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Bees of Northwestern
America: *HALICTUS*
(Hymenoptera: Halictidae)



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AUTHOR: Radclyffe B. Roberts is a research associate in entomology, Department of Entomology, Oregon State University.

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Bees of Northwestern America: *Halictus* (Hymenoptera: Halictidae)

RADCLYFFE B. ROBERTS

ABSTRACT

Diagnoses, synonymies, range maps, and an illustrated key are provided for the six species of *Halictus* found in the Northwest: *H. confusus*, *H. farinosus*, *H. ligatus*, *H. rubicundus*, *H. tripartitus*, and *H. virgatellus*. Observations by Chandler, Dolphin, and Roberts on nesting and foraging behavior is combined with a review of the literature on the biology of northwestern species. Abundant as well as aggregatory, *Halictus* species have demonstrable value as crop pollinators.

Key words: Bees, *Halictus*, synonymy, key, Pacific Northwest, biology, crops.

Introduction

The literature on the genus *Halictus* is both confused and confusing. Some authors (Stephen et al., 1969) include in the genus an enormous group of species which most authors now place in the genus *Lasioglossum* (Michener, 1944). Even *Lasioglossum* is separated into several genera by some workers (Mitchell, 1960). This bulletin will follow the majority of American workers in separating *Halictus* from *Lasioglossum*.

Species of *Halictus* are found throughout most of the world (Australia excepted), but this genus has never been monographed. In 1941, Sandhouse revised the North American species, thereby reducing 34 named species and subspecies to eight valid species and describing one additional species. Although *Halictus* is found from central Canada to Colombia, it is most abundant in the United States. Of the nine species discussed by Sandhouse (1941), six have been found in the Pacific Northwest.¹

Members of the genus *Halictus* are among the most ubiquitous and abundant bees in North America, yet little has been published on their habits. By far the most significant biological information on this genus is reported by Chandler (1955) and Dolphin (1966).

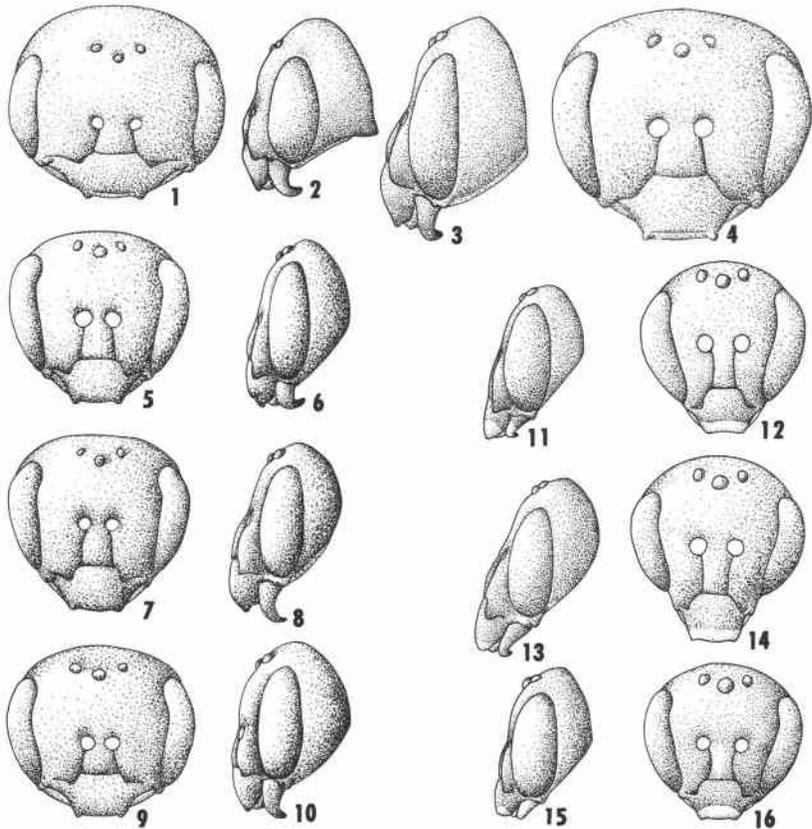
Species distributions are based largely on those given by Sandhouse (1941) and by Muesebeck, Krombein, Townes et al. (1951). The distribution maps are based on the collections at Oregon State University, Washington State University, and the University of Idaho.

¹ Here defined as Oregon, Idaho, Washington, British Columbia, Yukon, and Alaska.

Generic Diagnosis

Members of the genus *Halictus* are easily differentiated from those of the closely related *Lasioglossum* by the presence of pale fasciae, or hair bands, on the posterior margins of the metasomal terga of *Halictus* species (Figs. 17, 18). The northwestern species of *Halictus* are largely black or brown-black, sometimes with faint metallic tints (subgenus *Seladonia*), and are 4-15 mm long.

The subgenera *Halictus* and *Seladonia* are poorly differentiated, *Seladonia* (with exceptions) having faint metallic tints on the integument and *Halictus* lacking such tints. Species of *Seladonia* are generally shorter than 7 mm, while species of *Halictus* are generally longer.

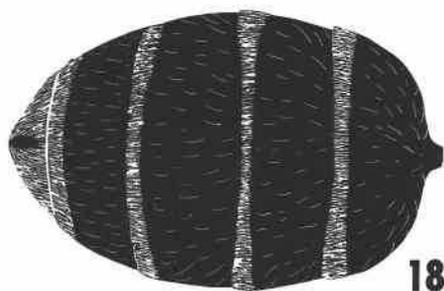
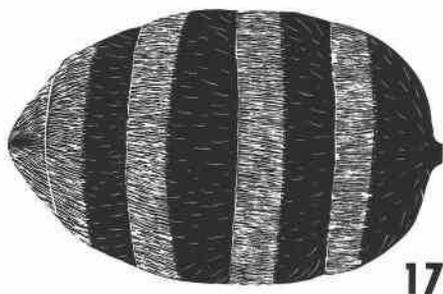


Figures 1-16. Front and side views of heads (females 1-10, males 11-16): (1,2) *H. ligatus*; (3,4) *H. rubicundus*; (5,6) *H. confusus*; (7,8) *H. virgatellus*; (9,10) *H. tripartitus*; (11,12) *H. confusus*; (13,14) *H. virgatellus*; (15,16) *H. tripartitus*.

