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(TECHNICAL BULLETIN) 40

NOVEMBER 1957

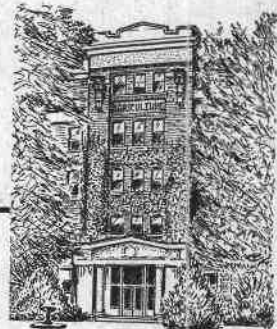
Bumble Bees of Western America

(Hymenoptera: Apoidea)

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(*Hymenoptera: Apoidea*)

Introduction

This research was undertaken as a preliminary study of Pacific Northwest bumble bees. Inevitable problems faced with studies of very restricted areas necessitated continued enlargement in scope, until bounds were drawn at the present limits. The area considered in detail includes the southern half of British Columbia, and the states of Washington, Idaho, Utah, Oregon, Nevada, and California. Opportunity has been taken to refer to the distribution of certain species beyond the immediate confines of the area cited above. In each instance this was done to secure certain necessary information for better understanding of the species involved.

The review has a twofold purpose. First, and most important, was preparation of a paper offering a satisfactory method of distinguishing the species and their numerous varietal designates published since Franklin's (1913) exhaustive study of Nearctic bumble bees. Second, was to acquaint the author with the group in Western America, preparatory to an expanded study of variation and systematics in the genus.

All the species and designated subspecies are redescribed fully, as many characters used by Franklin and subsequent authors were found to be unsatisfactory diagnostically, or else unmentioned characters were found to be more useful. To facilitate ready reference to the distribution of each species, locality records were plotted and appear as maps at appropriate places in the text. Male genitalia of all species are illustrated on a series of plates at the end of the bulletin.

The conventional synonymies are replaced by a catalog listing which includes reference only to the original description, synonyms, and homonyms.

Morphological terminology is that of Michener (1944), except the abdominal segments are numbered as if the propodeum were considered a portion of the mesosoma. Reference to the first metasomal segment is thus actually to the second true segment of the abdomen.

It was intended that brief notes on the bionomics of each species be included with the species descriptions; however, this information is so incomplete its inclusion does not seem justified.

Conclusions on the dispensation of many subspecies and varieties are based on the examination of approximately 35,000 specimens from western America.

Male Genitalia

As in most other groups of Hymenoptera the male genitalia of *Bombus* often offers discriminating characters when none other can be found. In most subgenera, and indeed in groups within the subgenera, the genitalic differences, while maintaining the structural cohesion of the taxon, present diagnostic features of unequalled value. Absence of these pronounced differences in genitalia among closely related species has led many workers in the group to reconsider the validity of the species within such complexes.

Within the subgenus *Pratobombus* it is sometimes impossible to distinguish among several species except by genitalic examination, and often this last resort fails. The subgenus, which is highly plastic, contains over half of the described species of American *Bombus*; of these, all but two occur in the western part of the continent. The recent origin and extreme plasticity of the group present numerous problems which cannot be solved by strict taxonomic means. As can be expected, problems of intergradation between presumably "valid" species within *Pratobombus* are common. This intergradation is by no means limited to color, but also to blending of various morphological characters including the genitalia. A glance at the genitalia of the species is sufficient to indicate their close relationship. Structural variability, not only between populations but within a single population of a given species, attests to their relatively recent origin and active evolution. Relationships of species of *Pratobombus* are discussed more fully below.

In spite of the wide usage of genital characters since 1884, there has not been a standardization of terminology for these structures. As indicated in a previous paper (Stephen 1954), available evidence indicates that primary genital structures of the ninth segment are serially homologous with legs, and the external genitalia of bees from the primitive *Paracolletes* through the highly specialized social forms are structurally homologous.

It is generally accepted that intergroup genitalic homology exists. There is considerable difference of opinion that the serial homology proposed by Michener (1944) is sufficiently documented for general acceptance. While additional morphological studies may prove few or many of his homologies to be in error, the general use of Michenerian terms in apoid systematics presents a workable standard for uniformity in capsule reference. This genitalic nomenclatorial system will be used by me until sufficient contrary documentary evidence is accrued.

Male genitalia as treated here, consist of the following parts (Figure 1):

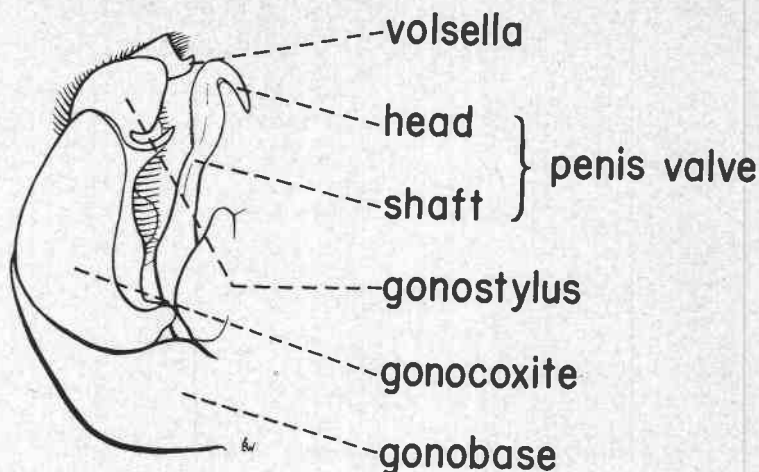


Figure 1. Capsule of male genitalia.

Seventh and eighth ventral plates (= outer and inner spathae = couvercle genital)—structurally homologous with the seventh and eighth metasomal sterna. These structures vary considerably in shape and size and are often of value as secondary diagnostic characters. It is suggested here that only when shape or hair pattern of this sternite are strikingly dissimilar should this character be used as one of specific status. In several of the subgenera containing groups of closely related species, features of this and the eighth sternum vary so greatly as to negate their use. Both plates are, however, of considerable value in determining relationship for they are essentially conservative in nature and undergo comparatively slow evolutionary change.

Gonobase (= cardo = basal ring)—a large basal sclerite providing for muscle attachments of the appendages of the ninth segment. This sclerite is of no diagnostic value.

Gonocoxite (= stipes = branch = parameral plate)—a lateral heavily sclerotized, and heavily muscled structure protecting the more delicate median penis valves and intromittent organ. The gonocoxite lacks the striking characters necessary for diagnosis, but does vary somewhat in shape.

Gonostylus (= squama = paramere = lacinia)—a weakly sclerotized structure attached to the apical end of the gonocoxite. It is either 1- or 2-lobed and of varying length. The gonostyli offer val-

uable diagnostic features at the species level in all subgenera except *Pratobombus*, in which they may be used in species grouping. Franklin and Frison have frequently referred to combined gonocoxites and gonostyli as the claspers, a term which has had wide acceptance by workers in this field.

Volsella (= lacinia = valvae internal)—an elongate process which appears to be an endite of the gonocoxite and attached to this structure near its base. Without exception the volsellae extend beyond the apical ends of the gonostyli and usually are densely haired. Apices of the volsellae bear variously shaped projections and are of variable width in relation to gonostyli width, thus making them of considerable diagnostic value. Caution should be practiced when using these apical structures of the volsellae as specific characters in closely related species groups.

Penis Valve (= sagitta)—an elongate, sclerotized structure lying mesad to each gonocoxite, arbitrarily divided into basal shaft and apical head. Penis valves offer the most reliable and striking characters of the capsule in both closely related and widely separated species. The head of the penis valve is a most useful species character since it takes on a variety of forms from broadly convoluted, to sickle-shaped, to an apical shaft extension.

Geographic Variation

It is difficult to present a general scheme of color variation exhibited by the bumble bees in western America; however, although generalizations may be hazardous, specific patterns and trends are discernible.

North-South Montane Distributions: In species distributed from the Arctic to southwestern United States in a general north-south plane, the most obvious color differences are in the intensities and contrasts of the color patterns. Arctic representatives of *bifarius* and *flavifrons*, and to a lesser extent *sitkensis*, *rufocinctus*, *sylvicola*, and *frigidus*, all have a much more intense yellow over the entire body than do their southern counterparts. It is felt this difference in intensity is not due solely to fading of pile, as newly emergent castes in all of these species exhibit little difference from the colony mother. Similar intensity differences in species having north-south distribution patterns are obvious in reds or red-ferruginous. Arctic specimens of *b. bifarius*, *rufocinctus*, *sylvicola*, and *f. flavifrons* all have a much brighter reddish pile on the metasoma. In association with increased intensity of the yellow pile this makes the color patterns much more striking and distinct.

In the preamble to *flavifrons* and *centralis* may be found a discussion of the relationships of those two species. Their identity in the southern limits of their range is subject to some question since both forms lose the metasomal ferruginous markings. Members of this complex from the southern Sierra Nevada, the San Bernardino, and the San Jacinto Mountains are somewhat arbitrarily designated as representatives of *centralis*. Regardless of species dispensation, the collections from that area are peculiar in having ferruginous pile on terga 2 and 3 (*centralis*) and black pile on these same terga (*flavifrons dimidiatus*) replaced by pale grayish-yellow. The San Bernardino-San Jacinto Mountain district is the known southern terminus of this complex and the continuum with the northern populations is apparently through the Sierras, rather than along the rather disjunct coastal Boreal outcroppings, even though individuals taken from Monterey and Santa Cruz-San Mateo areas resemble the southern populations most closely. Interesting points colorwise are replacement of the intense yellow of northern forms by a pale grayish-yellow; disappearance of the ferruginous; and black pile no longer offering sharp contrast. Rather a casual blending of the yellow with gray or grayish-black pile appears on the face, thoracic dorsum, and abdomen.

O. occidentalis is the only American species of wide distribution having areas of white pile on the terga. In this species the greatest quantity of white pile is found in northern and Boreal populations.

As one examines a north-south or Boreal-Sonoran cline of this species, the amount of white pile decreases, and the color assumes a tinge of gray or yellow-gray. A number of females taken from the central-interior of British Columbia and from the Boreal life zones of Idaho and Oregon have terga 4 to 6 of the metasoma completely covered with a bright, white pile, and among these specimens there are often trace amounts of white to the apex of tergum 3. The amount of white pile decreases in specimens taken from the southern Boreal zones and the Transitional life zones of the northwest. Populations occupying the extreme coastal margins invariably have the light pile restricted apically from the midline of tergum 4, and in many, only tergum 5 and 6 are so covered.

Color patterns in themselves may offer an increase in survival potential of a species. This is strikingly evident in the numerous mimics and melanics that have been reported in the Lepidoptera.

In the bumble bees it appears probable that existing color patterns, in themselves, contribute little to the success or failure of a given species. Color patterns, whether they be stable or variable in a species range, appear to be only a phenotypic expression of underlying genetic influence. If a set of alleles existing at a given locus offers some adaptive value to the species, each allele will have an unequal survival value. (Fisher has shown that while it is possible for a pair of alleles to have equal survival value, the preciseness of this adaptive neutrality must be so keen that the situation is rare.) No matter how small the adaptive superiority of one allele over the other, we could expect to find one phenotype gaining precedence over the others within a period of time.

From the analysis of populations of several polymorphic bumble bee species in the past three years and examination of long series of specimens collected over the past 60 years from western America, it is concluded this latter situation does not pertain. It appears that in polymorphic *rufocinctus* and *b. occidentalis*, genes for color control act independently from any physiologically adaptive norm. At least present evidence would not favor a hypothesis for linkage. For example, if color patterns were linked to physiological change, exceptional color differences in individuals from a single nest would lead to the belief that over half of the "aberrant" forms would then be physiologically and reproductively incompatible.

Variation in male color patterns of *rufocinctus* is discussed under that species. There are three different color patterns evident on faces of the males, three on the thoracic dorsum, and a multitude on the metasomal terga (see table 1). Color variation on the head and thorax is disregarded in this discussion and investigation is concentrated on the metasoma. Representatives of all of the described var-

iants plus several undescribed were found from the three complete nests examined. A total of 11 different variants were collected. The male, being haploid, has two possible color forms if the color of the metasoma is to be considered multiple allelic. The seven color variants taken from a single nest, therefore indicate that color patterns of the metasoma have a multifactorial basis, for multiple matings of the queen would have no effect on the haploid progeny produced. It is possible that one or more queens may supersede the original colony founder, accounting for some variation in total colony population during a single season. It is unlikely, however, that this is true in all examined nests, and it is also unlikely that queen replacement would occur during the relatively short period in late summer when the preponderance of haploid eggs are laid. Color variability in *rufocinctus* and *o. occidentalis* suggests that simple genetic alleles located at several loci control color, and that these species are strongly heterozygous for such genes.

This bulletin assumes that color is multifactorially controlled and linkage is unlikely. It then seems logical to agree that very slight, or perhaps no, physiological differences and therefore no selective advantage exist between several broadly divergent forms (colorwise) in a single population; or more precisely, that degree of phenotypic color variation is not indicative of the similar degree of magnitude in physiological and/or ecological adaptiveness.

It may be construed from the above that tolerance and latitude of color expression are great, and only when of distinct disadvantage is such a variant eliminated from a population. On the basis of the habits of bumble bees, their general polylectic tendencies, and their universal holarctic distribution, it appears that little direct selective advantage can be attributed to the presence or absence of yellow, black, white, or red body pile. The common occurrence of 1, 2, and 3 colors in a single population attests to this conclusion.

Further, the hypothesis that color is the effect of several genes acting cumulatively would lead to the possibility that independent action of these color determinants would result in a mathematical probability of identical color patterns appearing in two or more species. This is borne out in several unrelated species, some in markedly different subgenera. Perhaps the most striking resemblance exists between *vosnesenskii* and *caliginosus*. Both sexes are, for practical purposes, identical in color pattern and can be distinguished with certainty only on the basis of male genitalia. The two species are not completely allopatric but areas of overlap are very narrow. Both species belong to the same group. Similar duplications in color patterns occur between sympatric *appositus* and *fervidus* which are totally unrelated; between allopatric *fervidus* and *sonorus* (yellow

form); between *fervidus* and *californicus*; between *sonorus* and *nevadensis*; among *bifarus*, *huntii*, and *ternarius*; and etc.

Color similarities listed here and elsewhere in this bulletin are not to be taken as the result of excessive taxonomic splitting, for some criticism is expected of the conservative treatment accorded many of the subspecies and varieties now accepted in bumble bee nomenclature. Distinctiveness has been sacrificed for continuity within the species, the subgenera, and groups; but if contemporary or future workers were to reevaluate many of the synonymized population variants to varietal level there would be no recourse to such action. Differences in nomenclatorial practices, if they do arise, will have their foundation in concept interpretation (see Stephen, *Infra-specific Categories*, in press).

MELANISM. Several melanic specimens have come in collections from the Seattle, Washington area. All the material has been *occidentalis occidentalis*, and the degree of melanism has varied. Two of the 11 specimens recorded are completely melanistic, having no trace of either yellow or white pile, while the other 9 have faint yellowish casts to certain areas of the thorax or dull gray casts to the pile on the apical abdominal terga. These specimens were collected during the past 20 years; the first appearing in 1935, while others were taken at intervals between that time and 1950. There appears to be no numerical increase in their abundance if proportions of such individuals in collections can be used as a criterion.

The common occurrence of melanics, particularly in the Lepidoptera, has prompted considerable interest in their evolutionary significance. Ford (1955) presents a brief review of melanism genetics in several moths, and concludes that in all known forms the factor for melanism is either a partial or complete dominant. In many melanic forms it is unifactorial; however, in *Lymantria monacha* it appears to be due to cumulative action of three dominants.

Color control as a whole, including melanism, is so completely unknown in bumble bees that speculation as to its origin would be without foundation. In summary then, I am committed to the contention that it is more probable that color (and this would apply equally well to melanism) is under the control of several genes at different loci, rather than considered as the effect of multiple allelomorphs.

Of the several thousand specimens of *o. occidentalis* examined, only the 11 mentioned above are partial or complete melanics. Two specimens appear completely dark, and the other 9 have obvious traces of normal color patterns masked by melanin deposition. From this information it could be construed that melanism in *occidentalis* is unifactorial and the gene is a partial dominant. Incomplete melan-

ism would be the result of this factor in the heterozygous state, and complete, from the factorial homozygosity. Absence of male melanics is interesting, as collections of males from that area are numerically as great, or greater, than of females. This immediately prompts further speculation about melanism being sex-limited in this group, but such speculation could have no foundation with the limited sample and lack of genetic analysis.

Supraspecific Groupings Within the Genus *Bombus*

This study was not intended to include a detailed account of groupings of species within the genus but rather to acquaint the author with the species in an area where the genus is well represented and where the species exhibit a high degree of polymorphism. However, certain impressions are bound to be felt on the supraspecific groupings when any exhaustive study of related forms is undertaken. For the purposes of this paper the subgeneric limits as erected and defined by Vogt (1911), Krüger (1920), Franklin (1913), and Frison (1927) are followed. The lead of Skorikov (1922) in elevating various phyletic lines of this homogeneous group to generic level is rejected in favor of recognizing species groups as indicators of the closeness of relationships. The very process of splitting a homogeneous group into a number of distinct genera destroys Skorikov's prime objective—the indication of species relationship.

Within the genus three sections are recognized: *Odontobombus*, *Anodontobombus*, and *Boopobombus*. Within each of these groups are several species of intermediate nature which can be neatly fitted into the proposed groups when a rather selective, few characters are considered. The difficulty in citing clear breaks between each of the subjective limits of species groups, whether they be called genera (as proposed by Skorikov), subgenera, or sections, attests strongly to the homogeneity of the unit, and calls for a close scrutiny of contents with each species group.

The species included in this paper are grouped as follows:

SECTION: *Odontobombus* Krüger

Subgenus *Subterraneobombus* Vogt
appositus Cresson

Subgenus *Fervidobombus* Skorikov
californicus californicus F. Smith
californicus consanguineus Handlirsch
fervidus (Fabricius)
sonorus Say

SECTION : *Boopobombus* Frison

Subgenus *Bombias* Robertson
nevadensis nevadensis Cresson
nevadensis miguелensis Cockerell

Subgenus *Separatobombus* Frison
crotchii crotchii Cresson
crotchii semisuffusus Cockerell
griseocollis (Degeer)
morrisoni Cresson

Subgenus *Culumanobombus* Vogt
rufocinctus Cresson

SECTION : *Anodontobombus* Krüger

Subgenus *Bombus* Latreille
franklini (Frison)
occidentalis occidentalis Greene
occidentalis nigroscutatus Franklin
terricola Kirby

Subgenus *Pratobombus* Vogt
bifarius bifarius Cresson
bifarius nearcticus Handlirsch
caliginosus (Frison)
centralis Cresson
edwardsii Cresson
flavifrons flavifrons Cresson
flavifrons dimidiatus Ashmead
frigidus F. Smith
huntii Greene
melanopygus Nylander
mixtus Cresson
sitkensis Nylander
sylvicola Kirby
ternarius Say
vagans Smith
vandykei (Frison)
vosnesenskii Radoszkowski

Key to Queens and Workers

1. Metasomal terga 2 and/or 3 completely covered with ferruginous or orange pile 2
Metasomal terga 2 or 3 with pile yellow or black or with traces of ferruginous or orange pile 9
- 2(1). Scutum with portion anterior to tegulae with black and yellow pile intermixed giving surface a clouded appearance 3
Scutum anterior to tegulae with pile yellow not clouded 4
- 3(2). Tergum 2 with pile all yellow *flavifrons flavifrons*
Tergum 2 with pile all ferruginous *melanopygus*
- 4(2). Metasomal tergum 4 with pile exclusively or predominantly ferruginous *centralis*
Metasomal tergum 4 with pile usually yellow but often with some black intermixed 5
- 5(4). Scutellum with V-shaped notch of black pile extending back to posterior margin (corbicular fringes with pile bright ferruginous) *bifarius bifarius*
Scutellum with pile all yellow particularly about posterior one-half 6
- 6(5). Ocelli situated well below the supraorbital line; interalar band of black pile narrow and intermixed with yellow laterally (malar spaces three-quarters as long as apical widths) *rufocinctus*
Ocelli situated at supraorbital line; interalar band broad and with little or no yellow intermixed laterally 7
- 7(6). Malar spaces three-quarters as long as apical widths; (face with yellow in area about antennal bases, abundant black laterally but with little yellow or black intermixed) *ternarius*
Malar spaces as long as apical widths 8
- 8(7). Face with pile all yellow except for weak peripheral fringes of black; metasomal tergum 4 with pile all or predominantly yellow *huntii*
Face with pile preponderantly black, some yellow intermixed below antennal bases; tergum 4 with strong admixture of black pile medially *sylvicola*
- 9(1). First metasomal tergum with pile black 10
First metasomal tergum with pile yellow 15

- 10(9). Metasomal tergum 5 and/or 6 and sometimes 4 with pile pale ferruginous, pale yellow, light gray, or white.... 11
Metasomal terga 5 and 6 with pile all black 13
- 11(10). Vertex with pile predominantly yellow; corbicular fringes black 12
Vertex with pile mainly black; corbicular fringes with pile pale ferruginous *occidentalis*
- 12(11). Metasomal tergum 2 with pile yellow *crotchii*
Metasomal tergum 2 with pile all black *franklini*
- 13(10). Face with pile black; metasomal terga 2 and 3 with pile yellow *terricola*
Face with pile yellow; metasomal terga 2 and 3 with pile black 14
- 14(13). Flagellar segment 3, three-quarters as long as first; malar spaces as long as apical widths, to $1\frac{3}{4}$ as long as apical widths; metasomal sterna 4 and 5 with apico-lateral admixture of yellow pile *caliginosus*
Flagellar segment 3 subequal to 1; malar spaces three-quarters, to barely, as long as apical widths; metasomal sterna 4 and 5 with pile all black *vosnesenskii*
- 15(9). Mesopleura with pile below lateral lobes of pronotum, black 16
Mesopleura with at least upper one-half covered with light pile 20
- 16(15). Metasomal tergum 4 with pile yellow 17
Metasomal tergum 4 with pile black, never more than one-third of discal area with yellow pile 18
- 17(16). Metasomal terga 2 and 3 with pile yellow or yellowish grey *appositus*
Metasomal terga 2 and 3 with pile black or predominantly so *californicus*
- 18(16). Malar spaces shorter than apical widths; vertex with pile yellow *morrisoni*
Malar spaces as long as or longer than apical widths; vertex with pile mainly black 19
- 19(18). First flagellar segment barely longer than third; interalar band usually broad, black, and distinct *sonorus*
First flagellar segment equal to combined length of 2 and 3; interalar band absent, black pile present as median patch *nevadensis*

