted for underwater locomotion. Although classified as fully aquatic insects, water boatmen must come to the surface periodically to replenish air stores that are carried on the surface of the body. These air stores supply atmospheric oxygen to the tracheal system of the submerged insect, but they also function as a "physical gill" to extract dissolved oxygen from the water. Most corixids are detritivores or microphagous scavengers. They use their highly modified, scooplike fore tarsi to extract algae, protozoans, small metazoans, and various other plant and animal materials from bottom substrates. Some species, however, are largely predaceous and feed on zooplankton, insect larvae, and oligochaetes. Predators of Corixidae include shorebirds and waders, fish, salamanders, and a variety of aquatic invertebrates; larval water mites are common ectoparasites of water boatmen.

Synopsis

Corixids are small- to moderate-sized (1.5 to 16.0 mm), oval-shaped insects with short, three- or four-segmented antennae. Most species are yellow to yellowish gray with a dark, mottled or crossbanded pattern on the pronotum and hemelytra. The head is triangular and bears a pair of large, compound eyes. Ocelli are absent except in the rare Australian genus *Diaprepocoris* Kirkaldy. The labium is triangular, unsegmented, and broadly attached to the head. All other families of Nepomorpha have

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an elongate, three- or four-segmented labium. The pronotum is large and conceals the scutellum of most species. Adult corixids have metathoracic scent glands that open near the midcoxae; larvae have dorsal scent gland openings on abdominal terga III-V. The fore wing is leathery and the membrane lacks distinct veins. The hind wings usually are fully developed, but reduction in wing size (brachyptery) occurs in some species that occupy permanent habitats. Males have asymmetrical abdominal segments that are oriented either to the right (dextral) or to the left (sinistral) when viewed from above. A filelike structure termed the "strigil" is found on the hind margin of tergum VI of most male corixids. Females have symmetrical abdominal segments and lack a distinct ovipositor. The front legs are short and terminate with a one-segmented, scooplike tarsus called the "pala." The fore legs are used in food gathering, stridulation, and coupling of the sexes during mating. The middle legs are long and slender with a one-segmented tarsus and two elongate tarsal claws. They are used for clinging to the bottom or other submerged substrates when the insect is inactive. The hind legs are flattened and fringed with long hairs. They function primarily in locomotion, but also are used for cleaning the body and ventilating the external air stores.

Classification

The higher classification of the Corixidae has been and remains a subject of considerable controversy. Much of the early literature regarding the classification of this family is summarized by Walton (1943a) and Leston (1955a). The classification presented by Hungerford (1948a) is the most widely accepted among contemporary taxonomists. Hungerford recognized approximately 30 genera of Corixidae, dividing them among six subfamilies. The subfamilial and tribal categories of Hungerford's classification have been refined somewhat by Leston (1955a) and Popov (1971), but they continue to be a subject of disagreement. This controversy probably will not be resolved until the family is studied thoroughly on a worldwide basis. Hungerford's generic classification, however, has unanimously replaced the conservative schemes proposed by China (1943), Walton (1943a), and Macan (1955), and continues to be the most comprehensive treatment of corixid taxonomy for the world.

Habitats and Distribution

The Corixidae are familiar insects in virtually all aquatic habitats. They are most prevalent in oligotrophic to moderately eutrophic, freshwater environments, but also occur in saline and alkaline habitats, sewage ponds, and highly eutrophic waters contaminated by industrial wastes. Corixids have been collected from freezing waters beneath ice (Hussey 1921, Sailer 1952), hot springs and temporary pools with temperatures as

high as 40°C (Davis 1966, Kelts 1979), and salt ponds that reach a maximum annual salinity of more than 150 o/oo (Carpelan 1957). Although corixids typically are inhabitants of shallow, shoreline waters, they have been reported in lakes to depths of 10 meters (Hungerford 1939, Rawson and Moore 1944) and at considerable distances offshore in the ocean (Gunter and Christmas 1959, Polhemus and Hendrickson 1974). However, corixids have not been shown to reproduce and persist in deep waters of lakes or in the open ocean. Some authors have suggested that water boatmen collected from offshore waters were carried there by ocean currents (Hutchinson 1931, Scudder 1976).

Corixids have been particularly successful at invading coastal and inland saline environments. Twelve genera and approximately sixty species of Corixidae have been recorded from saline waters (see records compiled by Scudder, 1976). *Trichocorixa* is the only genus that occurs regularly in the marine environment, but not all members of this group are restricted to saline habitats. In Oregon and Washington, *Trichocorixa verticalis californica* Sailer and *Cenocorixa expleta* (Uhler) are found only in saline environments. Other Pacific Northwest corixids that sometimes occur in saline or alkaline waters are *Cenocorixa bifida hungerfordi* Lansbury, *C. utahensis* (Hungerford), *Hesperocorixa laevigata* (Uhler), and several species of *Corisella*.

The effect of salinity on distribution is well studied (Butler and Popham 1958, Scudder 1965, 1969a,b, 1983; Savage 1971b, 1982; Knowles and Williams 1973; Hammer et al. 1975). Most saline Corixidae can tolerate salinities in the range of 10 to 30 o/oo, but a few species of *Trichocorixa* occur regularly in habitats where salt concentrations reach 60 to 80 o/oo. One of the most saline-tolerant species in North America is *Trichocorixa reticulata* (Guérin-Ménéville), which has been reported from a salt pond in California with a mean annual salinity of 94 o/oo (range, 61 to 153 o/oo) (Carpelan 1957). Other environmental factors that affect distribution are habitat permanence (Brown 1951, Macan 1954), water depth (Crisp 1962b), availability of oviposition sites (Scudder 1976, Savage 1979), type and abundance of aquatic vegetation (Macan 1976), organic matter content (Macan 1938, 1954) and color of bottom sediments (Popham 1941, 1943a,c), and the influence of domestic and industrial pollutants (Jansson 1977a,b). In extreme environments, various physical and chemical properties of water (temperature, ion concentrations, dissolved oxygen, wave action) also can be important limiting factors.

Biological and ecological factors also affect distribution. For example, there is a significant correlation between habitat type and the dispersal potential of many Corixidae (Brown 1951, Popham 1964). Corixids with strong dispersal capabilities often are found in unstable, heterogeneous environments (Pajunen and Jansson 1969b, Pajunen 1970a, Campbell

1979), while flightless forms and species with low dispersal potential usually are restricted to permanent habitats. Other biological factors that influence seasonal or spatial distribution patterns are reproductive capacity (Pajunen 1970c), interspecific competition (Vepsäläinen 1978, Pajunen 1979a,b, 1982a), the action of predators (Macan 1965, Henrikson and Oscarson 1978) and parasites (Scudder 1983), and the abundance and distribution of prey (Campbell 1979, Pajunen 1979a).

Feeding Habits

Water boatmen are capable of ingesting both solid and liquid food. Their diets typically include a variety of food items, and shortage of food is rarely a limiting factor in most habitats. Many corixids are microphagous scavengers, feeding on algae, plant and animal fragments, protozoans, and small metazoans that they extract from bottom sediments. The scoop-like palae are used to sweep food particles past the bottom of the head, where they are ingested through the vertical stylet groove of the labium (Lauck 1979). A few corixids have been reported to feed on the cell contents of filamentous algae by piercing individual cells with their stylets (Hungerford 1917b, 1919, 1948a; Sutton 1951). Most species using this resource, however, seem to ingest solid fragments and even whole filaments of algae.

Although detrital and algal feeding habits are widespread in the Corixidae, considerable evidence suggests that many species are at least partly, if not predominantly, predaceous (Hussey 1921, Sutton 1947b, 1951; Sailer and Lienk 1954, Crisp 1962b, Zwart 1965, Pajunen 1970a, 1982a; Jansson and Scudder 1972, Reynolds 1975, Kelts 1979, Eriksson et al. 1980; Henrikson and Oscarson 1981). Much of this predation is directed towards zooplankton, but many other aquatic invertebrates (e.g., oligochaetes, mosquito and chironomid larvae, ephemeropterans, zygopterans, corixid larvae) and even fish fry have been reported as prey of Corixidae (see records compiled by Reynolds, 1975). Water boatmen, frequently among the most abundant of littoral organisms, may be significant predators in many aquatic environments. In acidified lakes of southwestern Sweden and Norway, corixids are often the top carnivores of the system, with an important role in the regulation of zooplankton communities (Eriksson et al. 1980, Henrikson and Oscarson 1981).

Many Corixidae appear to be part scavengers and part predators. Reynolds (1975) found this to be the dominant feeding strategy of corixids in saline lakes of British Columbia, Canada. Some water boatmen consume algae and other plant materials in addition to feeding on detritus and macroinvertebrates (Crisp 1962b, Reynolds 1975, Kelts 1979). These species appear to be truly omnivorous and capable of exploiting a wide variety of food resources.

Predators and Parasites

Unlike most aquatic Hemiptera, the Corixidae seem to be subject to considerable predation in all stages of the life cycle. Eggs are preyed upon by the larvae and adults of water mites (Davids 1973), mesoveliids, and saldids (Kelts 1979), and by Corixidae themselves (Crisp 1960, Young 1965b, Pajunen 1970c, 1979a). Egg cannibalism has been suggested as a mechanism for population regulation during periods of food shortage and high adult density (Crisp 1960, Pajunen 1979a).

Corixid larvae and adults are prey for numerous aquatic and semi-aquatic insects, including dragonfly naiads (Kelts 1979), naucorids and belostomatids (Scudder 1976), mesoveliids and saldids (Kelts 1979), notonectids (Griffith 1945, Scudder 1976), and the adults and larvae of water beetles (Crisp 1962b, Scudder 1976, Kelts 1979). Wolf spiders of the genus *Pardosa* are reported to be active predators of *Trichocorixa verticalis verticalis* var. *sellaris* (Abbott) in New Hampshire tidal marshes (Kelts 1979). Larval cannibalism has been observed in the genus *Cymatia* (Walton 1943b) and from two species of rock pool Corixidae, *Arctocorisa crinarta* (Sahlberg) and *Callicorixa producta* (Reuter) (Pajunen 1979a, 1982a). Malcolm (1980) found that corixids are much more susceptible to predation by Notonectidae in waters with low, nonlethal concentrations of oxygen. The surfacing rate of bottom-feeding corixids increases with falling oxygen concentration, thus increasing their availability to notonectids, which are open-water predators.

Fish are important predators of water boatmen in many aquatic environments (Frost and Macan 1948, Fernando 1956, Applegate and Kieckhefer 1977, Kelts 1979). Fish predation has been reported to influence the local and regional distribution of corixids, as well as species composition and abundance within specific environments (Macan 1965, 1976, 1977; Henrikson and Oscarson 1978, 1981; Eriksson et al. 1980). The disruptive color patterns of Corixidae help protect these insects from fish predators. In laboratory experiments, Popham (1941, 1943b, 1944) showed that minnow predators had difficulty detecting water boatmen resting on substrates that harmonized with the insects' coloration. However, minnows quickly spotted and consumed individuals that did not match the color patterns of bottom substrates.

Other vertebrates that are reported to feed on Corixidae are salamanders (Griffith 1945), water fowl and waders (Griffith 1945, Munro 1945), swifts and martins (Fernando 1959), and bats (Walton 1943b). Kelts (1979) found the tidal marsh corixid, *Trichocorixa verticalis verticalis* var. *sellaris* to be a major dietary component of the least sandpiper, greater yellowlegs, and several other migratory shorebirds. In portions of Mexico, the eggs of Corixidae are harvested in large numbers from submerged reeds and straw and used as food for humans (Ancona 1933, Peters and

Ulbrich 1973). Adults and larvae also are harvested for human consumption and for use in pet foods (Lauck 1979).

Larval water mites are common ectoparasites of Corixidae (Hungerford 1919, Griffith 1945, Leston 1955b, Fernando 1958, 1959; Davids 1973, Harris and Harrison 1974, Davids and Schoots 1975, Martin 1975, Smith 1977). They usually are attached to the abdominal terga, but they also occur on other parts of the body such as under the pronotal disk. Leston (1955b), noting that the presence of mites on the abdomen interferes with the formation of the dorsal air store, suggested that this may have an effect on the survival of the host. Smith (1977) has shown that mite parasitism delays sexual development and inhibits egg production in *Cenocorixa* species. Scudder (1983) suggested that the inability of *Cenocorixa expleta* to survive heavy mite parasitism may be the primary factor excluding this species from low-salinity lakes in central British Columbia.

The only endoparasites that have been found in Corixidae are nematodes (Larsén 1938, Banks 1939) and protozoans (Poisson 1935, Crisp 1962b).

The odoriferous secretions of the metathoracic scent glands of adult Corixidae and the dorsal abdominal glands of the larvae are believed to function primarily as a defense against predators (Remold 1963, Hepburn et al. 1973). Pinder and Staddon (1965b) also suggested the possibility that these secretions protect against settling of microorganisms on the body surface. In *Sigara falleni* (Fieber) and *Corixa dentipes* (Thomson), the adult secretion is a pale yellow oil composed predominantly of trans-4-oxohex-2-enal (Pinder and Staddon 1965a,b). A similar compound (trans-4-oxo-oct-2-enal) recently was identified as the primary constituent of the larval secretion of *C. dentipes* (Staddon et al. 1979). Additional information regarding the morphology and physiology of the metathoracic and dorsal abdominal scent gland systems of Corixidae is provided by Brindley (1929), Parsons (1976), Staddon (1979), and Staddon and Thorne (1979).

Life History

Corixidae in tropical regions seem to reproduce year around (see Peters and Spurgeon 1971, and Peters and Ulbrich 1973 for examples from Mexico), but species inhabiting temperate waters breed only during the spring and summer. Most temperate species have a single generation or partial second generation (Hungerford 1919, Bobb 1953, Crisp 1962a,b; Young 1965b, Pajunen and Jansson 1969a,b; Savage 1971a, Tones 1977), but a complete second or partial third generation has been reported for *Ramphocorixa acuminata* (Uhler) in Kansas (Griffith 1945), *Sigara alternata* (Abbott) in New York (Hungerford 1917a) and for several species of *Cenocorixa* in British Columbia and Colorado (Jansson and Scudder

1974, Dodson 1975). Applegate and Kieckhefer (1977) reported two generations per season for *Palmarcorixa buenoi* Abbott and *Trichocorixa borealis* Sailer in South Dakota, but they did not clearly establish whether the second generation was complete or partial. Environmental variables such as altitude and temperature are important factors determining the number of generations produced during the breeding season. The arrest of sexual maturity in late-season individuals is the primary mechanism responsible for the production of partial generations in water boatmen populations (Young 1965b, Pajunen 1970c, Jansson and Scudder 1974). The time of arrest of sexual development seems to be influenced by photoperiod, temperature, and nutritional factors.

Most temperate species pass the winter as adults (Hungerford 1948a), but *Micronecta* spp. (Poisson 1935) and northern populations of *Palmarcorixa buenoi* (Hungerford 1919, Applegate and Kieckhefer 1977) overwinter as late-instar larvae. The eggs of several species have been found during the winter (Poisson 1935, Griffith 1945, Fernando 1959), but only *Trichocorixa verticalis* (Fieber) is known to overwinter solely in the egg stage (Tones 1977, Kelts 1979). Most adult Corixidae remain active during the winter, and it is not uncommon to find these insects swimming beneath the ice (Hussey 1921, Griffith 1945, Sailer 1952).

Mating takes place in the early spring after females attain sexual maturity (Young 1965b, Pajunen and Jansson 1969b, Pajunen 1970c, Jansson and Scudder 1974). During mating the male rides above the female, grasping her along the lateral margins of the hemelytra with his front legs. The arrangement and fine structure of the palpal pegs are well adapted for gripping the female during copulation (Popham 1961, Furth et al. 1978). In engaging the female genitalia, the male abdomen is curved downward along either the right or left side of the female abdomen, depending on the abdominal asymmetry of the male. In cases of reversed abdominal asymmetry (Peters 1949, 1962), males simply engage females from the opposite side of the body than is normal. The strigil on the sixth abdominal tergum of the male also may be used for gripping during mating (Larsén 1938, Hungerford 1948a). Popham (1943b, 1947) noted that males of *Corixa distincta* Fieber tend to select mates that are similar to their own size and color. Aiken (1981a) found that the tendency of males of *Palmarcorixa nana* Walley to select mates primarily on the basis of body size resulted in high levels of homosexual mounting. The role that stridulation plays in the mating behavior of Corixidae has been investigated by Jansson (1972b, 1973a,b, 1974b) and Aiken (1982a,b) (see subsequent section on sound production).

The eggs of Corixidae are deposited below the surface of the water on aquatic plants (Leston 1955b, Savage 1971a, 1979; Peters and Spurgeon 1971, Peters and Ulbrich 1973, Dodson 1975), woody debris (Davis 1966,

Aiken 1981b), stones (Crisp 1962a,b; Scudder 1966, Tones 1977), and other available substrates. The most unusual oviposition habit is displayed by *Ramphocorixa acuminata*, which deposits its eggs exclusively on the exoskeletons of crayfish (Abbott 1912, Griffith 1945). Most corixids appear to be nondiscriminating in their choice of oviposition site, but some species prefer specific egg-laying substrates. Savage (1979) suggested that preference for oviposition site was important in determining the distribution of *Sigara concinna* (Fieber) in a saline lake near Cheshire, England.

The eggs of Corixidae have been studied by Poisson (1935), Hungerford (1948b), and Cobben (1968). They usually are ovoid or top-shaped, and slightly asymmetrical with one side more convex than the other. In the subfamilies Corixinae and Cymatiinae, the eggs are supported by a buttonlike disk or long stalk that is attached to the substrate by an adhesive material. The eggs of *Diaprepocoris* (Diaprepocorinae) and *Micronecta* (Micronectinae) lack a supporting structure and are attached horizontally to the substrate. Eggs usually are deposited singly or in small, well-spaced groups, but clumping of eggs may occur when preferred egg-laying substrates are scarce or when adult density is high. Female corixids are reported to lay eggs at a rate of 2 to 10 per day (Crisp 1962b, Young 1965b, Pajunen 1970a, Sweeney and Schnack 1977, Savage 1979). The oviposition period for a population may last several weeks or more, but for most individuals it lasts from several days to a week. In laboratory tests, Savage (1979) found that approximately 80 percent of the eggs of *Sigara concinna*, *S. lateralis* (Leach), and *S. stagnalis* (Leach) were deposited during the first two days of oviposition. The laboratory results of Young (1965b), however, suggest that individuals of *S. dorsalis* (Leach) and *S. scotti* (Fieber) continue to lay eggs for much longer periods of time. Fecundity is variable, ranging from 10 to 40 eggs in some temperate species of *Sigara* (Fernando 1959, Young 1965b, Savage 1979) to well over 900 for *Ahuautlea mexicana* de la Llave (formerly *Krizousacorixa femorata* Guérin-Ménéville), a tropical species with multiple generations and continuous egg deposition (Peters and Spurgeon 1971). The effect of temperature on oviposition has been investigated by Young (1965b) and Sweeney and Schnack (1977). The latter authors suggested a critical thermal region of 11.0 to 12.5°C for initiation and maintenance of egg-laying in most Nearctic Corixidae. However, Young (1965b) reported that a few large corixids in England begin oviposition at temperatures between 0°C and 4°C.

Incubation time varies with environmental temperature but is usually in the range of 5 to 15 days at temperatures between 15°C and 25°C (Hungerford 1919, Banks 1949, Crisp 1962b, Scudder 1966, 1983; Sweeney and Schnack 1977, Kelts 1979). At temperatures below 15°C, incubation

periods are often considerably longer. Arrest of egg development has been reported for several Palearctic species at 8 to 9°C (Banks 1949, Crisp 1962b). High temperatures also inhibit development and hatching, but the eggs of some *Trichocorixa* species can tolerate water temperatures up to 40°C (Davis 1966, Kelts 1979). Egg development also is influenced by salinity, as shown by the studies of Banks (1949), Davis (1965, 1966), and Kelts (1979). High salinity tends to retard the absorption of water by the egg and prolong development. The eggs of several euryhaline species of *Trichocorixa* can survive salt concentrations in the range of 40 to 60 o/oo.

In a few temperate species of Corixidae, egg diapause prevents the development of eggs that are laid late in the summer. These eggs overwinter and hatch in the spring when water temperatures are again conducive to egg development. Poisson (1935) observed that the eggs of *Corixa affinis* Leach required a cold shock in order to hatch the following spring. However, Tones (1977) found that exposure to cold was not necessary to break diapause in *Trichocorixa verticalis interiores* Sailer. The eclosion process of several corixid species is described by Hungerford (1919), Griffith (1945), Davis (1965), and Cobben (1968).

The Corixidae have five larval instars, except for *Corixa monticella* (Fieber) and *Krizousacorixa azteca* (Jaczewski) that are reported to have only four (see discussion by Peters and Spurgeon, 1971). Larval developmental rates vary with temperature and food availability, but are usually in the range of 4 to 10 days for each instar (Hungerford 1919, Griffith 1945, Sutton 1947a, Bobb 1953, Scudder 1966). The only detailed studies of the effect of temperature on larval development are by Pajunen and Sundback (1973) and Pajunen (1981). The tolerance of larval *Trichocorixa* to different temperature-salinity regimes has been studied by Kelts (1979). Pajunen (1981, 1982b) showed that large larvae and adults of *Callicorixa producta* inhibit the development of first- and second-stage larvae by way of direct interference with feeding and resting.