Key to the *Halictus* Species of the Pacific Northwest

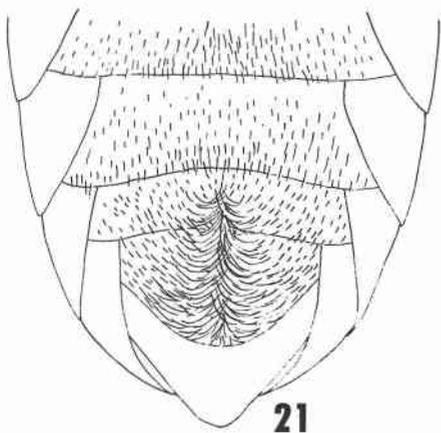
- 1 Female; 10 flagellar segments; scopa on hind leg 2
 Male; 11 flagellar segments; scopa absent 7
- 2 (1) Gena with tooth on posterior margin (Fig. 2); head and thorax black; head (Fig. 1) wider than thorax *ligatus*
 Gena rounded posteriorly; lacking tooth (Figs. 3-10); head and thorax black or with metallic tints; head usually narrower than thorax 3
- 3 (2) Malar space $\frac{2}{3}$ to $\frac{3}{4}$ as long as width of median ocellus (Figs. 7, 8); body less than 10 mm long *virgatellus*
 Malar space less than half as long as width of median ocellus (Figs. 3-6, 9, 10); body 4-15 mm long 4
- 4 (3) Head and thorax black; body 9-15 mm long 5
 Head and thorax with faint metallic tints; body 4-8 mm long 6
- 5 (4) Fasciae on metasomal terga narrow, especially medially (Fig. 18); posterior spur on hind tibia with large, irregular, subcontiguous teeth (Fig. 20) *rubicundus*
 Fasciae on metasomal terga uniformly broad (Fig. 17); posterior spur on hind tibia with small, regular, contiguous teeth (Fig. 19) *farinosus*
- 6 (4) Subantennal suture $\frac{6}{10}$ as long as distance between junctures of epistomal suture with subantennal sutures (Fig. 9) *tripartitus*
 Subantennal suture $\frac{9}{10}$ as long as distance between junctures of epistomal suture with subantennal sutures (Fig. 5) *confusus*
- 7 (1) Flagellum brown-black below; head and thorax black without metallic tints; body 7-15 mm long 8
 Flagellum honey-color to light brown below; head and thorax black, often with faint metallic tints; body 5-8 mm long 9
- 8 (7) Metasomal sternum 4 with brush of hairs along posterior margin, sternum 5 with posterior deeply emarginate medially (Fig. 22); mandible black, sometimes with small yellow spot centrally *rubicundus*

- Metasomal sternum 4 with marginal hairs like those of preceding sternite, sternum 5 with posterior scarcely emarginate medially (Fig. 21); mandible yellow centrally, black basally, and amber apically *farinosus*
- 9 (7) Metasomal sterna 2 and 3 with long suberect hairs (Fig. 23); head and thorax black *ligatus*
- Metasomal sterna 2 and 3 with short appressed hair (Figs. 24, 25); head and thorax usually with metallic tints 10
- 10 (9) Fore trochanters yellow or honey-color below; propodeum with dorsal area finely and irregularly striate *confusus*
- Fore trochanters brown below; propodeum with dorsal area finely and irregularly striate or with coarse parallel striae 11
- 11(10) Malar space at least half as long as width of median ocellus (Fig. 13); propodeum with dorsal area finely and irregularly striate *virgatellus*
- Malar space less than one-fourth as long as width of median ocellus (Fig. 15); propodeum with dorsal area with coarse parallel striae *tripartitus*

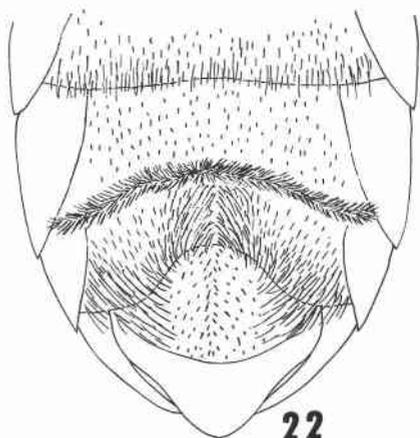


Figures 17-18. Dorsal view of white hair bands on abdomen of females: (17) *H. farinosus*; (18) *H. rubicundus*.

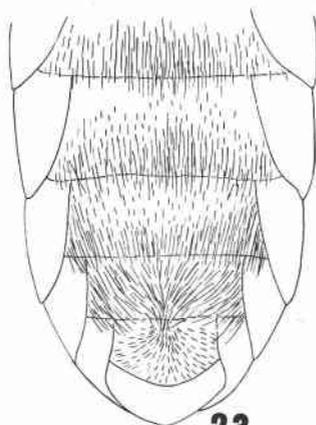
Figures 19-20. Lateral view of inner hind tibial spur of females: (19) *H. farinosus*; (20) *H. rubicundus*.



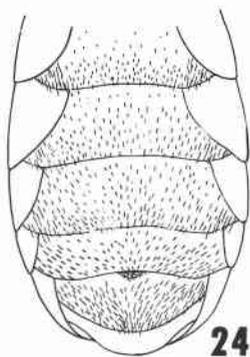
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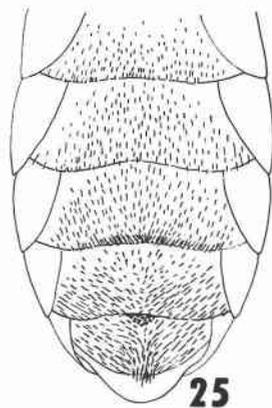
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Figures 21-25. Ventral views of male sterna: (21) *H. farinosus*; (22) *H. rubicundus*; (23) *H. ligatus*; (24) *H. confusus*; (25) *H. virgatellus*.