20(15).	Metasomal tergum 6 with pile yellow to ferruginous....	21
	Metasomal tergum 6 with pile black	24
21(20).	Scutellum with pile predominantly black to posterior margin, a few light hairs intermixed peripherally	22
	Scutellum with abundant light pile particularly about peripheral one-half, some black pile on medioanterior face	23
22(21).	Malar spaces $1\frac{1}{2}$ times as long as apical widths.....	
 <i>flavifrons dimidiatus</i>	
	Malar spaces as long as apical widths	<i>sitkensis</i>
23(21).	Scutum with face anterior to bases of tegulae having strong admixture of black and yellow pile, giving surface a clouded appearance	<i>mixtus</i>
	Scutum with pile anterior to tegulae yellow, not clouded by admixture of black pile	<i>frigidus</i>
24(20).	Metasomal tergum 4 with pile yellow	25
	Metasomal tergum 4 with pile black	32
25(24).	Malar spaces at least $1\frac{1}{3}$ times as long as apical widths..	26
	Malar spaces no longer than apical widths	29
26(25).	Scutum with a strong admixture of yellow and black pile giving scutellum and anterior face of scutum a clouded appearance	<i>flavifrons dimidiatus</i>
	Scutum with no black intermixed over anterior face.....	27
27(26).	Metasomal tergum 5 with pile all, or mostly yellow.....	
 <i>appositus</i>	
	Metasomal tergum 5 with pile black or predominantly so	28
28(27).	Metasomal terga 2 and 3 with pile all yellow, no black intermixed	<i>fervidus</i>
	Metasomal terga 2 and 3 with lesser or greater amounts of black pile on disc	<i>californicus consanguineus</i>
29(28).	Interalar band forming V-shaped notch of black pile reaching to posterior margin of scutellum; mesopleura with pile black	<i>bifarius nearcticus</i>
	Interalar band with posterior margin entire, not extending deeply onto scutellum; mesopleura with pile mainly yellow	30

- 30(29). Face with pile yellow, except for a small amount of black along inner orbital margins*edwardsii*
 Face with pile black, a few shorter yellow or pale gray hairs between antennal bases 31
- 31(30). Hypopygium with no median carina; malar spaces three-quarters, to as long as, apical widths; metasomal terga 2 and 3 with pile all ferruginous to orange*sylvicola*
 Hypopygium with strong medioapical carina; malar spaces $\frac{1}{2}$ to $\frac{3}{8}$ as long as apical widths; terga 2 and 3 primarily black*rufocinctus*
- 32(24). Malar spaces five-eighths as long as apical widths; ocelli situated well below supraorbital line*griseocollis*
 Malar spaces slightly longer than apical widths; ocelli situated at supraorbital line 33
- 33(32). Face with pile black; thoracic dorsum with pile all yellow, except for median patch of black*vagans*
 Face with pile pale grayish-yellow; thoracic dorsum usually with black interalar band, some black pile intermixed over anterior face of scutum and scutellum*flavifrons dimidiatus*

Key to Males

1. Eyes large, protuberant; ocelli placed well below supra-orbital line; malar spaces less than one-half as long as broad 2
 - Eyes not protuberant; ocelli placed at or above supra-orbital line; malar spaces at least three-quarters as long as apical widths 6
- 2(1). Thoracic pleura with pile black 3
 - Thoracic pleura with yellow pile predominating to coxal bases 4
- 3(2). Thoracic dorsum with distinct black interalar band; metasomal tergum 1 with abundant black pile medially *crotchii*
 - Thoracic dorsum with pile all yellow, a few black hairs medially; metasomal tergum 1 with pile lemon yellow *morrisoni*
- 4(3). Thoracic dorsum with black pile restricted to median circular patch; inner orbital margins strongly convergent above; volsellae protruding no more than length of gonostyli 5
 - Thoracic dorsum with interalar band more nearly complete, often intermixed with yellow; inner orbital margins parallel; volsellae long and protruding twice the length of gonostyli *rufocinctus*
- 5(4). Metasomal terga 3 and 4 with pile yellow *nevadensis*
 - Metasomal terga 3 and 4 with pile all black *griseocollis*
- 6(1). Metasomal tergum 7 and usually 6 with pile all ferruginous, yellow or white 7
 - Metasomal tergum 7 with pile all black 12
- 7(6). Metasomal terga 1 to 4 with pile all black; head as broad as long *franklini*
 - Metasomal terga 1 to 4 with some segments covered with yellow or ferruginous pile; head longer than broad 8
- 8(7). Metasomal tergum 1 with pile all black; pleura all black or with strong admixture of black pile especially posteriorly 11
 - Metasomal tergum 1 with pile all yellow; pleura with pile all light 9

- 9(8). Basal flagellar segments with tufts of hair laterally; posterior tibiae with pile all light ferruginous; metasomal tergum 4 with pile all ferruginous *mixtus*
 Basal flagellar segments with no hair tufts; posterior tibiae with admixture of black pile; metasomal tergum 4 with black pile predominating 10
- 10(9). Face with pile above antennal bases predominantly black or dark; interalar band distinct; tergum 3 with pile all black *frigidus*
 Face with pile above antennal bases yellow; interalar band obscure; tergum 3 with some yellow intermixed apically *sitkensis*
- 11(8). Metasomal tergum 2 with pile all yellow; tergum 4 and most of 5 with pile black *terricola*
 Metasomal tergum 2 with pile all or some black; terga 4 and 5 with pile yellow or white *occidentalis*
- 12(6). Metasomal tergum 1 with pile black 13
 Metasomal tergum 1 with pile yellow or mostly so 17
- 13(12). Metasomal tergum 4 with pile black 14
 Metasomal tergum 4 with pile yellow 15
- 14(13). Metasomal terga 2 and 3 with pile yellow *terricola*
 Metasomal terga 2 and 3 with pile black *franklini*
- 15(13). Face with black pile predominating *californicus*
 Face with pile yellow 16
- 16(15). Penis valves with apices distinctly globular; flagellar segments 1 and 3 subequal; malar spaces $1\frac{1}{2}$ to $1\frac{3}{4}$ times as long as apical widths *caliginosus*
 Penis valves with apices narrowed, almost pointed; flagellar segment 1 shorter than 3; malar spaces one and one-fourth times as long as apical widths *vosnesenskii*
- 17(12). Metasomal terga 2 and 3 with pile predominantly ferruginous; tergum 4 with pile yellow, at least laterally.... 18
 Metasomal terga 2 and 3 with pile yellow, black or only 3 ferruginous 23
- 18(17). Thoracic dorsum with admixture of yellow and black pile giving surface a clouded appearance; metasomal tergum 5 with pile almost wholly black 19
 Thoracic dorsum with pile yellow anterior to bases of tegulae; metasomal tergum 5 with pile predominantly yellow (except *ternarius*) 20

- 19(18). Interalar band with posterior margin straight; scutellum with dense yellow pile; abundant yellow pile immediately above antennal bases*melanopygus*
Interalar band with posterior margin V-shaped on to scutellum, black pile extending well back on scutellum; little or no yellow pile immediately above antennal bases*sylvicola*
- 20(18). Interalar band with posterior margin straight and distinct; posterior tibiae with numerous short black erect hairs on upper surface, fringes light*huntii*
Interalar band with posterior margin V-shaped on to scutellum, black pile extending towards posterior margin of scutellum; posterior tibiae with pile on upper surface ferruginous, fringes long and ferruginous 21
- 21(20). Flagellar segments strongly crenate ventrally; metasomal tergum 5 with pile predominantly black laterally*ternarius*
Flagellar segments filiform; metasomal tergum 5 with pile light laterally 22
- 22(21). Penis valves with apices distinctly globular; pile above antennal bases black*sylvicola*
Penis valves with apices narrowed, almost pointed; pile above antennal bases yellow*bifarius bifarius*
- 23(17). Metasomal terga 3 and 4 with ferruginous pile predominating 24
Metasomal terga 3 and 4 with pile yellow, black, or admixture of both 25
- 24(23). Interalar band usually distinct laterally to wing bases; malar spaces $1\frac{1}{4}$ times as long as apical widths; scutum anterior to bases of tegulae with yellow pile, little or no black intermixed*centralis*
Interalar band obscure, abundant light pile intermixed laterally; malar spaces $1\frac{1}{4}$ times as long as apical widths; scutum anterior to wing bases with some black pile intermixed, often giving surface a clouded appearance*flavifrons flavifrons*
- 25(23). Metasomal tergum 4 with pile black*vagans*
Metasomal tergum 4 always with yellow pile predominating 26

- 26(25). Gonostyli with long, medially directed basal endites; penis valves with apices broadly dilated and irregular (figure 8) 27
 Gonostyli uniformly rounded without endite process; penis valves with apices sickle-shaped and uniform (figure 18) 30
- 27(26). Metasomal tergum 6 with pile all or predominantly yellow *appositus*
 Metasomal tergum 6 with pile all or primarily black 28
- 28(27). Metasomal terga 2 and 3 with some black pile intermixed with yellow *californicus consanguineus*
 Metasomal terga 2 and 3 with pile all yellow 29
- 29(28). Metasomal tergum 5 with pile all black or with yellow basally; penis valves with apices extended apically (figure 9) *sonorus*
 Metasomal tergum 5 with pile all yellow, yellow often extending to base of tergum 6; penis valves with apices blunt (figure 8) *fervidus*
- 30(26). Malar spaces $1\frac{1}{2}$ times as long as apical widths; metasomal tergum 2 with yellow pile predominating *flavifrons dimidiatus*
 Malar spaces no more than one and one-eighth times as long as apical widths; metasomal tergum 2 with black pile predominating, especially laterally 30
- 31(30). Scutellum with a V-shaped notch of black pile extending back from interalar band to posterior margin; posterior tibiae with pile all light ferruginous; eighth ventral plate deeply emarginate apically (figure 29) *bifarius nearcticus*
 Scutellum with pile all yellow; posterior tibiae with pile all dark, a few hairs with tinges of dark ferruginous; eighth ventral plate quadrate apically (figure 22) .. *edwardsii*

Species Descriptions and Comments

Section: *Odontobombus* Krüger

Odontobombus Krüger, 1917. Ent. Mitteil. 6: 61.

Males: Eyes not protruding beyond sides of head; ocelli placed at supraorbital line; malar spaces longer than apical widths; volsellae protruding beyond apices of gonostyli, with laterally directed process arising from medioapical margin; gonostyli with strong medially directed basal endites.

Females: Ocelli and compound eyes small, ocelli situated at supraorbital line; middle metatarsus each with a strong tooth at the basoposterior margin; hind metatarsi distinctly spined, spines strong and sinuous; mandible with a distinct basal carina and accompanying basal furrow on lower basal face of disc.

Subgenus *Subterraneobombus* Vogt

(= *Borealis* group, Franklin)

Bombus subg. *Subterraneobombus* Vogt, 1911. Gesell. Naturf. Freunde Sitzber., p. 62.

Type: *Apis subterraneus* Linnaeus. Desig. Frison, 1927.

Males: Malar spaces longer than the apical widths; posterior tibiae with short indistinct corbicular fringes; volsellae protruding greatly beyond ends of gonostyli; apices with recurved medially directed apical projections, projections coarse and irregular; gonostyli with broad sickle-shaped basal endites; penis valves with broadly dilated irregular heads; seventh ventral plates broad and robust, about half as long as wide, when measured along median longitudinal line; eighth ventral plates robust with apical one-half quadrate, dense hair covering over apical one-third and along lateral margins; two longitudinal chitinous bands along median face of plates.

Bombus appositus Cresson

Bombus appositus Cresson, 1878. Acad. Nat. Sci. Philadelphia, Proc., p. 183.

This species resembles *B. fervidus* superficially but is not even closely related to that species. Its closest American relative is *B. borealis* found in the area east of the Rocky Mountains; yet it may prove that *appositus* ranks but subspecifically distinct from that species.

Queens and workers of *appositus* can be distinguished from *fervidus* since the former have predominantly light face pile and their fifth metasomal tergum pile is yellow rather than black. Males are much more difficult to distinguish from *fervidus*. They have the

first antennal segment much longer than the second, whereas in *fervidus* the two segments are subequal.

B. appositus is a common species in the Pacific Northwest but its range ends rather abruptly in the higher altitudes of northern California.

QUEENS:

Ocelli situated at the supraorbital line; malar spaces $1\frac{1}{3}$ to $1\frac{1}{2}$ times as long as apical widths; first flagellar segment almost $1\frac{1}{2}$ times as long as third; third segment one-quarter longer than second; tegulae shining brownish-black; wings brown; nervures dark brown to black.

Vertex with abundant, erect, pale yellow pile; face with pile long and pale yellow to white; area behind the eyes with pile mostly black; thoracic dorsum with pile anterior to interalar band pale yellow to white; scutellum with the pile long, dense, and distinctly yellow; thoracic pleura with light pile extending below the lateral lobes of the pronotum; mesopleura with pile usually predominantly black. Metasomal terga 1 to 5 with the pile all yellow; the pile medially on terga 2, 3, and 4 occasionally tinged with light ferruginous but blending with the yellow laterally; metasomal tergum 6 with pile all black; metasomal sterna with weak apical fringes of long white pile. Anterior two pairs of legs with pile black; posterior trochanters and femora with weak fringes of white pile posteriorly; corbicular fringes black.

WORKERS:

Identical with the queens except for their smaller size.

MALES:

Ocelli at supraorbital line; malar spaces $1\frac{1}{3}$ to 2 times as long as apical widths; flagellum very long; third flagellar segment approximately one-quarter longer than first; first segment one-third longer than second; tegulae deep brownish-hyaline.

Vertex with pile light yellow to whitish, a few dark hairs at lateral margins; face with an admixture of whitish and black pile; pile above antennal bases almost entirely black, below antennal bases pile predominantly white with some longer and coarser black hairs. Interalar band broad and black; anterior portion of scutum with the pile pale yellow to white; scutellum with the pile long, dense, and tinged with yellow; mesopleura covered with abundant long whitish pile; the posterior portion of the mesopleura, metapleura, and propodeum having black pile. Metasomal terga 1 to 5 with pile all yellow; tergum 6 with pile predominantly yellow on the apical and lateral margins, occasionally a mediolaterally directed band of black pile; tergum 7 with the pile all black; metasomal sterna with apical fringes of white pile. Femora with abundant, long, whitish pile over upper and posterior surfaces; tibiae with pile all black; posterior tibiae with very short, sparse, black pile.

Male genitalia: (figure 6). The apices of the penis valves are sharply expanded having almost a semilunar margin; the gonostylus and apex of gonocoxite are peculiar to this species.

VARIATION:

The thoracic pleura in most of the northern specimens and in those taken at the higher altitudes in areas of eastern Washington, Oregon, and Idaho have predominantly black pile. In the lower valleys, particularly coastal valleys of Oregon and Washington as well as

interior valleys of Washington and British Columbia, the amount of light pile increases, in some cases appearing to extend down to the coxal bases. The pile on the thoracic pleura of the male varies much as in the female but there does not appear to be the same definite topographic correlation. Black pile on the sixth metasomal tergum of some males is restricted to a very small median portion of the segment and in a few is barely evident. In others there is abundant black pile over the median and mediolateral margins with only the lateral apical margins exhibiting traces of yellow. Otherwise this species is remarkably constant in its color patterns with greatest variation noted in the fading of the yellow pile. The yellow is rarely intense and in many specimens is faded to a pale gray or white.

DISTRIBUTION:

This species appears to be most abundant in higher elevations of eastern Oregon and Idaho, being the predominant species between 3,500' and 5,000'. It occurs in lesser numbers along the Cascades and in the coastal plains of British Columbia and Washington, in the Willamette Valley and Cascades of Oregon, and at elevations over 5,000' in northern California (Map 1.).

BRITISH COLUMBIA:

Chapman; Chase; Chilcotin; Clinton; Cranbrook; Crows Nest; Hat Creek; Invermere; Kamloops; Kaslo; Minnie Lake; Nicola; Okanagan Lake; Penticton; Quesnel; Salmon Arm; Vancouver; Vernon; Yale.

WASHINGTON:

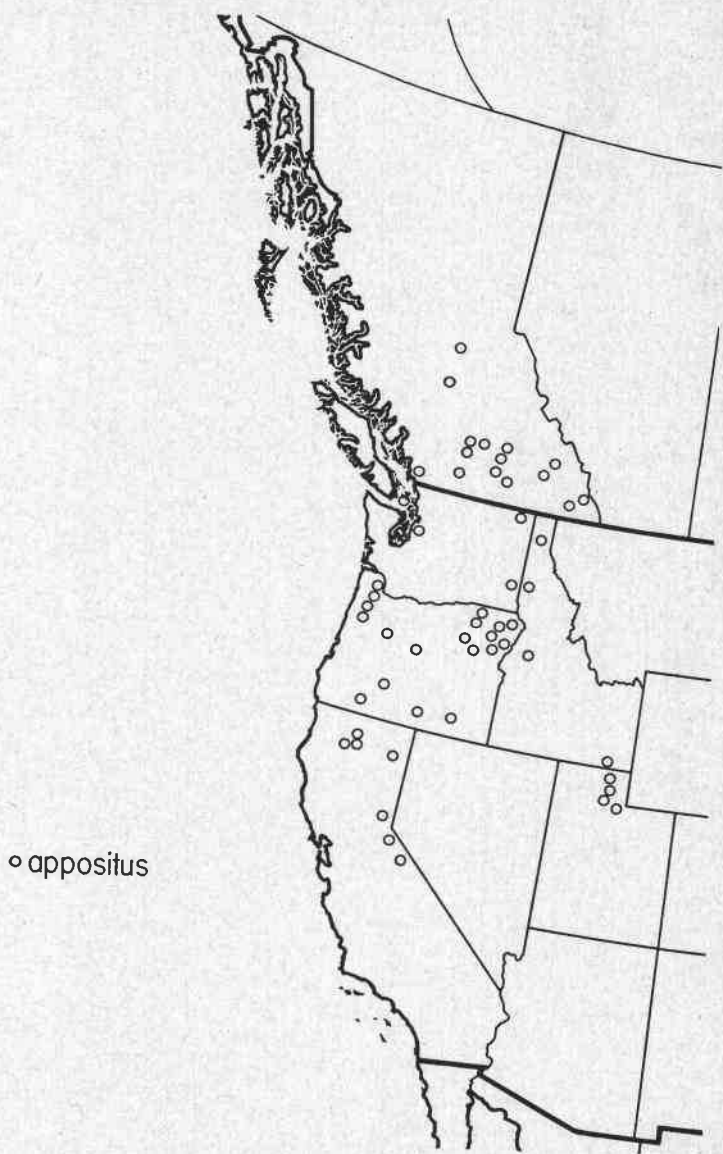
Friday Harbor; Northport; Pullman; Table Rock; Seattle; Wawawai; Whidby Island.

OREGON:

Alsea; Amity; Ashland; Baker; Blooming; Boyd; Carlton; Clackamas County; Cornucopia; Corvallis; Cove; Diamond Lake; Drake Peak; Forest Grove; Halfway; Hillsboro; Imnaha; Langdon Lake; Lostine; Meacham; Medford; Milton; North Powder; Ochoco Pass; Pendleton; Pine Creek; Prairie City; Prineville; Rickreall; Salem; Scappoose; Sheridan; Sherwood; Sulphur Springs; Summit Prairie; Union; Wallowa Lake; Waterloo; Wild Horse Canyon; Steens Mountains.

CALIFORNIA:

Alpine County: Hope Valley; Sonora Pass, 10,000'.
Mono County: Sardine Lake, 8,500'; Lake City.
Lassen County: Blue Lake.
Shasta County: Castella.



Map 1. Map showing the distribution of *appositus*.

Siskyou County: Sisson.

Sierra County: Webber Lake.

Trinity County: Coffee Creek; Carrville; Nash Mine.

IDAHO:

Central Grade; Deary; Donnelly; Franklin; McCall; Moscow; Preston; Sand Point.

UTAH:

Blacksmith Fork Canyon; Echo, Summit County; Logan; Ogden; Providence; Smithfield; Willard Peak, 8,000'; Elk Ridge; Provo.

BIOLOGY:

Little is known concerning the biology of this species. I have noted two nest entrance holes used by this species in the Wallowa Mountains of eastern Oregon. These were located at the edge of a woodland meadow at 4,100', hidden in clumps of long, dense grass.

FLIGHT RECORDS:

The queens have been recorded as flying between March 15 and August 10; workers from June 7 to September 12; and males June 29 to September 12.

The type of *appositus* is in the collections of the Academy of Natural Sciences of Philadelphia.

Subgenus *Fervidobombus* Skorikov

(= *Dumoucheli* group, Radoszkowski, Franklin)

Fervidobombus Skorikov, 1922, Sta. Région. Protect. Plantes, Petrograd 4:153.

Type: *Apis fervida* Fabricius, Desig. Frison, 1927.

Males: Malar spaces longer than apical widths; posterior tibiae with faces convex, corbicular fringes absent, a few short hairs over surface; capsule very broad basally, shorter than in *Subterraneobombus*; apices of volsellae much more truncate than in *Subterraneobombus* and with medioapical recurved processes, volsellae protruding beyond apices of gonostyli; gonostyli short and broad with long, medially directed, basal projections; penis valves short and thick basally, apices dilated, laterally directed with margins distinctly serrated; seventh ventral plates broad and robust, resembling those of *Subterraneobombus*; eighth ventral plates with apical discal area not nearly so broad as in *Subterraneobombus*, weakly and uniformly emarginate subapically, traces of two longitudinal chitinous bands medially.

Bombus fervidus (Fabricius)

Apis fervida Fabricius, 1798. Sup. Ent. System., p. 274.

Bombus fervidus var. *dorsalis* Cresson, 1879. Amer. Ent. Soc. Trans. 7:230.

Bombus nevadensis race *aztecus* Cockerell, 1899. Ann. Mag. Nat. Hist. (7)4:389.

Bombus fervidus var. *umbraticollis* Friese, 1931. Konowia 10:301.

This species is very close to *B. californicus consanguineus* and separation of the two is difficult. There are no morphological features in either species by which they can be distinguished, and separation is made exclusively on color patterns. A number of specimens appear to be intermediates between *consanguineus* and *fervidus* and these are impossible to place with accuracy.

Typical forms of *californicus* and *fervidus* can be readily separated by the distinctive color patterns of each, and in areas where the two species coexist, i.e. Willamette Valley of Oregon, intermediate color forms are poorly represented. The color form intermediate between the typical *californicus* and *fervidus* is here called *c. consanguineus*. This subspecies occurs sparingly in western Oregon and Washington but is the predominant form in a very restricted area from the Cascades to the Blue Mountains of Oregon. In all other portions of their ranges, typical members of these two species are sharply separated geographically and are readily recognizable. As the two species are morphologically identical and have essentially the same food plants and habits, it may be that the subspecies *c. consanguineus* is a hybrid between them having a greater adaptive value in the semiarid areas of eastern Oregon. There are no biological data to support such a hypothesis except morphological comparison and the fact that typical forms are rarely found where *consanguineus* predominates. Several typical specimens of *fervidus* taken from areas in the Willamette Valley however, might lend equal weight to the conclusion that no hybridization occurs and *consanguineus* is a simple subspecies of *californicus*. Biological and cytotaxonomic studies would be required to determine the status of the intermediates.

The male of this species bears close resemblance to *B. appositus* and *B. sonorus* but can be separated from the former by characters listed in the preamble to that species and from the latter by its range.

The designated variety *B. fervidus* var. *dorsalis* Cresson is applied to a population variant of *fervidus* having the thoracic dorsum completely covered with yellow pile. An examination of 42 specimens determined as *dorsalis* from the area under study, indicates by distribution and intergradation that this name has been applied to variants of questionable nomenclatorial rank. In both males and females, all intergrades between those having a broad black interalar band and

the complete absence of this band have been examined. Variation in this pattern is not a geographic one. However, it is interesting to note that most Arizona and New Mexico material in my possession falls into the Cresson variety *dorsalis*. Accompanying complete coverage of the thoracic dorsum with yellow pile is an increase in the amount of black pile covering the mesopleura, and in one queen from Arizona only the upper and anterior portions of the mesopleura were covered with yellow.