Dispersal

The Corixidae display a remarkable potential for dispersal by flight. This has allowed these insects to occupy a wide variety of temporary habitats, ranging from seasonal pools to aquatic environments with unstable and sometimes intolerable physical, chemical, or biological characteristics. Difference in dispersal potential of corixid species is strongly correlated with habitat permanence. Species inhabiting temporary environments usually have higher migration rates than those occupying stable, permanent habitats (Macan 1939, Brown 1951, 1954; Fernando 1959, Pajunen and Jansson 1969b). However, this relationship is often more a function of the proportion of individuals in a species population that are

capable of flight, rather than their inclination to fly (Young 1965b). Many species of *Cymatia* and *Micronecta* have reduced, nonfunctional wings and are unable to disperse by flight. These flightless species usually are restricted to permanent bodies of water that provide suitable habitats for overwintering adults (Brown 1951). Other corixids are polymorphic with respect to flight musculature and have both flying and flightless morphs (Young 1961, 1965a,b,c; Scudder 1964, 1971a, 1975; Acton and Scudder 1969, Scudder and Meredith 1972, Dodson 1975). The seasonal distribution of these morphs varies according to environmental conditions and life cycle phenomena, thus influencing the overall dispersal potential of the species.

In temperate regions, there are two major dispersal periods (Young 1966)—an obligatory, early spring migration that serves to distribute overwintered adults to suitable habitats for egg-laying and a period of facultative dispersal in the late summer and fall, usually in response to adverse environmental conditions such as habitat deterioration. Late-season dispersal events also serve the purpose of distributing individuals to suitable overwintering sites (Brown 1954, Pajunen and Jansson 1969a,b). Popham and Lansbury (1960) suggested that the rapid decrease in respiratory efficiency associated with rising water temperature is the primary cause of summer and fall dispersal from drying habitats. According to Popham (1964), developing thermal gradients in the water column may further increase the tendency of corixids to fly. Popham (1943a,c) also suggested that corixids are influenced to disperse from habitats that do not provide suitable background coloration. Climatic factors that are reported to affect the initiation and maintenance of flight include air temperature, atmospheric pressure, humidity, radiation intensity, and wind speed (Popham 1943a,c, 1952; Poisson et al. 1957, Fernando 1959). Biological factors such as food availability and population density also may influence the dispersal activities of some species.

Water boatmen in temperate regions disperse primarily during fair weather associated with anticyclonic periods (Popham 1964). Flight activity is highest during midday and falls off rapidly as light intensity decreases around dusk (Popham and Lansbury 1960, Popham 1964). Light-trap records indicate that most corixids discontinue flight within an hour following sunset (Leston 1953, Leston and Gardner 1953). However, some species may disperse by moonlight if air temperatures are favorable (Popham 1964). Campbell (1979) found that dispersal of the halobiont, *Trichocorixa verticalis*, from intertidal pools of a New Jersey salt marsh occurs primarily on cool summer nights. He explained this habit as an adaptive trait to minimize desiccative water loss during flight.

The flight range of Corixidae is variable and appears to be strongly influenced by air currents (Popham 1943b, 1952) and the insect's ability to

tolerate desiccation (Holdgate 1956, Oloffs and Scudder 1966). Transpirational water loss through the cuticle is especially rapid at high air temperatures because of instability of the cuticular wax layer. Oloffs and Scudder (1966) determined the "transition" or "critical" temperature of wax stability to be between 30 and 35°C of ambient dry air for adults of *Cenocorixa expleta*. On a windless day at 22°C, most corixids are unlikely to disperse more than 15 km (Popham 1951, 1952). Some species, however, have the potential of traveling 80 km or more in a single day given the right climatic conditions (Popham 1964). The flight speed of corixids in still air is believed to be on the order of 1 to 2 meters per second (Popham 1952, Popham and Lansbury 1960, Pajunen 1970b). The insects seem to locate bodies of water by way of light reflected from the surface, but they also are attracted to other shiny surfaces such as car tops (Schaefer and Schaefer 1979), wet tar and greenhouses (Popham 1964), and freshly watered streets (Lange 1905). Pajunen and Jansson (1969b) found that dispersing adults of *Arctocorisa carinata* and *Callicorixa producta* exhibited some ability to discriminate pool size. Most corixids, however, seem to be unable to select suitable habitats prior to landing.

Respiration

Adult Corixidae carry large, external stores of atmospheric air on their bodies that supply oxygen to the tracheal system of the submerged insect. There are two types of air stores: (1) concealed air bubbles trapped between the head and prothorax, between the prothorax and mesothorax, and beneath the fore wings; and (2) exposed air films on the ventral surfaces of the abdomen and thorax and along the lateral margin of the hemelytron. The ventral air films are retained by a fine pile of hairs on the integument (Scudder 1976). The air supply is renewed periodically by the insect contacting the water surface anterodorsally and taking air into the spaces beneath the head and pronotum (Parsons 1976). Air is then distributed to the other areas by movements of the middle and hind legs (Parsons 1970).

Parsons (1970) found that the air stores of water boatmen are more or less continuous through a complex network of interconnections. The exposed air films of Corixidae also function as a "physical gill" to extract dissolved oxygen from the water. Popham (1964) investigated the effect of temperature on the efficiency of the physical gill of *Corixa punctata* (Illiger). The respiratory efficiency of water boatmen is enhanced by ventilatory rowing movements of the hind legs over the body (Parsons 1970). Popham (1960) suggested that corixids normally are stimulated to surface by oxygen deficiency, but they may surface from abnormal depths because of stimulation of the mesothoracic scolopale organ ("Hagemann's organ" of many authors).

The respiratory morphology of Corixidae has been described in considerable detail by Popham (1960) and by Parsons (1970, 1974, 1976). Water boatmen differ from other Hydrocorisae in many characteristics, including the elongate pronotum and posterior margin of the head, the complex mesothoracic scolopale organ, the highly modified thoracic pleura, and the position of the metathoracic and first abdominal spiracles (Parsons 1976). The abdominal tracheal system is poorly developed, and respiratory exchange occurs primarily in the thoracic tracheae. The first pair of abdominal spiracles is the main site of inhalation (Popham 1960, Parsons 1976); expiration occurs primarily through the anterior thoracic spiracles (Popham 1960). The tracheal system of the first two larval instars of Corixidae is closed, and respiration occurs exclusively through the integument (Popham 1960). Late-instar larvae use the "air-bubble" mode of respiration that is typical of the adults.

Osmoregulation and Ionic Balance

The success of many Corixidae in saline and alkaline environments is largely a result of their ability to maintain a balance of salt and water. As indicated by Scudder (1976), this ability is related to cuticular permeability and the capacity of these insects to regulate ion concentrations of the haemolymph and urine. Corixids display a marked cuticular permeability, and the cuticle is believed to be an important site for the uptake of water. The cuticular permeability of some species has been shown to vary with the salinity of the external medium (Frick and Sauer 1974c, Cannings 1981), but even the halobiont, *Trichocorixa reticulata*, has a permeability similar to that of freshwater corixids (Sanguinetti 1980). Water boatmen also can gain water by drinking (Staddon 1964, 1966; Scudder 1965, Frick and Sauer 1974c). The ability to control drinking is essential for saline corixids and for freshwater species entering saline environments (Scudder 1976, 1983).

All species of Corixidae studied have some ability to regulate the concentration of ions in the haemolymph relative to changes in external salinity (Knowles and Williams 1973, Scudder 1971b, Scudder et al. 1972, Frick et al. 1972, Frick and Sauer 1974b). However, only the fully saline species of the genus *Trichocorixa* have the ability to hyporegulate with prolonged exposure to high salinities (Tones and Hammer 1975, Jang and Tullis 1980, Sanguinetti 1980). The labial epidermis (Jarial et al. 1969), iliac pad of the hind gut (Jarial and Scudder 1970), and transporting chloride cells in the integument of the frons and legs (Komnick and Wichard 1975, Komnick and Schmitz 1977) appear to be important sites of ion regulation in at least some Corixidae. The Malpighian tubules also are involved in ion regulation, but their primary function seems to be in altering sodium:potassium ratios of the haemolymph (Scudder 1983).

According to Szibbo and Scudder (1979), the Malpighian tubules of *Cenocorixa bifida hungerfordi* (as *C. bifida* (Hungerford)) are not reabsorptive and produce a fluid that is essentially isosmotic with the bathing medium over a wide range of osmotic pressures. Frick and Sauer (1974a) noted that the rate of secretion of the Malpighian tubules of *Corisella edulis* Champion was strongly influenced by salinity. The morphology and secretory activity of the individual segments of the Malpighian tubules of *C. bifida hungerfordi* are described in detail by Jarial and Scudder (1970) and Szibbo and Scudder (1979). Jarial and Scudder (1971) have found evidence of neuroendocrine control of the functioning of the Malpighian tubules in *Cenocorixa*.

Studies of freshwater Corixidae have revealed that these insects produce a urine that is hyposmotic to the haemolymph, even in saline conditions (Staddon 1964, Scudder et al. 1972, Frick and Sauer 1974c). Scudder (1976, 1983) considered this to be a major factor affecting the ability of freshwater species to enter and survive in saline environments. Although no studies of urine composition have been conducted using halophilic corixids, some species of *Trichocorixa* seem capable of producing hyperosmotic urine (Scudder 1976, Jang and Tullis 1980).

Sound Production

Many corixids produce acoustic signals by rubbing one region of the body against another. Commonly referred to as stridulation, these signals are now known to be produced by several mechanisms. Males of the genus *Micronecta* (Micronectinae) produce sound by rubbing the strigil against the edge of abdominal tergum V (Mitis 1936, King 1976). In the subfamily Corixinae, the strigil is not used for sound production; instead, it seems to be used for gripping the female venter during mating (Larsén 1938). Most stridulatory sounds of the Corixinae are produced by rubbing specialized pegs on the inner surface of the fore femur (pars stridens) against the sharp edges of the maxillary plates of the head (plectrum) (Mitis 1936, Hungerford 1948a, Jansson 1972b, 1976). Aiken (1982a) suggested that the head is the sound-radiating mechanism and is driven into oscillation by the action of the stridulatory pegs against the maxillary plate.

A third mechanism of sound production has been reported for *Palmacorixa nana* (Corixinae) (Aiken 1982a). Males of *P. nana* have a row of stout pegs on the inner surface of the middle femur. During mounting and copulation, males produce stridulatory sound by drawing these pegs across the lateral edges of the female hemelytra. This inter-individual method of stridulation also may be employed by some species of *Cenocorixa*. Jansson (1972b) recorded faint stridulatory signals when males of *C. blaisdelli* and *C. expleta* mounted conspecific females, but he was unable to determine the mechanism of sound production. Some

corixids also produce sound by rubbing the fore wings or abdomen with the hind legs (Jansson 1972b). These sounds, however, are apparently the by-products of cleaning movements and do not appear to have any communicative value. The sound-receiving structures of Corixidae are believed to be the mesothoracic and metathoracic scolopale organs (Prager 1973, 1976; Prager and Theiss 1982).

The stridulatory signals of Corixidae seem to be involved primarily with mating behavior. Jansson (1972b, 1973a) suggested that in the genus *Cenocorixa*, stridulation is important for the reproductive isolation of species. Stridulatory signals also may function agonistically to space out male individuals (Jansson 1973a, 1976), or synergistically to bring males together into singing aggregations for the purpose of attracting mates (Aiken 1982b). Synchronized chorus-stridulation has been reported for several European water boatmen by Finke and Prager (1980, 1981). According to Aiken (1982b), the females of *Palmarcorixa nana* are always attracted to dense male aggregations with high acoustic output.

Stridulatory signals usually are produced only by males, but female stridulation has been reported for some species of Corixinae (Jansson 1972b, 1973a, 1976, 1979; Aiken 1982a). Females of *Cenocorixa* stridulate only when sexually receptive, and then only in response to calls of conspecific males (Jansson 1973a, 1974b). Most males produce a single stridulatory signal that is emitted both spontaneously and in response to visual or auditory stimuli of other corixids (Jansson 1976). The males of several species, however, are reported to produce two or more structurally different signals that seem to serve different functions (e.g., courtship call, spontaneous call, mounting signal, copulatory signal) (Jansson 1976, Aiken 1982b). Corixid songs are species and sex specific, differing primarily in the temporal pattern of pulse-trains and amplitude of the signal (Jansson 1973a, 1976; Aiken 1982a). In general, the frequency ranges of corixid calls decrease with increased size of the insect (Jansson 1976, Finke and Prager 1981). The effect of temperature on the stridulatory signals of *Cenocorixa* has been investigated by Jansson (1974a).

Population Ecology

In the past decade, various field and laboratory studies have provided interesting information regarding the structure and dynamics of corixid populations (e.g., Istock 1973, Pajunen 1977, Campbell 1979, Kelts 1979, Scudder 1983). Perhaps most notable has been the interest in competitive interactions and their influence on distribution and population dynamics. Istock (1973) was the first to provide experimental evidence of interspecific competition in the Corixidae. In enclosure experiments, he found that *Hesperocorixa lobata* (Hungerford) was prevented from reaching maximum population size because of resource competition with a codomi-

nant species, *Sigara macropala* (Hungerford). Although these species show only weak niche differentiation, they coexist in natural populations apparently as a result of their different reproductive phenologies and seasonal switching of dominance, plus imperfect resource tracking by the competitively superior *S. macropala* (Istock 1977).

A similar case of competition and coexistence has been described for the European species, *Arctocorisa carinata* and *Callicorixa producta* (Vespäläinen 1978, Pajunen 1979a,b, 1982a). These species have similar reproductive phenologies, display complete resource overlap, and often occur in harmfully high densities during the reproductive season. They are both largely predaceous and co-occur throughout much of southern Finland in unstable rock pool environments. Pajunen (1979a) showed that food was frequently a limited resource in these environments, and that competition between the two species was non-equilibrium, favoring the larger *A. carinata*. However, the competitive inferiority of *C. producta* is offset by its high capacity for dispersal and ability to rapidly colonize refilled pools after periods of rain. *Callicorixa producta* is able to find refuge in the heterogeneous rock pool environment, thus avoiding intense competition and probable exclusion by *A. carinata*. In a stable environment, the exclusion of *C. producta* by *A. carinata* would be likely unless the former species could switch to a different food resource.

Intraspecific competition also occurs in the family Corixidae. Pajunen (1977, 1981) found that rock pool corixids developing during periods of high population density are smaller and develop more slowly than individuals undergoing development when density is low. A major factor contributing to this trend is resource depletion by the growing population, but Pajunen (1982b) found that, at least in *Callicorixa producta*, another factor is involved. The adults and large larvae of this species inhibit the development of early-instar larvae by way of direct interference with feeding and resting. This age-dependent interference often develops prior to signs of food shortage and thus may be the primary mechanism producing intra-generation variation in developmental rates and adult size of *C. producta*.

General Morphology

The general morphology of Corixidae is shown in Figures 2-6. Characters useful in the identification of taxa treated in this paper are discussed below. A more complete treatment of general morphology is provided by Griffith (1945).

Abdominal strigil of male. A filelike structure on the posterior margin of abdominal tergum VI (Fig. 3). The shape and size of the strigil are diagnostic for some species. In Oregon and Washington, all Corixidae except *Callicorixa* and *Trichocorixa* have the strigil on the right side of the

abdomen (dextral abdominal asymmetry). Males of *Trichocorixa* have the strigil on the left side of the abdomen (sinistral asymmetry) (Fig. 117), while in *Callicorixa* the strigil is absent (Figs. 15&16).

Abdominal terga of male. The shape of the posteromedial projection of abdominal tergum VII helps characterize some species of *Sigara*, but is difficult to see on dry-mounted specimens without removing the wings.

Clavopruina. A frosted region along the anterolateral margin of the clavus (Fig. 6), measured from the anterior apex of the clavus to the posterior tip of the pruina. The length of the clavopruina in relation to the length of the postnodal pruina is diagnostic for the genus *Hesperocorixa* and also helps differentiate some species of *Cenocorixa*.

Coriopruina. A frosted region between the clavopruina and the inner anterior margin of the corium (Fig. 6), measured from the anterior apex of the corium to the posterior tip of the pruina. The length of the coriopruina in comparison to the length of the clavopruina is useful in differentiating *Sigara* and *Callicorixa*.

Hemelytron. The texture and pattern of the hemelytra are valuable characters for distinguishing the genera of Corixidae. Hemelytral pattern also is diagnostic for many species. The textures of the clavi of Oregon and Washington genera are shown in Figure 1. Claval texture may be smooth or rugulose (minutely wrinkled) (e.g., *Corisella*, *Trichocorixa*), rugose (wrinkled) (e.g., *Cenocorixa*), or rastrate (with longitudinal scratches) (e.g., *Callicorixa*, *Graptocorixa*, *Sigara*). In *Hesperocorixa* species the clavus is rugose, rastrate, or both. The hairs on the hemelytra are not especially useful taxonomic characters.

Interocular space. Measured as the shortest distance between the eyes in dorsal view, this character, when compared to the dorsal width of an eye along its posterior margin, helps distinguish several species of *Hesperocorixa*.

Mesepimeron. This lateroventral sclerite of the mesothorax (Fig. 2) helps characterize certain species of *Hesperocorixa* and *Sigara*. The ventral portion of the mesepimeron is produced into a narrowed posterior region called the "mesepimeral process." The shape of this process and the location of the scent gland ostiole along its lateral margin are particularly useful characters.

Metaxyphus. The metaxyphus is the triangulate, posterior process of the metasternum, and is located more or less between the hind coxae (Fig. 2). The shape of this process is useful for differentiating the females of several *Cenocorixa* species.

Pala. The pala is the modified fore tarsus of Corixidae (Fig. 5). For males, the shape of the pala and the number and arrangement of the polar pegs are widely employed characters at both the generic and species levels. The female pala has little taxonomic value.

Palar pegs. A row of short, stout pegs across the inner face of the male pala (Fig. 5). The number and position of these pegs are diagnostic for many species of Corixidae. The males of *Corisella* have two peg rows (Figs. 58-60), while in *Callicorixa* the peg row is broken medially (Figs. 19-21). All other Oregon and Washington corixids have a single, undivided peg row.

Postnodal pruina. A frosted region on the embolium behind the nodal furrow (Fig. 3) measured from its anterior junction with the cubital vein to its apex (i.e., greatest length measurement). The length of this pruinose area in relation to the length of the clavopruina, diagnostic of the genus *Hesperocorixa*, also helps to differentiate some species of *Cenocorixa*.

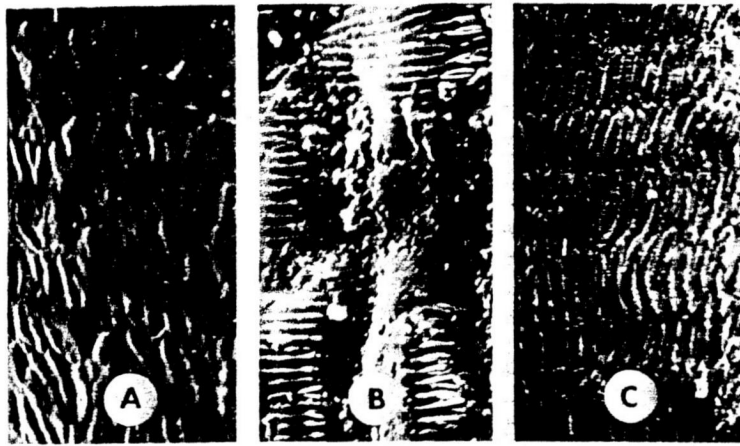
Pronotal disk. The shape, pattern, and texture of the pronotal disk are diagnostic for some species. The number and width of transverse bands on the disk are particularly useful for distinguishing the females of *Cenocorixa* and *Corisella* species.

Prothoracic lobe. A lateral process of the prothorax located near the base of the fore coxa (Fig. 2). The shape and size of this structure help characterize some species of *Graptocorixa* and *Hesperocorixa*.

Right clasper of male. The right clasper is one of the most valuable characters for identification of male corixids (in groups with sinistral asymmetry, such as *Trichocorixa*, the left clasper is the diagnostic character). It is narrowly attached to the genital capsule (Fig. 4) and freely visible when the capsule is removed from the abdomen. Extending or removing the capsule from relaxed or alcohol-preserved specimens is accomplished by inserting a fine, hooked needle or pair of jeweler's forceps between the lateral lobes of the eighth abdominal segment and gently pulling the structure from its supports.

Scent gland ostiole. The external opening of the metathoracic scent gland system in adult Corixidae (Fig. 2). The location of the ostiole in relation to the lateral bend and apex of the mesepimeral process is diagnostic for some species of *Hesperocorixa* and *Sigara*.