Halictus (Halictus) farinosus Smith, 1853

Synonymy: *Halictus montanus* Crawford, 1902; *Paranomia venablesii* Ashmead, 1903; *Halictus denticulus* Vachal, 1904; *Halictus procerus* Vachal, 1904.

Diagnosis. The largest of our northwestern species, *H. farinosus* may be distinguished from members of *Seladonia* by its size and lack of metallic tints. Females may be distinguished from those of *H. ligatus* by their lack of a postero-ventral genal tooth and from *H. rubicundus* by the broad fasciae on their metasomal terga (Figs. 17, 18) and the smaller contiguous teeth on their posterior hind tibial spur (Figs. 19, 20). Males may be distinguished from those of *H. ligatus* and *H. rubicundus* by the short, appressed hairs on the posterior margin of their fourth, antepenultimate, visible, metasomal sternite (Figs. 21-23).

Distribution. This species occurs from New Mexico west to California, north to British Columbia, and east to Nebraska (Fig. 30).

Biology. According to Stephen et al. (1969), overwintered queens return to the old nest site after emerging from hibernation. They move into old nests and await the maturation of their ovaries, a process lasting as long as two weeks. The first cells are constructed at a depth of about 10 cm, but by the end of the season the nest may be as deep as 35 cm. The tumulus hides a horizontal entry tube with an eccentrically situated opening. Unlike some species, *H. farinosus* is not reported to constrict its nest entrance. Nevertheless, this species does guard the nest entrance. As the first generation of summer females remain in the same nest with their mother, we can conclude that this species is primitively social. The overwintering queens are often infested with nematodes similar to those which attack bumble bee queens. Bohart (1953) has published a diagram of a nest of *H. farinosus*. This species is similar in appearance and behavior to *H. parallelus* Say, which replaces *H. farinosus* east of the Rocky Mountains.

Halictus (Halictus) ligatus Say, 1837

Synonymy: *Halictus poeyi* Lepeletier, 1841; *Halictus capitosus* Smith, 1853; *Halictus armaticeps* Cresson, 1872; *Halictus texanus* Cresson, 1872; *Halictus ornatipes* Cresson, 1872; *Halictus townsendi* Cockerell, 1896.

Diagnosis. The female of this species is easily distinguished from other females by its postero-ventral genal tooth (Fig. 2). The male may be distinguished from other males by the long suberect hairs on its second and third metasomal sterna (Fig. 23).

Distribution. This species occurs in North America from about 50 degrees north latitude, south to the West Indies and Colombia (Fig. 31).

Biology. The only significant work on this species is by Chandler (1955). Much information on *H. ligatus* is included in another section of this bulletin (Biology of *Halictus*) and will not be repeated here. In brief, *H. ligatus* is primitively social with conspicuous allometric differences between the large queens and smaller workers. Normally nesting in dense aggregations, *H. ligatus* has been reported to construct solitary nests in the vicinity of Oaxaca, Mexico (Chandler, pers. comm.). Although polylectic as a species, local populations obtain most of their pollen from just a few of the many flower species available.

Halictus (Halictus) rubicundus (Christ), 1791

Synonymy: *Apis rubicunda* Christ, 1791; *Halictus lerouxi* Lepeletier, 1841; *Halictus lerouxi ruborum* Cockerell, 1898; *Halictus (Halictus) lerouxii* Lovell, 1908; *Halictus lupinelli* Cockerell, 1936.

Diagnosis. This species may be distinguished from species of *Selandonia* by its large size and lack of metallic tints. The female of *H. rubicundus* may be distinguished from females of *H. ligatus* by its lack of a postero-ventral genal tooth (Figs. 2, 3), and from females of *H. farinosus* by the narrow fasciae on its metasomal terga (Figs. 17, 18) and by the large subcontiguous teeth on its posterior hind tibial spur (Figs. 19, 20). The male may be distinguished from males of other species by the brush of hairs on the posterior margin of its fourth metasomal sternum (Fig. 22).

Distribution. This species is holarctic, ranging in North America from British Columbia, Northwest Territories, and Newfoundland, south to California, Arizona, Texas, and Florida (Fig. 32).

Biology. *Halictus rubicundus* is primitively social or communal and nests in level ground free of vegetation. Nests excavated by the author in Moscow, Idaho, on August 5, 1970, contained adults of both sexes and were 20-25 cm deep. The narrowed nest entrances were guarded by the bees. Although males and females would sometimes leave the nests, the females were not observed to return with pollen loads. Both sexes spent the night in the nests (in many halictids males sleep on flowers). Perhaps the females were already the overwintering generation, or, perhaps owing to drought, were temporarily in an inactive state. Atwood (1933) reports that hibernation begins about August 20 in Nova Scotia. Some females may have been reproductively active, as cleptoparasitic satellite flies were abundant at the nest site. Stephen et al. (1969) report an anthomyiid fly (*Leucophora* sp.) which oviposits on the pollen carried by *H. rubicundus*.

Batra (1968) observed the behavior of *H. rubicundus* females which were induced to nest between sheets of transparent acrylic plastic. In the course of observations, several interesting aspects of nesting behavior came to light: (1) completed cells were left open; (2) the cell contents were frequently inspected by the adult females; (3) unrelated females sometimes cooperated in a single nest (there was some evidence of dominance); and (4) as many as seven cells were completely provisioned before the first eggs were laid. These behavioral traits are unusual (but by no means unique) in the Halictinae and should be looked for in natural nests.

Halictus (Seladonia) confusus Smith, 1853

Synonymy: *Halictus constrictus* Provancher, 1882; *Halictus provancheri* Dalla Torre, 1896; *Halictus nearcticus* Vachal, 1904; *Halictus arapohonum* Cockerell, 1906; *Halictus (Chloralictus) olivarius* Sandhouse, 1924.

Diagnosis. This species may be distinguished from members of the subgenus *Halictus* by its small size and faint metallic tints. The female of *H. confusus* may be distinguished from females of *H. virgatellus* by its shorter malar space (Figs. 6, 8) and from females of *H. tripartitus* by its longer subantennal suture (Figs. 5, 9). The male may be distinguished from males of *H. virgatellus* and *H. tripartitus* by the yellow or honey-color on the lower surface of its fore trochanters.