Perhaps the subspecies *dorsalis* may be applied to populations in the southern limits of the range; however, that phenotype is but a population variant in the north. It would be hazardous to draw any conclusion about the status of *dorsalis* with the limited material on hand from the southwest, and it seems certain that this is the only area in which this phenotype may warrant nomenclatorial rank.

QUEENS:

Ocelli located slightly below supraorbital line; malar spaces $1\frac{1}{4}$ to $1\frac{1}{2}$ times as long as apical widths; flagellum short; first flagellar segment one-third longer than third; segment 3, one-eighth longer than 2; tegulae brownish-black; wings fuscous to brown; nervures brown to brownish-black basally.

Vertex with abundant long black pile, intermixed with shorter light pile but with black predominating; face with pile mostly black but a few short light hairs intermixed above antennal bases; area behind eyes with pile all black. Interlar band variable, usually as broad as tegulae laterally, and distinct, but grading from this typical form to one having the thoracic dorsum completely covered with yellow; scutum with anterior portion having dense, yellow pile; scutellum with pile long, dense, and yellow; mesopleura with long yellow pile, covering the upper three-quarters of surface, an admixture of black pile, to exclusively black at coxal bases; metapleura with pile yellow above and black below; propodeum with abundant yellow pile on upper lateral margins and on posterior face, lower half with pile black. Metasomal terga 1 to 4 with pile long and yellow; metasomal terga 5 and 6 with pile all black; metasomal sterna with pile long, sparse, and black. Legs with pile all black; corbicular fringes black.

WORKERS:

As in the queen, but usually with yellow pile of mesopleura extending to coxal bases, a minor amount of black pile intermixed immediately above coxal bases. Malar spaces $1\frac{1}{4}$ to $1\frac{1}{2}$ times as long as apical widths; flagellum long; first flagellar segment two-thirds as long as third, second barely shorter than first; tegulae brown; wings fuscous; nervures brown.

Vertex with pile an admixture of yellow and black, black usually predominating but many having equal quantities of each; face with admixture of yellow and black pile, black longer, white short and appearing more dense; area immediately behind eyes with pile black, tending to be longer and yellow on posterior and ventral faces. Thoracic dorsum usually with distinct black interlar band but in some with strong admixture of yellow pile laterally, and a few having dorsum with pile all yellow; anterior portion of scutum and the scutellum with pile long, dense, and yellow; mesopleura, metapleura, and propodeum with pile all yellow. Metasomal tergum 1 to 5 with pile all yellow, pile short and erect on discal area of each tergum, pile on apical portions appearing to

be posteriorly directed; tergum 6 with color of pile variable, usually with some yellow pile basally but in many with abundant yellow pile laterally; tergum 7 with pile all black; metasomal sterna with short, white, apical fasciae. Anterior legs with pile black except for fringes of long, light pile on femora; middle legs with trochanters having pile predominantly black but with weak posterior fringes of light pile; midfemora with pile almost entirely short, yellow, and erect, upper surfaces with pile black; midtibiae with pile short and black; posterior trochanters with pile black, femora with numerous short, light hairs, a few black hairs intermixed, particularly on basal portion; posterior tibiae with very short, black pile, concentrated principally along anterior and posterior margins.

Male genitalia: (figure 7). When variability within the species is considered, the genitalia are, for all practical purposes, identical with *californicus*.

VARIATION:

The apex of the gonostylus and apex of the penis valve have minor differences which, at times, are of value. The seventh ventral plates of *fervidus* lack the highly membranous apex that is found in *californicus*.

It is difficult to determine whether those few specimens with black pile on the median portions of metasomal terga 2 and 3 are color variants of *fervidus*, or maximum yellow variants of *californicus consanguineus*. Only a thorough biological study of these species will contribute to their true identity. Many queens and workers of *fervidus* that have the thoracic dorsum predominantly yellow, also have abundant yellow pile on posterior femora. The distribution of yellow pile on the sixth metasomal tergum of the males is highly variable with extremes ranging from those having this tergum with pile all yellow to those having it all black. All intergrades between these two limits have been examined.

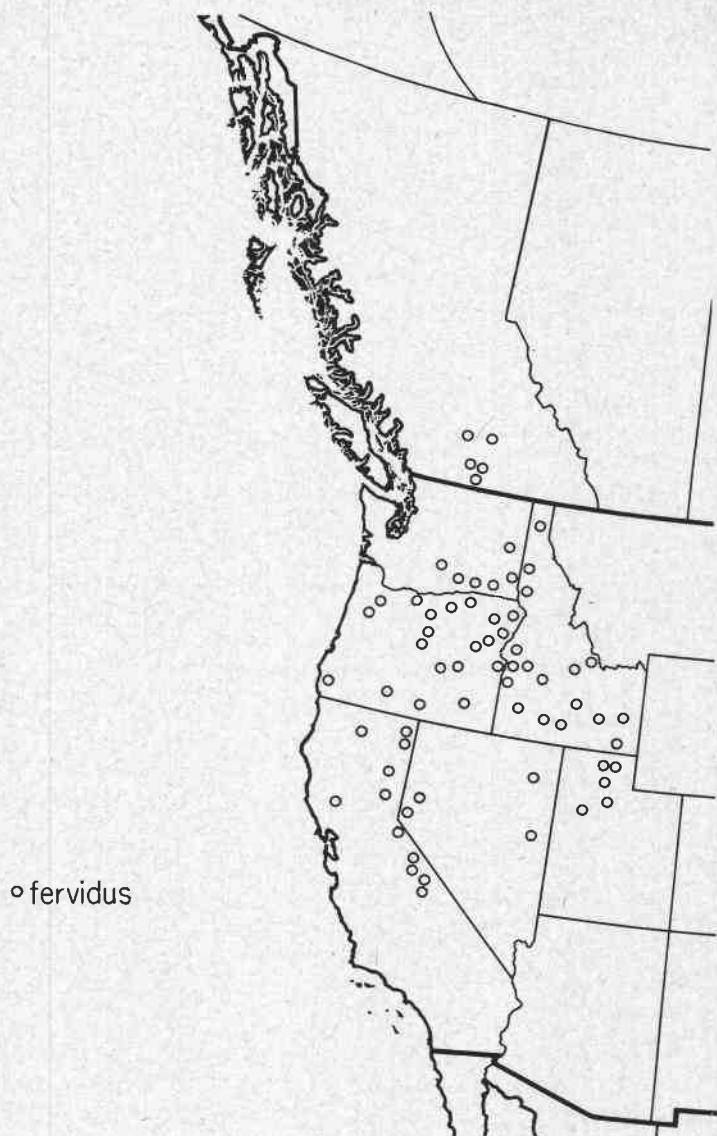
DISTRIBUTION:

The species is generally distributed through south central British Columbia, eastern Washington, Idaho, central and eastern Oregon and northern parts of California, Nevada, and Utah. With the exception of several records from the Willamette Valley of Oregon it is restricted to the higher elevations in the southern half of its range (Map 2).

Franklin (1913) cites Dr. Davidson's observation that this species is "the most common of all bumble bees in the vicinity of Los Angeles," and that it is the most abundant on the Pacific shore. It is suspected that these observations were based on records of *sonorus* Say which abounds in the area referred to.

BRITISH COLUMBIA:

Fairview; Kaleden; Kamloops; Minnie Lake; Nicola; Okanagan Mission; Oliver; Osoyoos; Penticton; Salmon Arm; Summerland; Walhachin.



Map 2. Map showing the distribution of *fervidus*.

WASHINGTON:

Medical Lake; Pasco; Prescott; Prosser; Pullman; Sunny Side; Vancouver; Vantage; Wawawai; Yakima.

OREGON:

Albany; Alsea; Aneroid Lake, 7,500'; Antelope; Baker, 3,700', 2,500'; Boardman; Burns, 4,150'; Cayuse; Cornucopia, 7,250'; Corvallis; Cove, Union Co.; Culver, Jefferson Co.; French Glen, Harney Co.; Grant Co., 5,800'; Hat Point, Wallowa Co., 9,000'; Hart Mt., Lake Co., 6,600'; Hereford, 3,660'; Hermiston; Huntington; Imnaha, Wallowa Co.; Ione, Jefferson Co.; Jordan Valley; Juntura, 3,100'; Klamath Falls; Labish; La Grande, 3,000'; Lake Co., 6,600'; Lakeview, 4,400'; Lakeview, 4,800'; Madras; Marys Peak; Mayville; North Powder, 3,240'; Nyssa; Ontario; PeeDee; Pendleton; Prairie City; Redmond; Richland, 2,200'; Sherwood; Sparta, Baker Co.; Steens Mountains, 4,500', Steens Mountains, 8,000'; The Dalles; Tumalo Reservoir, Deschutes Co.; Union Co., 2,700'; Wallowa Lake; Warner Mountains, Lake Co.; Wild Horse Canyon, Steens Mountains, 6,000'.

CALIFORNIA:

Alpine County: Hope Valley.

Inyo County: Big Pine; Carrol Creek; Independence; Lone Pine; Oak Creek; Owens Valley.

Lake County: Lower Lake.

Lassen County: Hallelujah Jct.

Modoc County: Canby; Cedarville; Davis Creek; Lake City.

Mono County: Bentons Crossing; Blanco's Corral, White Mountains; Coleville; Cottonwood Creek; Grant Lake; Mammoth; Sardine Creek; Topaz Lake.

Nevada County: Truckee.

Plumas County: Quincey.

Shasta County: Burney; Cayton.

Sierra County: Sierra.

Siskiyou County: Gazelle Creek.

IDAHO:

Aberdeen, 4,398'; Boise, 2,592'; Buhl, 2,500'; Central Grade, Nez Perce Co.; Challis, Custer Co.; Clover, Twin Falls Co.; Craters of the Moon; Dixie, Elmore Co.; Downey; Franklin; Hazelton, Jerome Co.; Homedale; Jerome, 3,800'; Leodore, 1,000'; Lewiston, 550'; Malta, Cassia Co.; Midvale, Washington Co.; Mt. Home, 3,138'; Moscow, 2,560'; Parma, 2,231'; Paul; Pingree; Sandpoint; Springfield, Bingham Co.; Taber, Bingham Co.; Webb, Nez Perce Co.

UTAH:

Cache Jct.; Dividend; Garden City; Logan, Salt Lake Co.; Newton; Ogden; Providence; Provo; Smithfield; Willow Canyon, Tooele Co.

NEVADA:

Carson City, Ormsby Co.; 27 mi. E. Elko, 5,200'; Ely, 6,400'; Pyramid Lake, Washoe Co.; Sparks, Washoe Co.; Verdi, Washoe Co.; Wells, 5,400'.

FLIGHT RECORDS:

This species has been collected from April 13 to September 15. Queens have been taken between April 13 and August 13; workers, from June 18 to September 15; and males from June 23 to September 5.

The location of the types of *fervidus*, race *aztecus*, and var. *umbraticollis* are unknown to me. The type of var. *dorsalis* is in the Academy of Natural Sciences of Philadelphia.

Bombus californicus F. Smith

This species is very close morphologically to *B. fervidus* (Fabr.) and is impossible to separate structurally from that species. Franklin (1913) states that he is of the opinion that "*californicus* and *fervidus* may eventually prove to be subspecies of a single species." The close morphological resemblance of the two species as well as the variation in male genitalia lends weight to Franklin's statement, however, until biological data is available these are recognized as two

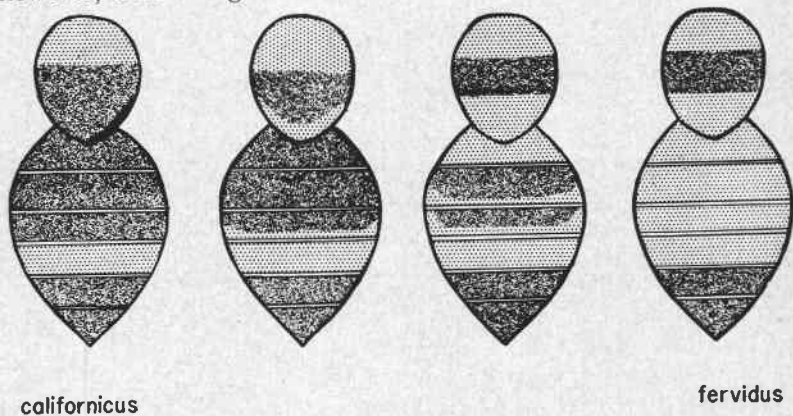


Figure 2. Illustrations showing intergradation of color patterns between *californicus* and *fervidus*. Black areas in this illustration equal black on the bee, while stipple is equivalent to yellow.

distinct sibling species. The possibility of hybridization is discussed in the preamble to *fervidus*.

The typical *californicus* is readily separable from all other American forms having the pile of the scutellum, thoracic pleura and the first three abdominal terga all black. All intergrades between this and *fervidus*, having the scutellum, thoracic pleura, and the first four metasomal terga all yellow, have been found (figure 2). However, some specimens of *fervidus* have the posterior portion of the mesopleura and the area immediately above the coxal bases with a strong admixture of black pile.

Californicus (s.s.) is found along the Pacific coast, in coastal valleys and to a lesser degree in some inland areas. As one examines material away from the coastal areas an increase in the amount of yellow pile on the scutellum and upper mesopleura is noted. In the interior of British Columbia, eastern Washington, and eastern Oregon the predominant color form is that having the scutellum completely covered with yellow pile. The amount of yellow pile on the mesopleura varies greatly; at times only the upper third is yellow while in others the yellow pile extends over halfway to the coxal bases. On these inland forms, metasomal tergum 1 and the basal portion of metasomal tergum 3 are chiefly covered with yellow pile. A number of specimens from western Idaho and the higher elevations of eastern Oregon are exceedingly close to *fervidus* having but a few black hairs intermixed on the median portions of metasomal terga 1 and 2. The maximum yellow form of *californicus* (as arbitrarily recognized in this paper) has femora pile strongly intermixed with yellow, a feature not common to *fervidus*.

Separation of the males of these two species is most difficult and is based exclusively on coloration of the pile of the scutellum and the metasomal terga. As delineated here, *fervidus* has the pile on these areas all yellow, while *californicus* has some black pile intermixed at least on metasomal terga 1 and 2.

Within the species recognized herein, two subspecies are designated: *californicus californicus* and *californicus consanguineus* Handl. The latter is here characterized by having yellow pile on the metapleura, scutellum, and terga 1 to 3. The form designated as variety *dubius* by Cresson, appears to be one of the numerous latinized varietal names incidental to taxonomic knowledge of the genus. *Dubius* has been applied to those intermediate forms which grade imperceptibly into *consanguineus* at one extreme and *californicus* at the other, and which may be included with one or the other subspecies. *Californicus californicus* therefore occupies the western coastal margins, while *californicus consanguineus* is common to higher elevations and inland areas of the Pacific Northwest.

Bombus californicus californicus F. Smith.

Bombus californicus F. Smith, 1854. Cat. Hym. Brit. Mus., V. 2, p. 400.
Bombus dubius Cresson, 1863. Ent. Soc. Philadelphia, Proc. 2:97 (in part).

Bombus neglectus Ashmead, 1902. Washington Acad. Sci. Proc. 4:124.

QUEENS:

Ocelli situated slightly below supraorbital line; malar spaces $1\frac{1}{4}$ to 2 times as long as apical widths; first flagellar segment one-quarter longer than third; third, one-quarter longer than second; tegulae deep reddish-brown hyaline; wings very deep brown to brownish black; nervures deep brown to black.

Vertex with pile black, a few, very short, light hairs intermixed; face with pile black, a few shorter, lighter hairs intermixed above antennal bases; area behind eyes with black pile. Thoracic dorsum with the pile anterior to tegulae yellow; pile posterior to tegulae and pile of scutellum, black; yellow pile of anterior portion of scutum extends to cover lateral lobes of pronotum; mesopleura, metapleura, and propodeum with pile all black; metasomal terga 1 to 3 with pile black; tergum 4 with pile yellow; terga 5 and 6 with pile black; metasomal sterna with weak, apical fringes of black pile; pile of legs black, corbicular fringes with pile long and black.

WORKERS:

As in the queens.

MALES:

Ocelli small, situated at, or slightly below, supraorbital line; malar spaces $1\frac{1}{2}$ times as long as apical widths; flagellar segment 3, one-half longer than 1; segment 1, one-half times longer than 2; tegulae brownish black; wings dusky-brown; nervures brown to dark brown.

Vertex with an admixture of yellow and black pile, black pile usually most evident; pile of face predominantly black with admixture of shorter, light hairs. Thoracic dorsum with dense, yellow pile anterior to tegulae; interalar band broad and dense; scutellum with pile variably colored; mesopleura with admixture of yellow and black pile, yellow usually predominating on upper and anterior one-half; metapleura and propodeum with pile usually black, occasionally an admixture of yellow hairs on the upper portion of propodeum. Metasomal tergum 1, with pile black; metasomal terga 2 and 3 with pile ranging from pure black to an admixture of black and yellow; metasomal terga 4 and 5 with yellow pile predominating; tergum 6 with an admixture of black and yellow pile, on some specimens all yellow and others all black; tergum 7 with pile primarily black, occasionally with an apical fringe of longer pile tinged with ferruginous. Anterior 2 pairs of legs with pile predominantly light, a few dark hairs intermixed on upper faces of femora and tibiae; posterior femora with the pile all light; posterior tibiae with abundant very short semi-appressed light ferruginous pile, tibiae appearing to be uniformly rounded above.

Male genitalia: (figure 8). Much as *fervidus* but having an apical membranous margin to the seventh ventral plate and minor nonconstant differences to the apices of the gonostyli and penis valves.

VARIATION:

There is considerable variation in specimens included within this subspecies. Tentatively included are all those queens and workers having black pile predominating on the scutellum, mesopleura, and first, second, and third metasomal terga, with coloration of the pile

on the scutellum and mesopleura being the most critical characters. Males are much more difficult to delineate, for even in extreme coastal areas the variation is great. Some males have black pile on the scutellum, the mesopleura, and the first 3 metasomal terga, much as in the females; however, intermixed with these are others with extremes having the pile of the scutellum, anterior and dorsal faces of the mesopleura, and metasomal terga 1 and 2 with pile all yellow.

DISTRIBUTION:

This is one of the most common species in California and western Oregon. It is less common in Washington and British Columbia and east of the Cascades where it is partially replaced by *fervidus* and *consanguineus*. Although Franklin (1913) records *californicus* (s.l.) from Colorado and the western Great Plains, I have not seen any material that could be so classified from the area east of the Continental Divide. Several of his records are based on males which may well prove to be *fervidus* (Map 3).

BRITISH COLUMBIA:

Agassiz; Alberni; Creston; Nanaimo; Point Gray; Saanich; Sidney; Victoria; Vancouver.

WASHINGTON:

Alder Springs; Bellingham; Cedar Mountain; Chuckanub Bay; Easton; Foster; Friday Harbor; Gig Harbor; Gilberton; Keyport; King County; Meadowdale; Mercer Island; Nahcotta; North Bend; Olympia; Palix River; Puyallup; Seabeck; Seattle; Tacoma; Tenino; Union City; Uniontown; Whatcom Co.; Whitman; Sumas.

OREGON:

Ashland, 4,700'; Astoria; Bellfountain; Blooming; Cannon Beach; Corvallis; Eagle Creek; Forest Grove; Grants Pass; Marion; Mayville; Medford; Milwaukie; Mt. Hood; Newport; Ochoco Pass, 4,800'; Roseburg; Salem; Sand Lake, Tillamook Co.; Shedd; Sheridan; Sulphur Springs; Summit Prairie; Wilderville, Josephine Co.; Wonder, Josephine Co.; Wood Creek, Benton Co.

CALIFORNIA:

Alameda County: Oakland; Piedmont; Tesla.

Butte County: Butte Meadows; Feather River.

Contra Costa County: Antioch, Camino Chili Var; Concord; Eldorado; Martinez; Mount Diablo; Placerville; Snowline Camp; Walnut Creek.

Del Norte County: Crescent City.

Fresno County: Fresno; Oxalis; Squaw Valley.

Glenn County: Artois; Fruito.

Humboldt County: Fort Seward; Orick.

○ californicus
● c. consanguineus



Map 3. Map showing the distribution of *c. californicus* and *c. consanguineus*.

Lake County: Lake Pillsburg.
 Lassen County: Blue Lake; Hallelujah Junction.
 Los Angeles County: Baldwin Hills; Camp Baldy; Claremont;
 Laurel Canyon; Los Angeles; Pasadena; Puerto Hills; Santa Monica; Tanbark Flat; Verdugo Hills; Westwood Hills.
 Madera County: Bass Lake; Oakhurst; San Joaquin Expt. Sta.
 Marin County: Bolinas; Fairfax; Novato.
 Merced County: Parache Hills.
 Modoc County: Cedar Pass; New Pine Creek; Adin Pass.
 Monterey County: Carraiss Springs; Carmel; Carmel Valley.
 Napa County: Calistoga; St. Helena; Mt. Veider; Samuel Springs; Walter Springs.
 Nevada County: Puckers Lake; Emigrant Gap; Boca; Nevada City.
 Orange County: Balboa Island; Costa Mesa; Laguna Beach; Newport Bay.
 Placer County: Alta; Auburn; Dutch Flat; Green Valley; Loomis; Tahoe.
 Plumas County: Bucks Lake; Quincy.
 Riverside County: Coachella Valley; Idylwild; Hemet; Perris; Riverside; San Jacinto Mts., Tachquitz Valley; Temecula.
 Sacramento County: Folsom; Galt; Sacramento.
 San Benito County: Pinnacles; San Benito.
 San Bernardino County: San Bernardino Mts.
 San Diego County: Encinitas; San Diego.
 San Luis Obispo County: San Miguel.
 San Francisco County: San Francisco.
 San Mateo County: Palo Alto.
 Santa Clara County: Gilroy; Mt. Hamilton; Alum Rock Park; San Antonio P. S.; San Jose; Silver Creek Hills.
 Santa Cruz County: Mt. Herman.
 Sierra County: Sierraville.
 Shasta County: Shingletown.
 Solano County: Vallejo.
 Sonoma County: Glen Ellen; Maacame Ct.; Mesa Grande; Monte Rio; Preston.
 Stanislaus County: La Grange; Patterson.
 Sutter County: Marysville Buttes.
 Tehama County: Red Bluff.
 Tulare County: Kawech; Mineralking; Sequoia Nat. Park.
 Tuolumne County: Dodge Ridge; Pine Crest; Strawberry; Mather.
 Ventura County: Oxnard.
 Yolo County: Davis; Elkhorn Ferry; Putah Canyon.

Several specimens from Adin in Modoc County and Blue Lake in Lassen County, California, resemble *c. consanguineus* but have only a few yellow hairs on the scutellum and mesopleura. Again, it is impossible to determine whether these are high elevation ecotypes of *californicus* or hybrids of *californicus* and *fervidus*, for both species inhabit these areas. As a matter of convenience these specimens have been included with the typical *californicus*.