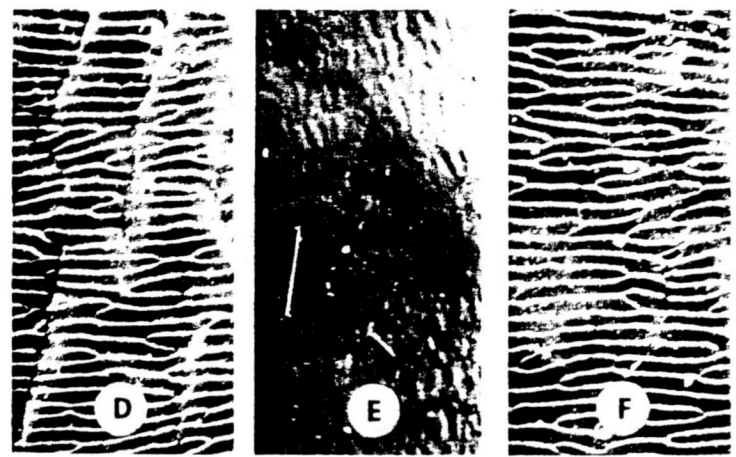
Male corixids usually are identified more easily than females, but accurate species identification often requires careful examination of the right clasper of the genitalic and the male pala. These structures are easily manipulated and observable in alcohol-preserved (75%) specimens. If specimens are to be dry-mounted, we recommend extending one fore leg of male specimens to show the inner surface of the pala and removing the genital capsules of several specimens for subsequent examination. Genital capsules can be stored in microvials containing glycerine and should be fixed below the specimen on the pin. The females of some corixid genera (e.g., *Cenocorixa*, *Sigara*) do not possess adequate structural characters



Graptocorixa
(100X)

Graptocorixa
(800X)

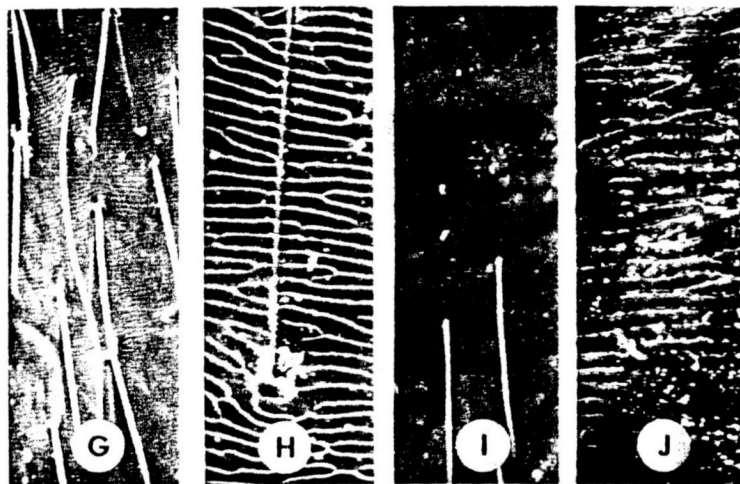
Callicorixa
(100X)



Callicorixa
(800X)

Cenocorixa
(100X)

Cenocorixa
(800X)

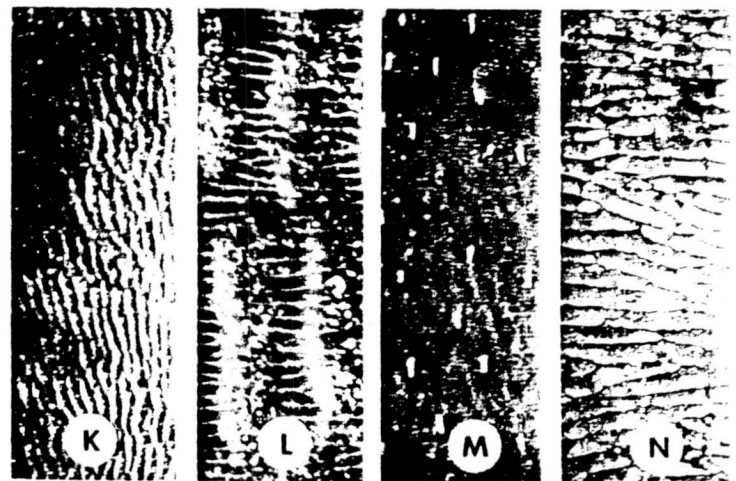


Corisella
(200X)

Corisella
(800X)

Hesperocorixa
(100X)

Hesperocorixa
(800X)



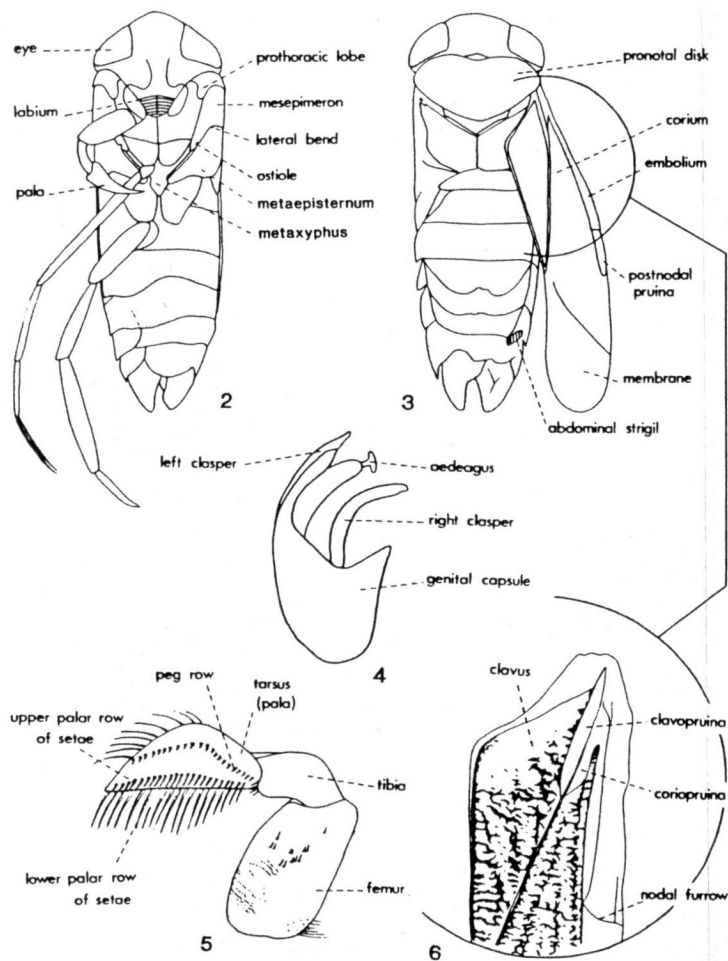
Sigara
(100X)

Sigara
(800X)

Trichocorixa
(200X)

Trichocorixa
(800X)

Figure 1. Scanning electron micrographs of clavus of hemelytron (above and on facing page).



Figures 2-6. General morphology of Corixidae (Lauck 1979): 2, ventral aspect of body of *Corisella decolor*; 3, dorsal aspect of body of *C. decolor*; 4, genital capsule of male showing position of right clasper; 5, male fore leg of *Cenocorixa blaisdelli*; 6, enlarged anterior half of hemelytron of *Corisella decolor*.

for positive species recognition. However, females often can be associated with known males by resemblances in size, color, and hemelytral pattern.

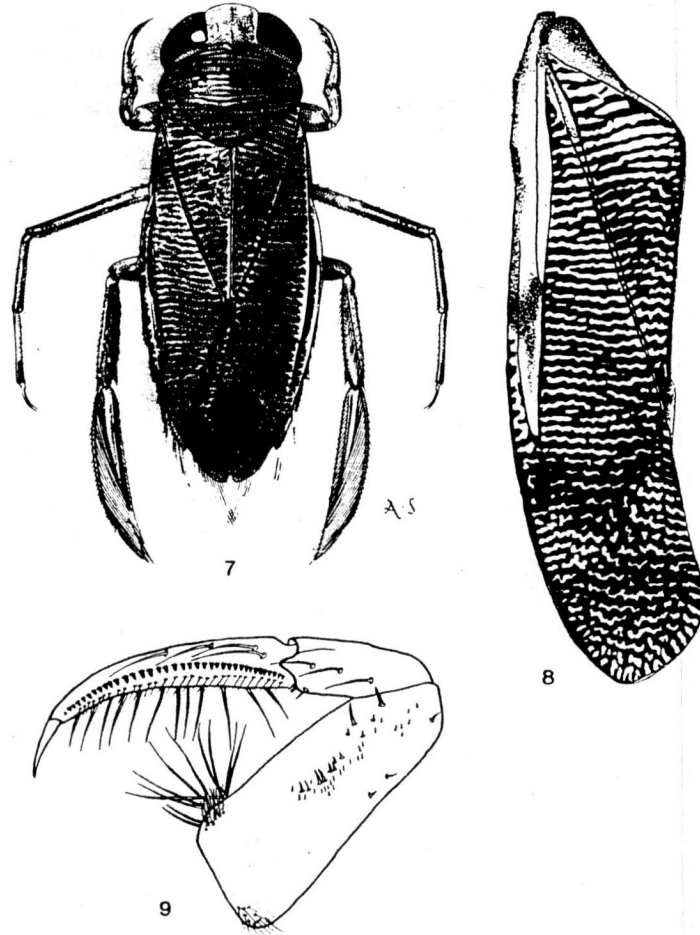
Two subfamilies of Corixidae are found in North America, but only the Corixinae occurs in the northwestern United States. In Oregon and Washington, this subfamily is represented by the tribes Corixini and Graptocorixini. Six genera of Corixini are known from the two-state region (*Callicorixa*, *Cenocorixa*, *Corisella*, *Hesperocorixa*, *Sigara*, *Trichocorixa*); the Graptocorixini is represented by the genus *Graptocorixa*.

Key to the Oregon and Washington Genera of Corixidae (Adults)

1. Palae of both sexes narrowly digitiform, approximately 5 times as long as median width (Fig. 9); palar claw stout, much thicker than setae of lower palar row (Fig. 9) (Graptocorixini)..... *Graptocorixa* Hungerford
Palae not distinctly digitiform, never more than 4 times as long as median width; palar claw setiform, similar to setae of lower palar row (Fig. 5) (Corixini)..... 2
2. Apices of clavi not exceeding a line drawn through the nodal furrows (Fig. 115); males with sinistral abdominal asymmetry (Fig. 117)..... *Trichocorixa* Kirkaldy
Apices of clavi clearly exceeding a line drawn through the nodal furrows; males with dextral abdominal asymmetry (Fig. 3)..... 3
3. Clavopruina one-half to two-thirds as long as the postnodal pruina (Fig. 70); prothoracic lobe quadrate or trapezoidal, about as long as broad..... *Hesperocorixa* Kirkaldy
Clavopruina greater than two-thirds the length of the postnodal pruina; prothoracic lobe elongate, distinctly longer than broad..... 4
4. Clavus smooth and shiny, at most only faintly rugulose (Figs. 1G&H)..... *Corisella* Lundblad
Clavus rough, either rastrate, rugose, or both..... 5
5. Clavus and corium strongly rastrate (Figs. 1C,D,K,&L); claval pattern consisting predominantly of broad transverse bands (Figs. 17,18,&81-88)..... 6
Clavus rugose (Figs. 1E&F), corium smooth or slightly rugulose; clavus usually with open, reticulate pattern (Figs. 28-32); if somewhat transversely banded, then bands irregular or broken (Fig. 27)..... *Cenocorixa* Hungerford
6. Coriopruina extending to middle of clavopruina or beyond (Figs. 85-87); males with abdominal strigil (Figs. 89-96); male pala with unbroken peg row..... *Sigara* Fabricius
Coriopruina not extending to middle of clavopruina (Figs. 17&18); males without abdominal strigil (Figs. 15&16); male pala with distinct break in peg row (Figs. 19-21)..... *Callicorixa* White

TRIBE GRAPTOCORIXINI

There are two North American genera in this tribe, but only *Graptocorixa* occurs in Oregon and Washington. Members of the tribe are recognized by the narrowly digitiform fore tarsus with stout apical claw and by the dense mat of hairs on the frons in both sexes.



Figures 7-9. *Graptocorixa californica*: 7, dorsal view of adult male (Usinger 1956); 8, female hemelytron (Lauck 1979); 9, male fore leg.

Genus *Graptocorixa* Hungerford

Graptocorixa Hungerford 1930:22. Type species: *Corixa abdominalis* Say 1832:38.

The genus *Graptocorixa* is comprised of 15 species distributed in western North America, Mexico, and Central America. A single species, *G. californica* (Hungerford), occurs in Oregon and Washington.

Graptocorixa californica (Hungerford)

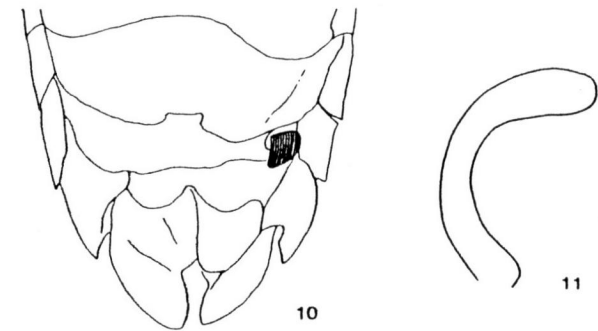
Figs. 7-11, 119

Arctocorixa californica Hungerford 1925a:18. Holotype male: Stanford Univ., California (University of Kansas).

Graptocorixa californica is distinguished from other Oregon and Washington Corixidae by the narrowly digitiform pala in both sexes that terminates in a stout apical claw (Fig. 9). This species is comparable in size (length: males, 8.4 to 9.8 mm; females, 9.7 to 10.6 mm) to some of our *Hesperocorixa* species but differs externally by the dense mat of hairs on the frons and by the deeply rastrate hemelytra (Figs. 1A&B).

Oregon and Washington records (Fig. 119). *Graptocorixa californica* has been collected in six counties in western and north-central Oregon and in four counties in central and southeastern Washington. Collection dates are from February to November. The Washington records are the first for the state, and they represent a considerable extension of the northern boundary of this species distribution. *Graptocorixa californica* is found primarily in ditches, small streams, and spring-fed pools.

Geographic range. Northern California to central Washington.



Figures 10-11. (Lauck 1979). *Graptocorixa californica*: 10, dorsal view of male abdomen; 11, right clasper of male genitalia.

TRIBE CORIXINI

The Corixini is comprised of 20 genera, most of which have New World representatives. The members of this tribe are characterized by the spinelike or setiform apical claw of the fore tarsus, variously shaped pala (but never narrowly digitiform) with peg row(s) usually well removed from upper row of palar setae, and by the absence of matlike setae on the frons. Six genera of this tribe occur in Oregon and Washington.

Genus *Callicorixa* White

Callicorixa White 1873:62. Type species: *Corisa praeusta* Fieber 1848:521 (designated by Kirkaldy 1898:253).

Callicorixa is a northern Holarctic genus comprised of 11 species and 3 subspecies. There are six species in North America, three of which occur in Oregon and Washington. Males are readily distinguished from other Pacific Northwest corixids by the absence of an abdominal strigil (Figs. 15&16) and by the distinct break in the peg row of the pala (Figs. 19-21). Other distinguishing characteristics of the genus include the strongly rastrate clavus and corium (Figs. 1C&D), the transverse banding pattern of the hemelytra (Figs. 17&18), and the bicolorous first tarsal segment of the hind leg (Fig. 12), except tarsus concolorous for *C. audeni*. The hemelytral pattern of *Callicorixa* is similar to that of *Sigara*, but less strongly contrasting. *Callicorixa* species also are larger (6.5 to 8.3 mm) than most *Sigara* (except *S. decoratella*, 7.3 to 8.6 mm) and have a coriopruiua that does not exceed half the length of the clavopruiua (Fig. 17). *Sigara* species have the coriopruiua extending to half the length of the clavopruiua (Fig. 17). *Sigara* species have the coriopruiua extending to half the length of the clavopruiua or more.

The Pacific Northwest *Callicorixa* are predominantly inhabitants of ponds and small lakes, but they sometimes occur in irrigated canals, sloughs, and calm sections of rivers and streams.

Key to *Callicorixa* of Oregon and Washington

- 1. First tarsal segment of hind leg infuscated apically (Fig. 12)..... 2
 First tarsal segment of hind leg uniformly pale.....*audeni* Hungerford
- 2. Second tarsal segment of hind leg darkened along lower basal margin; male pala with basal portion of peg row nearly straight, apical 2 or 3 pegs displaced dorsally toward distal section of peg row and more or less linking the 2 peg fields together (Fig. 20); right clasper of male as in Figures 23 and 24.....
 *scudderi* Jansson
- Second tarsal segment of hind leg concolorous, not distinctly darkened anteroventrally; male pala with basal peg field slightly curved dorsoventrally,

apical 1 or 2 pegs sometimes displaced dorsally, but never placed so as to close the gap between the basal and distal peg fields (Fig. 21); right clasper of male as in Figures 25 and 26.....*vulnerata* (Uhler)

Callicorixa audeni Hungerford

Figs. 13,15,17,19,22,120

Callicorixa audeni Hungerford 1928:229. Holotype male: Adams Lk., British Columbia (University of Kansas).

Callicorixa canadensis Walley 1930:80. Holotype male: Natashquan, Quebec (Canadian National Collection).

This species is easily separated from *C. scudderi* and *C. vulnerata* by the concolorous first tarsal segment of the hind legs and by the narrow dark bands on the pronotum (Fig. 13). The pala (Fig. 19) and right clasper (Fig. 22) of the male are similar to those of *C. vulnerata*, but the clasper usually is less strongly curved. Length: males, 6.7 to 7.7 mm; females, 7.0 to 8.0 mm.

Oregon and Washington records (Fig. 120). *Callicorixa audeni* is widely distributed east of the Cascade Range but has not been collected in north-central Oregon, south-central Washington, or the extreme central region of either state. We have examined specimens from five counties in Oregon and eight counties in Washington. Collection dates range from March to December. Hungerford (1948a) reported *C. audeni* from Lake Cushman in western Washington, but we have not found this species anywhere west of the Cascade Range.

Geographical range. Boreal distribution, but extending to southern Colorado in the Rocky Mountains, and in the Sierra Nevada and coastal mountains of California to San Diego County.

Callicorixa scudderi Jansson

Figs. 20,23,24,121

Callicorixa scudderi Jansson 1978:261. Holotype male: Little Fort, British Columbia, Canada (University of Helsinki, Zoological Museum).

Males of this species are recognized by the dorsal displacement of the apical two or three palar pegs of the basal peg field. These pegs tend to fill the gap between the basal and distal sections of the peg row, more or less linking the two peg fields together (Fig. 20). Males are further differentiated from *C. vulnerata* by the nearly straight proximal region of the palar peg row and by the shorter and only slightly curved apical region of the right clasper (Figs. 23&24), often with preapical tubercle or other irregularity. Females of *C. scudderi* usually can be distinguished from other Oregon and Washington *Callicorixa* by the strongly slanted infuscation

on the first tarsal segment of the hind leg, and by the darkened anteroventral region of the second tarsal segment. However, these characters will not always distinguish *C. scudderi* from *C. vulnerata*, especially in regions where the two species are sympatric. Length: males, 6.6 to 7.8 mm; females, 6.6 to 8.0 mm.

Oregon and Washington records (Fig. 121), *Callicorixa scudderi* is widely distributed in the two-state region but appears to be most common east of the Cascade Range. We have examined specimens from seven counties in Oregon and five counties in Washington; collection dates are from February to September.

In portions of western Oregon and Washington where populations of *C. scudderi* and *C. vulnerata* are narrowly sympatric, there is often considerable variation in the characters used to distinguish these species (i.e., paler peg arrangement, right clasper, color pattern of hind tarsus). Jansson (1978) considered most of this to be intraspecific variation within the species he redefined as *C. vulnerata* (Uhler), but we feel that many variant individuals are hybrids. The increased occurrence of these individuals in sympatric populations and the intermediate condition of their defining characters seem to support this hypothesis. If hybridization is involved, it would be more appropriate to treat *vulnerata* and *scudderi* as subspecies, a ranking which is further supported by the predominantly allopatric distributions of the two forms. For the purpose of this study, we are maintaining these taxa as distinct species, realizing that the problem requires further investigation.

Geographic range. Oregon, Washington, British Columbia.