Distribution. This species ranges from Nova Scotia to British Columbia, and south to Oregon, Utah, Texas, and Georgia (Fig. 33).

Biology. This species has been studied extensively by Dolphin (1966) and Chandler (1955). Aspects of its biology are described in another section of this bulletin. *H. confusus* is aggregatory and primitively social, though lacking morphologically distinct castes. Unlike *H. ligatus*, this species usually founds new nests each spring (Dolphin, pers. comm.). Like *H. farinosus*, this species creates a horizontal entry tube beneath the tumulus. The bees guard the narrowed nest entrance. Although polylectic as a species, local populations of *H. confusus* restrict their pollen gathering to a few of the many available flower species.

Halictus (Seladonia) tripartitus Cockerell, 1895

Synonymy: *Halictus meliloti* Cockerell, 1895; *Halictus catalinensis* Cockerell, 1903.

Diagnosis: This species may be distinguished from members of the subgenus *Halictus* by its small size and faint metallic tints. The female may

be distinguished from females of *H. confusus* by its shorter subantennal suture (Figs. 5, 9) and from females of *H. virgatellus* by its shorter malar space (less than half the width of median ocellus) (Figs. 8, 10).

Distribution. This species ranges from Idaho, Colorado, and Texas, west to Washington, California, and Baja California (Fig. 34).

Biology. According to Linsley (1946), these bees are aggregatory and nest in flat areas below "the level of cultivation."

Halictus (Seladonia) virgatellus Cockerell, 1901

Synonymy: *Halictus sansoni* Crawford, 1911; *Halictus fraseriae* Cockerell, 1961; *Halictus typographicus* Cockerell, 1918; *Halictus (Seladonia) ororyctes* Cockerell, 1933.

Diagnosis: Because this species is nearly devoid of metallic integumental tints, it is easily confused with members of the subgenus *Halictus*. The female of *H. virgatellus* may be distinguished from females of other species by its malar space which is at least two-thirds as long as the width of its median ocellus (Figs. 7, 8). The male of *H. virgatellus* may be distinguished from males of *H. farinosus* and *H. rubicundus* by the honey-color or yellow on the underside of its flagellum, from males of *H. ligatus* by the lack of long suberect hairs on its metasomal sterna 2 and 3 (Figs. 23, 25), from males of *H. confusus* by the lack of honey-color or yellow on the underside of its fore trochanter, and from males of *H. tripartitus* by the malar space (Figs. 13-16) which is at least half as long as the width of its median ocellus.

Distribution. The rarity of this species in collections can be attributed to its altitudinal distribution. In the Pacific Northwest, the author has not seen specimens collected below 6,000 feet (1,829 m) and has collected it at 8,200 feet (2,500 m). Bee collectors seldom work at high altitudes and those that do are generally after the very large and conspicuous bumble bees. This species occurs from British Columbia, the Northwest Territories, and Alberta, south to Oregon, Colorado, and New Mexico (Fig. 34).

Biology. Unknown.

Biology of *Halictus*

Observations on European (Friese, 1923), African (Michener, 1969b), and Indian (Batra, 1966) species of *Halictus* are in general accord with the account below.

Nest site

Halictus ligatus, *H. confusus*, and *H. rubicundus* normally nest in level, well-drained, hard-packed soil free of vegetation. Their nests are most frequently encountered in dirt roads and paths.

The bees usually nest in silt or loam. Such soil has a fine, loose grain structure which makes it easy for the bees to excavate. Furthermore, such soil has the capacity to retain moisture during times of drought and to shed excess water in times of heavy rain. In many areas, a shortage of bare soil with suitable grain size and moisture characteristics limits the populations of *Halictus* species.

Halictus confusus, *H. farinosus*, *H. ligatus*, and *H. rubicundus* usually nest in dense aggregations. The bees continue to utilize a nest site year after year until crowded out by encroaching vegetation or decimated by parasites or disease. Such gregarious behavior is characteristic of many (but by no means all) of the Halictinae. The tendency to nest in aggregations is advantageous in enabling the cooperation of bees in the repulsion of parasites (Lin, 1964) but disadvantageous in minimizing the time spent by predators in search of prey, or parasites in search of hosts.

The overwintered queens of *H. ligatus* (Chandler, 1955), prefer remodeling old nests to initiating new nests. The survival value of continued use of an old nest site, and even an old nest, is obvious. Presumably, those bees which nest at the old site or in an old nest produce a greater number of descendants than those bees which nest elsewhere. Thus, selection favors bees which remain at the original site to nest. Of course, there are occasions when those bees which have nested elsewhere survive a catastrophe which eliminates those nesting at the original site. On such occasions, selection favors bees which have dispersed. As a result of these counterbalancing selective forces, a tendency to disperse is maintained in a population which has a strong tendency to occupy a nest site year after year.

Gregarious nesting behavior is the *sine qua non* of managing wild bees for crop pollination. *Halictus confusus* has been found to be vital to the pollination of dwarf marigold (*Tagetes patula*) grown for seed in Oregon (Roberts, 1972). Growers are now taking steps to protect *Halictus* nest sites from pesticides and encroaching vegetation.