The type of *californicus*, a queen from California, is in the British Museum of Natural History; that of *dubius* from western Kansas (questionable record-author) is in Academy of Natural Science in Philadelphia and that of *neglectus* Ashmead, is in the United States National Museum.

Bombus californicus consanguineus Handlirsch

Bombus consanguineus Handlirsch, 1888. K. K. Naturhist. Hofmus. Ann. 3:239.

Bombus dubius Cresson, 1863. Ent. Soc. Philadelphia, Proc. 2:97 (in part).

Queens and workers of this subspecies can be distinguished from *c. californicus* by having the scutellum with pile predominantly, to exclusively, yellow; mesopleura with yellow pile extending well below the wing bases; and yellow pile on at least the first tergum of the metasoma. Males are much more difficult, and at times impossible, to separate from *californicus*, for the variable coloration of pile on the metasomal terga is great and most males could fall within the limits of population variation found in the extreme coastal margins. However, males of this subspecies have scutellar pile exclusively yellow; the mesopleura mostly covered with yellow pile that extends to the coxal bases on the anterior face. In most males of *consanguineus* yellow pile covers all except the extreme posterior margin of the mesopleura, while pile of the propodeum, particularly the upper and lateral surfaces has a strong admixture of yellow.

VARIATION:

This subspecies includes all those queens and workers with yellow pile predominating on the scutellum, mesopleura, and first metasomal tergum. In some specimens, 1 and 4 may be the only terga having yellow pile, while in others terga 1 to 4 have the pile predominantly yellow with but a few black hairs on median portions of the first and second. Mesopleura and metapleura may be covered with yellow pile or the yellow may be restricted to anterior and upper margins of the mesopleura.

In the males there is considerable variation in the amount of yellow pile found on the vertex and face. For the most part, pile on these two areas is mainly black, but in a few instances yellow

takes over. The thoracic pleura may have an abundance of black pile, particularly on posterior margins of the mesopleura and on the metapleura, but in some males these areas are completely covered with yellow, closely resembling males of *fervidus*. Greatest variation occurs in the coloration of metasomal terga; some having the terga pile colored much as in typical *californicus*, while in others the only character separating them from *fervidus* is the presence of a few black hairs on median portions of terga 1 and 2.

DISTRIBUTION:

This subspecies is found in the northern and eastern sections of British Columbia as well as in the eastern part of the Pacific Northwest. Throughout this area it overlaps with *fervidus* (Map 3).

BRITISH COLUMBIA:

Adams Lake; Canim Lake; Centurian; Chilcotin; Clinton; Fernie; Harris; Kaleden; Kamloops; Lac DuBois; Oliver; Quesnel; Quick; Smithers; Vernon; Walhachin.

Buckell (1951) reports *californicus consanguineus* from Vancouver and various places on Vancouver Island. Specimens in the Buckell Collection from these areas have varying amounts of yellow pile on the scutellum, but in none does the yellow pile of the anterior portion of the scutum extend down below the lateral lobes of the pronotum. Therefore these are considered variations within the limits of *c. californicus*.

WASHINGTON:

Mt. Adams, 4,500'; Pullman.

OREGON:

Anthony Lake, Blue Mts. 7,100'; Buck Mountain; Fall Mountain, Grant County 5,500'; Imnaha, Wallowa County; La Grande; Meacham; Milton; Ochoco Pass, 4,800'; Pendleton, 3,200'; Sparta, Summit Prairie; The Dalles; Wild Horse Canyon, Steens Mts., 5,200'. (Several males from the Corvallis area have abundant yellow pile on the scutellum and faint traces of yellow pile on the upper mesopleura. These are intermediates between *californicus* and *consanguineus* and have been included with the former.)

IDAHO:

Moscow; Sandpoint; Soda Springs; Stanley.

FLIGHT RECORDS:

Flight records for *consanguineus* are similar to those for *californicus* and all specimens in my possession have collection data which would fall within the limits cited for *californicus*.

The location of the type of *consanguineus* is unknown to me.

Bombus sonorus Say

Bombus sonorus Say, 1837. Boston Jour. Nat. Hist., 1:413.

Bombus sonorus flavodorsalis Franklin, 1913. Amer. Ent. Soc. Trans. 7:230
(new synonymy).

This species is one of the larger bumble bees in western America, and is restricted to the Upper and Lower Austral Zones. It is closely related to *B. fervidus* and the males of the two species are often difficult to separate. Most males of *sonorus* have only the first 4 tergites covered with yellow pile, but some material from the San Joaquin and Southern Sacramento Valleys has varying amounts of yellow on tergum 5. The males of *fervidus* have the fifth metasomal tergum completely covered with yellow pile and often have yellow on the mediobasal portion of tergum 6. In addition, the seventh ventral plate and the apices of the penis valves show striking differences in hair patterns and shape (figures 8 and 9). The queens and workers have the yellow pile of the metasoma restricted to the first three metasomal terga whereas in *fervidus*, these, plus tergum 4, are covered with yellow.

Franklin (1913) erected the subspecies *sonorus flavodorsalis* for " - the specimens from California (that) have the yellow on the dorsum of the thorax encroaching more or less on the black band between the bases of the wings, and some specimens . . . (with) the dorsum being entirely covered with yellow pile." While there is an encroachment of yellow onto the black interalar band in some of the California material, the degree of difference is very difficult to measure. Those specimens having the scutum completely covered with yellow pile can be easily separated from the typical *sonorus*; however, the distribution of these, as well as the numerous intergrades, is such that subspecific designation is unwarranted. In western America those specimens having the thoracic dorsum almost or completely covered with yellow pile are found throughout the range of the species (see Map 4). It is noteworthy that only in a few areas of the central San Joaquin Valley does the yellow form predominate. This may be a result of incomplete collection, for only 8 specimens from the area are in my possession and of these, only 2 are typically *sonorus*. In addition several of the yellow forms from New Mexico and Texas have been examined and it is concluded that the form is a population variant without subspecific status.

QUEENS:

Ocelli situated at supraorbital line; malar spaces as long as, or slightly longer than apical widths; first flagellar segment one-third longer than third, second flagellar segment one-quarter shorter than third; tegulae black; wings dark brown to brownish black basally; nervures dark brown to black basally, becoming a pale opaque brown apically.

Vertex and face with pile all black. Mesoscutum with a broad band of bright yellow pile anterior to the bases of the tegulae, yellow pile extending down to cover lateral lobes of pronotum and a very small area immediately beneath anterior portions of tegulae; interalar band of black pile distinct between wing bases; scutellum with long, dense, bright yellow pile; mesopleura, metapleura, and propodeum with pile all black. Metasomal terga 1 to 3 with abundant bright yellow pile; metasomal terga 4 to 6 with pile all black; metasomal sterna with weak apical fringes of dark pile, a few bright ferruginous hairs along medioapical margin of each sternite. Pile of legs and corbicular fringes black.

WORKERS:

As in the queens, but having the first and third antennal segments more nearly subequal.

MALES:

Ocelli situated at supraorbital line; malar spaces $1\frac{1}{2}$ to $1\frac{1}{4}$ times as long as apical widths; third flagellar segment $1\frac{1}{2}$ times as long as first; first and second flagellar segments subequal; tegulae dark brown to brownish-black; wings dusky brown; nervures deep brown to brownish black basally, becoming opaque brown apically.

Vertex with pile black; face with an intermixture of long, black, and shorter, whitish-yellow pile, particularly about antennal bases, with black pile predominating. Mesoscutum with portion anterior to tegulae with abundant bright yellow pile; interalar band of black pile distinct; scutellum with abundant, long, erect, bright yellow pile; yellow pile of scutum extending down to cover lateral lobes of pronotum and covering, to varying degrees, areas on dorso-anterior margins of mesepisterna, yellow pile often extending immediately below anterior wing bases; metapleura and propodeum with pile black. Metasomal terga 1 to 4 completely covered with bright yellow pile, occasionally a few black hairs along basal margin of tergum 4; metasomal terga 5 to 7 with pile long and black; metasomal sterna with apical fringes of short, black pile. Legs with pile predominantly black with varying amounts of yellow or whitish pile intermixed, particularly on the mid- and hind femora and on mid- and hind trochanters.

Male genitalia (figure 9). Similar to *fervidus* but having the penis valves extended apically and endite processes of gonocoxites sharper and somewhat narrower; seventh ventral plate of *sonorus* broadened sharply medioapically and virtually hairless.

VARIATION:

The amount of yellow pile on the mesepisterna is subject to variation in both the queens and the workers. For the most part, only lateral lobes of the pronotum are covered with yellow pile, but those specimens having the interalar band narrowed by the encroachment of yellow pile usually have a corresponding increase in the amount of yellow on the anterior and dorsal one-half of the mesepisterna. This, however, cannot always be correlated, since several specimens having the thoracic dorsum covered with yellow pile also have the thoracic pleura colored as in the typical form.

Males of this species exhibit greater color variation than females. Extreme yellow forms having thoracic dorsum covered predominantly or completely with pale yellow pile also have a strong mixture of white pile on the vertex, the mesepisterna almost wholly, or completely covered with pale, whitish-yellow pile, the fifth metasomal tergum with yellow pile basally and an increased amount of light pile on the trochanters and femora. All intergrades between this and typical form have been noted.

DISTRIBUTION :

The species is restricted to the Upper and Lower Austral Zones of California. It apparently does not occur east of the San Jacinto Mountains but extends southward into Baja, California and Mexico. It is not a particularly abundant species, but a very large and striking one, which may account for its presence in most collections. I have one questionable record of a queen from Logan Canyon, Utah (Map 4).

CALIFORNIA :

- Contra Costa County : Antioch.
- Fresno County : Firebaugh ; Oxalis.
- Glenn County : Artois.
- Kern County : Ft. Tahon ; Tehachapi.
- Los Angeles County : Baldwin Hills ; El Segundo ; Glendale ; Inglewood ; Pasadena ; Playa Del Rey ; Pomona ; San Dimas ; San Fernando ; San Pedro ; Santa Monica ; Westwood ; Whittier.
- Merced County : Dos Palos ; Los Banos ; Merced.
- Orange County : Balboa Island ; Laguna Beach ; Newport Bay ; Santa Ana.
- Placer County : Loomis.
- Riverside County : Beaumont ; Corona ; Hemet ; Riverside ; Soboba Spring.
- Sacramento County : Folsom ; Sacramento.
- San Bernardino County : Little Bear Valley.
- San Diego County : Coronado ; Encinitas ; La Jolla ; Mission Gorge ; Pt. Loma ; San Diego.
- San Joaquin County : Lodi.
- Solano County : Fairfield ; Ryer Island ; Suisun.
- Stanislaus County : Turlock ; Westley.
- Tulare County : Visalia.
- Ventura County : Oxnard ; Santa Paula.
- Yolo County : Clarksburg ; Davis ; Elkhorn Ferry ; Woodland.
- Yuba County : Marysville.



Map 4. Map showing the distribution of *sonorus*.

FLIGHT RECORDS:

Queens of the species have been collected from April 5 until October 21; males from June 25 until October 18; and workers from April to October 30.

The type of *sonorus* from Mexico has not been located and is presumed lost: that of *sonorus flavodorsalis* from California is in the Academy of Natural Sciences of Philadelphia.

Section: *Boopobombus* Frison

Boopobombus Frison, 1927. Amer. Ent. Soc. Trans. 53:62.

Males: Eyes very large and bulging from sides of head; ocelli large and situated well below the supraorbital line (in *rufocinctus* the ocelli are not particularly large), malar spaces very short, never more than $\frac{3}{4}$ the length of their apical widths; volsellae usually protruding well beyond the apices of the gonostyli.

Females: Ocelli very large and situated well below supraorbital line (in *rufocinctus* the ocelli are only about average size); first flagellar segment longer than third, and often as long as 2 and 3 combined; basitarsi of mid- and hind legs without pronounced projection from basoposterior margins.

Subgenus *Bombias* Robertson

(= *Auricomis* group, Franklin.)

Bombias Robertson, 1903. Amer. Ent. Soc. Trans. 29:176.

Type: *Bombias auricomis* Robertson. Orig. desig.

Nevadensibombus Skorikov, 1922. Sta. Région. Protect. Plantes Petrograd Bull. 4:149.

Type: *Bombus nevadensis* Cresson. Desig. Frison, 1927.

Males: Vertex above ocelli narrower than region between eyes at ocelli; eyes very large and protuberant; posterior tibiae covered with fine short pile; volsellae protruding greatly above gonostyli, tending to be quadrate; gonostyli much longer than wide, each with flap-like basomedial endite; penis valves short and columnar; seventh ventral plates as long as broad with a deep apical emargination; eighth ventral plates shorter than width across bases.

Bombus nevadensis nevadensis Cresson

Bombus nevadensis Cresson, 1874. Amer. Ent. Soc. Trans., 5:102.

Bombus improbus Cresson, 1878. Acad. Nat. Sci. Philadelphia, Proc., p. 186.

Bombus nevadensis race *cressoni* Cockerell, 1899. Ann. Mag. Nat. Hist. (7) 4:388.

This species is most abundant in the Boreal and Transitional Zones of western America but is by no means restricted to them. Except for the Willamette Valley of Oregon, it is found east of the Sierra-Cascade Mountains in the western United States. However, in British Columbia it has been taken on Vancouver Island and heavily wooded areas of the interior. It is a very large and conspicuous bee and the rather meager numbers present in the various collections attest to its elusiveness and paucity.

Queens and workers have been confused with the yellow color variant of *B. sonorus* having the interalar band reduced, even though

the ranges of these two species are mutually exclusive. In addition to spatial separation, the two species can be separated by the very long first flagellar segment of *nevadensis*, which is subequal to the combined lengths of the second and third. In *sonorus* the first flagellar segment is just slightly longer than the third.

The males bear a rather striking resemblance to those specimens of *crotchii* having a reduced amount of ferruginous pile on the apical abdominal terga and an infringement of yellow on to the interalar band. Again, the two species can be separated by the comparative lengths of the first flagellar segments. In *nevadensis*, segment 1 is subequal to the combined lengths of 2 and 3, while in *crotchii* segments 1 and 3 are subequal.

QUEENS:

Ocelli situated well below supraorbital line in narrowest part of face; malar spaces $1\frac{1}{4}$ to $1\frac{1}{2}$ times as long as apical widths; antennae short; first flagellar segment equal in length to segments 2 and 3 combined; segment 2 slightly shorter than 3; tegulae black; wings dark brownish-black; nervures deep brown to brownish-black.

Vertex with pile predominantly black, occasionally a few shorter lighter hairs intermixed; face with pile jet black, some having an admixture of short light pile about antennal bases; areas behind eyes with pile black. Thoracic dorsum with a dense covering of yellow pile; mesopleura with yellow pile restricted to lateral lobes of pronotum and to areas immediately below lobes, remainder of mesopleura with pile black; metapleura and propodeum with pile all black. Metasomal tergum 1 with long yellow pile, particularly dense on lateral portions of disc, a weak covering of short, black pile on anterior discal area; metasomal tergum 2 completely covered with yellow pile; metasomal tergum 3 with pile yellow, often tinged with ferruginous or orange, a few black hairs often intermixed at extreme lateral faces; metasomal terga 4 and 6 with pile black; metasomal sterna with pile all black. Pile of legs and corbicular fringes all black.

WORKERS:

As in the queens but usually having slightly longer malar spaces, ranging from $1\frac{1}{4}$ to $1\frac{1}{2}$ times as long as apical widths. There is usually more yellow pile on upper portions of the mesopleura, and metasomal tergum 3 is always completely covered with yellow pile.

MALES:

Ocelli situated well below supraorbital line in narrow part of face; compound eyes extremely large, occupying over half of surface of the head; clypeus sharply protuberant; malar spaces three-quarters as long as apical widths; flagellum short; first flagellar segment as long as combined lengths of segments 2 and 3; second flagellar segment one-third shorter than third; tegulae brown, wings light brown; nervures brown.

Vertex with pile all yellow to whitish-yellow, a few dark hairs intermixed about periphery; face with pile short, dense, and pale yellow to whitish, some dark hairs intermixed between antennal bases, along clypeofrontal suture and over clypeus. Thoracic dorsum with abundant, dense, yellowish pile and indistinct, median patch of black pile of considerable size, pile intermixed with yellow and dark brown hairs about peripheral portions of patch; scutellum with

pile dense and yellow; mesopleura covered with short, yellow to whitish pile; metapleura and propodeum with pile all light, all dark, or intermixed yellow and black. Metasomal terga 1, 2, and 3 completely covered with yellowish pile; metasomal tergum 4 with the disc having abundant black pile, weak fringes of yellow on lateroapical margins; tergum 5 with pile mainly black, often with a very weak apical fringe or fascia tinged with ferruginous; metasomal terga 6 and 7 with abundant short ferruginous pile; metasomal sterna with long apical fasciae of light pile, tending to be tinged with ferruginous on the apical 2 sterna. Anterior legs with pile black except for very long fringes of yellow on lateroposterior margins of femora, trochanters and coxae; midlegs much as the forelegs, however, with pile at apex of tibiae strongly tinged with ferruginous, long posterior fringes of yellow ferruginous pile on metatarsi; posterior femora with the pile mostly black, long fringes of light pile on posterior-ventral margins; posterior tibiae with weak longitudinal groove barely reaching apical ends, pile along anterior margins of tibiae short and dark, pile along posterior margins long, and usually tinged with light ferruginous or golden.

Male genitalia: (figure 10). The genitalia of *nevadensis* are unique, resembling only those of the eastern *auricomus* (Robt.). The short, shaft-like penis valves and elongate gonostyli immediately separate the males from those of any other western species.

VARIATION:

On the whole, this species has rather stable color patterns. In queens and workers some variation is evident in the pile of vertex and face. Some specimens have exclusively black pile, while others have a weak admixture of shorter, light hairs in both of these areas. In all cases the black pile is distinctly predominant. The median patch of black pile on the thoracic dorsum varies somewhat in size in the females. It is usually quite distinct and small. However in some specimens it is represented only by a few black hairs. The pile of the third metasomal tergum is typically yellow, but often with evidence of black pile on the extreme lateral margins.

The males exhibit variation in the size of the median patch of black pile on the thoracic dorsum. In some it is quite distinct and broad, occupying most of the area between the wing bases. Such specimens have the pile about the periphery of this median patch strongly tinged with yellow or brown. At the other extreme, the males have but a few dark hairs medially and the median patch is very difficult to discern. Usually the pile of metasomal tergum 4 is black, with apicolateral fringes of light ferruginous or yellowish pile; however, in several males, all of the pile on this tergum is black. Pile of tergum 5 may be all black or all pale ferruginous.

Two males from Mono county, California, have the pile of metasomal tergum 3 black, except for weak apicolateral fringes of yellow. On these specimens ferruginous pile on the apical terga is restricted to 6 and 7. There is no doubt that these specimens are *nevadensis* and are here treated as variants within the range of that species.

DISTRIBUTION:

The species is rather poorly represented in collections and approximately 90% of the specimens examined were queens and workers (Map 5).

BRITISH COLUMBIA:

Chilcotin; Invermere; Kamloops; Kaslo; Quesnel; Royal Oak, V.I.; Salmon Arm; Sidney V.I.; Vernon; Victoria, V.I.; Williams Lake.

WASHINGTON:

Emerald; Pullman; Tablerock; Wapato; Wawawai; Wenatchee.

OREGON:

Albert Lake; Andrews, 4,270'; Athena; Bend; Burns; Corvallis; Eagle Ridge, Klamath Lake; Elgin; Grande Ronde, Union Co.; La Grande; Lakeview, 4,200'; Lostine; Lane Co., 6,600'; McMinnville; Metolius, Jefferson Co.; Milton; North Powder, 3,240'; Sparta, Baker Co.; Strawberry Lake, Grant Co., 6,800' to 7,000'; Summerville; Summit Prairie; Terrebonne, Deschutes Co.; Thorn Hollow; Trail Crossing Flat, Jefferson Co.; Wallowa Lake, 6,300' to 7,000'; Wild Horse Canyon, Steens Mts.

CALIFORNIA:

Lassen County: Blue Lake.

Modoc County: Alturas; Cedarville; Davis Creek, 4,800'; Hackamore; Lake City; New Pine Creek.

Mono County: Blanco's Corral, White Mts., 10,000'; Bridgeport; Mono Lake; Sonora Pass, 9,624'; Topaz Lake.

Nevada County: Truckee.

Plumas County: Quincy.

Shasta County: Shingletown.

IDAHO:

Boise; Franklin; Gifford; Lenore; Lewiston; Parma; Potlatch; St. Anthony.

UTAH:

Blacksmith Fork Canyon; Eureka; Fillmore; Immigration Camp, Salt Lake Co.; Logan; Newton; Ogden.

NEVADA:

Ruby Valley, Elko Co.

YUKON TERRITORY:

Little Salmon; Whitehorse.



Map 5. Map showing the distribution of *nevadensis*.

FLIGHT RECORDS:

The species is most abundant during July and August but extremes in collection data indicate that queens have been collected from April 24 to September 20; workers from July 1 to July 27; and males from June 23 to August 13.

The types of *nevadensis* and *improbus* are located in the collections of the Academy of Natural Sciences of Philadelphia.

Bombus nevadensis miguensis Cockerell

Bombus nevadensis miguensis Cockerell, 1937. Pan-Pac. Ent. 13:148.

Cockerell described this subspecies on the basis of a single male taken on a collecting trip to the coastal islands of California. The record of *nevadensis* from this area is most unexpected, for the species is now found only in northern portions of the Great Basin and in the mountains of northeastern California. An examination of the type indicates that it is *nevadensis*, and the only conclusion that can be drawn is that the insular populations represent populations of this species cut off many years past. It is somewhat surprising that only a single specimen was taken during collecting done on the island and in recognizing this subspecies, it is assumed that further search of the area will turn up additional material.

This subspecies can be separated from typical *nevadensis* by the intermixture of black and yellow pile on the vertex; by black pile over the lower half of the mesopleura; by an almost complete interalar band; and by having the pile of the third metasomal tergum black, except for apical fringes of yellow pile.

Genitally the two form are identical.

DISTRIBUTION:

San Miguel Island, California, July 28, 1937 (William Smith).

The type is located in the collections of the California Academy of Sciences.

Subgenus *Separatobombus* Frison

(= *Fraternus* group (in part) Franklin)

Bremus subg. *Separatobombus* Frison, 1927. Amer. Ent. Soc. Trans. 53:64.

Type: (*Bombus separatus* Cresson) = *Apis griseocollis* Degeer. Orig. desig.

Males: Ocelli situated about halfway from supraorbital line to bases of antennae; eyes greatly bulging from sides of head; posterior metatarsi about four times as long as wide; volsellae protruding beyond gonostyli, usually with extreme apex emarginate; gonostyli about as long as broad, with medially directed basal projection of var-

iable length; usually short and robust; penis valves robust with medially directed sickle-shaped apices, apices of penis valves short and blunt; seventh ventral plates robust, with quadrate or weakly emarginate apices; eighth ventral plates with apical one-third either quadrate or weakly triangular, usually densely pilose.