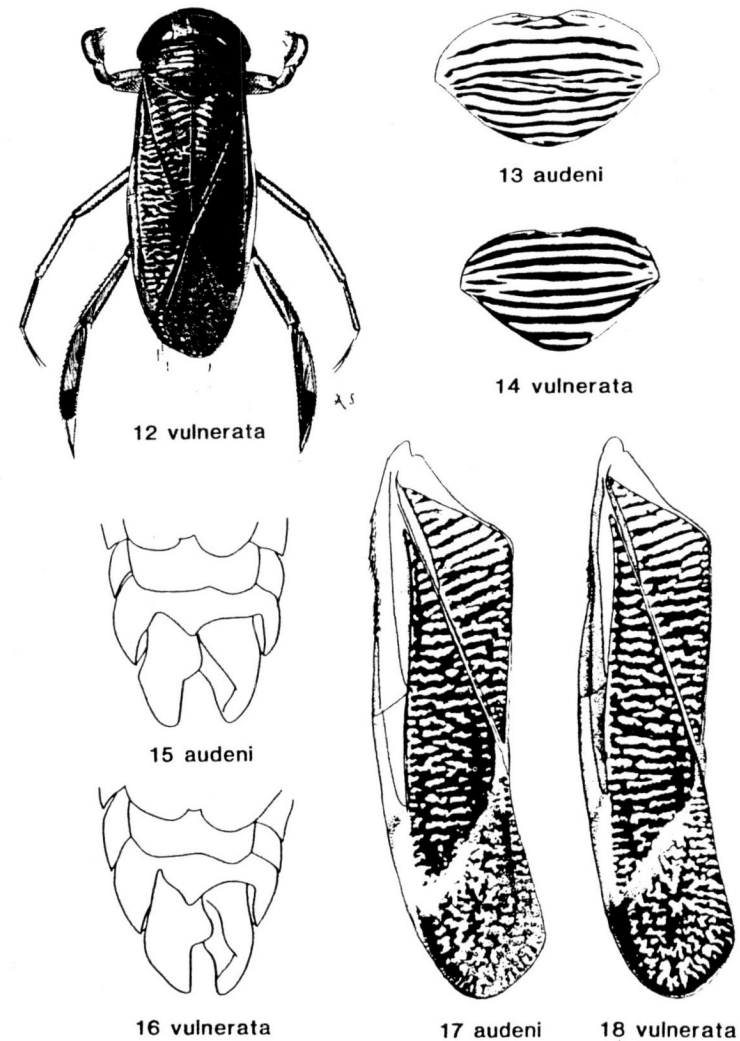
Callicorixa vulnerata (Uhler)

Figs. 12,14,16,18,21,25,26,122

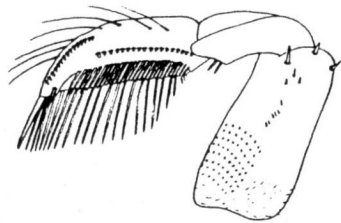
Corixa vulnerata Uhler 1861:284. Described from two female specimens collected in the Washington Territory and labeled "*Corisa vulnerata* Uhler, N.W.B. Surv., Dr. Kennerly" (Holotype not designated).

Callicorixa vulnerata, Hungerford 1948a:482. Lectotype designation: One female specimen from Uhler's syntype series (United States National Museum of Natural History).

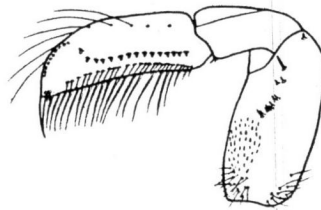
Callicorixa vulnerata is distinguished from *C. audeni* by the bicolored first tarsal segment of the hind leg (Fig. 12) and by the broad, dark bands on the pronotal disk (Fig. 14). Males of *C. vulnerata* differ most noticeably from those of *C. scudderi* by the distinct break in the peg row of the pala (Fig. 21) and by the longer and more strongly curved apical region of the right clasper (Figs. 25&26). Also, the basal region of the paler peg row is somewhat curved dorsoventrally in *C. vulnerata* but is nearly straight



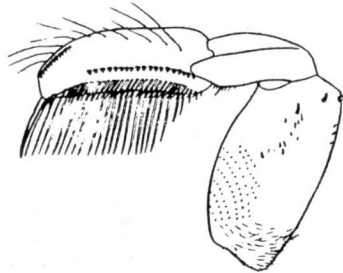
Figures 12-18. *Callicorixa* species: 12, dorsal view of adult male of *C. vulnerata* (Usinger 1956); 13-14, female pronotal disk; 15-16, dorsal view of male abdomen; 17-18, female hemelytron (Lauck 1979).



19 audeni



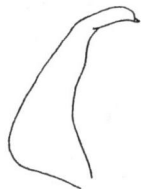
20 scudderi



21 vulnerata



22 audeni



23 scudderi



24 scudderi



25 vulnerata



26 vulnerata

Figures 19-26. *Callicorixa* species: 19-21, male fore leg; 22,23,25, lateral view of right clasper of male genitalia; 24,26, ventral view of right clasper of male genitalia (Figs. 19,21-22 from Lauck 1979).

for *C. scudderi* (compare Figs. 20&21). Females of these two species are difficult to separate with certainty, but for *C. vulnerata*, the second tarsal segment of the hind leg is usually concolorous and the darkened apical

region of the first tarsal segment has a truncate proximal margin. In *C. scudderi*, the second tarsal segment is infuscated anteroventrally, and the darkened region of the first segment usually has an oblique proximal margin. Length: males, 6.5 to 7.7 mm; females, 7.0 to 8.3 mm.

Oregon and Washington records (Fig. 122). This species occurs throughout western Oregon and Washington and has been collected east of the Cascade Range in Kittitas and Yakima counties, Washington, and Klamath Co., Oregon. We have seen specimens from 11 counties in Oregon and 17 counties in Washington. Collection dates are from January to December.

Geographic range. Alaska, British Columbia, California, Oregon, Washington. Also recorded from Idaho, Montana, Utah, and Wyoming (Hungerford 1948a), but these records were not verified in the detailed study of *C. vulnerata* and *C. scudderi* conducted by Jansson (1978).

Genus *Cenocorixa* Hungerford

Cenocorixa Hungerford 1948a:564. Type species: *Arctocorixa wileyae* Hungerford 1926a:271.

Cenocorixa is a Nearctic genus with the majority of species restricted to western and midwestern portions of the United States and Canada. The genus is comprised of eight species, one of which is represented by two subspecies. In a recent revision of the genus, Jansson (1972a) relegated four additional species to synonymy and provided a revised key to males. The species key given by Hungerford (1949a) is inadequate for accurate species identification.

Scudder and various coworkers at the University of British Columbia have conducted extensive research on the members of this genus, including studies of immature stages, life cycles, and sexual development (Scudder 1966, 1969a,b; Jansson and Scudder 1974); mechanisms of sound production (Jansson 1972b); development and polymorphism of flight muscles (Scudder 1964, 1971a, 1975; Acton and Scudder 1969, Scudder and Meredith 1972); and osmoregulatory mechanisms (Scudder 1971b, Jarial and Scudder 1970, 1971; Scudder et al. 1972).

Six species of *Cenocorixa* occur in Oregon and Washington. They are distinguished from other corixids of this region by body size, 6.3 to 8.2 mm; the rugose, hairy clavi of the hemelytra (Figs. 1E&F); and by the openly reticulate and sometimes anastomosing pattern on the clavus and corium. *Sigara* and *Callicorixa* species of comparable size have strongly rastrate clavi and more or less transversely banded hemelytral patterns. *Corisella* and *Trichocorixa* species have smooth, shiny clavi. The Oregon and Washington species of *Graptocorixa* and *Hesperocorixa* (except *H. michiganensis*) are larger (length 8.2 to 11.6 mm) than *Cenocorixa* species.

Key to *Cenocorixa* of Oregon and Washington

1. Males—abdominal segments asymmetrical; pala with distinct field of pegs 2
Females—abdominal segments symmetrical; pala without pegs 7
2. Pala with sharply incised peg row (Fig. 51); abdominal strigil small, composed of 4 or 5 combs *wileyae* (Hungerford)
Pala with gently curved peg row (Figs. 46-50); abdominal strigil large, composed of 10 or more combs 3
3. Pala with large, spinose process basally (Fig. 49); clavopruina longer than greatest length of postnodal pruina *expleta* (Uhler)
Pala without spinose process basally; length of clavopruina equal to or less than greatest length of postnodal pruina 4
4. Apex of right clasper bifurcate (Figs. 41&44) 5
Apex of right clasper weakly bilobed (Figs. 40&42) but never distinctly bifurcate 6
5. Palar pegs more widely spaced near middle of peg row (Fig. 47); apical processes of right clasper broadly produced (Fig. 41) *bifida hungerfordi* Lansbury
Palar pegs more or less evenly spaced throughout peg row (Fig. 50); apical processes of right clasper narrowly produced (Fig. 44) *utahensis* (Hungerford)
6. Relatively straight proximal portion of palar peg row approximately half the length of the pala (Fig. 46); right clasper as in Figure 40 *andersoni* Hungerford
Relatively straight proximal portion of palar peg row no more than one-quarter the palar length (Fig. 48); right clasper as in Figure 42 *blaisdelli* (Hungerford)
7. Clavopruina longer than greatest length of postnodal pruina; lateral margins of pronotal disk sharply angulate (Fig. 36) *expleta* (Uhler)
Length of clavopruina equal to or less than greatest length of postnodal pruina; lateral margins of pronotal disk rounded or broadly angulate (Figs. 34,35,&37-39) 8
8. Metaxyphus distinctly longer than broad *blaisdelli* (Hungerford)
Metaxyphus broader than long, or sometimes as broad as long 9
9. Dark bands on anterior half of pronotal disk approximately equal to width of intervening pale areas (Figs. 34&35) 10
Dark bands on anterior half of pronotal disk much narrower than intervening pale areas (Figs. 38&39) 11

10. Claval pattern consisting largely of transverse bands (Fig. 27) *andersoni* Hungerford
Claval pattern imperfectly reticulate, sometimes with irregular or broken transverse bands (Fig. 28) *bifida hungerfordi* Lansbury
11. Pronotal disk with 8 to 9, mostly entire, transverse bands (Fig. 38) *utahensis* (Hungerford)
Pronotal disk with 10 to 14, partially dissected, transverse bands (Fig. 39) *wileyae* (Hungerford)

Cenocorixa andersoni Hungerford
Figs. 27,34,40,46,123

Cenocorixa andersoni Hungerford 1948a:573. Holotype male: Kalama R., Washington (University of Kansas).

Cenocorixa malkini Hungerford 1956:39. Holotype male: Chase Lake, Snohomish Co., Washington (University of Kansas).

Cenocorixa downesi Lansbury 1960:40. Holotype male: Stanley Park, Vancouver, British Columbia (University of British Columbia).

This species is distinguished from other Oregon and Washington *Cenocorixa* by the following combination of characters: pronotal disk with eight or nine dark bands that are as broad as the intervening pale areas, lateral margins of disk broadly angulate (Fig. 34); clavus with distinct transverse bands (Fig. 27); clavopruina shorter than postnodal pruina; metaxyphus broader than long; male abdominal strigil large, composed of 12 to 14 combs; right clasper of male not bifurcate, apex narrowly produced (Fig. 40); and male with relatively straight proximal portion of palar peg row approximately half the length of the pale (Fig. 46). Length: males, 6.9 to 7.6 mm; females, 7.4 to 8.2 mm.

Oregon and Washington records (Fig. 123). *Cenocorixa andersoni* is widely distributed west of the Cascade Range from **Whatcom** Co., Washington, to **Lane** Co., Oregon. We have seen specimens from 5 counties in Oregon and 10 counties in Washington. Specimens also were examined from **Frater Lake (Pend Oreille Co.)** in the northeastern corner of Washington, indicating an eastern extension of the range of this species across the mountainous northern counties of Washington and possibly southern British Columbia, Canada. *Cenocorixa andersoni* inhabits a variety of aquatic habitats ranging from ponds and small streams to large rivers and lakes. Collection dates are from January to October.

Geographic range. Oregon, Washington, British Columbia.

***Cenocorixa bifida hungerfordi* Lansbury**

Figs. 28,35,41,47,124

***Cenocorixa hungerfordi* Lansbury 1960:36.** Holotype male: Kamloops, British Columbia (University of British Columbia).

***Cenocorixa bifida hungerfordi* Jansson 1972a:450 (new status).**

Males of this species are easily recognized by the bifurcate right clasper with broadly produced apical processes (Fig. 41) and by the widely spaced paler pegs near the middle of the peg row (Fig. 47). Females are distinguished from other *Cenocorixa* species by the following characteristics: dark bands on pronotal disk equal to or slightly less than width of pale intervening areas, lateral margins of disk broadly angulate (Fig. 35); claval pattern imperfectly reticulate, lacking distinct transverse bands (Fig. 28); clavopruina equal to or less than greatest length of postnodal pruina; and metaxyphus as broad as or slightly broader than long. Length: males, 6.8 to 7.4 mm; females, 6.8 to 8.0 mm.

Oregon and Washington records (Fig. 124). This species is known from eight counties in central and northeastern Washington. Collection dates range from May to September. *Cenocorixa bifida hungerfordi* inhabits low to moderate elevation ponds and lakes and is often found in moderately saline environments (Scudder 1969a).

Geographic range. Washington and British Columbia.

***Cenocorixa blaisdelli* (Hungerford)**

Figs. 29,37,42,48,125

***Arctocorixa blaisdelli* Hungerford 1930:26.** Holotype male: Vine Hill, Contra Costa Co., California (California Academy of Sciences).

***Cenocorixa columbiensis* Lansbury 1960:38.** Holotype male: University of British Columbia, Vancouver, British Columbia (University of British Columbia).

This species closely resembles *C. andersoni* but is distinguished by having the metaxyphus longer than broad; male with relatively straight proximal portion of paler peg row not more than one-quarter the length of the pala (Fig. 48); and by the broad apical region of the male right clasper (Fig. 42). The broadly angulate lateral margins of the pronotal disk and short clavopruina separate females of this species from those of *C. expleta*, and the long metaxyphus distinguishes *C. blaisdelli* from all other *Cenocorixa* females in Oregon and Washington. Length: males, 6.3 to 7.3 mm; females, 6.5 to 8.1 mm.

Oregon and Washington records (Fig. 125). *Cenocorixa blaisdelli* is distributed west of the Cascade Range in streams, rivers, ponds, and

lakes. The distribution of this species is very similar to that of *C. andersoni*, ranging from Whatcom Co. in Washington to Lane Co. in Oregon. We have examined specimens from 3 counties in Oregon and 10 counties in Washington. Collection dates are from March to October.

Geographic range. California, Oregon, Washington, British Columbia. In California, this species occurs in coastal areas from the northern border to Santa Barbara County (Lauck 1979).

***Cenocorixa expleta* (Uhler)**

Figs. 30,33,36,43,49,126

***Corisa expleta* Uhler 1895:63.** Described from two female specimens; Fort Collins and Spring Can[y]on, Colorado (Holotype not designated).

***Cenocorixa expleta*, Hungerford 1948a:576.** Lectotype female designated with label data: "164," "*Corisa expleta* Uhl., Col.," "Co-type U.S.N.M." (United States National Museum of Natural History).

Cenocorixa expleta is distinguished from other Oregon and Washington species of the genus by the sharply angulate lateral margins of the pronotal disk (Fig. 36) and by having the clavopruina distinctly longer than the postnodal pruina. Males are further differentiated by the spinose process at the base of the pala (Fig. 49) and by the weakly curved right clasper with acute apex (Fig. 43). Length: males, 7.0 to 7.7 mm; females, 6.6 to 8.0 mm.

Oregon and Washington records (Fig. 126). This species has been collected at the following localities in central and southeastern Washington: Douglas Co.: Pine Canyon. Grant Co.: Dry Falls; Lake Lenore; Park Lake; Soap Lake. Kittitas Co.: Lake Keechelus Park; Vantage. Okanogan Co.: Alkali Lake, T3ON-R28E-Sec. 5; Duley Lake. Whitman Co.: Pullman. Collection dates range from April to June. *Cenocorixa expleta* usually is found in saline or alkaline ponds and lakes and has been reported from interior lakes of British Columbia, Canada, with conductivity readings as high as 29 micromhos/cm (Scudder 1969a).

Geographic range. Colorado, North Dakota, Washington, Alberta, British Columbia, Manitoba, Saskatchewan.

***Cenocorixa utahensis* (Hungerford)**

Figs. 31,38,44,50,127

***Arctocorixa utahensis* Hungerford 1925a:22.** Holotype male: Emery Co., Utah (University of Kansas).

Males of *Cenocorixa utahensis* are recognized by the bifurcate right clasper with narrowly produced apical processes (Fig. 44), and by having

the paler pegs evenly spaced throughout the peg row (Fig. 50). Females are distinguished from other *Cenocorixa* species by the following characteristics: pronotal disk with eight or nine transverse bands that are distinctly narrower than the intervening pale areas, lateral margins of disk broadly angulate (Fig. 38); clavopruina shorter than greatest length of postnodal pruina; and metaxyphus broader than long. Length: males, 6.5 to 7.6 mm; females, 7.0 to 7.8 mm.

Oregon and Washington records (Fig. 127). We have examined specimens of *C. utahensis* from the following localities: OREGON. Hood River Co.: 2 mi. E Hood River; Umatilla Co.: Hermiston. WASHINGTON. Lincoln Co.: Wilson Crk., T25N-R31E-Sec. 16. Okanogan Co.: Alkali Lake, T30N-R28E-Sec. 5; Duley Lake; Leader Lake; Malott; T33N-R25E-Sec. 27 (roadside pond). Stevens Co.: Rocky Lake. This species also is reported from south of Worden, Klamath Co., Oregon (Hungerford 1948a), and from Mesa and Scootenay Reservoir, Franklin Co., Washington (Lauck 1979). Collection dates for the above records range from April to December. In the Pacific Northwest, *C. utahensis* occurs primarily in ponds and small lakes.

Geographic range. Widely distributed in the western United States and Canada; also reported from Iowa, Kansas, North Dakota, South Dakota, Texas, Manitoba, Ontario, and Saskatchewan (Hungerford 1948a, Brooks and Kelton 1967, Jansson 1972a). According to Lauck (1979), the California records of *C. utahensis* given in Hungerford (1948a) are misidentifications of the closely related species, *C. kuiterti* Hungerford. Jansson (1972a) also found that the British Columbia records of this species (Hungerford 1948a, Lansbury 1960, Sparrow 1966) belong to *C. bifida hungerfordi*.

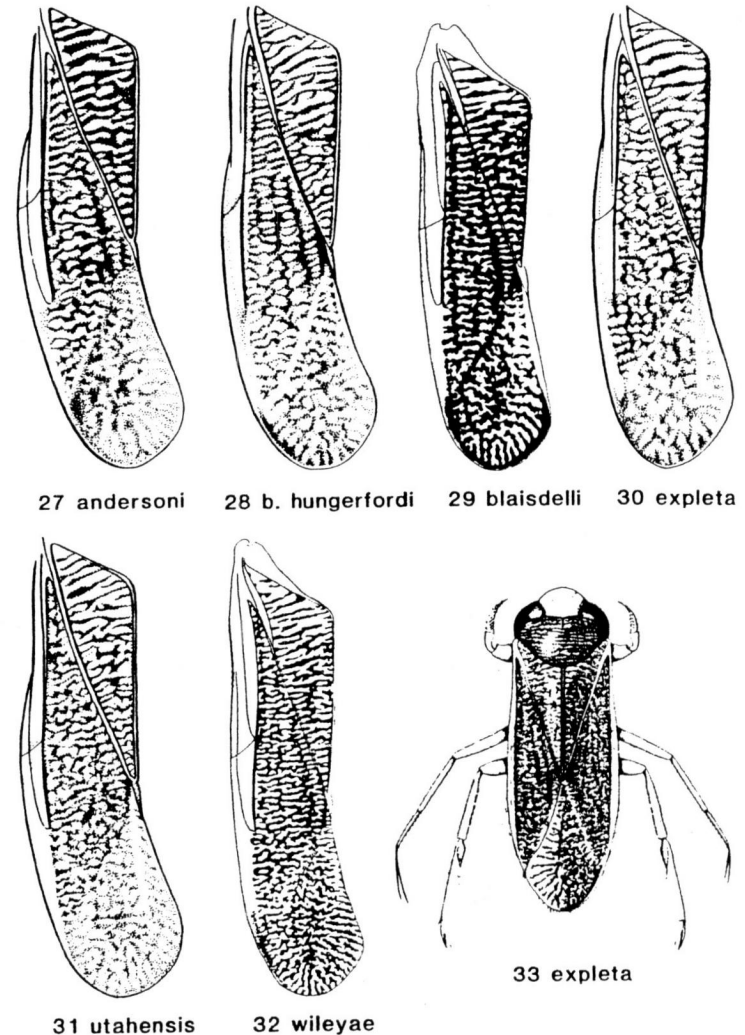
***Cenocorixa wileyae* (Hungerford)**

Figs. 32,39,45,51,128

***Arctocorixa wileyi* Hungerford 1926a:271.** Holotype male: Wasatch Mountains, Utah (University of Kansas).

***Cenocorixa wileyae*, Hungerford 1948a:578** (proper emendation).

The males of *C. wileyae* are distinguished from other Oregon and Washington *Cenocorixa* by the sharply incised peg row of the pala (Fig. 51) and by the small abdominal strigil that is composed of four or five combs. Females of this species are very similar to *C. utahensis* females, but they differ by the greater number (10 to 14) and more dissected nature of the dark pronotal bands (Fig. 39). The lateral margins of the pronotal disk are broadly angulate and the clavopruina is shorter than the greatest length of the postnodal pruina. The metaxyphus is broader than long in both sexes. Length: males, 6.6 to 7.7 mm; females, 6.7 to 8.0 mm.



Figures 27-33. *Cenocorixa* species: 27-32, female hemelytron (Figs. 29&32 from Lauck 1979); 33, dorsal view of adult *C. expleta* (from Scudder 1976).