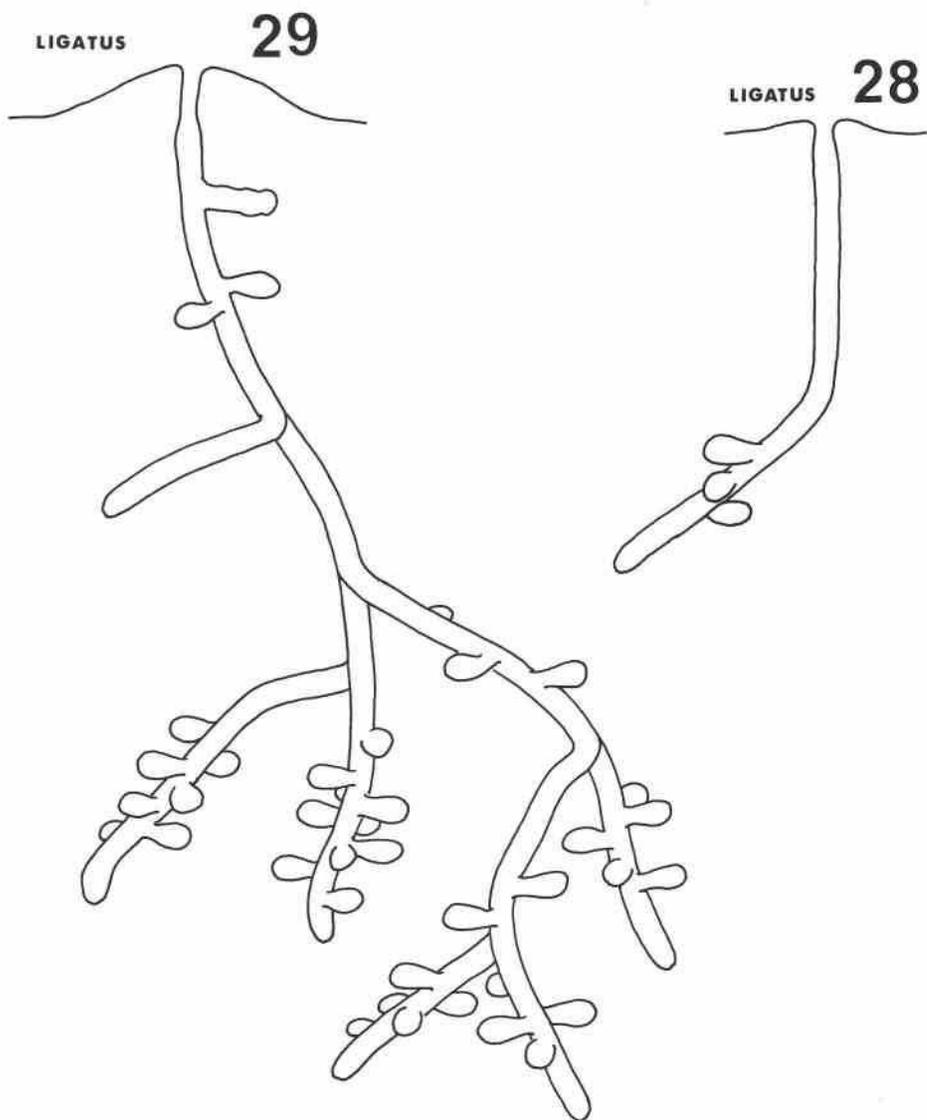
Nest architecture

Despite small but consistent interspecific differences, nests of *Halictus* are typified by a more or less vertical burrow with contiguous brood cells. This type of nest also occurs in the genus *Lasioglossum* but differs from the nests of *Agapostemon* which have brood cells at the ends of long lateral burrows (Roberts, 1973).

As the bees excavate their burrows, they push soil out the entrance and it accumulates in a small mound or tumulus. Subject to dispersal by wind or water, the tumulus is often temporary. While the size of the tumulus is inconstant, the symmetry shows consistent interspecific differences. The tumuli of *H. ligatus* and *H. rubicundus* are radially symmetrical about a vertical burrow entrance, whereas the tumuli of *H. confusus* and *H. farinosus* are usually bilaterally symmetrical about a gently sloping burrow entrance (Figure 26). If the excavated soil pushed from the nest entrance is moist, it sticks together as a tube. In *H. ligatus* and *H. rubicundus* the tube remains as a vertical turret if the surrounding unconsolidated tumulus is dispersed (Figure 27). In *H. farinosus*, the tunnel through the tumulus is nearly horizontal and remains temporarily as a consolidated tube if the rest of the tumulus is dispersed. But after the surrounding tumulus is dispersed, the bees make no attempt to repair the disintegrating tube or turret.

The nests of *H. ligatus* described by Chandler (1955) were in a thin layer of soil (about 25 cm deep) underlaid with a deposit of sandy gravel. Subject to extreme fluctuations of moisture, the sandy gravel was only marginally suitable for brood rearing. Thus the bees confined most of their brood cells to the top 25 cm of soil. In older nests, the bees added branches to the main burrow, apparently to exploit more fully the layer of soil most suitable for the brood cells. In situations where shallow soil does not impose such severe restrictions, *H. ligatus* burrows may reach a depth of 70 cm (Sakagami and Michener, 1962). According to Chandler (pers. comm.), the placement of cells and the depth of the nests of *H. ligatus* and *H. confusus* are directly correlated with soil moisture. In summary, it is possible to make the following generalizations about the burrows of *Halictus*: (1) burrow depth, while limited by edaphic factors, is positively correlated with the age of the nest and the number of its female inhabitants; (2) burrow branching, although positively correlated with the age of the nest and the number of its female inhabitants, is negatively correlated with burrow depth (Figs. 28, 29).

The brood cells of *Halictus* are horizontal, oval cavities opening directly into the main burrow. Dolphin (1966) reports that *H. confusus* first excavates the cell in rough form and, after smoothing the cell walls and constricting the entrance with soil particles, lines the cell with a water-



Figures 28-29. Nests of *H. ligatus*: (28) excavated in spring with one queen and no workers; (29) excavated in summer with one queen and six workers.

repellent secretion. Batra (1964) observed this sequence of cell construction in *Lasioglossum zephyrum*. Other species of *Halictus* and *Lasioglossum* probably employ the same techniques.

The number of brood cells in an active nest is positively correlated with the age of the nest and the number of female inhabitants. However, owing to the re-use of old nests and the fact that these bees are primitively social, it is difficult to estimate the number of brood cells produced in the course of a season. The overwintered females of *H. confusus* provision two to eight brood cells (Dolphin, 1966) and those of *H. ligatus* three to six cells (Chandler, 1955). When the workers emerge, they assume the task of constructing and provisioning cells. Dolphin (1966) excavated an inactive nest of *H. confusus* on August 11, 1964, and found, in addition to one old and four young females, 32 cells containing the following: two dead parasitic rhipiphorid beetles, four rhipiphorid pupae, two large rhipiphorid larvae, one pollen ball overgrown with fungus, two male adults, three male pupae, two female pupae, one pupa of undetermined sex, and 15 abandoned cells filled with soil. On September 12, 1953, Chandler (1955) excavated a nest of *H. ligatus* with several quiescent queens, a few queen pupae, and 40 cells (presumably those without queen pupae were abandoned). These are the largest reported nests for *H. confusus* and *H. ligatus*.