Bombus griseocollis (Degeer)

- Apis griseocollis* Degeer, 1773. Mem. Serv. Hist. Insects, V. 3, p. 576.
(?) *Apis virginica* Olivier, 1789. Encycl. Meth., V. 4, p. 66.
(?) *Apis virginica* Fabricius, 1793. Ent. System, V. 2, p. 318.
(?) *Bombus virginicus* Fabricius, 1804. Systema Piezatorum, p. 346.
Bombus separatus Cresson, 1863. Ent. Soc. Philadelphia, Proc., 2:165.
Bombus mormonorum Franklin, 1911. Amer. Ent. Soc. Trans., 37:171
(new synonymy).

This species bears a superficial resemblance to *B. morrisoni*, from which it can be separated by the presence of yellow pile on the mesopleura and black pile on metasomal tergum 3. *Morrisoni* has the pile on the mesopleura black and that of the third tergum yellow.

During the past century there has been considerable speculation over the identity of Degeer's species, *Apis griseocollis*. Franklin (1913) was of the opinion that Degeer's species was *Bombus impatiens* and in that work, cited those two species as possible synonyms. In disposing of the name *griseocollis* in this manner, he applied Cresson's *separatus* to this species, and in most collections *griseocollis* will be found under that name. It wasn't until 1939 that Babiý located the type of *griseocollis* and through comparison found it to be conspecific with *separatus*.

Cresson (1863) commented on Olivier's species *virginicus* and the Fabrician reference to that name. There is no possibility of ever locating the material upon which this name was based, for as Cresson points out, the original description (Olivier, 1789) was based upon an illustration by Drury (1770). Apparently Olivier had never seen the material upon which the description was based. Thus we can only speculate as to the identity of *virginicus* and in doing so the name is here questionably synonymized with *griseocollis*.

Franklin (1911) described the variety *mormonorum* for this species and stated that this variety had the following combination of characteristics: the face and vertex with abundant yellow pile, the thoracic dorsum completely covered with yellow pile with no central median patch of black, and metasomal tergum 2 usually completely covered with yellow or brownish pile. Among the specimens on hand are numerous examples of individuals exhibiting one, or all of these characters. There is no correlation of geographic or relief distribu-

tion to account for these differences of *mormonorum*, and as the form and all intergrades between it and the typical *griseocollis* occur in most areas of the west, it is concluded that these differences are but indicative of population variants not warranting subspecific status. Specimens fitting Franklin's *mormonorum* for all three characters have been recorded from British Columbia, Washington, Idaho, Utah, and Oregon with about 5% of the total material showing at least 1 of his diagnostic characters.

QUEENS:

Ocelli large, located well below supraorbital line; malar spaces five-eighths as long as apical widths; first flagellar segment $1\frac{1}{4}$ times as long as third; third segment $1\frac{1}{2}$ times as long as second; tegulae black; wings brown; nervures deep brown to black.

Vertex with pile preponderantly black (a few specimens with some yellow pile intermixed or even with yellow predominating); face with abundant, erect, black pile, varying amounts of yellow intermixed, particularly about antennal bases. Thoracic dorsum with pile all yellow to whitish-yellow except for median patch of erect, black pile; mesopleura with pile all yellow; metapleura with pile yellow except for black on extreme lower faces; propodeum with pile black. Metasomal tergum 1 with pile yellow; tergum 2 with varying amounts of yellow pile, extreme basal portion and basomedial portion always having yellow pile, apical margins with pile black; metasomal terga 3 to 6 with pile black; metasomal sterna with sparse black pile; legs with pile black; corbicular fringes black.

WORKERS:

Much as in queens and undergoing similar variation.

MALES:

Ocelli situated well below supraorbital line in narrowest sector between compound eyes; compound eyes very large, occupying greater part of front of head; malar spaces $\frac{1}{4}$ to $\frac{1}{2}$ times as long as apical widths; flagellum long, segments 1 and 3 subequal, segment 2, two-thirds as long as 1 or 3; tegulae brownish-black; wings fuscous to pale apically; nervures brown.

Vertex with abundant yellow pile; face with plentiful yellow pile particularly below antennal bases and over clypeus. Thoracic dorsum completely covered with yellow pile except for a median patch of black hairs; mesopleura, metapleura and upper portions of propodeum with abundant, long, yellow pile, lower faces of propodeum with black pile. Metasomal tergum 1 with pile yellow; second metasomal tergum with varying amounts of light pile, lateral margins and basal area of 2 with brown tinged pile appearing brownish-yellow; apex of tergum 2 and terga 3 to 7 with pile black; metasomal sterna with pile all black or with a few long yellow hairs on sterna 2 and 3. Anterior coxae and trochanters with primarily black pile, weak yellow fringes on posterior margins; femora with strong posterior fringes of yellow pile, anterior, dorsal, and posterior surfaces with sparse, erect, black pile; midlegs with pile much as forelegs; posterior coxae, femora, and trochanters with strong fringes of yellow on posterior margins, anterior, dorsal, and posterior surfaces with shorter, sparse, black pile; posterior tibiae with pile all black, anterior fringes short, posterior fringes with pile much longer, apices of some of hairs on posterior fringes tinged with brown or ferruginous.

Male genitalia: (figure 13). Most closely resembles *morrisoni* but with subapical endite processes of gonocoxites very short; apices of penis valves rather abrupt and short; seventh sternite densely pilose apically; eighth sternite narrowed apically and with weak apical notch.

VARIATION:

Both sexes of this species exhibit considerable variation in pile color, particularly on head, thoracic dorsum, and abdomen. The pile of vertex may range from completely black to completely yellow, but usually black predominates. The face pile is generally all black with a few short, yellow hairs intermixed above antennal bases. However, in some, the pile is yellow with a few dark hairs at the front, clypeal suture and along the inner orbital margins. Typically, the thoracic dorsum has some black medially, but in a number of specimens it is completely yellow. Pile of metasomal tergum 2 varies from those having yellow restricted to the basomedial portion of the segment to others having the entire tergum covered with yellow or brownish-yellow. On the latter specimens traces of yellow pile are also evident along the lateral margins of terga 3 and 4, and on the apical margin of 4. In the typical *griseocollis*, pile of the legs is all black; however, in extreme yellow population variants, the femora of all three pairs of legs have weak posteroventral fringes of yellow or yellowish pile.

Males are much more constant in color patterns than are the females, with thoracic dorsum pile being the only obvious variable. The median patch of black pile is usually small and weak and in some it is absent. The amount of yellow pile on the second metasomal tergum varies slightly but in none of the specimens examined has the second tergum been completely covered with yellow pile.

DISTRIBUTION:

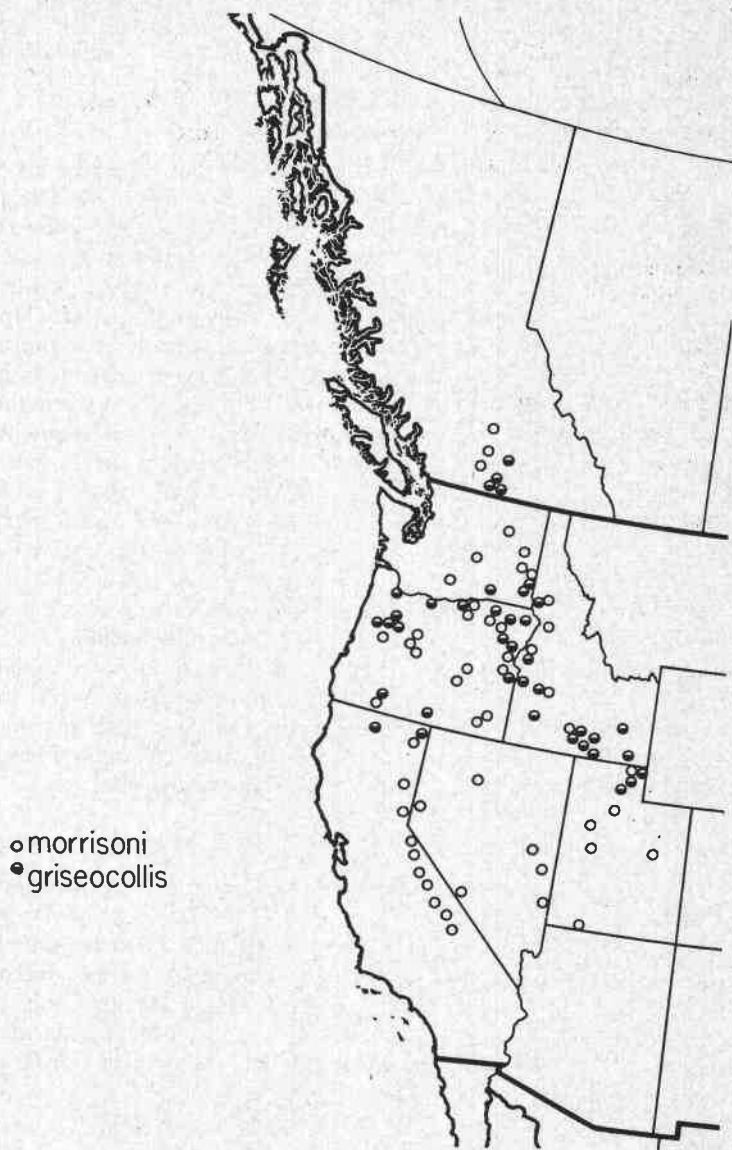
This species is sparingly distributed throughout western America. It is found in the Willamette Valley and Medford areas of Oregon, in eastern Washington and the southern interior of British Columbia, but has yet to be recorded from the extreme coastal areas. Records indicate that it is most abundant in Idaho and northern Utah. Apparently its southern limit in the west is northern California and it is suspected to also occur in Nevada although not recorded from that state (Map 6).

BRITISH COLUMBIA:

Fairview; Okanagan Falls; Oliver; Osoyoos; Penticton; Vaseaux Lake; Vernon.

WASHINGTON:

Pasco; Pullman; Wawawai.



Map 6. Map showing the distribution of *morrisoni* and *griseocollis*.

OREGON:

Albany; Arlington; Baker, 3,400'; Boardman; Cayuse; Corvallis; Eagle Pass, Jackson Co.; Elgin; Fish Lake, Wallowa Mts., 5,000'; Hermiston; Imbler, Union Co.; Kiger's Island; Labish; Lakeview, Marion County; Marys Peak; Medford; North Powder, 3,250'; Ontario; Peoria; Portland; Richland, 2,200'; Salem; Tangent; The Dalles; Vale.

CALIFORNIA:

Modoc County: Cedarville; Fandango Pass.

Siskiyou County: Gazelle.

IDAHO:

Aberdeen, 4,398'; Albion, 4,300'; Balanced Rock, Twin Falls Co.; Blackfoot; Boise, 2,739'; Buhl, 3,500'; Clover, Twin Falls Co.; Grand Central Grade, Nez Perce Co.; Hansen, 4,022'; Hazelton, Jerome Co.; Malder, Cassia Co.; Midvale, Washington Co.; Mountain Home, 3,138'; Parma, 2,224'; Pingree; Preston; Strevell, Thousand Springs.

UTAH:

Cache Junction; Gosher; Logan; Logan Canyon; Newton; Ogden; Providence; Willard Peak.

FLIGHT RECORDS:

The species is most abundant during the mid- and late summer; however, some early spring records of queens, workers, and males are available. Queens have been collected from April 20 to September 26; workers from June 10 to September 5; and males from June 7 to October 24.

The type of *griseocollis*, a worker, is in the collections of the Museum of Natural Sciences of Stockholm, Sweden; that of *separatus* is in the Academy of Natural Sciences of Philadelphia; and those of *mormonorum* in the United States National Museum, the collections of University of Massachusetts and in the Museum of Brooklyn Institute.

Bombus morrisoni Cresson

Bombus morrisoni Cresson, 1878. Acad. Nat. Sci. Philadelphia, Proc., p. 183.

This is a widespread, but sparingly distributed species in western America. It is most closely related to *B. griseocollis* and *B. crotchii*, but is morphologically distinct from those species. Except for several records from the Willamette and Rogue River Valleys of Oregon, *morrisoni* is found in the more arid areas east of the Cascade-Sierra chain.

B. morrisoni is rather common in southern Idaho and in Utah, becoming one of the most common species in New Mexico and Arizona.

QUEENS:

Ocelli situated well below supraorbital line; malar spaces $\frac{3}{4}$ to $\frac{1}{2}$ as long as apical widths; first flagellar segment much longer than either 2 or 3, actually three-fourths of the combined length of segments 2 and 3, segment 3 slightly longer than 2; tegulae black; wings dull, fuscous; nervures dark brown.

Vertex with pile bright yellow, a few dark hairs about anterior margin; face with pile dense and black, concentrated principally about antennal bases. Thoracic dorsum with dense, yellow pile, no evidence of black pile medially, pile extending laterally to cover lateral lobes of pronotum; pleura with black pile. Metasomal terga 1 and 2 and mediobasal portion of tergum 3 with bright yellow pile, remainder of tergum 3 and terga 4 to 6 with pile black; metasomal sterna with pile black; legs with pile all black.

WORKERS:

Much as queens but with malar spaces almost seven-eighths as long as apical widths; first flagellar segments not as long proportionally as in queen. Metasomal tergum 3 with preponderance of yellow pile, much more than in the queen, in most cases only the lateral margins of tergum 3 with black pile. A number of specimens with mediobasal portion of tergum 4 with yellow pile.

MALES:

Eyes large and protuberant; ocelli placed well below supraorbital line in narrowest part of face; antennae long; flagellar segments 1 and 3 subequal in length; 2, half the length of 3; malar spaces short, about one-third as long as apical widths; tegulae and wings, rufous to brown, very much lighter than wings of queen.

Vertex with pile bright yellow; face with yellow and black pile intermixed, yellow usually predominant about antennal bases. Thoracic dorsum with pile dense and yellow, occasionally a few dark hairs intermixed medially, yellow pile extending to lateral lobes of pronotum and occasionally to upper portions of mesopleura directly beneath tegulae; thoracic pleura with pile black, at times a very faint tinge of yellow to hairs on anterior faces of mesopleura. Metasomal terga 1 to 3 with pile bright yellow, sometimes with narrow yellow fringe to base of tergum 4; apex of tergum 4 and terga 5 to 7 with pile all black. Forelegs with pile all black; median legs with pile predominantly black, a weak admixture of yellow pile on posterior margins of femora; hind legs with abundant yellow pile on trochanters and femora; tibiae with pile black.

Male genitalia: (figure 12). Resembles *griseocollis* most closely but with the subapical endite process of gonocoxite intermediate in length between *griseocollis* and *sonorus*; apices of penis valves blunt and considerably longer than in *griseocollis*; seventh sternite similar to that of *griseocollis* in outline but practically devoid of pile.

VARIATION:

This species of the subgenus is the most uniform in color pattern; however, some slight variation in color patterns does occur in workers and males. Workers have the third metasomal tergum as in the queen in most cases, but a few specimens have yellow pile on the base of tergum 4. In both sexes the pile of

vertex, face, and, to a lesser extent the thoracic dorsum, tends to be a paler yellow in specimens from the north and higher altitudes. Males undergo similar variation in respect to pile coloration on the fourth metasomal tergum and in extremes will have the pile of this tergum all yellow except for the apical margin. Those males having metasomal tergum 4 covered with yellow pile, usually have the pile of the apical metasomal sterna tinged with yellow. Some males have tinges of yellow pile extending well below the wing bases on the mesopleura, with faint traces of yellow evident halfway to the coxal bases. In these specimens, the yellow is intermixed with black.

DISTRIBUTION:

The records of Los Angeles and Chino cited by Franklin are questionable. It is possible that these were males of *crotchii* lacking the apical ferruginous pubescence to the abdomen. My own most southerly record of this species from California is Whitney Portal in Inyo County, which like all other California records is over 6,300' (Map 6).

BRITISH COLUMBIA:

Chilcotin; Kamloops; Lillooet; Nicola; Walhachin; White Lake.

WASHINGTON:

Emerald; Grand Coulee; Medical Lake; Pullman; Vantage; Wenatchee; Yakima.

OREGON:

Albany; Andrews; Bend; Blitzen Valley; Boardman; Corvallis; Culver; Echo; Elgin; French Glen; Hood River; Huntington; Ione; Jefferson County; Juntura; Medford; Metolius; Ontario; Pike Creek, Steens Mountains; Prineville; Redmond; Salem; Terrebonne, Deschutes County.

CALIFORNIA:

Alpine County: Carson Pass, 8,600'.

Inyo County: Alabama Hills; Big Pine; Panamint Mts.; Ma-zoorka Canyon; Surprise Canyon; Westguard Pass; White Mts.; Whitney Portal.

Lassen County: Susanville.

Modoc County: Cedar Pass.

Mono County: Blanco's Corral; White Mts., 10,000'; Mammoth Lakes; Mono Lake; Topaz Lake.

Nevada County: Truckee.

IDAHO:

Midvale; Mountain Home; Nez Perce; Twin Falls County; Weiser.

UTAH:

Capitol Reef; Delta; Dry Canyon, Salt Lake Co.; Fruita; Kanab; Logan; Newton; Petersboro; Provo; Salt Lake City; S. Willow Canyon, Tooele Co.; Springdale; Woodside, Emery Co.; Zion Park.

NEVADA:

Caliente, 6,300'; Ely, 6,400'; 27 mi. SE of Ely, 6,600'; Golconda, Humboldt Co.; Lida Pass, Esmeralda Co.; Mt. Wheeler; Pyramid Lake, Washoe Co.; Wadsworth; Verdi, Washoe Co.

FLIGHT RECORDS:

Queens have been taken as early as April 3 in Washington, but the main flight does not occur until May and June, with some queens in the higher elevations of Oregon appearing as late as July 19. The workers are most abundant during July and August, with many being taken as late as September 12. The male records indicate they are most abundant during the latter part of August and early September.

The types of *morrisoni* from Colorado are in the collections of the Academy of Natural Sciences of Philadelphia.

Bombus crotchii crotchii Cresson

Bombus crotchii Cresson, 1878. Acad. Nat. Sci. Philadelphia, Proc. p. 184.

Bombus nigrocinctus Provancher, 1888. Addit. Corr. Faune Ent. Canada Hymen., p. 342.

Bremus crotchii var. *nigricaudus* Frison, 1927. California Acad. Sci. Proc., (4) 16: 375 (new synonymy).

This large, rather striking bumble bee is restricted to California and northern Mexico. It is most closely related to *B. morrisoni* from which it can be distinguished by characters outlined in the key.

Frison (1927) selected several specimens having traces of or no, ferruginous pile on the apical metasomal terga as representative of his variety *nigricaudus*. These specimens, and forms having varying amounts of ferruginous pile on terga 4 to 6, are found distributed throughout the range of the species from San Diego to Tulare County. All intergrades between the specimens having ferruginous pile on the apex of tergum 3, on terga 4, 5, and 6, and those with the pile on these terga all black have been taken on the same date from Woody, Kern County; Hemet, Riverside County; Borago, San Diego County; Costa Mesa, Orange County; and Lemon Cove, Tulare County. This varietal designation is therefore considered to be the extreme form in this polymorphic species and does not warrant sub-specific status.

QUEENS:

Ocelli situated slightly below supraorbital line; malar spaces seven-eighths as long as apical widths; first flagellar segment $1\frac{1}{2}$ times as long as third; third segment one-quarter longer than second; tegulae black; wings dark brown to brownish-black; nervures black to dark brown apically.

Vertex with pile predominantly bright yellow, a few dark hairs above ocelli; face with pile all black. Thoracic dorsum black except for bright yellow pile covering portion anterior to tegulae, yellow pile of scutum extending to lateral lobes of the pronotum; scutellum with pile all black; mesopleura and propodeum with pile all black. Metasomal tergum 1 and mediobasal portion of tergum 2 with pile black; metasomal tergum 2 with remaining pile yellow; metasomal terga 3 and 4 with pile all black; metasomal terga 5 and 6 with pile rufous to ferruginous. Legs and metasomal sterna with pile all black.

WORKERS:

Much as in the queens, but showing greater variation in the amount of ferruginous pile on apical metasomal tergites.

MALES:

Compound eyes very large, occupying greater surface of frontal portion of head; ocelli large, situated well below supraorbital line in narrowest portion of face; malar spaces $\frac{2}{3}$ to $\frac{1}{2}$ times as long as apical widths; antennae with flagellar segments 1 and 3 subequal; flagellar segment 2, two-thirds as long as 3.

Vertex and face covered with abundant, short, yellow pile, a few black hairs intermixed along inner orbital margins and frontoclypeal suture. Mesoscutum with abundant, erect, yellow pile on portion anterior to bases of tegulae; distinct, black interalar band between wing bases; some yellow pile intermixed with black along lateral face of scutum; scutellum with abundant, long, yellow pile; mesepisterna having yellow pile extending down from lateral lobes of pronotum three-quarters of the way to coxal bases, this yellow pile strongly intermixed with black; metepisterna and propodeum with pile black. Metasomal tergum 1 with long yellow pile, extreme anterior face of first tergum with pile black; metasomal tergum 2 and extreme apical portion of metasomal tergum 3 with pile yellow; metasomal terga 3 and 4 with pile black; metasomal tergum 5 with pile black, intermixed with ferruginous, or entirely ferruginous; metasomal terga 6 and 7 with pile bright ferruginous; metasomal sterna with abundant, long, black pile. Fore- and midpairs of legs with pile black, except for weak fringes of yellow pile on ventrobasal margins of femora; hind legs with pile all black.

Male genitalia; (figure 15). The genitalia bear only superficial resemblance to those of *morrisoni*. Penis valves are elongate and sharply pointed apically; the seventh sternal plate is very broad, tending to be subquadrate and very densely haired. The eighth sternal plate is similarly densely pilose and sharply angulate apically.

VARIATION:

Except for the color of the pile on the apical metasomal terga, this species exhibits little pile color variation. In the typical form, metasomal terga 4, 5, and 6 have the pile ferruginous. However, the amount of ferruginous pile varies; at one extreme some specimens have only traces of ferruginous pile on the sixth metasomal tergum, and at the other, the apical portion of tergum 3, as well as terga 4, 5, and 6 are covered with bright ferruginous pile. There is some

variation in the amount of black pile on the second metasomal tergum of both queens and workers. In typical specimens there is only a small amount of black pile on the mediobasal portion of tergum 2. Before me are specimens which have the second tergum almost completely covered with yellow pile and only a few black hairs intermixed, and others in which the basal one-third of the segment is covered with black pile. This black pile is evident as a much narrower band laterally, but at times will completely cover the basal portion of the second tergum even at its lateral extremities.

In the males, as in the females, the amount of ferruginous pile on the apical metasomal terga is quite variable. The ferruginous pile on the apex of the abdomen may be evident only as lateral fringes, or may cover the apical portion of tergum 3 as well as all of terga 4 to 7. The amount of yellow pile on the anterior face of the mesopleura may extend slightly below the lateral lobes of the pronotum, or may reach from the lateral lobes of the pronotum to the anterior coxal bases. The width of this band of yellow pile is subject to some variation however, and in no case does the yellow pile cover more than the anterior two-thirds of the mesopleura.

DISTRIBUTION:

The species is found throughout the southern half of California and extends up the central valley well into the Sacramento region. A number of records are also available of *crotchii* from Baja, California and it is assumed to be present also in Arizona and Old Mexico. (Map 7).

CALIFORNIA:

Alameda County: Pleasanton.