34 andersoni



35 b. hungerfordi



36 expleta



37 blaisdelli



38 utahensis



39 wileyae



40 andersoni



41 b. hungerfordi



42 blaisdelli



43 expleta

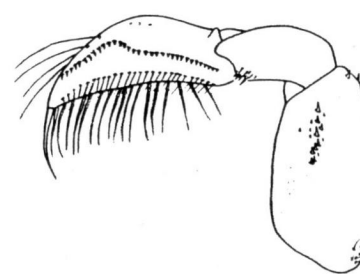


44 utahensis

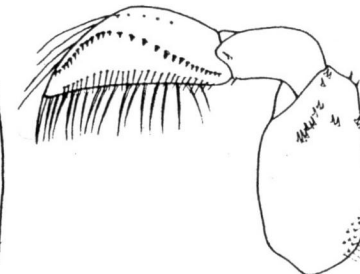


45 wileyae

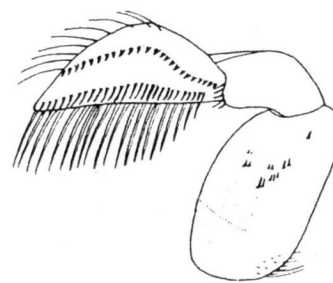
Figures 34-45. *Cenocorixa* species: 34-39, female pronotal disk; 40-45, right clasper of male genitalia (Figs. 37&39 from Lauck 1979).



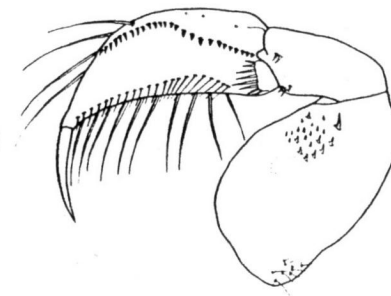
46 andersoni



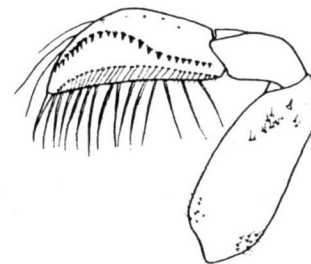
47 b. hungerfordi



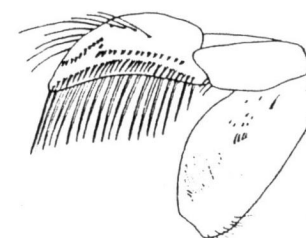
48 blaisdelli



49 expleta



50 utahensis



51 wileyae

Figures 46-51. Male fore leg of *Cenocorixa* species (Figs. 48&51 from Lauck 1979).

Oregon and Washington records (Fig. 128). *Cenocorixa wileyae* has a rather unusual distribution in the Pacific Northwest. It is widely distributed east of the Cascade Range in Oregon, but is known only from a single locality (Potholes Reservoir, Grant Co.) in eastern Washington. This species also occurs in the Puget Sound area of northwestern Washington, but is not known from British Columbia, Canada, or southwestern Washington. Although we have not found *C. wileyae* west of the Cascade Range in Oregon, it is reported from Florence, Lane Co., and Yoncalla, Douglas Co., by Hungerford (1948a). In Oregon and Washington, this species inhabits ponds and small lakes; specimens have been collected from May to December.

Geographic range. Widespread in the western United States, but not reported from Idaho or Montana.

Genus *Corisella* Lundblad

Corisella Lundblad 1928:158. Type species: *Corixa merenaria* Say 1832:39.

The genus *Corisella* is comprised of seven species distributed predominantly in the western United States and Mexico. Only two species, *C. edulis* (Champion) and *C. tarsalis* (Fieber) are reported east of the Rocky Mountains (Hungerford 1948a). Three species of *Corisella* are known from Oregon and Washington. *Corisella edulis*, a species distributed in Mexico and the southern United States, was erroneously reported from Rogue River, Oregon, by Hungerford (1948a). *Corisella* species are distinguished from other corixids of the Pacific Northwest by the smooth to faintly rugulose, shiny hemelytra with numerous fine hairs (Figs. 1G&H) and by the triangular pala of the male with two peg rows (Figs. 58-60). Also, the dark bands on the anterior third of the clavus usually are effaced or distinctly narrowed, especially near the inner basal angle. Males are further differentiated by the fleshy pad or protuberance on the inner apical margin of the fore tibia.

Externally, smaller species of *Corisella* are very similar to members of the genus *Trichocorixa*. *Corisella* males are easily distinguished from males of *Trichocorixa* by having dextral abdominal asymmetry and two rows of paler pegs. Females can be separated by the position of the nodal furrow in relation to the apex of the clavus. In *Corisella* species, the apices of the clavi clearly exceed a line drawn through the nodal furrows, whereas in species of *Trichocorixa* the apices of the clavi do not exceed this line.

Corisella species often are found in saline or alkaline environments. All three Oregon and Washington species have been collected in mildly saline habitats east of the Cascade Range. *Corisella decolor* and *C. inscripta* also have been collected in highly stagnant and septic habitats.

Usinger (1956) reported both of these species from sewage oxidation ponds in Concord, California.

Key to *Corisella* of Oregon and Washington

1. Hind tarsi brown; upper peg row of male pala with 1 or 2 stout pegs (Fig. 60); abdominal strigil small, composed of 3 combs on a long petiole (Fig. 63) *tarsalis* (Fieber)
Hind tarsi yellow; upper peg row of male pala with 7 or more pegs (Figs. 58&59); abdominal strigil large, composed of 5 or 6 combs on a short petiole (Figs. 61&62) 2
2. Pronotal disk with 6 to 8 dark transverse bands (Fig. 65); anterior fourth of disk usually with median, longitudinal carina; upper peg row of male pala with 7 or 8 pegs (Fig. 58) *decolor* (Uhler)
Pronotal disk with 10 to 14 dark bands (Fig. 66); disk without median, longitudinal carina; upper peg row of male pala with 11 to 14 pegs (Fig. 59) *inscripta* (Uhler)

Corisella decolor (Uhler) Figs. 52,55,58,61,64,65,129

Corixa decolor Uhler 1871:106. Holotype male: Clear Lake, California (United States National Museum of Natural History).

Corixa dispersa Uhler 1875:841. Holotype male: Owens Valley, California (United States National Museum of Natural History).

Corisella decolor is distinguished from other Oregon and Washington *Corisella* by the following combination of characters: hind tarsi yellow; pronotal disk with six to eight dark transverse bands (Fig. 65); anterior fourth of pronotal disk usually with median, longitudinal carina; abdominal strigil large, composed of five or six combs on a short petiole (Fig. 61); and upper peg row of male pala with seven or eight widely spaced pegs (Fig. 58). Length: males, 4.5 to 5.5 mm; females, 4.9 to 6.1 mm. Lauck (1979) stated that the postnodal pruina is shorter than the clavopruina in both sexes of *C. decolor* (see Fig. 52). However, we found the postnodal pruina of males to be longer than the clavopruina for all Oregon and Washington specimens examined. For females, we found the length of the postnodal pruina to be approximately equal to that of the clavopruina. Lauck also stated that *C. decolor* could be distinguished from other California species of the genus by the more prominent and broader bands on the pronotum (see Fig. 65). While broad pronotal bands are common in this species, we have found considerable variation in band width of Oregon and Washington specimens and do not consider the width of pronotal bands to be a reliable diagnostic character.

Oregon and Washington records (Fig. 129). *Corisella decolor* is broadly distributed east of the Cascade Range. We have examined specimens from six counties in Oregon and seven counties in Washington. This species also has been taken at two localities in northwestern Washington: Lake Ozette, Clallam Co.; Still Lake, Whidbey Island, Island Co. Collection dates range from March to October. *Corisella decolor* inhabits ponds and small lakes and is often found in saline or alkaline habitats. Usinger (1956) reported this species from sewage oxidation ponds in Concord, California. *Corisella decolor* is attracted to light sources at night, especially in arid areas around dusk.

Geographic range. British Columbia and all western states except Arizona and New Mexico.

***Corisella inscripta* (Uhler)**

Figs. 53,56,59,62,66,130

***Corixa inscripta* Uhler 1894:294.** Described from specimens collected near Cabo San Lucas, Baja California, and labeled "Cal. 2" apparently by Uhler (Holotype not designated).

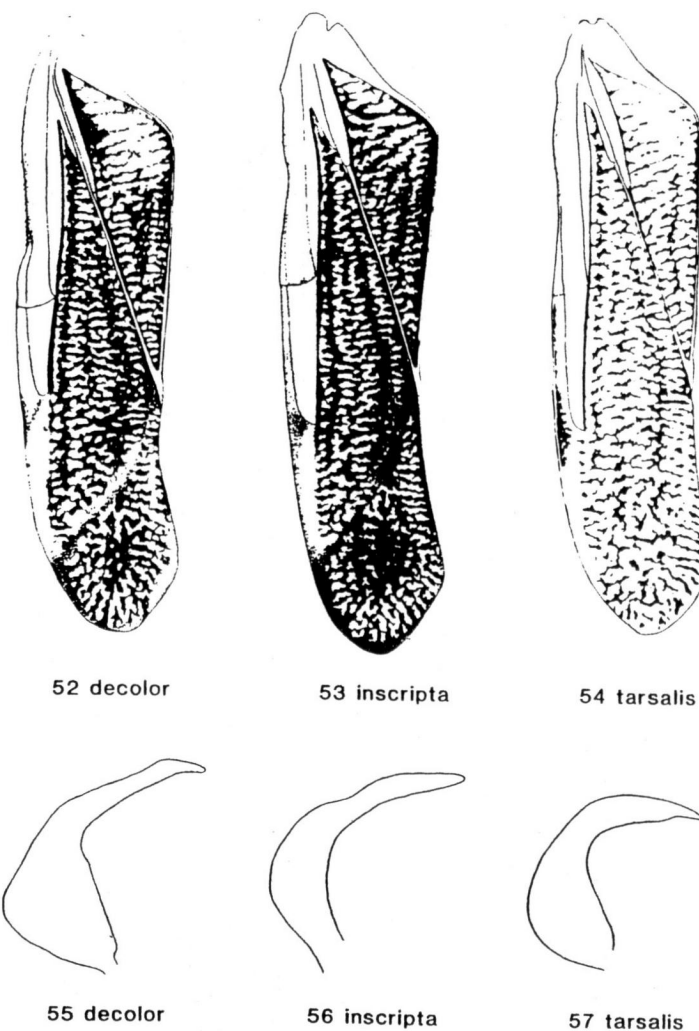
***Corisella inscripta*, Hungerford 1948a:279.** Lectotype designation: Two specimens with label data "Cal. 2" (United States National Museum of Natural History).

***Corisella inscripta*, Lauck 1979:104.** Note concerning invalid lectotype designation by Hungerford.

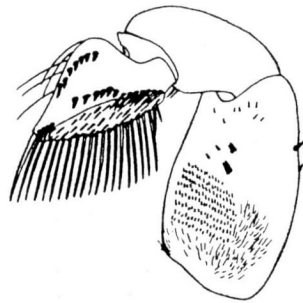
The large size of *C. inscripta* (males, 6.1 to 7.8 mm; females, 6.2 to 8.7 mm) and the number of dark bands on the pronotal disk (10 to 14) distinguishes this species from *C. decolor* and *C. tarsalis*. The pronotal disk lacks a median, longitudinal carina, and the postnodal pruina is distinctly longer than the clavopruina in both sexes (Fig. 53). The male abdominal strigil is large, composed of five regular combs on a short petiole (Fig. 62). The male pala has 11 to 14 pegs in the upper peg row (Fig. 59) compared to one or two for *C. tarsalis* and seven or eight for *C. decolor*.

Oregon and Washington records (Fig. 130). Widely distributed in the two-state region; known from 13 counties in Oregon and 11 counties in Washington. Collection dates are from March to October. *Corisella inscripta* is a common pond species found at low to moderate elevations in the Pacific Northwest. It often occurs in saline, septic, or stagnant water and is commonly taken at lights.

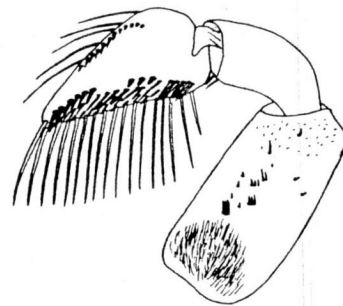
Geographic range. Arizona, California, Idaho, Oregon, Utah, Washington, British Columbia, Baja California.



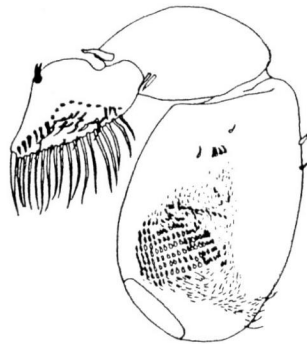
Figures 52-57 (from Lauck 1979). *Corisella* species: 52-54, female hemelytron; 55-57, right clasper of male genitalia.



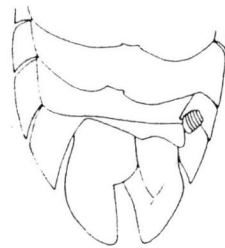
58 decolor



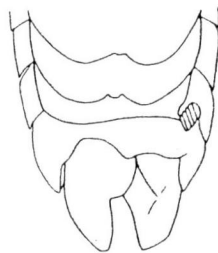
59 inscripta



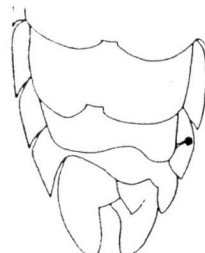
60 tarsalis



61 decolor



62 inscripta

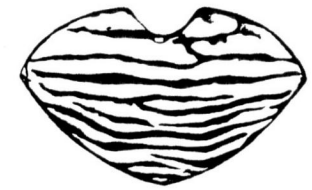


63 tarsalis

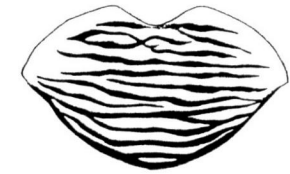
Figures 58-63 (from Lauck 1979). *Corisella* species: 58-60, male fore leg; 61-63, dorsal view of male abdomen.



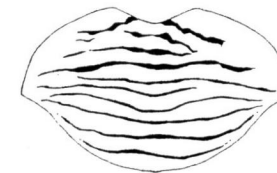
64 decolor



65 decolor



66 inscripta



67 tarsalis

Figures 64-67. *Corisella* species: 64, dorsal view of adult male of *C. decolor* (from Usinger 1956); 65-67, female pronotal disk (from Lauck 1979).

Corisella tarsalis (Fieber)
Figs. 54, 57, 60, 63, 67, 129

Corisa tarsalis Fieber 1851:231. Holotype female: Pennsylvania (Halle Museum, Germany).

Corixa tumida Uhler 1877:454. Syntype male: Sloan Lake, near Denver, Colorado (United States National Museum of Natural History).

Corisella texcocana Jaczewski 1931:202. Syntypes: 15 males and 50 females, Texcoco, Mexico (2 males and 2 females, University of Kansas).

Corisella tarsalis is easily distinguished from *C. decolor* and *C. inscripta* by the brown hind tarsi and by the fine, widely spaced reticula-

tions on the hemelytra (Fig. 54). The pronotal disk is crossed by 7 to 10 narrow, transverse bands (Fig. 67); anterior third of disk sometimes with indistinct median carina. The postnodal pruina and clavopruina are about equal in length for females, but the postnodal pruina of males is distinctly longer than the clavopruina. The male abdominal strigil is very small and composed of three combs on a long petiole (Fig. 63). The upper peg row of the male pala has only one or two stout pegs (Fig. 60). Length: males, 5.2 to 6.0 mm; females, 5.8 to 6.6 mm.

Oregon and Washington records (Fig. 129). Not previously reported from the Pacific Northwest but now known from two localities in eastern Washington: **Grant Co.**, Moses Lake, VI-14-1932, and **Okanogan Co.**, roadside pond at T36N-R26E-Sec. 25, IX-2-1977.

Geographic range. Arizona, California, Colorado, Montana, New Mexico, New York, Oklahoma, Pennsylvania, South Dakota, Texas, Utah, Washington, Alberta, Manitoba, Saskatchewan, Mexico.

Genus *Hesperocorixa* Kirkaldy

Hesperocorixa Kirkaldy 1908:118. Type species: *Arctocorixa brimleyi* Kirkaldy 1908:120.

Anticorixa Jaczewski 1924:76 (described as a subgenus of *Callicorixa* with *C. sahlbergi* Fieber as the subgeneric type; synonymized with *Hesperocorixa* by Hungerford (1948a)).

Hesperocorixa is a Holarctic genus comprised of 34 species (see 1979 revision and phylogenetic study by Dunn). Eighteen species are known from the Nearctic, four of which occur in Oregon and Washington. With the exception of *H. michiganensis*, these are large (8.4 to 11.6 mm), broad corixids that most closely resemble members of the genus *Graptocorixa*. They are distinguished from *Graptocorixa* species by the broader pala with setiform apical claw in both sexes (compare Figs. 9 and 77). Other distinguishing characteristics of *Hesperocorixa* species include the quadrate or trapezoidal prothoracic lobe (usually broader than long), the short and broadly rounded clavopruina that is from one-half to two-thirds as long as the postnodal pruina, and the distinct carina at the base of the male pala (Figs. 77-80). The pronotal disk and hemelytra are faintly to strongly rastrate in *Hesperocorixa* species, except the disk is often predominantly smooth and shiny in *H. laevigata*.

The Oregon and Washington species of *Hesperocorixa* occur primarily in ponds and lakes at low to moderate elevations and are most common in habitats with dense populations of submergent aquatic vegetation. *Hesperocorixa atopodonta* and *H. michiganensis* also inhabit calm waters of streams and rivers.

Key to *Hesperocorixa* of Oregon and Washington

1. Body length 6.5 to 7.7 mm; scent gland ostiole located closer to lateral bend of mesepimeron than apex *michiganensis* (Hungerford)
Body length 8.0 mm or more; scent gland ostiole located closer to apex of mesepimeron than lateral bend 2
2. Hemelytral pattern reticulate (Fig. 70); pronotal disk smooth or slightly rugose *laevigata* (Uhler)
Hemelytral pattern predominantly of transverse bands (Figs. 69&72); pronotal disk strongly rastrate 3
3. Interocular space equal to or less than dorsal width of eye; male pala gradually rounded apically, distal peg of peg row well removed from remaining pegs (Fig. 77) *atopodonta* (Hungerford)
Interocular space greater than dorsal width of eye; male pala truncate or weakly concave apically, distal peg of peg row congruent with remaining pegs (Fig. 80) *vulgaris* (Hungerford)

Hesperocorixa atopodonta (Hungerford)

Figs. 69,73,77,131

Arctocorixa dubia Abbott 1916:342. Holotype male: Peru, Massachusetts (University of Kansas).

Arctocorixa atopodonta Hungerford 1927:35. New name for *A. dubia* Abbott.

This species is distinguished from other *Hesperocorixa* in Oregon and Washington by the following characteristics: length 8.4 to 9.7 mm; hemelytral pattern predominantly of transverse bands (Fig. 69); and interocular space equal to or less than dorsal width of the eye. Males are further distinguished by having the distal peg of the paler peg row widely separated from the remaining pegs (Fig. 77). Right clasper of male as in Figure 73. Length: males, 8.4 to 9.2 mm; females, 8.5 to 9.7 mm.

Oregon and Washington records (Fig. 131). *Hesperocorixa atopodonta* is distributed west of the Cascade Range from **Whatcom Co.**, Washington, to **Benton Co.**, Oregon. We also have seen specimens from two localities in eastern Washington; these are Turnbull National Wildlife Refuge, **Spokane Co.**, and Norma Berona Pond, 2 mi. E Beverly, **Grant Co.** Collection dates range from February to September. This species usually is found in ponds and lakes but occasionally occurs in calm waters of streams and rivers.

Geographic range. Transcontinental in southern Canada and the northern United States; south to Pingree Park, Colorado, in the Rocky Mountains. Also reported from Newfoundland and Northwest Territories by Lansbury (1955).

Hesperocorixa laevigata (Uhler)

Figs. 70,74,78,132

Corixa laevigata Uhler 1893:384. Described from specimens collected in California, Nevada, and Washington (Holotype not designated).

Hesperocorixa laevigata, Hungerford 1948a:521. Lectotype male designated with label data: "San Diego, Cal., 10-19-1890, *Corixa laevigata* Uhler" (United States National Museum of Natural History).

Hesperocorixa laevigata is easily distinguished from other Oregon and Washington species of the genus by the reticulate hemelytral pattern (Fig. 70) and smooth to faintly rugose pronotum. Pala and right clasper of male as in Figures 78 and 74, respectively. Length: males, 9.4 to 10.6 mm; females, 9.9 to 11.6 mm.

Oregon and Washington records (Fig. 132). This species is broadly distributed on both sides of the Cascade Range. We have seen specimens from 12 counties in Oregon and 25 counties in Washington. Collection dates range through every month of the year. *Hesperocorixa laevigata* is perhaps the most common pond-inhabiting corixid in the Pacific Northwest.

Geographical range. Transcontinental in Canada and the United States, but absent or uncommon in southeastern states; also reported from Real del Monte, Hidalgo, Mexico, by Hungerford (1948a).