The cells are not always constructed in strict vertical sequence. In young nests of *H. ligatus* (Chandler, 1955) the queen tends to complete the uppermost cells first and to construct subsequent cells at progressively greater depths. Each worker seems to construct her own cell series and, by the latter part of the season, there is a tendency for cell construction to be regressive (i.e., with the newer cells at ever decreasing depths). Chandler (pers. comm.) reports that in Indiana regressive cell placement is the result of summer drought followed by fall rains, whereas in Kansas, where fall rains are sparse, regressive cell placement does not occur.

Life history

These bees overwinter (usually in the old nests) as inseminated immature queens. Usually, several such queens cluster in a group below the frost line. These queens emerge in the spring (different species at different times). After a few days foraging and inspecting the nest site, they either construct a new nest or move into a nest from the previous year. Oviposition may be delayed for up to two weeks before ovarian maturation is complete. After completing several cells, the queen closes the nest entrance with soil and becomes quiescent at the bottom of her burrow. The development of *H. confusus* from egg to adult takes about 36 days in the spring when soil temperatures are low, and about 28 days in the summer

when soil temperatures are higher (Dolphin, 1966). The developmental time of *H. ligatus* (Chandler, 1955), and probably of other *Halictus* species, is comparable to that of *H. confusus*.

As members of the first summer brood emerge, they begin constructing and provisioning new cells. The queen becomes active and lays an egg in each cell as it is completed. Although she may occasionally forage for herself, she does not provision cells. The queen spends much of her time guarding the nest entrance. Throughout the remainder of the season, cell construction continues with interruptions during periods of heavy rain, drought, or otherwise inclement weather. There may be as many as three generations of bees, possibly more in areas with a longer blooming season. The workers generally live about three weeks. According to Chandler (pers. comm.), the workers of *H. ligatus* never supersede the queen or found new nests. Thus, loss of the queen results in the decline of her nest. In *H. confusus* the queen usually dies in midsummer and is replaced by one of the older "workers." According to Dolphin (1966), the first brood of *H. confusus* averaged one male to six females but by the end of the season equal numbers of males and females were being produced.

Mating commonly takes place at the flowers, although Bohart (1950) reports *H. ligatus* males mating with females feeding on broken watermelons. As copulation lasts only about 10 seconds, it is not surprising that it is rarely observed. The young inseminated queens feed at flowers and spend the rest of their time in the nest but do no work there. At the end of the summer the old queen, workers, and males die of old age, cold, or starvation. The inseminated overwintering queens, with enlarged fat bodies but immature ovaries, enter hibernation in abandoned burrows.

Sociality

From the observations of Dolphin (1966) and Chandler (1955) it is apparent that *H. confusus* and *H. ligatus* are primitively social (*sensu* Michener, 1969a). The criteria for primitive sociality are: (1) castes and division of labor; (2) adults of two or more generations in a single nest; (3) cooperative work on cells; and (4) morphologically similar females (allometry notwithstanding) and queens which overwinter without males or workers. *Halictus rubicundus* may be primitively social or it may be merely communal (females sharing nest but without division of labor).

Although it seems that other American *Halictus* species are at least aggregatory in their nesting behavior, it is not clear whether they are also primitively social. The occupancy of a burrow by two or more females is insufficient evidence of sociality (see *Agapostemon virescens*, Roberts, 1973). In order to demonstrate sociality one must ascertain the existence of separate worker and reproductive castes.

Foraging

Members of the genus *Halictus* visit a large number of flower species for pollen and/or nectar. Chandler (1955) reports *H. ligatus* visiting 204 species in 119 genera and 43 plant families. Dolphin (1966) reports *H. confusus* visiting 165 species in 126 genera and 40 plant families. Although this host diversity is indicative of behavioral and dietary plasticity at the species level, it should not be construed as indicative of nonspecificity at the level of the nesting aggregation, much less the individual forager. Dolphin (1966) reports that 95 percent of the pollen collected by a population of overwintered queens came from winter cress (*Barbarea vulgaris*; Cruciferae). The great majority of the emerging workers provisioned cells with pollen from white clover (*Trifolium repens*; Leguminosae) and red clover (*Tr. pratense*). A population of *H. ligatus* with nests intermingled with those of *H. confusus* had quite different host preferences. The overwintered queens of *H. ligatus* provisioned the majority of their cells with pollen from yarrow (*Achillea millefolium*; Compositae) in 1952 and dandelion (*Taraxacum officinale*; Compositae) in 1953. Despite abundant clover, *H. ligatus* seldom visited those blossoms so attractive to *H. confusus*. Thus, despite their great plasticity at the species level, it is apparent that at the local level *H. ligatus* and *H. confusus* collect pollen from quite different and quite restricted groups of flower species.

The foragers of *H. confusus* and *H. ligatus* normally open their burrows soon after sunrise, when the soil temperature 2.5 cm below the surface is about 18° C. If the sun is shining, the bees begin foraging within a few minutes. During the morning a forager will bring in approximately eight loads of pollen and nectar. Presumably, this is sufficient provisions for a single cell. Most foraging ceases by noon, although some foragers will fly in the afternoon. The nest entrances are usually blocked with soil ejected from the burrow during the afternoon and evening. Cell construction probably takes place at this time.