Contra Costa County: Antioch, Mt. Diablo.

Fresno County: Coalinga; Fresno; Huntington Lake 7,000'; Oxalis; Trimmer.

Glenn County: Artois; Orland.

Inyo County: Haiwee; Pine Creek.

Kern County: Arvin; Bakersfield; Blackwells Corner; Caliente; Cummings Valley; Ft. Tejon; Kern Canyon; Kernville; Lebec; Tehachapi; Woody.

Los Angeles County: Altadena; Baldwin Hills; Big Dalton Dam; Claremont; Griffith Park; Inglewood; Johnson Peak; Llano; Pomona; San Gabriel Mts.; Santa Monica; Tanbark Flat; Walnut; Westward Hills; Westwood; Whittier.

Madera County: San Joaquin Exper. Res.

Merced County: Dos Palos; Panoche Hills.

Orange County: Costa Mesa; Newport Bay; Santa Ana.



Map 7. Map showing the distribution of *crotchii*.

Riverside County: Banning; Hemet; Idyllwild; Riverside; Temecula.

San Bernardino County: Bloomington; Cramer Hills; Little Bear Valley; Ontario; Phelan, Rialto; SCELEY.

San Diego County: Borago; Ramona.

San Joaquin County: Vernalis.

San Luis Obispo County: Paso Robles.

San Mateo County: Palo Alto.

Santa Barbara County: Santa Barbara.

Santa Clara County: Alum Rock Park, San Jose.

Stanislaus County: Patterson.

Tulare County: Keweah, Lemon Cove; Mineralking; Porterville; Visalia.

Tuolumne County: Jamestown.

Ventura County: Ventura.

Yolo County: Davis.

The type of *crotchii* is in the collections of the Academy of Natural Sciences of Philadelphia; that of *nigrocinctus* is in the United States National Museum; and that of *nigricaudatus* is in the California Academy of Sciences collections.

Bombus crotchii semisuffusus Cockerell

Bombus crotchii semisuffusus Cockerell, 1937. Pan-Pac. Ent. 13:148.

This subspecies, like that of *nevadensis miguelensis* was based on a single specimen taken on a collecting trip to San Miguel Island. No further specimens from that area, have been seen but an examination of the type indicates that for the present the subspecific name should be recognized. The type is a highly aberrant female that can be separated from typical *crotchii* without difficulty. Morphological divergence from the typical form, if generalization can be based on a single specimen, would indicate that the channel islands offer an effective isolating barrier to members of this genus.

The type is so markedly different in the length of the malar-spaces that one is inclined to question the conspecificity of this form with the typical *crotchii*. This subspecies differs from *c. crotchii* in having malar spaces $1\frac{3}{8}$ as long as the apical widths; pile of the vertex all black; and the amount of yellow pile on the second metasomal tergum markedly less than in the typical form. The yellow pile on tergum 2 is restricted to the apical one-third; elsewhere on the disc there is either an admixture of black and yellow or a preponderance of black.

DISTRIBUTION:

San Miguel Island, California, July 30, 1937.

The type is located in the collections of the California Academy of Sciences.

Subgenus *Cullumanobombus* Vogt

(= *Fraternus* group (in part) Franklin)

Bombus subg. *Cullumanobombus* Vogt, 1911. Gesell. Naturf. Freunde Sitzber. p. 57.

Type: *Apis cullumanus* Kirby. Desig. Frison, 1927.

Bremus subg. *Rufocinctobombus* Frison, 1927. Amer. Ent. Soc. Trans. 53:78. pl. 17, fig. 9.

Type: *Bombus rufocinctus* Cresson. Monob.

Males: Ocelli just slightly below supraorbital line; eyes only slightly bulging from sides of head; posterior tibiae with outer surfaces weakly concave, long fringes particularly to posterior margins; volsellae protruding greatly beyond apices of gonostyli, sharply curved mesad; gonostyli shorter than wide; penis valves robust, apices dilated and sickle-shaped; seventh ventral plates semilunar with deep median emarginations apically; eighth ventral plates broadly triangular, apical one-third of discs as densely haired quadrate projections.

Bombus rufocinctus Cresson

Bombus rufocinctus Cresson, 1863. Ent. Soc. Philadelphia, Proc., 2:106.

Bombus iridis Cockerell and Porter, 1899. Ann. Mag. Nat. Hist. (7) 4:390.

Bombus prunellae Cockerell and Porter, 1899. Ann. Mag. Nat. Hist. (7) 4:391 (in part).

Bombus iridis var. *phaceliae* Cockerell, 1906. Canadian Ent. 38:160.

Bombus rufocinctus var. *astragali* Cockerell, 1907. Entomologist 40:97.

Bombus hyperboreus var. *albertensis* Cockerell, 1909. Canadian Ent. 41:36.

Bombus rufocinctus var. *castoris* Cockerell, 1915. Ann. Mag. Nat. Hist. (8) 15:537.

This species exhibits the greatest color pattern variation of any found in western America (figure 3). It also exemplifies the confusion resulting from the application of incidental names to color variants of bumble bees during past years. At present there are 6 latinized variety names in the literature, in addition to Franklin's numbered color variants of 7 females and 9 males. There are collections in which these color variants were religiously numbered or labeled resulting in a mass of detail that confuses rather than clarifies relationships within this polymorphic species. Examination of the male genitalia of all 6 varieties, as well as the 9 color variants has been undertaken, and there is no constant, observable difference in the structure between any of the forms. As much variation is exhibited by color variants having identical color patterns as between those at the extremes of the color range.

There is little to be gained nomenclatorially, and nothing to be gained in understanding the relationship of the color forms, by profuse tagging of variants found within this species. Concepts and

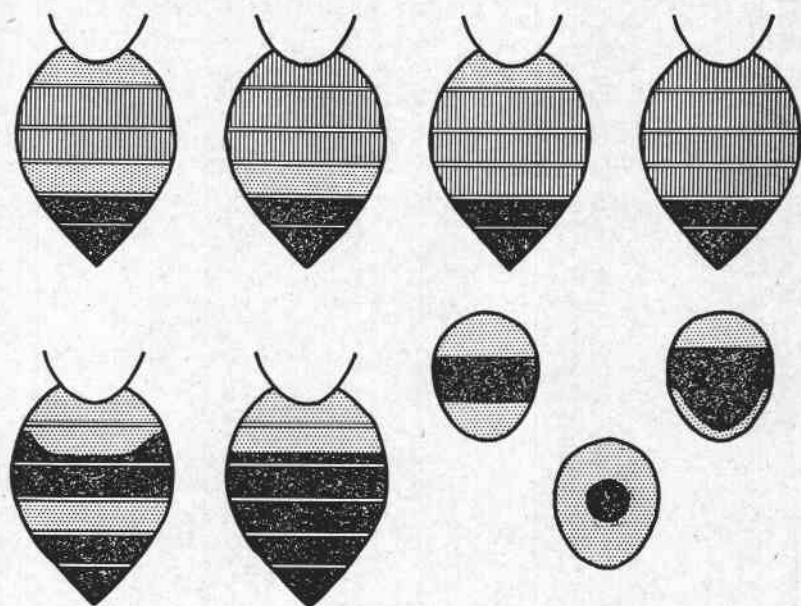


Figure 3. Illustrations showing the intrapopulation variation in color patterns of the metasoma and thoracic dorsum of *rufocinctus*. In these illustrations black indicates black on the bee, vertically lined areas equal a red-orange, while stipple is used for areas that are actually yellow.

nomenclatorial practices are outlined in the Introduction to this bulletin and in the light of such standards all variants are included in the highly polymorphic *B. rufocinctus*. A thorough study of the distribution of all the color forms indicates no correlatable ecophenotypic color expression or apparent subspeciation in any area of western America. Most, if not all, color forms have been taken at the same place and at the same time.

Entire populations of three nests, averaging 26 specimens each, are at hand and there are at least 4 of the 6 named varieties represented in each. These nests taken at Medford, Oregon; Parma, Idaho; and Central Grade, Nez Perce County, Idaho; include all the varieties as well as numerous intergrades among their number. This, plus the fact that several varieties appear endemic at 23 localities throughout the species' range in western America, suggests rather strongly that pile color on the abdominal terga is controlled by simple genetic alleles and the species is strongly heterozygous for genes controlling

color characters. Only in the northeastern corner of California does there appear to be some stability in color pattern. Pile on specimens from Modoc, Mono, and Nevada counties exists as in the typical form.

It is noteworthy that throughout the range of this polymorphic species, specimens with terga 2 and 3 having the pile ferruginous (typical form) predominate.

Franklin (1913) redescribed this species from a series of 15 queens, 10 workers, and 7 males, basing the description on the form having metasomal terga 2 and 3 covered with black pile. However, in Cresson's original description he indicates that both male and worker have considerable reddish pile on the abdominal dorsum. Dr. H. J. Grant of the Academy of Natural Sciences of Philadelphia, informs me that the worker has reddish pile on the apex of tergum 2 and completely covering terga 3 and 4. This would indicate that Franklin's description was based upon queens and workers of the variant having the color patterns he outlined. Thus, if a neallotype queen were to be designated, it should have abdominal coloration resembling that of Cresson's worker; that is, reddish pile on terga 2, 3, and 4.

Typical material, or specimens determined by the original authors of all of the designated varieties of *rufocinctus* have been examined, with the exception of var. *henshawii* and var. *sladeni*. The latter is restricted to eastern America and does not enter the scope of this study. The variety *henshawii*, however, was described from San Francisco and Palo Alto, but the cotypes have not been seen. The broad gap between known California records of *rufocinctus* and *henshawii*, and the fact that extensive collecting in the Bay Area has not produced any specimens resembling *rufocinctus* or *henshawii*, make me somewhat skeptical of Frison's synonymy, *rufocinctus* var. *henshawii*.

QUEENS:

Ocelli situated slightly below supraorbital line; compound eyes small; malar spaces three-quarters as long as apical widths; flagellum short; third flagellar segment $\frac{2}{3}$ to $\frac{3}{4}$ as long as first, second flagellar segment $\frac{2}{3}$ to $\frac{3}{4}$ as long as third; tegulae light brown to brownish-black; wings fuscous to pale brownish; nervures brown to deep brown.

Vertex with abundant, long, erect, yellowish pile, some black pile intermixed about periphery; face with black pile predominating below antennal bases, a few, short, light hairs intermixed in the region between antennal bases and above frontoclypeal margin; pile above antennal bases predominantly black, but with abundant yellow in some specimens; area behind eyes with pile black. Thoracic dorsum with abundant yellow pile on scutum anterior to tegulae; black interalar band usually present; however, the band tends to be somewhat indistinct towards lateral margins on most specimens, abundant yellow pile intermixed along lateral margins in some to make it appear as if the interalar

band is but a large median patch of black pile; scutellum with pile long, dense, and yellow, occasionally a few black hairs intermixed on the median portion of disc; mesopleura with abundant, long, yellow pile over upper portions of disc; pile black immediately above coxal bases and along extreme lower, anterior margins of mesopleura; metapleura with abundant, yellowish pile above, some black pile on lower surfaces; propodeum with long fringes of yellow pile on dorsolateral margins, pile of lower faces black.

Metasomal tergum 1 with long tufts of yellow pile laterally, pile much shorter, almost absent medially; metasomal tergum 2 variably colored, on typical specimens with median and apical portion of tergum having a strong covering of reddish-orange pile, lateral one-quarter of disc with pile reddish to ferruginous; metasomal tergum 3 with pile ferruginous; metasomal 4 with pile variable colored, usually yellow though a number of specimens have traces of ferruginous pile along the basal portion; metasomal tergum 5 with abundant yellowish pile laterally, median portion of disc with pile black; metasomal tergum 6 with pile black; metasomal sterna with weak apical fringes of whitish to dark brown pile. Anterior legs with pile black, pile on apical portion of tibiae tinged with ferruginous; midlegs with pile of coxae, trochanters, femora and tibiae all black; posterior legs with pile black, occasionally a few light hairs over ventral surface of femora; corbicular fringes black.

WORKERS:

Much as in the queens, except with face pile predominantly black; the interalar band much more distinct to wing bases; the metasomal terga exhibiting various color patterns; the typical form tending to have ferruginous pile restricted to metasomal terga 2 and 3, or at most, the base of tergum 4, however, this ferruginous pile may be found only on the apex of 2, on metasomal tergum 3 and most of tergum 4.

MALES:

Ocelli large, situated well below supraorbital line; compound eyes large, occupying greater surface of frontal portion of the head; malar spaces $\frac{3}{4}$ to $\frac{5}{8}$ as long as apical widths; antennae with flagellar segment 3, one-third longer than 1 and segment 2, one-third shorter than 1; tegulae brownish-black; wings pale brown to fuscous; nervures brown.

Vertex with abundant, long yellow pile, a few black hairs about periphery; face with abundant, yellowish pile below antennal bases and covering clypeus, yellow pile above antennal bases, admixture of black pile along the innerorbital margins, between antennal bases and at frontoclypeal margins. Thoracic dorsum with abundant, long, yellow pile to tegulae; interalar band obscure, a strong admixture of yellow and black pile laterally; scutellum with abundant, long, pale yellow pile, a few black hairs intermixed over anterior portion of disc; mesopleura with long, pale yellow pile, some black pile immediately above coxal bases and along lower anterior margins; metapleura with abundant, long, yellowish pile above and a few shorter black hairs below; propodeum with dense fringes of long, yellowish pile at laterodorsal margins, lower faces of propodeum with black pile, occasionally intermixed with some yellow. Metasomal terga 1 and 2 with pile yellow or grayish-yellow; metasomal terga 3 and 4 with abundant ferruginous pile, pile tending to be yellow-ferruginous on lateral extremities of tergum 4 as well as on apical and lateral margins of that segment; metasomal terga 5 and 6 covered with long, pale yellow to grayish-yellow pile; metasomal tergum 7 with abundant grayish to grayish-yellow pile laterally, a few dark hairs intermixed at the extreme apex and over median portion of disc; metasomal sterna with apical fringes of whitish to grayish-white pile.

Anterior legs with pile black except for long, dense posteroventral fringes of yellow pile on coxae, trochanters, and femora; midlegs much as forelegs; hind legs with abundant, shorter, yellowish pile on coxae and trochanters; femora with sparse, yellowish to pale gray hairs above, frequently intermixed with black towards apices; posterior tibiae with short black hairs along anterior margins, dorsal surfaces almost bare, posterior margins with an admixture of short, black hairs and longer light to golden hairs.

Male genitalia: (figure 11). The genitalia of this species are unique among members of this genus in America. They can readily be distinguished by elongate medially directed gonostyli and sharp, hook-like apices of the penis valves.

VARIATION:

It is difficult to describe the variation in color pattern characteristics for members of this species in western America. Some of the variation about the typical form is described above but this is by no means complete.

The following remarks are directed at the principal variability in color patterns in both sexes starting at the face and terminating on the abdominal dorsum.

In queens and workers, pile of the vertex varies from all yellow, to a strong admixture of black, however, in all specimens yellow does predominate. The pile of the face above antennal bases ranges from pure black in some, to almost pure yellow in others; generally there is a mixture of black and yellow pile in this region with yellow predominating. The pile on the scutum undergoes a considerable variation in pattern (figure 3). In a number of specimens the interalar band is broad, black and rather distinct, while in others there are only a few black hairs on the median face of the disc. Pile of the scutellum is usually all yellow; however, in some there is a strong admixture of black pile on the anteriomedian portion of the disc. The upper faces of the mesopleura are always covered with yellow pile. In some, this yellow pile is complete to coxal bases, but in most there is a rim of black pile immediately above the coxae, over the lower anterior and along the posteroventral portion of the mesopleura. In some specimens this black pile extends one-third of the way up towards the wing bases.

The most discernible variation in color pattern occurs on the metasomal terga (figure 3). In the typical form, the pile of metasomal terga 2 and 3 is bright ferruginous, while terga 1 and 4 are covered with yellow. A number of specimens have metasomal terga 1, 2, and 3 covered with ferruginous pile, with tergum 4 yellow. In others, 2, 3, and 4 may be covered with ferruginous pile, with tergum 5 black. Still others have metasomal terga 1 to 4 covered with ferruginous pile, and the pile of tergum 5, black. In the redescription of this species, Franklin refers to that form having metasomal tergum 1 and the mediobasal portion of metasomal tergum 2 with yellow

pile. The remainder of tergum 2 as well as tergum 3 is covered with black pile, while the pile of tergum 4 is yellow. Four specimens have been noted as having metasomal tergum 1 and the major portion of metasomal tergum 2 covered with yellow pile. The remaining abdominal terga are all covered with black pile.

In the males, face pile ranges from all yellow, except for black rims along the innerorbital margins, to abundant black intermixed over the facial area. The scutum of the males may have a rather distinct black interalar band or the pile of mesoscutum may be predominantly yellow with an admixture of black hairs only on the median discal area. The scutellum is usually covered with a predominance of yellow pile, but there may be a strong admixture of black over the anterior discal area. The color of the metasomal pile undergoes equal or greater variation than that of queens and workers.

Rather than verbally outline limits of this variation, a chart has been prepared (Table 1) which gives the most common color forms found in western America. It is by no means all inclusive, for intergrades between two or more of the listed variants have been seen. Many varietal names have been applied to these color forms but on the basis of this study they have been reduced to synonyms of the polymorphic *B. rufocinctus*.

Pile on the hind margins of the posterior tibiae of the males is usually tinged with whitish or golden, but in a few specimens it is black, with only the fringe apices tinged with ferruginous.

DISTRIBUTION:

The species is widely distributed in western America in the area east of the Cascade Mountains, but Buckell (1951) records two queens from Vancouver Island. It is found as far north as Chilcotin (latitude 52°) in British Columbia and occurs in northeastern California and parts of northern Nevada. For the most part the species appear to follow the Canadian and Transitional Life Zones but is by no means restricted to them (Map 8).

BRITISH COLUMBIA:

Chilcotin; Crows Nest; Fernie; Kalden; Kamloops; Kaslo; Lumby; Oliver; Walhachin.

WASHINGTON:

Addy; Kamiak Butte; Prescott; Pullman.

OREGON:

Anthony Lake, Blue Mts., 7,100'; Baker, 3,400'; Cayuse; Cove, Union Co.; Elgin; 10 mi. E. Elgin, 3,638'; Enterprise; Fish Lake, Steens Mts., 7,000'; Ft. Klamath, 4,200'; Grand Ronde, Union Co.; Granny Lake, Wallowa Co.; Klamath Falls; Lakeview, 4,400'; Lost-

○ *rufocinctus*



Map 8. Map showing the distribution of *rufocinctus*.

TABLE 1. Variation in pile color on the metasomal terga in
B. rufocinctus males

Tergum	Variants											
	A	B	C	D	E	F	G	H	I	J	K	L
#1	Y	Y	Y	Y	Y	Y	F	Y	Y	Y	Y	Y
#2	Y	Y	Y	Y	Y	Y	F	Y	Y	Y+B	Y	Y+B
#3	Y	Y	F	F	F	F	F	F	B	B	B	B
#4	Y	F	Y	F	F	F	F	F	B+Y	B	B	B
#5	Y	Y	Y	Y	Y	F	F	Y	Y	B+Y	B	B
#6	Y	Y	Y	Y	F	F	F	Y+B	Y	Y	B	B
#7	Y	Y	Y	Y	F	F	F	B	B	B or F or Y	B	B

Y = yellow, F = ferruginous, B = black, Y+B = Yellow basally, black apically, B+Y = Black basally, yellow apically.

ine, 3,360'; Meacham; Medford, Jackson Co.; 5 mi. N. Medford;
North Powder, 3,240'; Summer Lake; Wallowa Lake.

CALIFORNIA:

Modoc County: Canby; Cedarville; Goose Lake; Lake City.

Mono County: Cornet Lake.

Nevada County: Truckee.

IDAHO:

Ashton, 5,000'; Central Grade, Nez Perce Co.; Deary; Donnelly,
Valley Co.; Downey; Gifford; Juliaetta; Lakefork, Valley Co.; Le-
nore; Lewiston; Melrose; Midvale, Washington Co.; Moscow; Mos-
cow Mts.; Plummer; Potlatch; Preston; Reubens; Sandpoint, 2,086';
Smithfield; Troy, 2,475'; West Twin Mts.

UTAH:

Immigration Canyon, Salt Lake Co.; Logan; Millville; Myton;
Newton; Ogden; Petersboro; Providence; Wellsville Mts.

NEVADA:

Angel Lake Road; Wells, 5,400', Elko Co.

FLIGHT RECORDS:

The species has been recorded as flying from May until October
with the peak flight of queens and workers occurring during late
June, July, and August. Queens have been taken from May 6 to
October 27; workers from June 11 to September 25; and males,
July 1 to September 24.

The type of *rufocinctus* is in the Academy of Natural Sciences of Philadelphia; that of *prunellae* is in the collections of the United States National Museum; the types of *iridis*, *iridis* var. *phacellae* and *rufocinctus* var. *castoris* are also in the United States National Museum. The types of *hyperboreus* var. *albertensis* and *rufocinctus* var. *astragali* have not been located although a number of specimens from the type locality of each, determined to be conspecific with each variety by Cockerell are in the collections examined.

Section: *Anodontobombus* Krüger

Anodontobombus Krüger, 1917. Ent. Mitteil. 6:57.

Males: Eyes not protruding beyond sides of head; ocelli placed at supraorbital line; malar spaces usually shorter than apical widths; volsellae protruding slightly, or not at all, beyond apices of gonostyli; gonostyli with, at most, a short spine-like process at mediobasal margins; antennae short or of moderate length.

Females: Ocelli situated at supraorbital line; head short, inclined to be almost round; malar spaces never longer than apical widths; midmetatarsus without tooth at basoposterior margins; hind metatarsus not distinctly spined; mandibles without distinct basal carina or furrow.

Subgenus *Bombus* Latreille

(= *Terrestris* group Radoszkowski, Franklin)

Bremus Jurine, 1801. Intell. Blatt. Litt.-Ztg. Erlangen 1:164. Suppressed by Internatl. Comm. Zool. Nomencl., Op. 135, 1939.

Type: *Apis terrestris* Linnaeus. Desig. Morice and Durrant, 1915.

Bombus Latreille, 1802. Hist. Nat. Fourmis, p. 437.

Type: *Apis terrestris* Linnaeus. Monabasic.

Bremus Panzer, 1804 (?). Faunae Ins. German., p. 85.

Type: *Apis agrorum* Fabricius. Desig. Sandhouse, 1943.

Bombus subg. *Leucobombus* Dalla Torre, 1880. Naturhistoriker, V. 2, p. 40.

Type: *Apis terrestris* Linnaeus. Desig. Sandhouse, 1943.

Bombus subg. *Terrestribombus* Vogt, 1911. Gesell. Naturf. Freunde Sitzber. p. 55.

Type: *Apis terrestris* Linnaeus. Desig. Frison, 1927.

Males: Head short, more or less round; malar spaces less than one-half as long as apical widths; posterior tibiae with distinct corbicular, corbicular fringes long on both anterior and posterior margins; capsule robust; volsellae irregularly rounded apically, barely protruding beyond ends of gonostyli; gonostyli with slender, medially directed endites arising at bases, gonostyli sharply and deeply emarginate immediately above basal endites; penis valves twisted, apices

convoluted and flaring; seventh ventral plates narrow with disc tending to be quadrate and at least twice as broad as long; eight ventral plates weakly triangular with deep median incision, apically, bifid apices weakly pilose.