Hesperocorixa michiganensis (Hungerford)

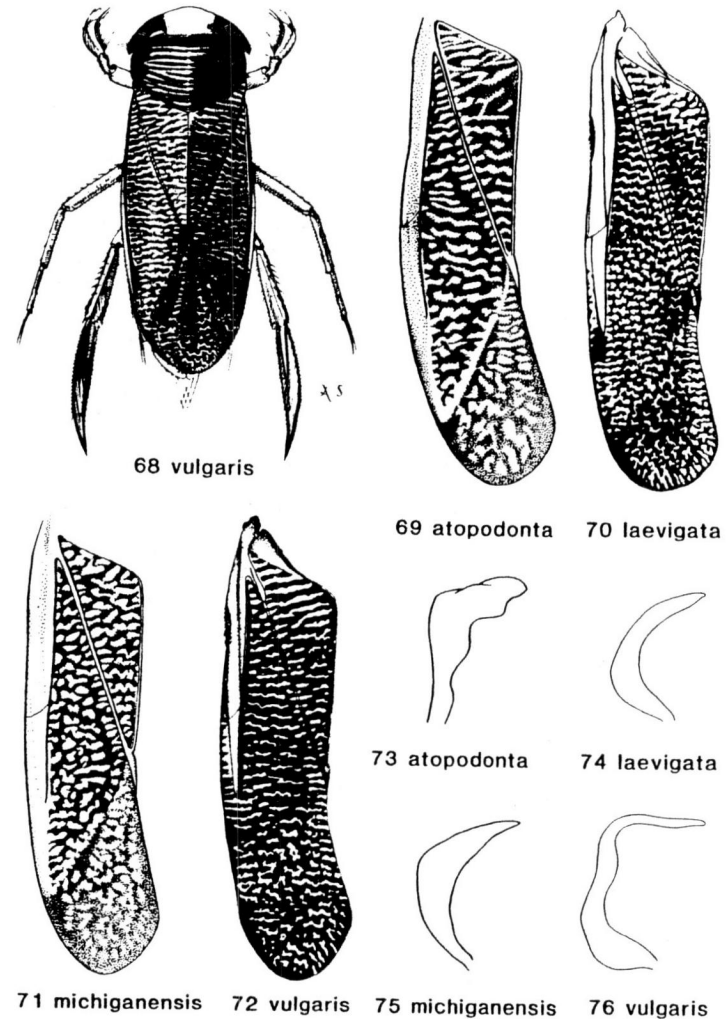
Figs. 71,75,79,133

Arctocorixa michiganensis Hungerford 1926b:197. Holotype male: Douglas Lake, Michigan (University of Kansas).

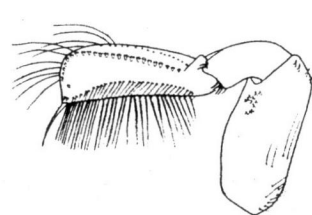
This species readily is recognized by its small size (males, 6.6 to 7.5 mm; females, 7.0 to 7.7 mm) and by the broad mesepimeron with the scent gland ostiole located nearer the lateral bend than the tip. The dark markings on the hemelytra are wavy but more or less transverse (Fig. 71). Pala and right clasper of male as in Figures 79 and 75, respectively.

Oregon and Washington records (Fig. 133). *Hesperocorixa michiganensis* has been collected at the following localities in Washington: Lewis Co.: Chehalis R. at Alexander Park; pond at T14N-R2W-Sec. 30. Pend Oreille Co.: 2.7 mi. N Cusick on St. Hwy. 20 (irrigation canal). Thurston Co.: Beaver Crk., T16N-R2W-Sec. 5. Whatcom Co.: pond at T38N-R2E-Sec. 15. Collection dates are from April to September.

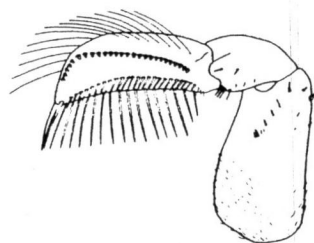
Geographical range. Transcontinental in southern Canada and the northern United States.



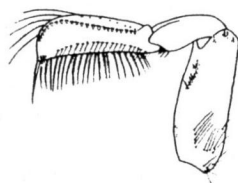
Figures 68-76. *Hesperocorixa* species: 68, dorsal view of adult *H. vulgaris* (from Usinger 1956); 69-72, female hemelytron; 73-76, right clasper of male genitalia (Figs. 70,72,74,&76 from Lauck 1979).



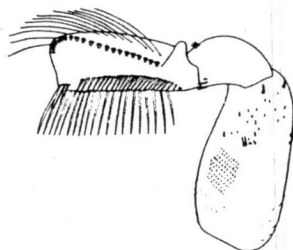
77 atopodonta



78 laevigata



79 michiganensis



80 vulgaris

Figures 77-80. Male fore leg of *Hesperocorixa* species (Figs. 78&80 from Lauck 1979).

Hesperocorixa vulgaris (Hungerford)
Figs. 68,72,76,80,134

Arctocorixa vulgaris Hungerford 1925b:143. Holotype male: Douglas County, Kansas (University of Kansas).

This species closely resembles *H. atopodonta* but is distinguished by the broad interocular space that is greater than the dorsal width of the eye, and by the apically truncate to weakly concave male pala (Fig. 80). Body size and the location of the scent gland ostiole near the tip of the mesepimeron will distinguish *H. vulgaris* from *H. michiganensis*, while the transversely banded hemelytral pattern (Fig. 72) and strongly rastrate pronotal disk differentiate this species from *H. laevigata*. Length: males, 9.4 to 10.0 mm; females, 9.6 to 11.0 mm.

Oregon and Washington records (Fig. 134). *Hesperocorixa vulgaris* occurs on both sides of the Cascade Range in the Pacific Northwest. We

have examined specimens from 7 counties in Oregon and 14 counties in Washington. Collection dates are from January to September. This species has been collected from a variety of aquatic habitats including ditches, swampy areas, ponds, lakes, streams, and rivers.

Geographic range. Widely distributed in the midwestern and eastern United States and across southern Canada and the northern states to Washington, Oregon, and northeastern California.

Genus *Sigara* Fabricius

Sigara Fabricius 1775:691. Type species: *Notonecta striata* Linnaeus 1758:439.

Sigara is a cosmopolitan genus comprised of many variable species that are distributed among 19 different subgenera (see Lauck 1979 for complete listing of proposed subgenera). All Oregon and Washington species belong to the subgenus *Vermicorixa* Walton except *Sigara decoratella*, which is placed in the subgenus *Arctosigara* Hungerford. Eight species are known from Oregon and Washington, and five additional species are found in areas adjacent to the two-state region. These bordering species are: *S. bicoloripennis* (Walley), *S. mullettensis* (Hungerford), *S. penniensis* (Hungerford), and *S. solensis* (Hungerford), all reported from southern British Columbia, Canada (Hungerford 1948a, Lansbury 1960, Sparrow 1966), and *S. nevadensis* (Walley), known from the Humboldt River in north-central Nevada (Hungerford 1948a). Hungerford (1948a) reported *S. ornata* (Abbott) from an unspecified locality in Oregon, but we have not found this species in Oregon or Washington and question its occurrence in the Pacific Northwest.

The Oregon and Washington species of *Sigara* are easily recognized by the coarsely rastrate clavus (Figs. 1K&L) and corium and by the strongly contrasting transverse bands on the hemelytra (exception: corial pattern of *S. omani* imperfectly reticulate). Members of the genus *Callicorixa* also have transversely banded, rastrate hemelytra, but the dark pattern is weakly contrasting compared to that of *Sigara* species. Except for *S. decoratella* (length, 7.3 to 8.6 mm), species of *Sigara* are usually smaller (length, 4.5 to 6.9 mm) than *Callicorixa* species (length, 6.5 to 8.3 mm). *Callicorixa* males are further differentiated by having a distinct break in the peg row of the pala and by the absence of an abdominal strigil.

Key to *Sigara* of Oregon and Washington

1. Body length 7.3 to 8.6 mm; male pala elongate, approximately four times as long as greatest width *decoratella* (Hungerford)
Body length 4.5 to 6.9 mm; male pala broad, length never exceeding three times the greatest width 2
2. Metathoracic scent gland ostiole located near lateral bend of mesepimeron (Fig. 108) *grossolineata* Hungerford
Metathoracic scent gland ostiole located approximately midway between lateral bend and apex of mesepimeral process, or distal to midway point 3
3. Ostiole located closer to apex of mesepimeral process than to midway point (Figs. 111&112) 4
Ostiole located closer to midway point of mesepimeral process than to apex (Figs. 106,109,110,&113) 5
4. Corium with distinct transverse bands (Fig. 87); anterolateral margin of clavus explanate, projecting laterally over clavopruina; lateral margins of pronotal disk sharply angulate *vandykei* Hungerford
Corium with imperfect, reticulate patterning (Fig. 86); anterolateral margin of clavus angulate, not projecting over clavopruina; lateral margins of pronotal disk rounded *omani* (Hungerford)
5. Mesepimeral process parallel-sided or slightly divergent from ostiole to lateral band (Figs. 106&110) 6
Mesepimeral process broadest just anterad of ostiole, then narrowing slightly to lateral bend (Figs. 109&113) 7
6. Clavus with 13 to 16 dark, transverse bands; corial bands broad, entire or nearly so (Fig. 85); embolium of hemelytron with dark region bordering apex of postnodal pruina *mckinstriyi* Hungerford
Clavus with 17 to 20 dark bands; corial bands narrow, moderately to highly dissected (Fig. 81); embolium without dark region beyond apex of postnodal pruina *alternata* (Say)
7. Anterior one-third to one-half of metaepisternum fuscous; posteromedial projection of seventh abdominal tergum of male triangular (Fig. 92) *krafti* Stonedahl
Metaepisternum entirely pale, or fuscous only along extreme anterior margin; projection of seventh abdominal tergum of male nearly trapezoidal (Fig. 96) *washingtonensis* Hungerford

Sigara (Vermicorixa) alternata (Say)

Figs. 81,89,98,106,135

Corixa alternata Say 1825:329. Described from Missouri (original type lost).

Corisa erichsonii Fieber 1851:247. "Habitat in America boreali (Roser), Pennsylvania (Mus. Berol. et Coll. German)" (types missing and assumed lost).

Arctocorixa parshleyi Abbott 1916:342. Holotype male: Providence, Rhode Island (University of Kansas).

Sigara alternata, Hungerford 1948a:653. Neotype male designated: St. Louis, Missouri (University of Kansas).

Sigara alternata is distinguished from other Pacific Northwest *Sigara* by the parallel-sided mesepimeral process with the ostiole located closer to the midpoint than the tip (Fig. 106), and by the hemelytral pattern (Fig. 81). The bands on the corium usually are more highly dissected and irregular than in other *Sigara* species, except *S. omani*, and the embolium lacks a dark region behind the postnodal pruina. The male right clasper (Fig. 98) is similar to that of *S. decoratella*, but with the apex acute and more strongly produced. Abdominal terga of male as in Figure 89. Length: males, 5.7 to 6.3 mm; females, 5.9 to 6.9 mm.

Oregon and Washington records (Fig. 135). This species is widely distributed east of the Cascade Range but also is known from western localities in **Whatcom** Co., Washington, and **Benton** Co., Oregon. We have examined specimens from 4 counties in Oregon and 10 counties in Washington. Collection dates range from April to September. *Sigara alternata* is most common in ponds and small lakes but also occurs in ditches, streams, and small rivers in the Pacific Northwest. This species has been taken in black-light traps in eastern Oregon.

Geographic range. Widespread in North America except uncommon in the southwestern United States and not reported from the following southeastern states: Alabama, Florida, Georgia, Kentucky, Louisiana, Mississippi, South Carolina, Tennessee. Hungerford (1948a) reported *S. alternata* from two localities in California. These records were not discussed by Lauck (1979).

***Sigara (Arctosigara) decoratella* (Hungerford)**

Figs. 82,90,99,107,136

***Arctocorixa decoratella* Hungerford 1926b:195.** Holotype male: Mackinac Island, Michigan (University of Kansas).

This species is easily distinguished from other Oregon and Washington *Sigara* by its large size (males, 7.3 to 8.4 mm; females, 7.6 to 8.6 mm) and by the elongate pala of the male, nearly four times as long as broad. The male right clasper is very similar to that of *S. alternata*, except for the blunt apex (Fig. 99).

Oregon and Washington records (Fig. 136). Not previously recorded from the northwestern United States but now known from Bonaparte Lk., Okanogan Co., Washington, IX-4-1977. *Sigara decoratella* has been reported from Alberta and British Columbia, Canada (Walley 1936, Hungerford 1948a, Lansbury 1960, Sparrow 1966) but is not a common species in western Canada and probably has a limited distribution in the northwestern United States.

Geographic range. Transcontinental in Canada and across the northern United States from Maine to North Dakota and South Dakota. Also reported from Tajique, New Mexico, by Hungerford (1948a), but it is unlikely that *S. decoratella* occurs that far south of its normal distribution.

***Sigara (Vermicorixa) grossolineata* Hungerford**

Figs. 83, 91, 100, 108, 136

***Sigara grossolineata* Hungerford 1948a:676.** Holotype male: Carlson, Minnesota (University of Kansas).

The location of the metathoracic scent gland ostiole near the lateral bend of the mesepimeron (Fig. 108) will separate *S. grossolineata* from other *Sigara* species in Oregon and Washington. The hemelytral pattern (Fig. 83) is similar to that of *S. alternata* and *S. washingtonensis*, with the transverse bands being somewhat irregular. Right clasper and abdominal terga of the male as in Figures 100 and 91, respectively. Length: males, 5.0 to 5.6 mm; females, 5.2 to 5.8 mm.

Oregon and Washington records (Fig. 136). Not previously reported from the northwestern United States but now known from two localities in eastern Oregon: Baker Co., 3 mi. NE Baker, VIII-6-1963; Harney Co., Burns, VII-20-1963. All specimens examined were taken in black-light traps.

Geographic range. Widespread in North America but not found in the southeastern United States and uncommon in southwestern states.

***Sigara (Vermicorixa) krafti* Stonedahl**

Figs. 84,92,101,109,137

***Sigara krafti* Stonedahl 1984:42.** Holotype male: Marys R., 1 mi. W Jct. St. Hwy. 34 on US 20, Benton Co., Oregon.

Sigara krafti is recognized by the following combination of characters: metathoracic scent gland ostiole located closer to middle of mesepimeron than tip; mesepimeral process broadest just anterad of ostiole, then narrowing slightly to lateral bend (Fig. 109); anterior one-third to one-half of metaepisternum fuscous; anterior one-third of male right clasper swollen, apical projection distinct (Fig. 101); abdominal strigil of male small, composed of four or five combs; and posteromedial projection of seventh abdominal tergum of male triangular (Fig. 92). Hemelytral pattern as in Figure 84. Length: males, 5.3 to 5.8 mm; females, 5.4 to 6.1 mm.

Oregon and Washington records (Fig. 137). This species is distributed west of the Cascade Range primarily in small, coastal rivers. It is most abundant in shallow, static, or slow-moving water over silty or muddy substrates. Specimens have been collected from five counties in Oregon and three counties in Washington. Collection dates are from March to September. *Sigara krafti* is often found in association with *S. washingtonensis*.

Geographic range. Western Oregon and Washington.

***Sigara (Vermicorixa) mckinstryi* Hungerford**

Figs. 85,93,97,102,110,138

***Sigara mckinstryi* Hungerford 1948a:681.** Holotype male: Contra Costa Co., California (University of Kansas).

Sigara mckinstryi is a rather small species (males, 4.6 to 5.6 mm; females, 4.8 to 5.7 mm) with broad transverse bands on the hemelytra (Figs. 85&97). The mesepimeron is parallel-sided or slightly divergent from the ostiole to lateral bend, and the ostiole is located closer to the middle of the mesepimeron than the tip (Fig. 110). The right clasper of the male has a distinct notch on the inner subapical margin, and the apical projection is small (Fig. 102). Abdominal terga of male as in Figure 93.

Oregon and Washington records (Fig. 138). This species is known from two localities in southwestern Oregon: Douglas Co., N Umpqua R. at I-5 Bridge, X-16-1983; Jackson Co., Rogue R., Tou Velle St. Pk., 8 mi. N Medford, V-21-1960. According to Lauck (1979), *S. mckinstryi* is the most common *Sigara* in California and is widely distributed in the northern counties. This species is largely replaced in Oregon and Washington

by *S. washingtonensis* and probably does not occur outside of southwestern Oregon. In California, *S. mckinstrii* inhabits ponds and the margins of streams and rivers (Lauck 1979).

Geographic range. California and southwestern Oregon.

***Sigara (Vermicorixa) omani* (Hungerford)**

Figs. 86,94,103,111,139

***Arctocorixa omani* Hungerford 1930:25.** Holotype male: Carson City, Nevada (University of Kansas).

This species is recognized by the imperfect (and sometimes effaced) reticulate pattern on the hemelytra (Fig. 86), and by the location of the ostiole near the tip of the mesepimeron (Fig. 111). The shaft of the male right clasper is long and slender (Fig. 103), and the abdominal strigil of the male is quite large (Fig. 94). *Sigara omani* also has fewer palmar pegs (20 to 24) than other Oregon and Washington species of *Sigara*. Length: males, 5.1 to 6.3 mm; females, 5.4 to 6.4 mm.

Oregon and Washington records (Fig. 139). Widely distributed; known from 17 counties in Oregon and 18 counties in Washington. Specimens have been collected year-round in the Pacific Northwest. This species is primarily an inhabitant of ponds and small lakes but sometimes occurs in calm shoreline waters of streams and rivers.

Geographic range. California, Idaho, Nevada, Oregon, Washington, Wyoming, British Columbia.

***Sigara (Vermicorixa) vandykei* Hungerford**

Figs. 87,95,104,112,140

***Sigara vandykei* Hungerford 1948a:685.** Holotype male: Mouth of Van Duzen R., (California Academy of Sciences).

Sigara vandykei is distinguished from other Oregon and Washington species of *Sigara* by the broad, transverse bands on the hemelytra (Fig. 87); explanate anterolateral margin of the clavus that projects laterally over the clavopruina; and by the location of the ostiole near the tip of the mesepimeron (Fig. 112). Females are further distinguished by the protuberance on the lateral margin of the hemelytron near the apex of the corium (Fig. 87). Right clasper and abdominal terga of male as in Figures 104 and 95, respectively. Length: males, 4.7 to 5.6 mm; females, 4.8 to 5.9 mm.

Oregon and Washington records (Fig. 140). Distributed west of the Cascade Range primarily in coastal rivers and streams; known from six counties in Oregon and four counties in Washington. Collection dates

range from January to October. This species occurs in habitats similar to those occupied by *S. krafti* and *S. washingtonensis*.

Geographic range. Western Oregon and Washington, northwestern California.

***Sigara (Vermicorixa) washingtonensis* Hungerford**

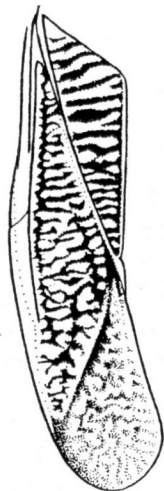
Figs. 88,96,105,113,141

***Sigara washingtonensis* Hungerford 1948a:673.** Holotype male: Republic, Washington (University of Kansas).

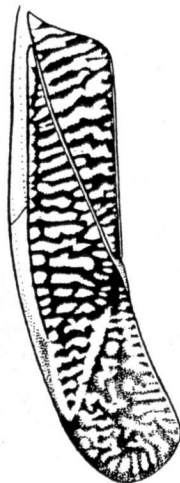
This species closely resembles *S. krafti*, but differs by the narrower shaft of the right clasper of the male (Fig. 105), larger abdominal strigil, nearly trapezoidal posteromedial projection of the seventh abdominal tergum of the male (Fig. 96), and by having the metaepisternum entirely pale or darkened only along the extreme anterior margin. Also, the transverse bands on the hemelytra are usually more irregular in *S. washingtonensis* (compare Figs. 84&88). Length: males, 4.5 to 5.2 mm; females, 4.6 to 6.2 mm.

Oregon and Washington records (Fig. 141). This species is the most common *Sigara* in Oregon and Washington. It is widely distributed on both sides of the Cascade Range and inhabits a variety of aquatic habitats ranging from ditches, small streams, and ponds to large rivers and lakes. We have examined specimens from 12 counties in Oregon and 24 counties in Washington. Collection dates are from January to October.

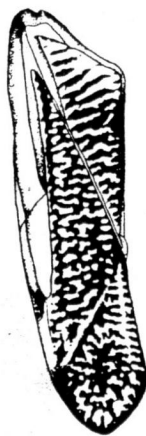
Geographic range. Western United States and Canada (also Saskatchewan and Manitoba).