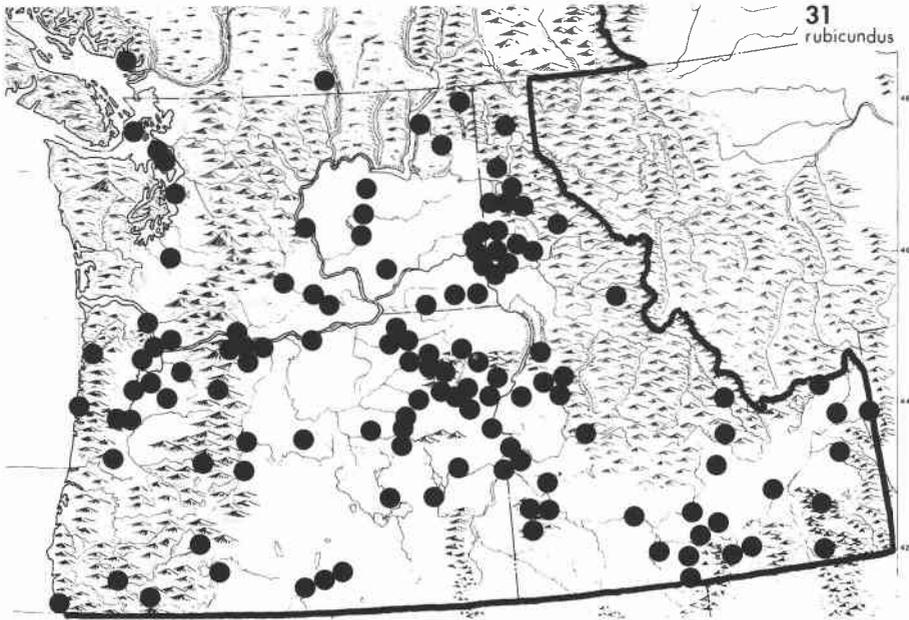
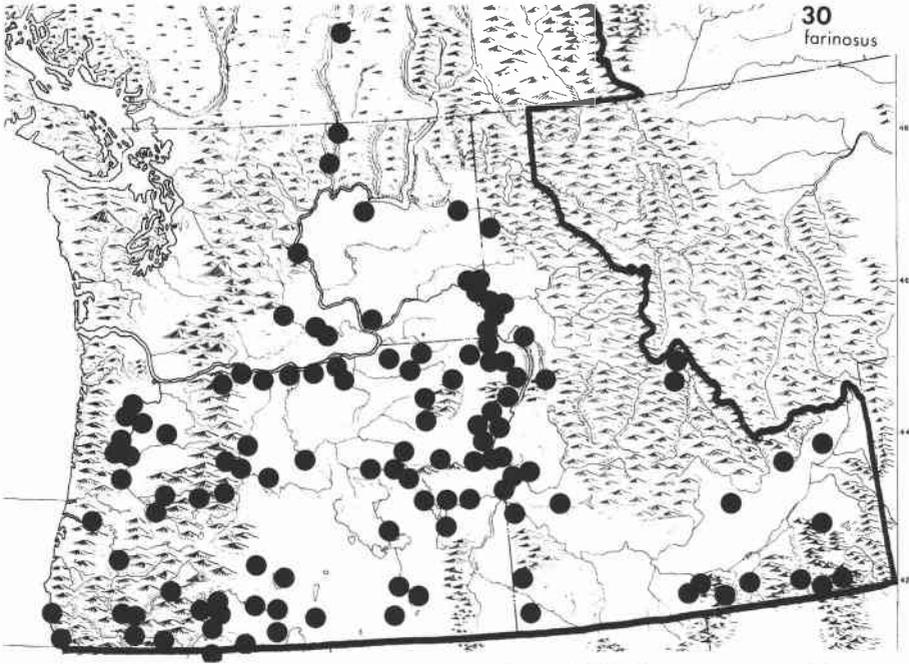
Members of the genus *Halictus*, especially *H. confusus* and *H. ligatus*, are both widespread and abundant. From this alone, one can safely conclude that they are among the most important North American pollinators. Chandler (1955) recorded the abundance of *H. confusus* in samples swept from clover fields in Indiana. He found that this bee constituted an average of 21.7 percent of all pollinators, and in some fields as much as 37.5 percent of the pollinators were *H. confusus*. In Oregon, these bees are essential to the production of marigold seed and of considerable importance in the production of zinnia seed (Roberts, 1972). They probably are important to other specialty crops whose pollinators have not been surveyed.

Seed growers should take steps to increase populations of these bees by: (1) being careful as to where and when they apply pesticides; (2) keeping existing nest sites free of vegetation; and (3) supplying the bees with additional nest sites. Further research is necessary to learn the soil and moisture requirements of these bees. If we can satisfy these requirements, it should be possible to exploit the aggregatory tendency of these bees in much the same way as *Nomia melanderi* Ckll. has been exploited.