Bombus occidentalis Greene

This species is one of the more variable bumble bees in America and is closely related to the old world *terrestris* group. Its closest allies in America are *terricola* and *terrestris moderatus* Cresson both of which have the second tergum completely covered with yellow, rather than black pile. *Occidentalis* is abundant throughout the Pacific Northwest and northern California, becoming less numerous in the southern Rocky Mountain area. It is a highly polymorphic species throughout most of its range and the distribution pattern of *occidentalis* and the subspecies recognized below, have prompted speculation and criticism on the subjective subspecies concept currently held.

For the past decade three subspecies or varieties have been recognized: *occidentalis occidentalis* Greene; *occidentalis nigroscutatus* Franklin, and *occidentalis* var. *proximus* Cresson. The variety *proximus* and the subspecies *nigroscutatus* bear a marked similarity to each other but can be distinguished by the amount of yellow pile on the scutellum; color and amount of light pile on the apical terga; and the amount of light pile on the face. *Proximus* was applied originally to a specimen taken from Utah, but color forms resembling this variety occur throughout the range of the species. As indicated on Map 9, color forms resembling *occidentalis*, *proximus* and in lesser numbers, *nigroscutatus*, have been taken from the same place and at the same time in all endemic areas except coastal regions of California about the Bay Area. In this latter region the color form *nigroscutatus* occurs exclusively, gradually intergrading with polymorphic *occidentalis* in Humboldt County and to the north.

If one were to consider the entire range of the species, exclusive of the Bay Area in California, the species would of necessity be treated as highly polymorphic and monotypic. All subspecies and varieties would have no taxonomic status. The variety *proximus* obviously does not deserve nomenclatorial recognition, for it, typical *occidentalis*, and their intergrades have been taken from the same nests. This would apply to *nigroscutatus* were it not found exclusively and in abundance in the Bay Area; however, as the form from this latter region withstands objective analysis, it merits subspecific status. Individuals morphologically identical with *nigroscutatus*, but scattered throughout the range of the species are not included with this subspecies as they are few in number; of scattered distribution; and in all likelihood are much more closely related genetically to the typical

occidentalis. This would indicate that color patterns in polymorphic *occidentalis* are under the control of simple, nonselective genetic alleles.

Therefore, *occidentalis nigroscutatus* is, in my opinion, a valid subspecies that must of necessity be geographically and biologically defined.

Bombus occidentalis occidentalis Greene

Bombus occidentalis Greene, 1858. Lyc. Nat. Hist. N. Y. Ann. 7:12.

Bombus modestus Smith, 1861. Jour. of Ent. 1:153.

Bombus proximus Cresson, 1863. Ent. Soc. Philadelphia, Proc., 2:98.

Bombus howardi Cresson, 1863. Ent. Soc. Philadelphia, Proc. 2:99.

Bombus perixanthus Cockerell and Porter, 1899. Ann. Mag. Nat. Hist. (7) 4:389.

Bombus mckayi Ashmead, 1902. Washington Acad. Sci. Proc., 4:125.

Bombus proximus var. *coloradensis* Titus, 1902. Canadian Ent. 34:28.

As cited above, this subspecies is highly polymorphic throughout its range. It is particularly abundant in the Pacific Northwest states and southern British Columbia and is found from sea level to 8,000 feet. As here recognized, *o. occidentalis* occupies most of western America with the exception of coastal California around the Bay Area.

QUEENS:

Ocelli located at or slightly below supraorbital line; malar spaces seven-eighths as long as apical widths; flagellum short, first flagellar segment one-third longer than third, second flagellar segment one-quarter shorter than third; tegulae black; wings brown to deep fuscous; nervures brown to brownish-black basally.

Vertex with pile predominantly black, a few very short light hairs intermixed; face with an admixture of black and light pile, black predominating; pile above antennal bases black, except for a very small patch of short light pile medially; pile below antennal bases with admixture of black and light pile, black predominating; area between antennal bases and inner orbital margins with pile black; area behind eyes with pile black. Scutum, from tegulae to anterior margins, with pile dense and yellow; scutellum with pile all black in typical form; mesopleura with pile black except for some light pile in regions about the lateral lobes of pronotum; metapleura and propodeum with pile all black. Metasomal terga 1 to 3 with pile all black in typical form; metasomal tergum 4 with some black pile basally, but with apical two-thirds of tergum having pile all white; metasomal tergum 5 with pile white, to tinged with fuscous; metasomal tergum 6 with light pile laterally, discal area with sparse short brownish to fuscous pile. Legs with pile of coxae, trochanters and femora black; anterior and midtibiae with pile black; posterior tibiae with long ferruginous corbicular fringes.

WORKERS:

Much as in the queens but with face and vertex having greater proportion of black to light pile, and in having the light pile of metasomal tergum 4 usually restricted to the apical one-third of the tergum.

MALES:

Ocelli situated at supraorbital line; malar spaces as long as apical widths; first and third flagellar segments subequal; second flagellar segment two-thirds as long as 1 or 3; tegulae brown to dark brown; wings light brown to whitish-brown apically; nervures brown.

Vertex with strong admixture of light pile, some black intermixed about margins and between vertex and eyes; face with yellow pile predominating below antennal bases and over clypeus, pile usually intermixed with black; pile above antennal bases, black with weak admixture of short, whitish or yellow pile; inner orbital margins with abundant black pile. Scutum with pile anterior to tegulae bright, dense and yellow; posterior portion of scutum and scutellum with pile all black; mesopleura with black pile predominating, abundant yellow pile on upper anterior portions about lateral lobes of pronotum, yellow pile often extending towards coxal bases along extreme anterior margins; metapleura and propodeum with pile black. Metasomal terga 1 to 3 with pile all black; metasomal tergum 4 variable but usually with black pile intermixed over basal one-half, and white to fuscous pile over apical one-half; metasomal terga 5 and 6 covered with light pile, usually whitish; metasomal tergum 7 with light pile tinged with fuscous; metasomal sterna 1 to 4 with apical fringes of black pile; metasomal sterna 5 and 6 with abundant light pile apically. Legs with pile all black except for ferruginous, posteroventral fringes on fore- and midtibiae; posterior tibiae with long anterior and posterior fringes of pile tinged with ferruginous or golden, abundant shorter, dark pile intermixed along anterior margins.

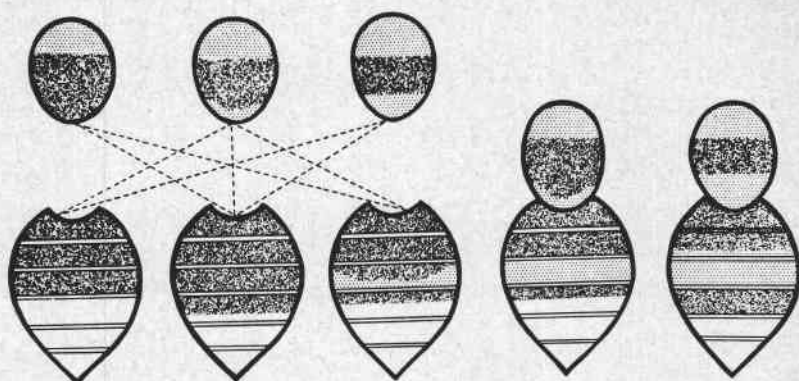
Male genitalia: (figure 14). Capsule closely resembling that of *terricola* and *franklini* but differing from these in the convolution of the apices of the penis valves and the apicomedian process of the gonostyli; seventh ventral plate practically indistinguishable from that of *terricola*.

VARIATION:

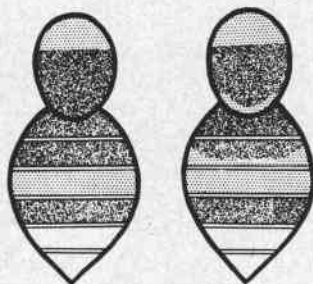
There is extensive variation in the color patterns of the species. In the queens and workers, pile of the vertex is always predominantly black; however, the amount of light pile intermixed undergoes random variation throughout its range. Similarly the pile of the face is usually almost all black, above and below the antennal bases, but in a number of specimens pile below the antennal bases may have a very strong admixture of yellowish pile.

Color of the pile on the scutellum and the metasomal tergum is highly variable throughout the species' range. The presence and amount of yellow pile on the scutellum is not associated with any single tergal colorative pattern. Since a verbal description of the variation found in color patterns would be lengthy and perhaps confusing, a series of diagrams are included (figure 4) to indicate the principal combinations observed.

In males, pile of the vertex and face is predominantly yellow, but may vary from all yellow, except for inner orbital fringes of black, to specimens having enough black pile intermixed to give the face a clouded appearance. The pile on the metasomal terga forms color patterns much as in the females. All intergrades between the



occidentalis



o. nigroscutotus

Figure 4. Integration and variation in color patterns of the metasoma and thoracic dorsum of the polytypic *occidentalis*. Colors of the bees are indicated as follows: blank equals white; stipple indicates yellow; and black is used for black.

extreme yellow form and the extreme black form (typical) have been examined with no apparent geographic or topographic correlation. Three males from Colton, Utah; Anthony Lake, Blue Mountains, Oregon; and Salem, Oregon represent the greatest yellow extreme observed. They have yellow pile on all except the base of tergum 2, completely covering tergum 3 and over the basal half of tergum 4. In those specimens the yellow pile and white pile are confluent on the median face of the fourth tergite.

DISTRIBUTION: (Map 9).

BRITISH COLUMBIA:

Alberni, V. I.; Agassiz; Armstrong; Burns Lake; Cedarvale; Chase; Chilcotin; Clinton; Cranbrook; Crows Nest; Duncan; Fernie; Golden; Invermere; Kalden; Kamloops; Kaslo; Keremeos; Kitwanga; Lillooet; Lytton; Milner; Minnie Lake; Naniamo, V. I.; Newgate; Nicola; Oliver; Penticton; Prince Rupert; Radium; Salmon Arm; Salvus; Shuswap; Sidney; Smithers; Summerland; Terrace; Vancouver; Vernon; Victoria, V. I.; Walhachin; Yale.

WASHINGTON:

Bay Center; Bear River; Bothell; Echo Lake; Harstine Island; Keyport; Loomis; Loomis Lake; Manchester; Mercer Island; Metline Falls; Mt. Rainier; Naselle River; North Bend; Olympia; Palix River; Paradise Valley; Prescott; Pullman; Redmond; Renton; Samish; Seabeck; Seattle; Seaview; Shelton; Spokane; Table Rock; Tacoma; Thelan; Wapato; Wenatchee.

OREGON:

Albany; Alsea; Aneroid Lake, 7,500'; Antelope Mt., Harney Co., 6,500'; Anthony Lake, 7,100'; Ashland, 4,900'; Astoria; Baker, 3,440'; Breitenbush, 2,222'; Coos Bay; Corvallis; Crater Lake, 6,000'; Crescent Lake, Klamath County, 4,837'; Dayville; Diamond Lake, 5,182'; Dixie Mt., Blue Mts., 5,280' to 6,000'; Drakes Peak, Lake County; Fish Lake, Steens Mountains, 7,000'; Ft. Klamath, 4,200'; Gold Beach; Halfway; Independence; John Day; Kelsy Valley, Douglas Co., 4,100'; Klamath Lake; La Grande, 5,000'; Lake of the Woods, Klamath Co., 4,250'; Lakeview, 4,800'; Langdon Lake; Lava Lake, Deschutes Co., 4,200'; Lucky Boy Camp, Blue River; Marys Peak; McKenzie Pass; Meacham; Mt. Hood, 6,000'; Newport; North Powder, 4,240', Blue Mts.; Ontario; Oswego; Philomath; Paulina Lake, Deschutes Co.; Roseburg; Salem; Shedd; Sparks Lake, Deschutes County; Sparta, Baker County; Three Sisters; Toledo; Triangle Lake; Vernonia; Wallowa Lake, 5,500'; Waquia; Willow Prairie, Jackson Co.

CALIFORNIA:

Alpine County: Hope Valley.
Butte County: Brush Creek.
Humboldt County: Eureka; Fortuna; Orick.
Lake County: Blue Lake.
Lassen County: Bridge Creek Camp; Hat Lake; Manzanita Lake; Summit Camp; Susan River Camp.
Mendocino County: Fort Bragg; Little River.
Modoc County: Hackamore.
Nevada County: Boca.

○ *o. occidentalis*
● *o. nigroscutatus*



Map 9. Map showing the distribution of *o. occidentalis* and *o. nigroscutatus*.

Placer County: Lake Tahoe.

Plumas County: Buck's Lake; Greenville; Lake Almanor; La Porte; Little Grass Valley; Meadow Valley; Quincy.

Shasta County: Burney Falls; Lake Eiler; Vista.

Tehama County: Mineral.

Trinity County: Carrville; Eagle Creek, 5,350'; Trinity River.

IDAHO:

Ashton; Boise; Coeur d'Alene; Coolin; Downey; Franklin; Juliaetta; Lewiston; McCall; Midvale, Washington County; Moscow; New Meadows; Potlatch; Lowell, Idaho Co.; Preston; Sandpoint; Starkey; Tamarack; Twin Lakes; Wallace.

UTAH:

Colton, Utah Co.; Delta; Green Canyon, Cache Co.; Logan; Ogden; Provo; Wellsville Mts., Cache Co.; S. Willow Canyon, Tooele Co.

FLIGHT RECORDS:

Queens have been taken from March 28 to September 7; workers from April 30 to September 10; and males from June 29 to October 22. The main flight period is from May to September.

The types of *occidentalis* have not been located but were once examined by Cresson; apparently they were placed either in the collections of the Boston Society of Natural History, or in the Museum of Comparative Zoology but cannot be found at either site. The species was redescribed by Franklin, and his "neotypes" (although not so designated) were placed at a number of institutions including the United States National Museum. I have not seen the types of *modestus* Smith and *proximus* var. *coloradensis* Titus, but agree with Franklin that both are synonymous with *occidentalis*. The Cresson types of *proximus* and *howardi* are in collections in the Academy of Natural Sciences of Philadelphia. The type of *mckayi* Ashmead is in the United States National Museum, and that of *perixanthus* Cockerell and Porter is in the American Museum of Natural History.

Bombus occidentalis nigroscutatus Franklin

Bombus nigroscutatus Franklin, 1908. In Fletcher and Gibson, Ent. Soc. Ontario, Ann. Rept. 39:111.

Bombus occidentalis nigroscutatus Franklin, 1913. Amer. Ent. Soc. Trans. 38:269, 271.

Franklin (1913) reduced *nigroscutatus* to subspecific rank essentially on the basis of California material, but included with this subspecies, individual variants from British Columbia, Oregon, Utah, Montana, and Colorado. As indicated in the preamble to *occidentalis*

this subspecies is considered to consist only of coastal California populations. Phenotypically similar individuals from various areas within the range of *o. occidentalis* are treated as individual variants of that polymorphic subspecies.

Southern geographical limits of *o. nigroscutatus* can be defined as the coastal counties of California in and about the Bay Area. There is a sparsely populated longitudinal zone of intergradation along the coast from Mendocino County, California, to Newport, Oregon, but there is apparently no direct contact with populations of *o. occidentalis* in the mountains of northeast California.

Queens and workers of this subspecies have the following phenotypic characters distinguishing them from *o. occidentalis*: pile of the scutellum black; metasomal tergum 2 with apex and apicolateral margins having yellow pile; metasomal tergum 3 with pile all yellow; metasomal tergum 4 with pile all black; metasomal tergum 5 with all, or at least the apical half, ferrugino-fuscous; tergum 6 with ferrugino-fuscous pile at least as peripheral fringes, often this tergum is predominately black but always with some trace of light pile.

The male genitalia show no constant subspecific or individual difference. Color patterns of the male of *nigroscutatus* are as follows: scutellum with pile predominately black, but with some light pile intermixed apically; vertex and face, below antennal bases with pile yellow; metasomal tergum 2 with yellow pile apically and along lateroapical margins; metasomal tergum 3 yellow; metasomal terga 5 to 7 (often only 6 and 7) with pale ferruginous or fuscous pile.

DISTRIBUTION:

CALIFORNIA:

Alameda County: Albany; Berkeley; Niles; Oakland; Pleasanton; San Lorenzo.

Contra Costa County: Antioch; Brentivard; Concord, Pirrle; Walnut Creek.

Humboldt County: Eureka.

Marin County: Bolinas; Point Reyes; San Rafael.

Mendocino County: Little River.

Monterey County: Carmel; Pacific Grove; Salinas; San Lucas.

Napa County: Calistoga; Napa; Walter Spring.

San Francisco County: San Francisco.

San Joaquin County: Coral Hollow.

San Mateo County: Burlingame; Millbrae; Palo Alto; San Bruno Hill.

Santa Clara County: San Jose; Stevens Creek; Syerville.

Santa Cruz County: Capitola.

Solano County: Suisun City.

Sonoma County : Saline Vista ; Valleys ; Wright's Beach.
Yolo County : Davis.

FLIGHT RECORDS:

Queens have been taken from March 23 to October 21; workers from May 24 to December 8; and males from May 17 to November 10.

Cotypes of *nigroscutatus* are located in the United States National Museum, Academy of Natural Sciences of Philadelphia, and in the collections of Stanford and Massachusetts Universities.

Bombus franklini (Frison)

Bremus franklini Frison, 1921. Ent. News, 32:147.

The original description of this species was based on two queens from Nogales, Arizona and in the following year, (Frison, 1922) the worker and male from Oregon were described as the other castes of *franklini*. The present work has yielded 48 specimens that are here considered to be representatives of this species. This distribution, of Nogales, Arizona; and Medford, Gold Hill, and Roseburg, Oregon, is indeed peculiar. On the basis of many thousands of specimens examined from western America, none, other than those from southeastern Oregon, could be assigned to this species.

It may be that *franklini* is sparingly distributed throughout the region between the recorded sites, but extensive collecting done since the time of the original description has failed to yield further material. Until additional collections are made the Oregon material will be treated as members of the monotypic, sparsely distributed *franklini*.

Both sexes of this species are similar to *occidentalis occidentalis*, and often separation is difficult. Queens and workers have the pile of the vertex long, dense, and yellow; the yellow pile on the anterior face of the scutum extends back along the lateral margins as far as the scutellum, forming a median, U-shaped emargination of black pile; metasomal terga 1 to 4 are all black; there are faint traces of pale, ferruginous pile on the lateral margins of terga 5 and 6; the corbicular fringes are black.

In the male, pile of the face and vertex is long, dense, and yellow, with but a few black hairs laterally; the yellow pile of the scutum is much as in the females but the median, U-shaped patch of black is not so distinct, and posterior fringes of the corbiculae are tinged with ferruginous.

QUEENS:

Ocelli situated at supraorbital line; malar spaces $\frac{3}{4}$ to $\frac{7}{8}$ times as long as apical widths; flagellum short; first flagellar segment one-third longer than third, third flagellar segment one-third longer than second; tegulae black; wings brownish-black to violaceous; nervures black to violaceous.

Vertex with pile long, dense, and whitish-yellow; face with black and yellowish pile intermixed, black pile predominating in the area between antennal bases and in area immediately above and below antennal bases, pile along inner orbital margins black; area behind eyes with pile black. Mesoscutum with long, dense, yellow to whitish-yellow pile, yellow pile of scutum extending back along lateral margins to anterior face of scutellum, only a small U-shaped patch of black pile at medioposterior margin of scutum; scutellum with pile black; mesopleura with pile black except for yellow in area about lateral lobes of pronotum; metapleura and propodeum with pile black. Metasomal terga 1 to 4 with pile all black; metasomal tergum 5 with whitish to grayish pile along lateroapical margins, a few light hairs intermixed along lateral portions of disc; metasomal tergum 6 with pile black; metasomal sterna with weak apical fringes of dark pile. Legs with pile black; corbicular fringes black.

WORKERS:

Much as in queen but having pile of face with more black predominating, whitish and whitish-yellow pile shorter and sparser over fascial region; malar spaces approximately three-quarters as long as apical widths; wings lighter than in queen, usually deep fuscous to brownish fuscous; metasomal tergum 6 with some light pile, particularly along lateral margins.

MALES:

Ocelli situated at supraorbital line; malar spaces as long as apical widths; first flagellar segment barely shorter than third; second flagellar segment two-thirds as long as third; tegulae brownish-black; wings deep brown; nervures brown to dark brown.

Vertex with pile long, dense, and yellow, a few dark hairs intermixed about periphery; face with pile predominantly yellow below antennal bases, a few black hairs intermixed immediately below antennal bases; clypeus with pile long and yellow; area above antennal bases with strong admixture of black and yellow pile, black appearing to predominate. Mesoscutum with pile long, dense, and yellow over anterior surface, yellow pile extending along lateral portions to anterior margins of scutellum, forming a U-shaped emargination of black pile on medioposterior margin; scutellum with pile all black; mesopleura with pile black, except for yellow in regions about lateral lobes of pronotum and below tegulae, a few light to yellow hairs intermixed along extreme anterior margin of mesopleura; metapleura and propodeum with pile all black. Metasomal terga 1 to 4 with pile all black; metasomal tergum 5 with basal and median portion having pile black, lateroapical third of disc with pile tinged with golden; metasomal tergum 6 with golden pile along lateral margins, major portion of disc covered with black pile; metasomal tergum 7 with admixture of short, black, and long, golden hairs; metasomal sterna with long apical fringes of light pile. Forelegs with pile all black; median trochanters and coxae black with posteroventral fringes having some light gray pile intermixed; midfemora with pile all black; midtibiae with pile black except for posteroventral fringes tinged with golden or ferruginous; posterior trochanters and femora with pile black, a few light hairs intermixed on posteroventral margins; posterior tibiae with fringes brownish-black basally and golden or light ferruginous apically.

Male genitalia: (figure 16). Aside from slight differences in the convolutions of the apices of the penis valves, and minor differences in the subapical median processes of the gonocoxites and apices of the gonostyli, the capsule closely resembles that of *occidentalis*. The seventh ventral plate of *franklini* tends to be much more quadrate than either *occidentalis* or *terricola*.

VARIATION:

Within the known range there is but slight variation in the color patterns of the pile. In the workers the amount of black pile intermixed over fascial area varies considerably. A specimen from Roseburg has the pile predominantly black over the fascial region with but a few short, light hairs intermixed, while in others there appear to be equal quantities of light and dark pile below and above the antennal bases. The amount of light pile on metasomal terga 5 and 6 of the workers varies slightly; in some there are only traces of whitish or yellowish pile, while in others this pile is rather conspicuous over lateral portions of the disc. In males the face pile is predominantly yellow. The amount of black, along inner orbital margins and about the antennal bases, however, varies considerably. Pile of metasomal terga 5 to 7 tends to be golden or tinged with ferruginous but in a number of specimens this pile has a whitish cast similar to *occidentalis*. Most of the material examined has light pile over the apical one-half of metasomal tergum 5, but a specimen from Gold Hill has metasomal tergum 5 almost completely covered with black pile, with but a trace of light at the lateroapical margins. Two specimens of *franklini* from Medford have traces of whitish or yellowish pile over the mediobasal portion of tergum 2 and over the extreme lateral margins of this tergum. This light pile is evident only on microscopic examination.