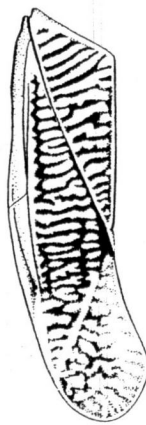
81 alternata



82 decoratella



83 grossolineata



84 krafti



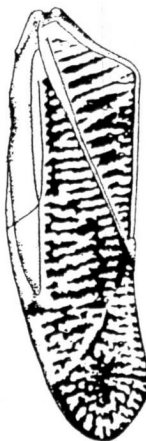
85 mckinstryi



86 omani

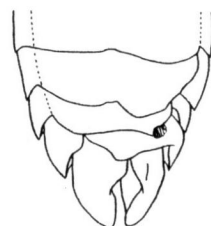


87 vandykei

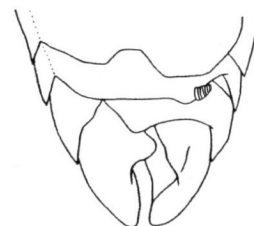


88 wash.

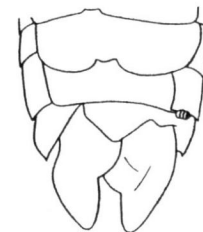
Figures 81-88. Female hemelytron of *Sigara* species (Figs. 83, & 85-88 from Lauck 1979).



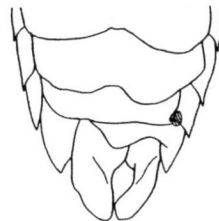
89 alternata



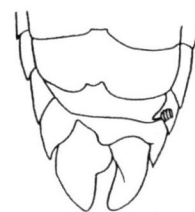
90 decoratella



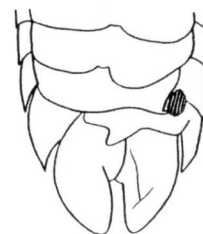
91 grossolineata



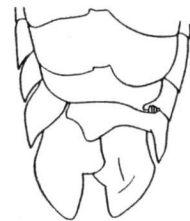
92 krafti



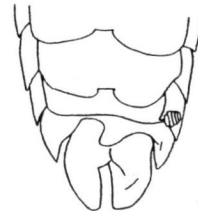
93 mckinstryi



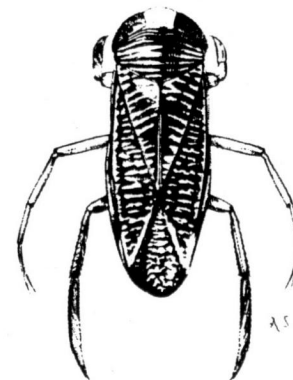
94 omani



95 vandykei

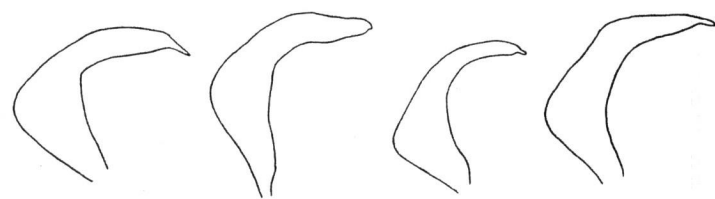


96 washingtonensis

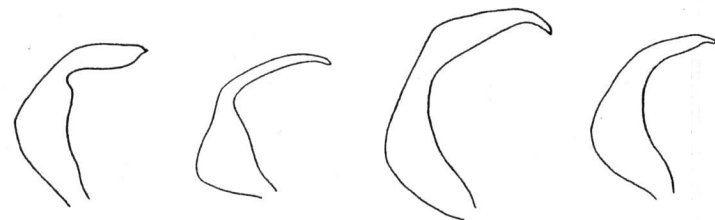


97 mckinstryi

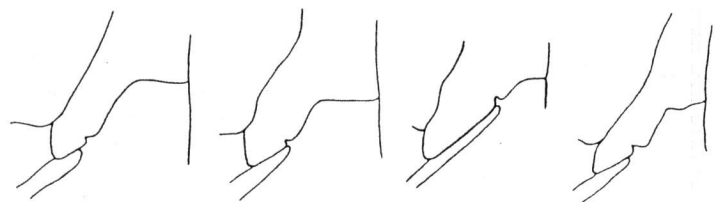
Figures 89-97. *Sigara* species: 89-96, dorsal view of male abdomen (Figs. 91, & 93-96 from Lauck 1979); 97, dorsal view of adult male of *S. mckinstryi* (from Usinger 1956).



98 alternata 99 decoratella 100 grossolineata 101 krafti



102 mckinstriyi 103 omani 104 vandykei 105 wash.



106 alternata 107 decoratella 108 grossolineata 109 krafti



110 mckinstriyi 111 omani 112 vandykei 113 wash.

Figures 98-113. *Sigara* species: 98-105, right clasper of male genitalia; 106-113, mesepimeral process of female (Figs. 100, 103, 108, & 111 from Lauck 1979).

Genus *Trichocorixa* Kirkaldy

Trichocorixa Kirkaldy 1908:117. Type species: *Corisa pygmaea* Fieber 1851:236 = *Corisa verticalis* Fieber 1851:236.

Members of this genus are distributed throughout the Western Hemisphere from Manitoba, Canada, south to Argentina, and from Bermuda to the Hawaiian Islands in the west. Sailer (1948) provided a monographic revision of the genus in which he established new synonymies and described a number of new species and subspecies. In Oregon and Washington the genus is represented by a single subspecies of *T. verticalis* (Fieber).

Trichocorixa verticalis californica Sailer

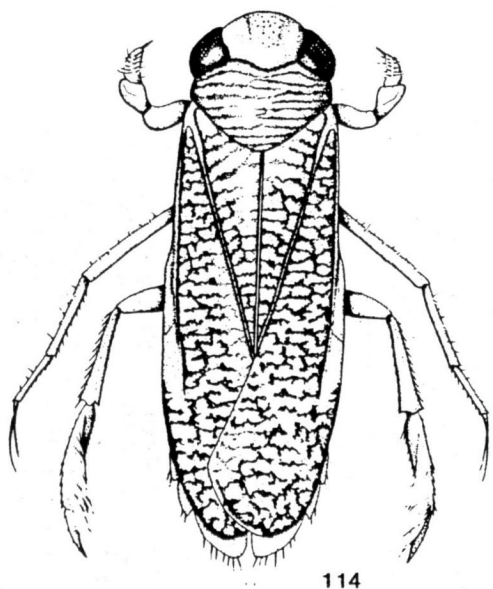
Figs. 114-118, 142

Trichocorixa verticalis californica Sailer 1948:352. Holotype male: Eureka, California (University of Kansas).

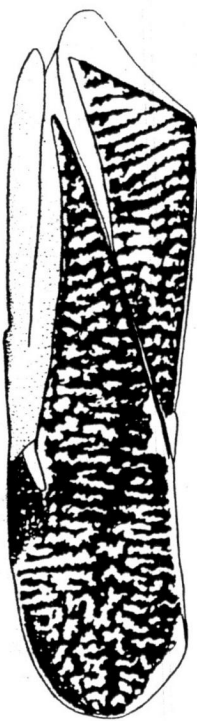
Trichocorixa verticalis californica is distinguished from other corixids of Oregon and Washington by its small size (length: males, 4.1 to 5.0 mm; females, 4.6 to 5.2 mm); smooth, shiny pronotum and hemelytra (Figs. 1M&N); and by the broad, triangular pala of the male (Fig. 116). It is the only corixid of our region in which the males have sinistral abdominal asymmetry (Fig. 117). Females of *T. verticalis californica* are sometimes confused with smaller members of the genus *Corisella* (*C. decolor* and *C. tarsalis* in our region), but differ in having longer and fewer hairs on the hemelytra and apices of the clavi that do not exceed a line drawn through the nodal furrows. In *Corisella* species the apices of the clavi exceed the nodal furrows.

Oregon and Washington records (Fig. 142). *Trichocorixa verticalis californica* has been collected at the following coastal localities in Oregon and Washington: **Clatsop Co.:** Astoria; **Lane Co.:** Florence. **Island Co.:** Crockett Lk., T31N-R1E-Sec. 22; **Pacific Co.:** Bay Center; **San Juan Co.:** Lopez Is.; San Juan Is.; Egg Lk., T35N-R3W-Sec. 17; Cattle Point. **Skagit Co.:** Mouth Samish R., T35N-R3E-Sec. 5. **Thurston Co.:** McAllister Crk., T18N-R1E-Sec. 7. **Whatcom Co.:** Lk. Fazon; ponds at T38N-R1E-Sec. 10 and T38N-R2E-Sec. 35. Collection dates for the above records range from February to November. This species appears to prefer saline or brackish waters but is occasionally taken in freshwater habitats near the coast.

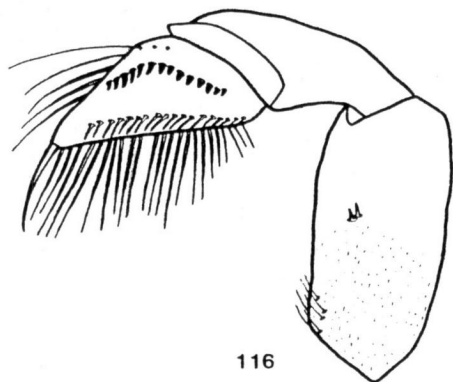
Geographic range. Coastal areas from Orange County, California, to Whatcom County, Washington, and southern Vancouver Island, British Columbia.



114

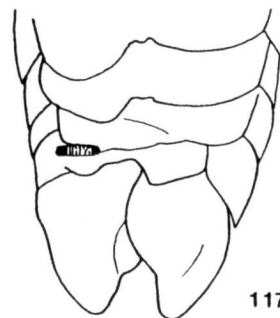


115

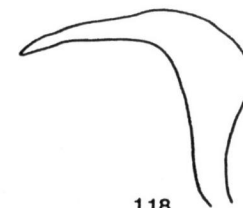


116

Figures 114-116. *Trichocorixa verticalis*: 114, dorsal view of adult (from Scudder 1976); 115, female hemelytron (from Lauck 1979); 116, male fore leg.



117



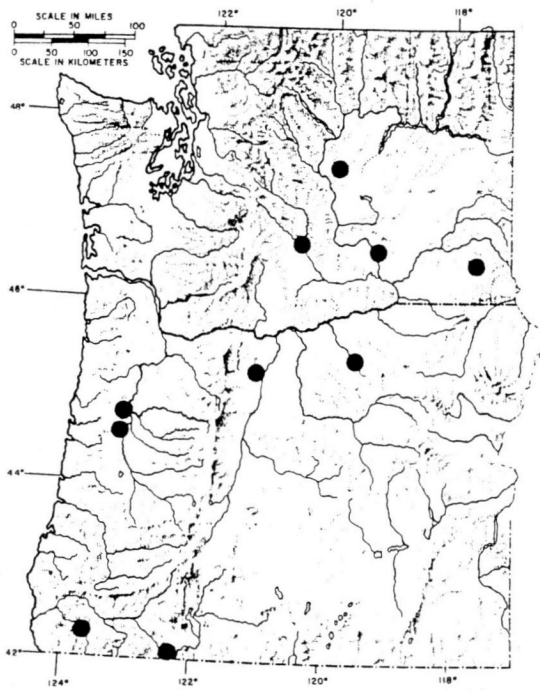
118

Figures 117-118 (from Lauck 1979). *Trichocorixa verticalis*: 117, dorsal view of male abdomen; 118, right clasper of male genitalia.

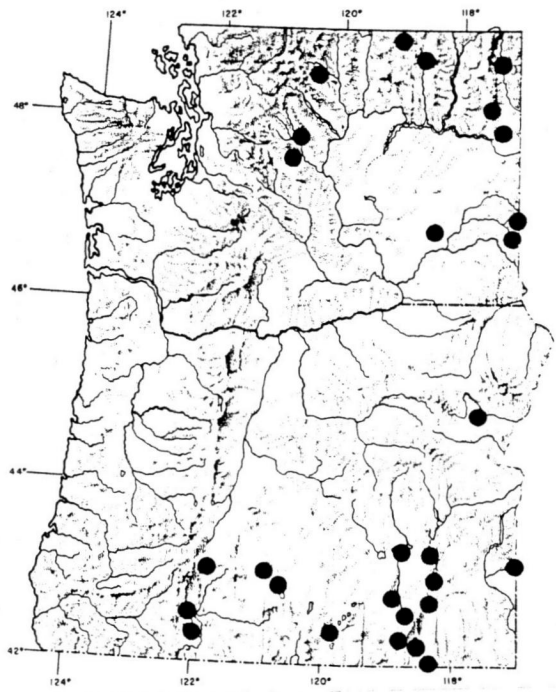
Distribution Maps

Distribution maps for Corixidae in Oregon and Washington (Figs. 119-142) include various species of the following genus: *Graptocorixa*, *Callicorixa*, *Cenocorixa*, *Corisella*, *Hesperocorixa*, *Sigara*, and *Trichocorixa*. A list of figures and corresponding page numbers is shown below.

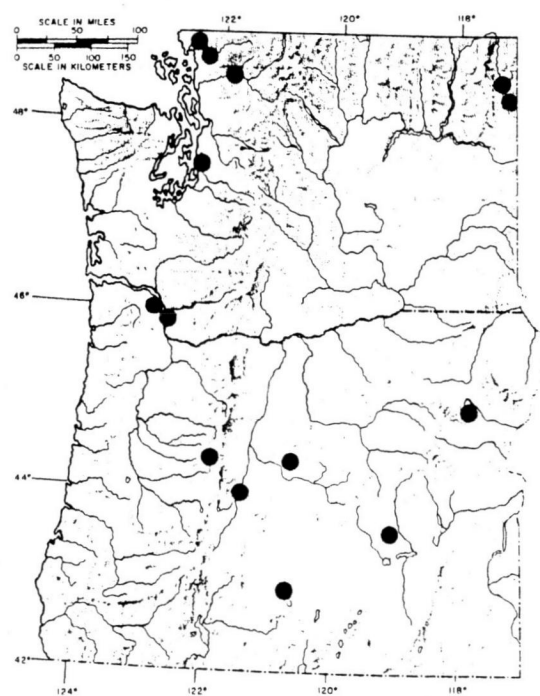
Figure 119.	<i>Graptocorixa californica</i>	62
Figure 120.	<i>Callicorixa audeni</i>	62
Figure 121.	<i>Callicorixa scudderi</i>	63
Figure 122.	<i>Callicorixa vulnerata</i>	63
Figure 123.	<i>Cenocorixa andersoni</i>	64
Figure 124.	<i>Cenocorixa bifida hungerfordi</i>	64
Figure 125.	<i>Cenocorixa blaisdelli</i>	65
Figure 126.	<i>Cenocorixa expleta</i>	65
Figure 127.	<i>Cenocorixa utahensis</i>	66
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Figure 129.	<i>Corisella decolor</i> and <i>C. tarsalis</i>	67
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Figure 131.	<i>Hesperocorixa atopodonta</i>	68
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Figure 140.	<i>Sigara vandykei</i>	72
Figure 141.	<i>Sigara washingtonensis</i>	73
Figure 142.	<i>Trichocorixa verticalis californica</i>	73