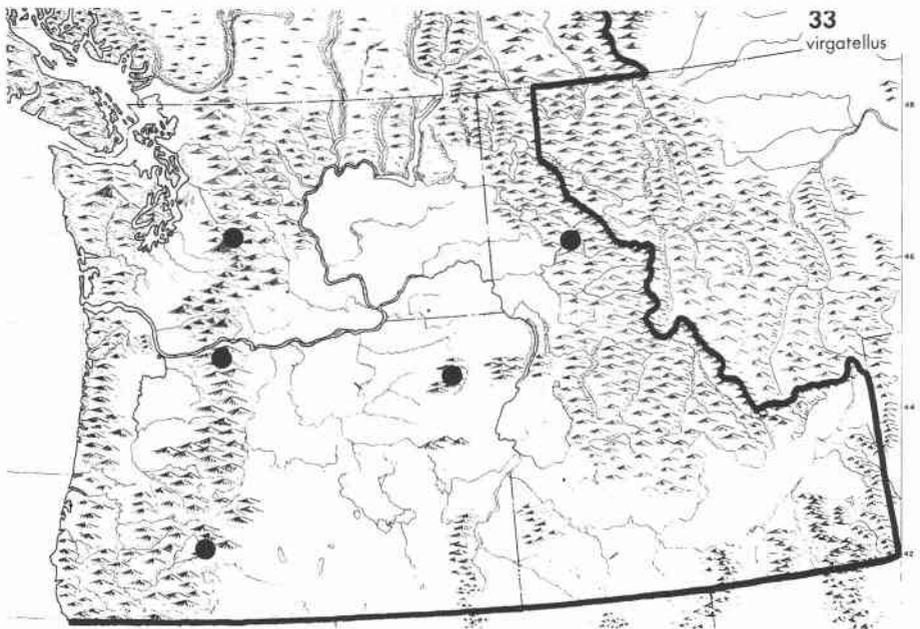
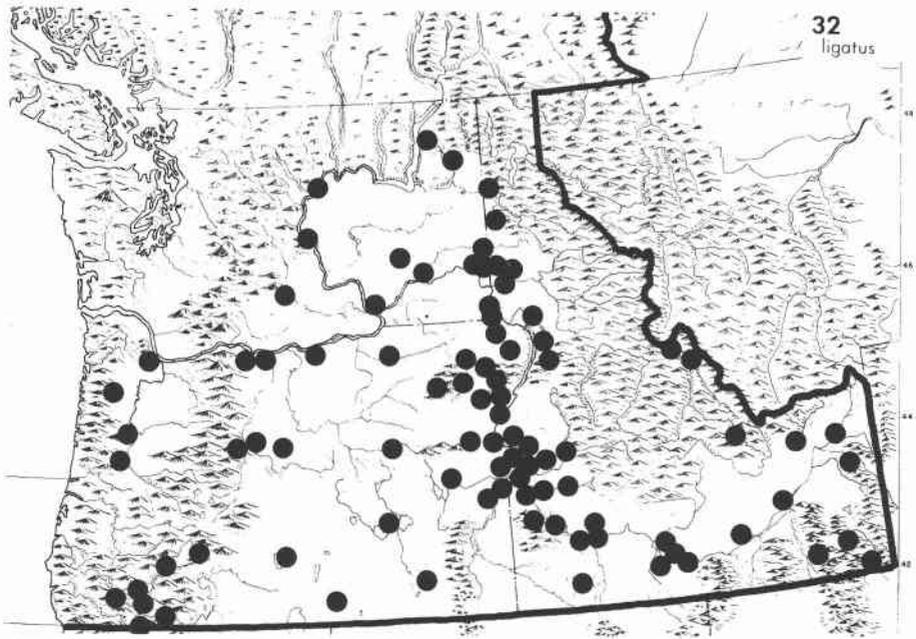
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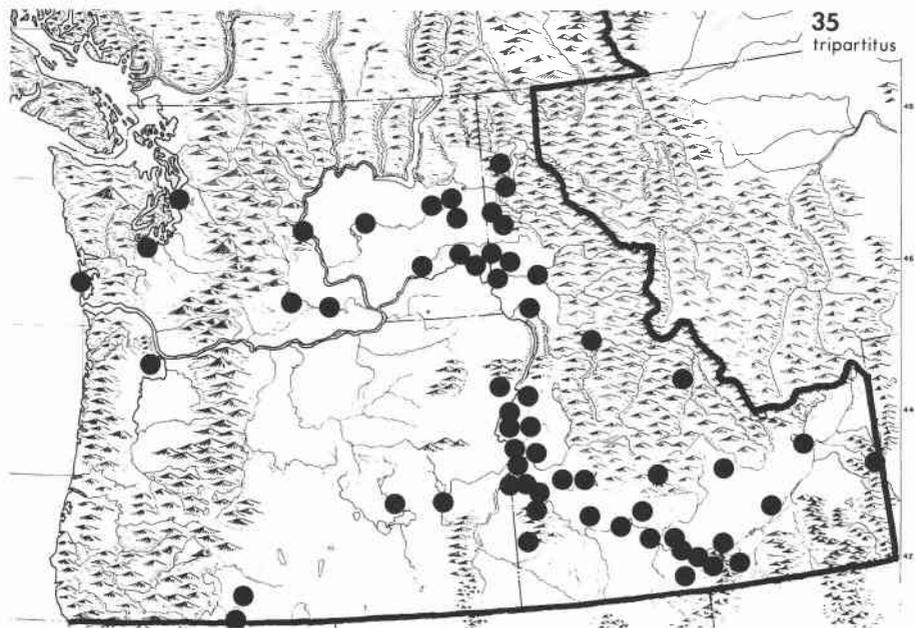
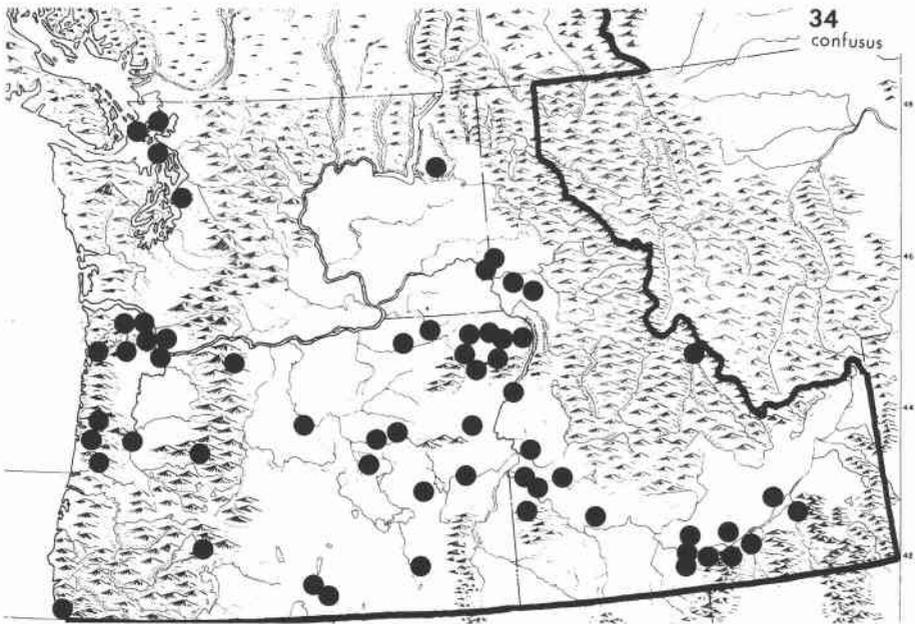
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Figures 30-31. Distribution of *H. farinosus* (Fig. 30) and *H. rubicundus* (Fig. 31) in Idaho, Oregon, Washington, and British Columbia.



Figures 32-33. Distribution of *H. ligatus* (Fig. 32) and *H. virgatellus* (Fig. 33) in Idaho, Oregon, Washington, and British Columbia.



Figures 34-35. Distribution of *H. confusus* (Fig. 34) and *H. tripartitus* (Fig. 35) in Idaho, Oregon, Washington, and British Columbia.