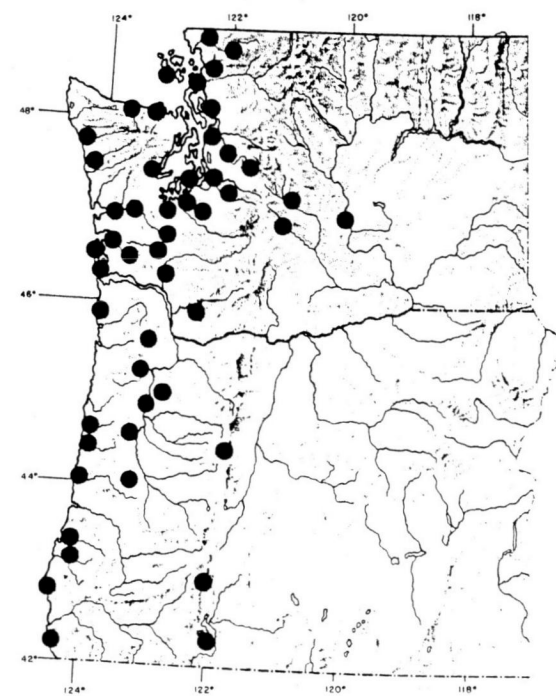
119 *Graptocorixa californica*



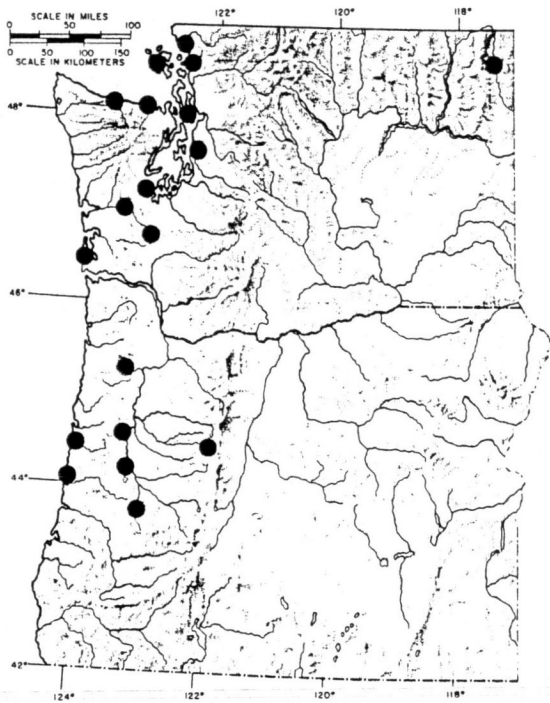
120 *Callicorixa audeni*



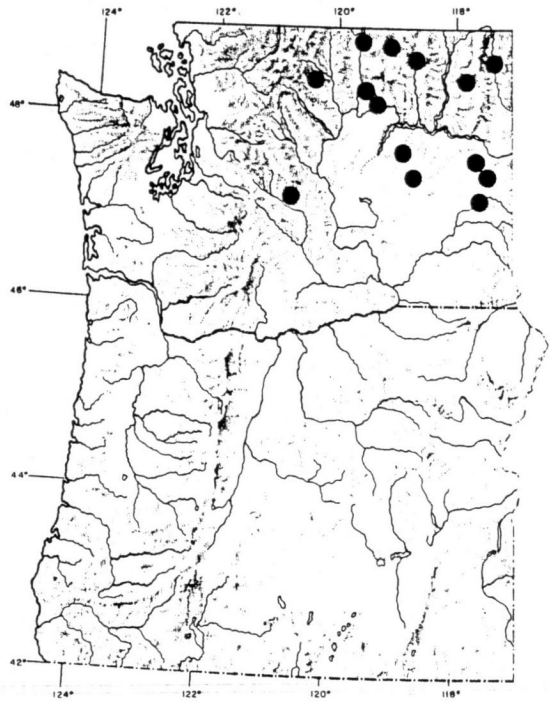
121 *Callicorixa scudderi*



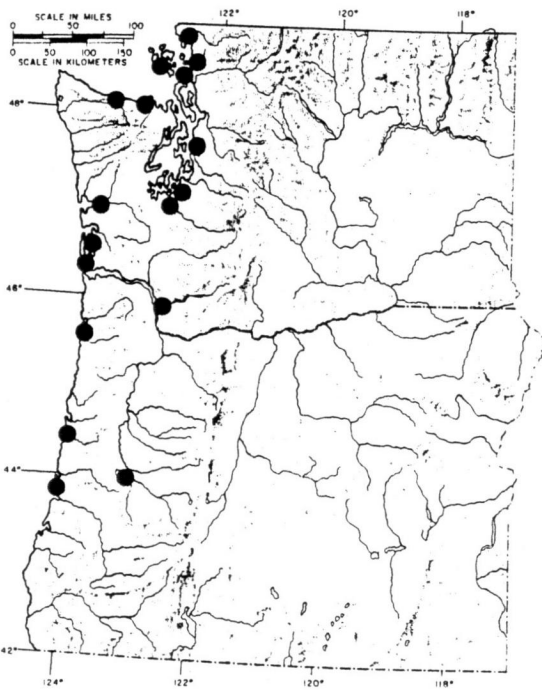
122 *Callicorixa vulnerata*



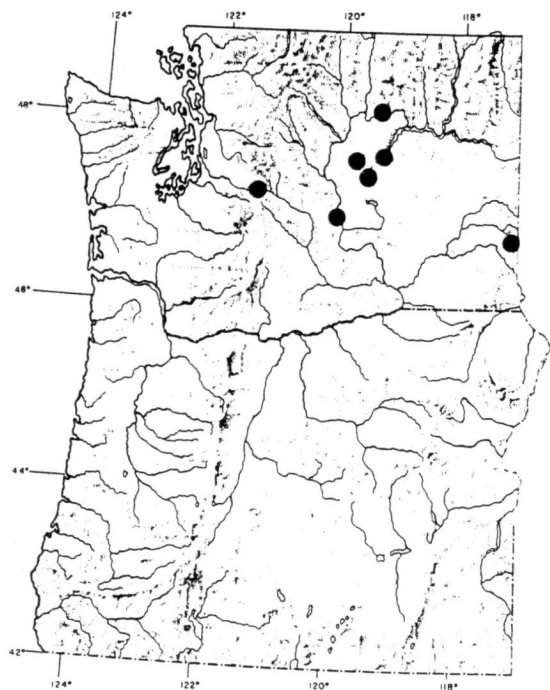
123 *Cenocorixa andersoni*



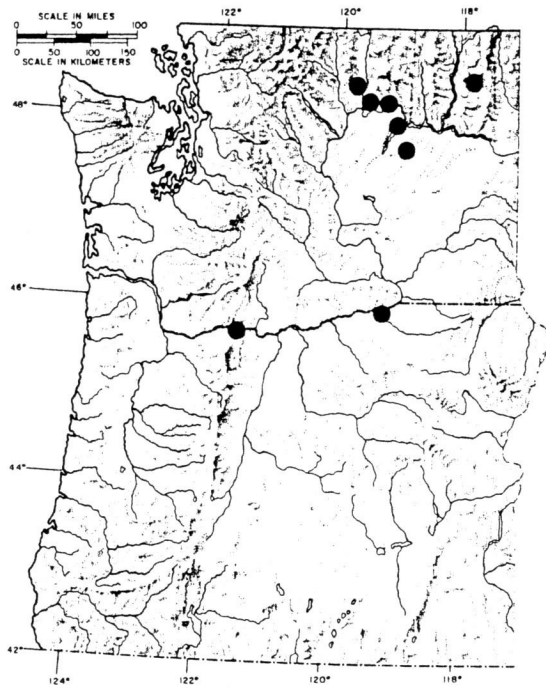
124 *Cenocorixa bifida hungerfordi*



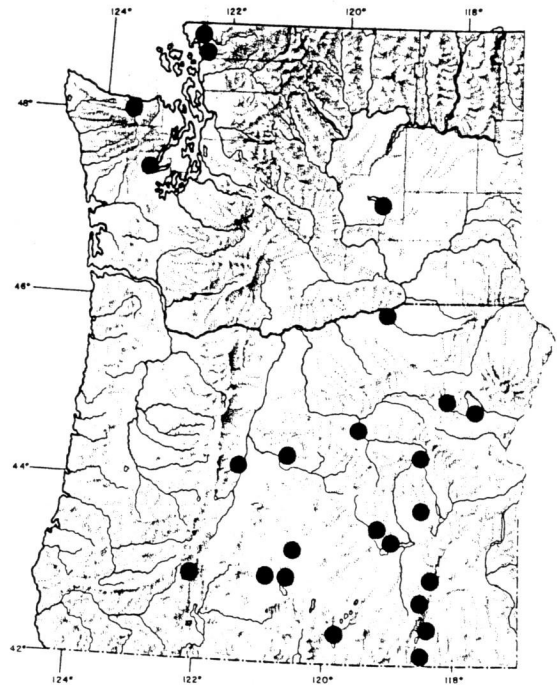
125 *Cenocorixa blaisdelli*



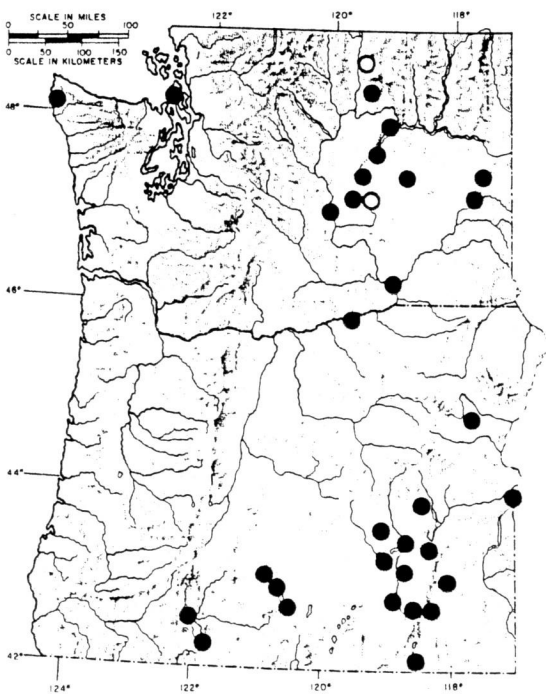
126 *Cenocorixa expleta*



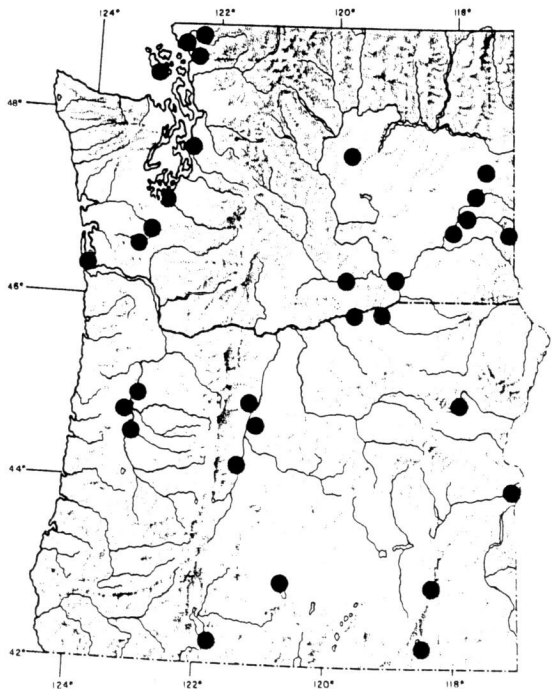
127 *Cenocorixa utahensis*



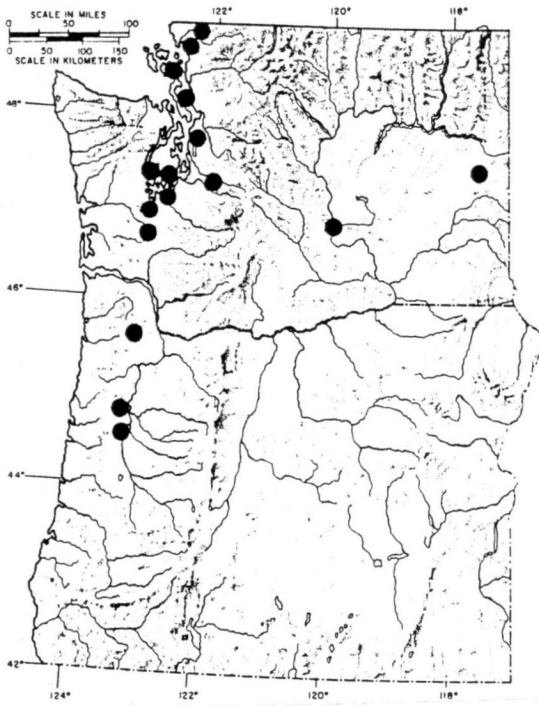
128 *Cenocorixa wileyae*



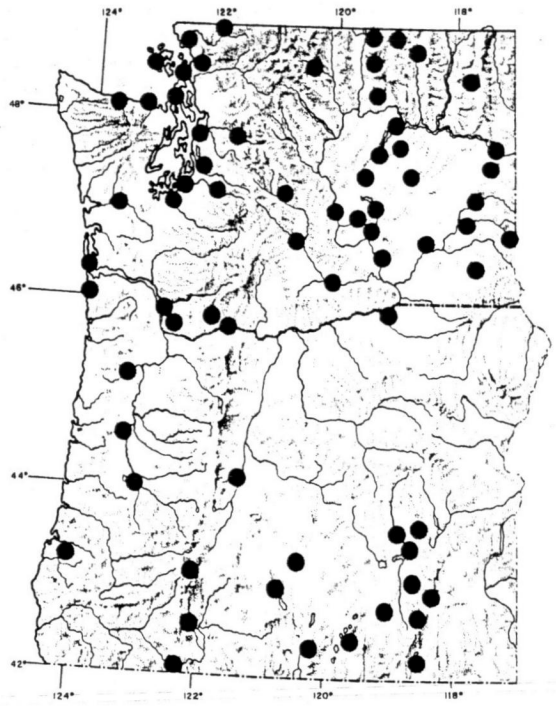
129 *Corisella decolor* (dots) and *C. tarsalis* (circles)



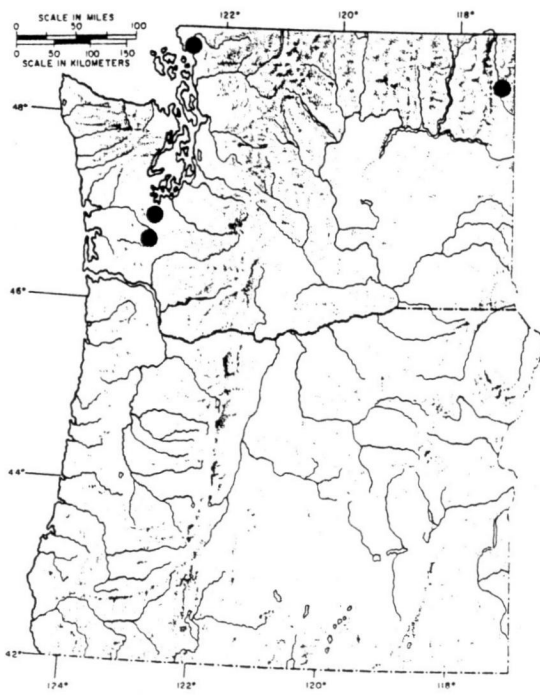
130 *Corisella inscripta*



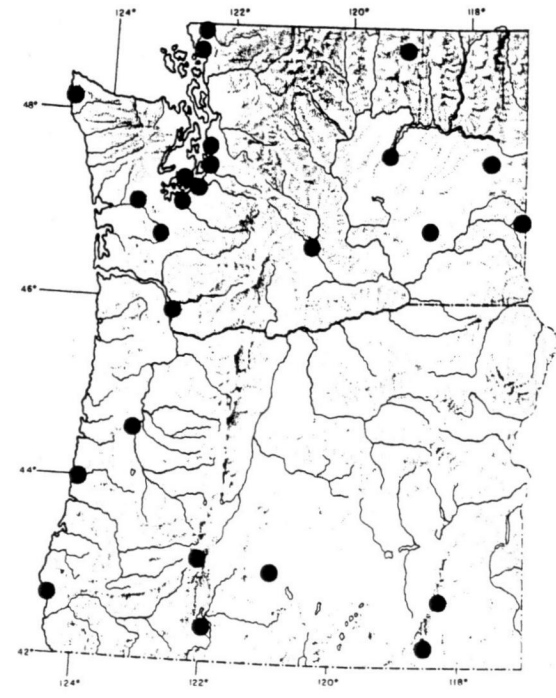
131 *Hesperocorixa atopodonta*



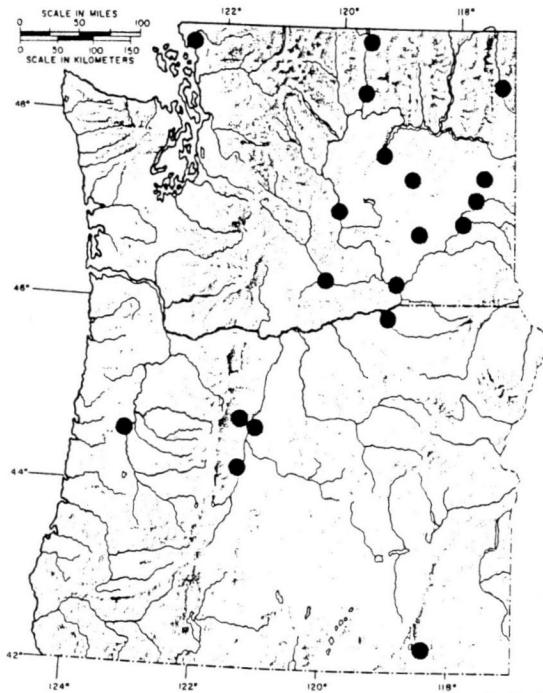
132 *Hesperocorixa laevigata*



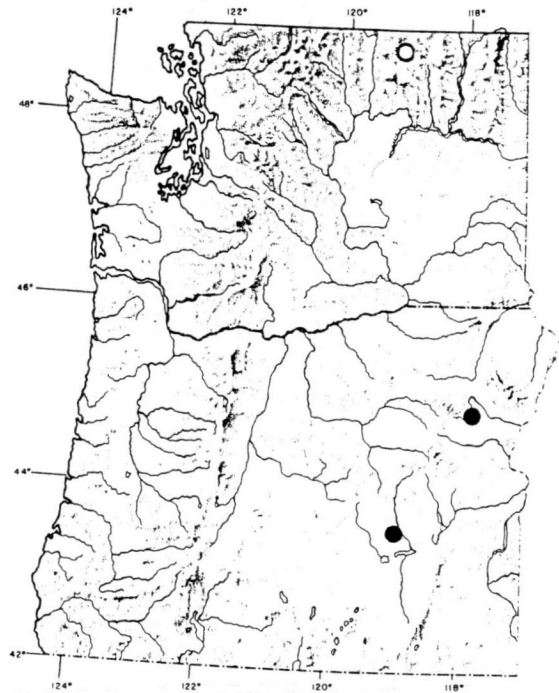
133 *Hesperocorixa michiganensis*



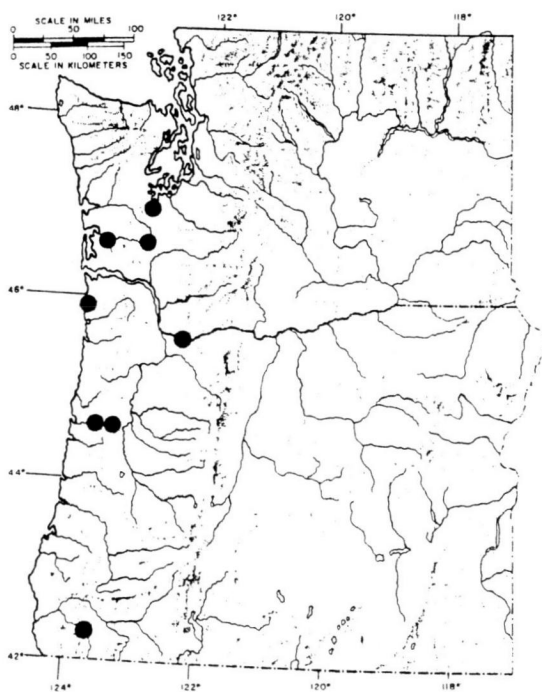
134 *Hesperocorixa vulgaris*



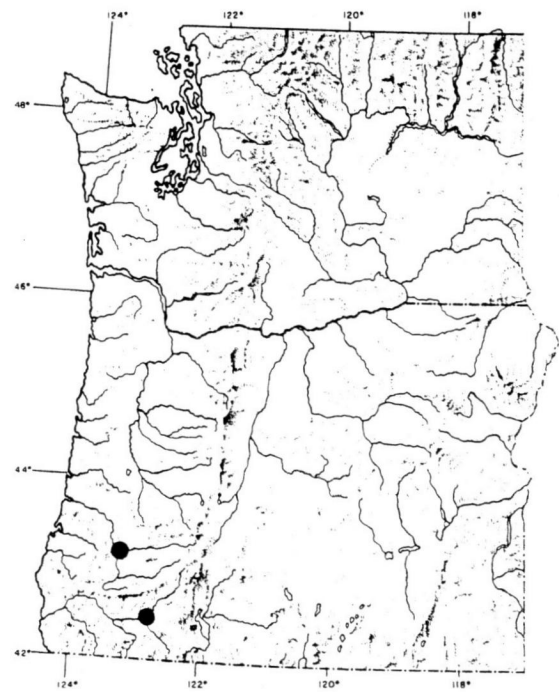
135 *Sigara alternata*



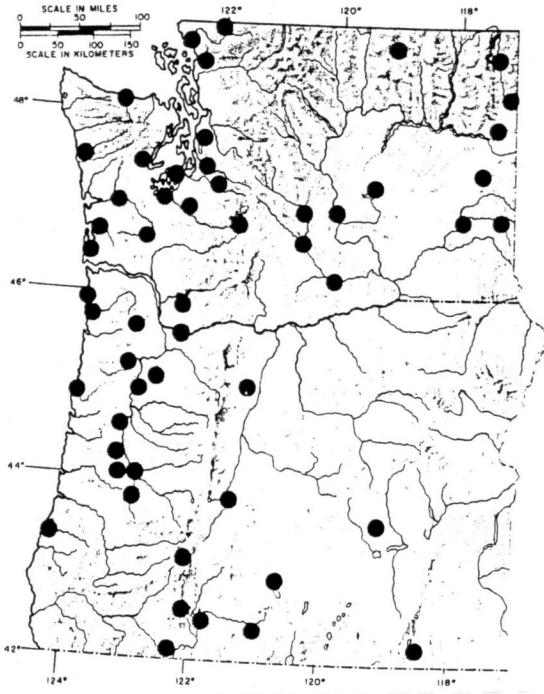
136 *Sigara decoratella* (circle) and *S. grossolineata* (dots)



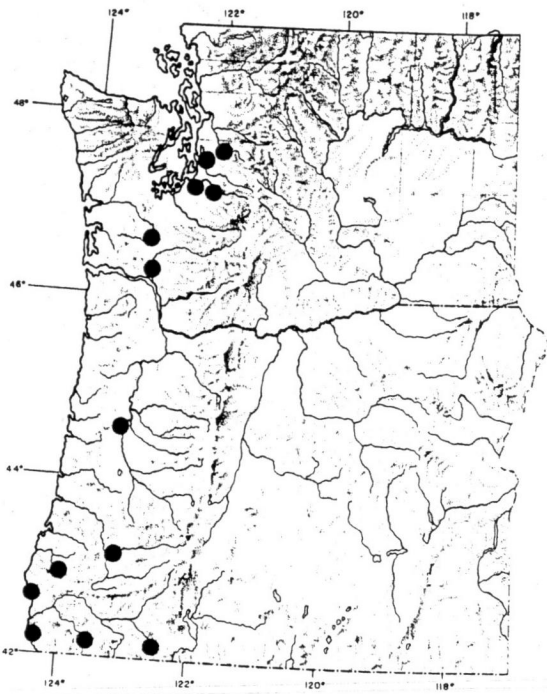
137 *Sigara krafti*



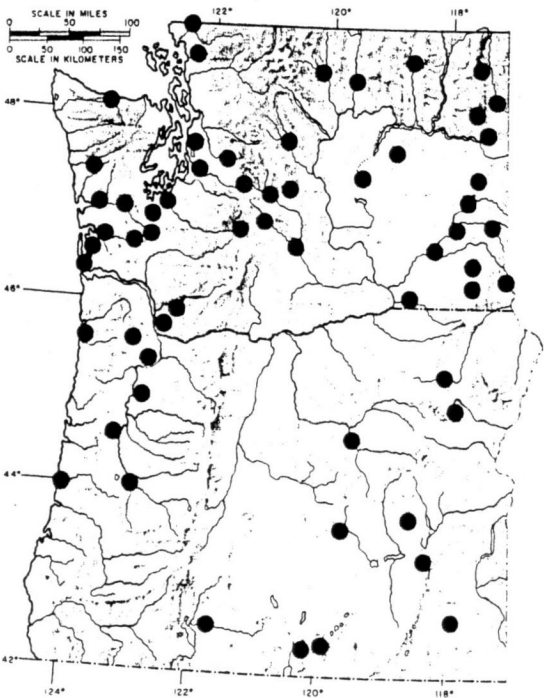
138 *Sigara mckinstryi*



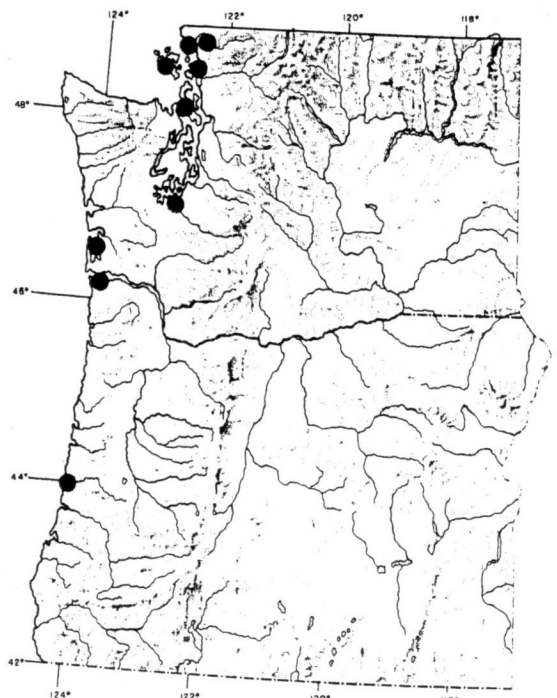
139 *Sigara omani*



140 *Sigara vandykei*



141 *Sigara washingtonensis*



142 *Trichocorixa verticalis californica*

Acknowledgments

Our thanks to Bonnie B. Hall for the illustrations of the hemelytron and pronotum of various *Cenocorixa*, *Hesperocorixa*, and *Sigara* species; to Gerald F. Kraft (Western Washington University, Bellingham) and William J. Turner (Washington State University, Pullman) for providing specimens for study; and to Paul W. Oman, John T. Polhemus, and Geoffrey G. E. Scudder for reviewing the manuscript; special thanks to Julie A. Stonedahl for extensive help in preparing the manuscript. The Elsevier Science Publishers, Amsterdam, granted permission to use the habitus drawings of *Cenocorixa expleta* and *Trichocorixa verticalis* from Scudder (1976), and the University of California Press, Berkeley, allowed the use of illustrations from Usinger (1956) and Lauck (1979).

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