DISTRIBUTION:

The species is known only from the Umpqua and Rogue River Valleys of Oregon and Nogales, Arizona. Collections were as follows: 2 queens, 12 workers, 24 males, Medford, Oregon, September 3 to 10, 1950, (A. T. McClay); 5 workers, 4 males, Medford, Oregon; September 9 to 11, 1953, (A. T. McClay); 1 worker, Gold Hill, Oregon, July 12, 1950, (H. A. Scullen); and 1 male, Roseburg, Oregon, July 11, 1930, (H. A. Scullen).

The type from Nogales, Arizona is in the Illinois Natural History Survey collections.

Bombus terricola Kirby

Bombus terricola Kirby, 1837. Fauna Bor.—Amer., V. 4, p. 273.

This species is known only from British Columbia in the west. Buckell (1951) states that it is the most common of all bumble bees in the central interior portion of British Columbia, but is distinctly uncommon from the southern interior of the province. One specimen from Vancouver is my only coastal record of the species.

This species and *occidentalis* are very close to the old world *terrestris* and both Friese and Handlirsch have long considered them to

be conspecific. However, *occidentalis* and *terrestris moderatus* are endemic to certain areas of southern Alaska and the endemism of *occidentalis* and *terricola* in British Columbia without any phenotypic intergradation appears to attest to the validity of all three species.

B. terricola is one of the most color stable species in western America and shows little or no variation throughout its range. It resembles some color variants of *occidentalis* but can be distinguished from that species in having tergum 2 always yellow; tergum 4, black; and the apical abdominal terga with the pile much more yellow than white.

QUEENS:

Ocelli situated at supraorbital line; malar spaces two-thirds as long as apical widths; flagellar segments 1 and 3 subequal, segment 2, shorter than either; tegulae brownish-black; wings fuscous to dark brown.

Vertex, face, and areas behind the eyes with pile all black. Thoracic dorsum with dense, yellow pile anterior to tegulae; pile posterior to tegulae black, occasionally with a few yellow hairs on scutellum; thoracic pleura with pile all black. Metasomal terga 1 and 4 with pile black; terga 2 and 3 with pile dense and yellow; terga 5 and 6 with abundant, yellowish-white pubescence. Fore- and midlegs with pile all black; posterior legs with pile all black, except corbicular fringes, which have abundant ferruginous pile along posterior margins.

WORKERS:

Much as the queen but with the malar spaces tending to be three-quarters as long as apical widths and in having light pile restricted to the apical portion of the fifth metasomal tergum.

MALES:

Ocelli situated at supraorbital line; malar spaces slightly longer than apical widths; flagellar segments 1 and 3 subequal but $1\frac{1}{2}$ times longer than 2; tegulae reddish-brown to black; wings pale brown.

Vertex with an admixture of black and yellow pile, black pile predominating; pile above antennal bases black, with a sparse admixture of yellow; pile below antennal bases predominantly yellow or white with a strong admixture of black. Thoracic dorsum with abundant dense yellow pile anterior to tegulae; scutellum with pile black, a few specimens with a very weak admixture of yellow pile along posterior margin; mesopleura with pile mostly black, some yellow pile extending down anterior faces of mesopleura, often as far as the coxal bases. Metasomal terga, 1, 4, and 5 with pile black; metasomal terga 2 and 3 with pile dense and yellow; metasomal terga 6 and 7, and occasionally the apex of tergum 5, with pile light, occasionally tinged with orange. Fore- and midlegs with pile of the femora and tibiae mainly black, occasionally a few light to ferruginous hairs on posterior margins of the tibiae; posterior femora usually black; pile of the tibiae preponderantly ferruginous on posterior margins and weakly ferruginous along anterior margins.

Male genitalia: (figure 17). Similar in most respects to those of *occidentalis*; minor difference in convolution on the apices of penis valves and terminus of gonostyli; eighth ventral plate more deeply incised; seventh ventral plate with apex more truncate.

VARIATION:

While the queens and workers are rather constant in color patterns, males exhibit some variation, particularly in the amount of yellow pile on the mesopleura. In some specimens from Prince George, British Columbia, the mesopleura is covered to a great extent with yellow or light pile, while males from the interior have traces of yellow pile restricted to the extreme dorsoanterior margins. The amount of light pile at the apex of the abdomen also varies within each population. Typically, terga 6 and 7 are covered with light pile, but occasionally only terga 7 is so colored. Pile on the posterior tibiae varies from pure ferruginous in some to a predominance of black in others, but in most specimens the ferruginous pile predominates.

DISTRIBUTION: (Map 10).

BRITISH COLUMBIA:

Burns Lake; Canim Lake; Cedarvale; Chilcotin; Hazelton; Kamloops; Kitwanga; Minnie Lake; One Hundred Mile House; Pouce Coupe; Prince George; Quesnel; Ridge Lake; Rolla; Salmon Arm; Savona; Smithers; Terrace; Vancouver; Vernon; Walhachin; Williams Lake.

FLIGHT RECORDS:

Queens have been collected from April 28 to August 19; workers from June 16 to August 19; and males from May 4 to August 20.

The type of *terricola* should be in the British Museum of Natural History, but intensive search has not turned it up.

Subgenus *Pratobombus* Vogt

(= *Pratorum* group, Radoszkowski, Franklin)

Bombus subg. *Pratobombus* Vogt, 1911. Gesell. Naturf. Freunde Sitzber., p. 49.

Type: *Apis pratorum* Linnaeus. Desig. Frison, 1927.

Males: Malar spaces from 1 to $1\frac{1}{2}$ times their apical widths; posterior tibiae with outer faces concave, always with rather dense anterior and posterior fringes of long hair; capsule delicate, longer than wide; volsellae protruding slightly beyond gonostyli, often not visible from above, apices usually narrowed with weak medial projections; gonostyli at least as long as wide and often considerably longer; gonostyli uniformly rounded, without any endite processes; penis valves long and slender, with medially directed sickle-shaped apices, a prominent lateral projection at middle of each valve; seventh ventral plates semilunar with weak to moderate pile apically; eighth ventral plates roughly triangular, tapering towards apices, apical one-third usually densely haired.

○ *edwardsii*
● *terricola*



Map 10. Map showing the distribution of *edwardsii* and *terricola*.

Bombus flavifrons Cresson

This species is widely distributed in Pacific America from Alaska well into California. It is one of the most variable bumble bee species in America, but unlike *rufocinctus* and *occidentalis*, it has a number of closely related species with overlapping distributions which, at times, make species discrimination difficult if not impossible.

The two extremes in color variation are represented by the typical *flavifrons* and the varietal designate *ambiguus* of Frison, which is here treated as a melanistic variant of *f. dimidiatus*. While all intergrades between these extremes have been examined, the typical forms of the subspecies *f. flavifrons* and *f. dimidiatus* predominate. *B. f. flavifrons*, with a strong admixture of black pile on the anterior face of the scutum and bright ferruginous pile on metasomal terga 3 and 4, is found throughout Alaska and British Columbia and is the predominant form in higher elevations of eastern Oregon, Idaho, Montana, Wyoming, and Colorado. The subspecies *f. dimidiatus*, on the other hand, is the most prevalent in western Washington, western Oregon and California.

A great number of specimens from eastern slopes of the Cascades in southern Oregon and northeastern California could be either *f. flavifrons* or *centralis*, but the blending of diagnostic characters applicable to northern populations of the 2 species makes separation impossible. For example, the 2 species can be separated where they coinhabit the northern Transition Zone on the basis of the length of malar spaces, intensity and definition of the interalar band, intermixture of black pile on the anterior part of the mesoscutum and face, as well as certain minor but definite features of the eighth ventral plate and the genitalic capsule. However, in southern Oregon and Northeastern California, the majority of those specimens having ferruginous pile on the third and fourth terga could be placed with either species. Phenotypically, they resemble *centralis* in having pile of face and vertex predominantly bright yellow; the pile on the mesoscutum anterior to the bases of the tegulae yellow, with a very few black hairs intermixed; the interalar band is broad and distinct; and the seventh and eighth ventral plates of some of these individuals are close to those of the northern populations of that species. On the other hand, these same specimens have certain characters more indicative of *f. flavifrons* in that the malar spaces are $1\frac{1}{2}$ times as long as the apical widths, flagellar segments 1 and 3 are as in that species and the seventh and eighth ventral plates are often typically *flavifrons* or intermediate between that species and *centralis*.

Thus, in the higher mountains the subspecies *f. dimidiatus* greatly predominates, and along the eastern slopes of the mountains this form is replaced by what is here termed *centralis*. Between these

two areas, and overlapping to some extent, are found numbers of specimens showing signs of intergradation. This intergradation is by no means complete. Sympatric distribution and variation in the samples at hand, however, indicate that intergradation or hybridization may be occurring.

It is interesting to note that the amount of black pile intermixed over the mesoscutum in the area anterior to the bases of the tegulae in *f. dimidiatus*, becomes progressively more sparse in the southern part of its range. This, plus the fact that there appears to be a slight increase in the amount of black pile on the ferruginous forms, negates this character as one of diagnostic value. Indications of intergradation or hybridization are to be found particularly in the *dimidiatus*-like males and workers from Lake and Klamath Counties in Oregon and Modoc, Sierra, Nevada, Lassen, Eldorado, and Mono Counties in California. In these specimens there are often traces of ferruginous pile on the apices of terga 3 and 4, but this pile never covers more than the apical one-third of each tergum. Associated with this increase in ferruginous pile there is a corresponding increase in the color intensity of the yellow pile over the body, so that the light pile of the body closely resembles that of *centralis* rather than the dull yellow-gray of *dimidiatus*. But *centralis* is very poorly represented along the eastern slopes of the Cascades in Oregon and Washington, thus making it difficult to account for the sudden appearance of this species in numbers in the southwestern limits of its range.

The status of the two forms in this area and the relationship between them is even more critical, for *centralis* was described from a queen taken at Fort Crook, California, which lies in this zone where the relationship is not understood.

It is tempting to consider these forms as conspecific, but until additional data are available, the following interpretation is advanced about the dispensation of species in this area. Forms having ferruginous pile completely covering terga 3 and 4 are found only along the eastern slopes of the Cascades and Sierras and in the higher elevations east of these chains; there does not appear to be any indication of a partial replacement of ferruginous pile by black in this body region, although some fading of the ferruginous pile has been noted. Thus, there is no evident gradation from the ferruginous form (*centralis*) towards the black form (*f. dimidiatus*) in this one character that is considered of diagnostic value.

On the other hand, the form having the body pile a pale yellow-gray (*f. dimidiatus*) is the exclusive form in the central Cascades and Sierras as well as in areas to the west. It is only in the areas where one finds sympatric distribution of both forms that a question arises as to the status of the species involved. While numbers of

specimens of *f. dimidiatus* having traces of ferruginous pile on the third and fourth terga have been seen, none have the ferruginous pile covering more than the apical one-third of each tergum. Most queens from this area of overlap closely resemble *centralis*. Workers and males, with either yellow or ferruginous pile on terga 3 and 4 could well be placed with either species, while other specimens of both of these castes are distinctly *f. dimidiatus*. For the present, an arbitrary designation of the limits of each species is essential in this area. Extensive collecting, biological studies, and cytotaxonomic research will be needed before the problem can be solved satisfactorily.

Until such evidence is accrued, a tentative, arbitrary diagnosis of the two species in southern Oregon and eastern California is proposed. Included with *centralis* are all females having the third and fourth metasomal terga completely covered with ferruginous or faded ferruginous pile, the light pile of the body yellow rather than yellow-gray and with little or no black pile intermixed over the anterior face of the mesoscutum. Those females having terga 3 and 4 with the pile predominantly black, but often with traces of ferruginous apically, with the body pile generally yellow-gray and with some black pile intermixed over the anterior face of the mesoscutum are here placed as *f. dimidiatus*. Males can usually be separated by the same combination of characters as the females.

Members of this complex extend down into the southern Sierra Nevada, the San Bernardino and San Jacinto Mountains, and these are placed with some uncertainty. Collections from the southern limits of the range are made up entirely of males and all have the pile of the metasomal terga pale yellow, yellow-gray, or pale yellow with a few black hairs intermixed. As the males of these two species in the southern extremities of their ranges are not separable on any morphological structure, and as the males of *f. dimidiatus* all have the pile of terga 3 and 4 predominantly black, these are tentatively considered as males of *centralis*. The continuum, if one exists, between these southern isolates and the northern populations is most likely through the Sierras, although several phenotypically identical males have been taken from the disjunct Boreal outcroppings along the California coast.

An examination of the type of *ambiguus* Franklin, shows it to be a melanistic form of *f. dimidiatus* with increased black pile on the face and scutellum and some pale or ferruginous pile on the apices and lateral margins of metasomal terga 5 and 6 in some specimens. This form has been found throughout the range of *dimidiatus* and does not warrant formal recognition from that subspecies.

Bombus flavifrons flavifrons Cresson

Bombus flavifrons Cresson, 1863. Ent. Soc. Philadelphia, Proc., 2:105.

Bombus alaskensis Ashmead, 1902. Washington Acad. Sci., Proc., 4:128.

Bombus flavifrons var. *veganus* Cockerell, 1903. Amer. Nat., 37:891.

In this subspecies are included all forms having metasomal terga 3 and 4 covered with ferruginous or faded ferruginous pile, and that material which has a predominance of ferruginous pile on these two terga. This subspecies is found throughout Alaska and British Columbia and the higher elevations of the Rocky Mountains and its subsidiary chains and is known to occur at least as far south as Colorado.

B. f. flavifrons is most closely related to *B. centralis* and can be distinguished from that species only with difficulty. In the northern part of the range, females can be separated from *centralis* by their longer malar spaces, the strong admixture of black pile over the anterior portion of the mesoscutum and face, and a rather poorly defined interalar band. Males of the two species can be separated by the same combination of characters although the amount of black intermixed over the head and thorax is greatly reduced. At times the interalar band in the males of *flavifrons* is barely discernible and is always poorly defined, whereas in *centralis* the band is sharply delimited and broad. The first flagellar segment in *flavifrons* is subequal or slightly longer than the third, while the second is shorter than either. In *centralis*, the first flagellar segment is shorter than the third and the second is shorter than the first.

QUEENS:

Ocelli situated at supraorbital line; malar spaces $1\frac{1}{2}$ to $1\frac{3}{4}$ times as long as apical widths; first flagellar segment $1\frac{1}{2}$ times as long as third; third segment one-quarter longer than second; tegulae brown to brown-black; wings brownish-hyaline; nervures dark brown to black basally, dark brown apically.

Vertex with abundant, long, pale yellow to gray-yellow pile, with long black pile about periphery; face with abundant light pile, pale gray to yellow-gray about antennal bases; inner orbital margins with black pile. Thoracic dorsum with black pile in interalar area; a strong admixture of black and pale yellow pile on anterior portion of scutum giving surface a clouded appearance; scutellum with a broad peripheral fringe of pale yellow-gray pile with a number of black hairs intermixed, median and medioapical surface with pile predominantly black; lateral lobes of pronotum with admixture of black and pale yellow pile; mesepisterna with pale yellow pile to coxal bases; propodeum with lateral fringes of yellow-gray and black pile above, black ventrally. First metasomal tergum with abundant, pale yellow pile laterally, median one-third of disc with pile all black; metasomal tergum 2 with pale yellow pile except for a few, shorter, black hairs on median portion of disc; terga 3 and 4 covered with a deep ferruginous pile, often a few black hairs along basal portion of each segment; metasomal terga 5 and 6 with pile black, often with lateral fringes of whitish to pale gray pile; metasomal sterna with long, dense, whitish pile as apical fringes; apical metasomal sternum (hypopygium) with an abrupt, elevated median carina. Fore- and midtrochanters and coxae with long fringes of pale gray pile, weaker basal fringes to anterior and median femora, rest of

femora with pile black; tibiae with pile black except for apical posterior fringes of pile tinged with ferruginous; posterior legs with dense, pale gray fringes to coxae, trochanters and femora, remainder of femora with pile black; corbicular fringes long, yellow-ferruginous.

WORKERS:

As queens, except having a stronger admixture of black pile on scutellum, vertex, and face. In some specimens there is a preponderance of black rather than light pile on vertex; malar spaces usually fully $1\frac{1}{2}$ times as long as apical widths; third flagellar segment in workers is more obviously longer than second; median carina on hypopygium not nearly as distinct as in queens; pile of corbicular fringes tends to be darker, usually with basal half of hairs brown, to brown-ferruginous.

MALES:

Ocelli situated at supraorbital line; malar spaces $1\frac{1}{2}$ times as long as apical widths; first flagellar segment approximately $\frac{1}{2}$ longer than third, third segment $\frac{1}{2}$ longer than second; tegulae deep brown to brownish-black; wings fuscous; nervures dark brown basally, light brown apically.

Vertex with abundant long pale yellow pile, a few dark hairs about periphery; face with pale yellow pile above, below, and lateral to antennal bases; inner orbital margins with fringes of black pile. Thoracic dorsum with long black and pale yellow pile intermixed; scutum with face anterior to bases of tegulae predominantly pale yellow with a few black hairs scattered over surface; interalar area with strong admixture of black and yellow pile, pile pure black medially, to intermixed with yellow laterally; scutellum with a preponderance of black pile on median and apicomedian face, a weak admixture of black with pale yellow on periphery; mesepisterna with abundant long, pale yellow pile; propodeum with lateroposterior fringes of black and pale yellow dorsally and shorter black pile ventrally. Metasomal tergum 1 with pile long, pale yellow to gray-yellow, anterior-median face of disc with small patch of black pile; metasomal tergum 2 with pile long gray-yellow; terga 3 and 4 with pile long and deep ferruginous; metasomal tergum 5 with basal portion covered with admixture of deep ferruginous and black pile, apical one-half with pile all black; metasomal terga 6 and 7 with pile all black; sterna with long, weak apical fringes of pale gray pile. Coxae, trochanters and femora with pile long and pale gray, occasionally with some shorter black hairs on apices of femora; tibiae with admixture of short black and longer yellow-ferruginous pile.

Male genitalia: (figure 18). Very similar to those of *centralis* and difficult to separate from that species in the southern part of the species ranges. Seventh ventral plate of *flavifrons* usually more semilunar and with longer apical pile; eighth ventral plate short, with apex almost membranous, very fine pile covering extreme apex of plate. Readily separable from *sitkensis* by the shape of the apices of the penis valves, the strongly protruding gonostyli, and the eighth ventral plate.

VARIATION:

Queens of the typical form undergo only slight variation, and this is in the amount of black pile intermixed over the anterior portion of the scutum and the scutellum. Length of the malar spaces in *flavifrons* varies from about $1\frac{1}{2}$ to $1\frac{5}{8}$ times as long as apical widths.

The amount of ferruginous pile on the metasoma varies slightly; terga 3 and 4 being covered predominantly with ferruginous pile, at times faded to a light, or yellowish-orange. A number of specimens from British Columbia show varying amounts of light ferruginous pile on the medioapical and apical margins of the fifth metasomal tergum and at times there are a few ferruginous hairs along the lateral margins of the sixth. For the most part, however, the terminal terga are covered with a black or brownish-black pile. Pile of the corbicular fringes in the species varies slightly. They are bright, to yellow-ferruginous, in the more northerly specimens; however, in southern British Columbia many specimens have been examined with corbicular fringes varying from dark ferruginous to having only the tips of the corbicular hairs with ferruginous.

The workers of *flavifrons* undergo essentially the same degree of variation as the queens except in having a broader range of variability in the amount of black and yellow pile on the thoracic dorsum and the face. For the most part the preponderance of black in these two areas is greater in workers than in queens.

The males, by contrast, exhibit rather extensive variation, although not nearly as much as *f. dimidiatus*. In a number of specimens the black pile on the thoracic dorsum, although concentrated in the median interalar band region, is strongly intermixed over the anterior portion of the scutum and scutellum. However, all intergrades between the dark form and those males having the thoracic dorsum with the pile all yellow, except for a median patch of black pile, have been examined. The intensity of the ferruginous pile on metasomal terga 3 and 4 is subject to some variation and may be bright ferruginous or faded to a light orange or yellow. It appears that the decrease in the amount of black pile intermixed on the thoracic dorsum is closely associated with fading of the ferruginous pile on the metasomal terga, and a reduction in the amount of black pile on the median portion of metasomal tergum 1. The pile on the posterior tibiae of the males varies from black-ferruginous to all light, and this too is directly correlated with the amount of yellow pile over the body.

DISTRIBUTION:

Flavifrons is essentially a Boreal form with considerable overlapping into the Transitional life zone. It is found from Alaska through British Columbia into the higher elevations of eastern Oregon, Idaho, and Utah. (Map 11).

ALASKA:

Mt. McKinley National Park, 3,500'; Rampart; Skagway; Tanana.



Map 11. Map showing the distribution of *f. flavifrons* and *f. dimidiatus*.

BRITISH COLUMBIA:

Agassiz; Atlin; Barkerville; Bridge Lake; Buccaneer Bay; Burns Lake; Canim; Canim Lake; Cedarvale; Chase; Chilcotin; Crows Nest; Fairview; Fernie; Fraser Lake; Golden; Hat Creek; Kaleden; Kamloops; Kaslo; Kitwanga; Milner; Minnie Lake; Nanaimo, V. I.; Nicola; North Saanich, V. I.; Oliver; Quesnel; Quick; Radium; Revelstoke; Royal Oak, V. I.; Saanich, V. I.; Salvus; Sidney, V. I.; Skidgate; Smithers; Vancouver; Vanderhoof; Vernon; Victoria, V. I.

WASHINGTON:

False Bay; Friday Harbor; Newport; Oak Harbor; San Juan Island; Seattle; Whidby Island.

OREGON:

Anthony Lake Trail, 7,100' to 7,650'; Blue Mts., 7,100' to 7,700'; Cornucopia, 5,900'; Cornucopia, 7,250'; Enterprise; Fish Lake, Steens Mts., Harney Co.; Granny Lake, Wallowa Co.; Homestead; La Grande; Langdon Lake; Meacham, 3,680'; Robinette; Wallowa; Wallowa Lake, 6,400'.

IDAHO:

Coeur d'Alene; Crater Peak, St. Joe National Forest; Downey; Lewiston; Moscow; Moscow Mts.; Orofino; Priest Lake, Coolin; Weippe.

UTAH:

Logan; Logan Dry Canyon; Petersboro; Smithfield; Uintah Mts.; Willard Peak.

The types of *flavifrons* are in the Academy of Natural Sciences of Philadelphia; those of *alaskensis* and *veganus* are in the United States National Museum.

Bombus flavifrons dimidiatus Ashmead

Bombus dimidiatus Ashmead, 1902. Washington Acad. Sci., Proc. 4:129.
Bombus ambiguus Franklin, 1911. American Ent. Soc., Trans. 37:159.

The females of *f. dimidiatus* vary considerably but all those specimens having a preponderance of black pile on metasomal terga 3 and 4 have been included with this subspecies. Traces of ferruginous pile are often noted on the apical margins of terga 3 and 4, particularly in material from the mountains of northeastern Oregon, northwestern Washington, and to a lesser extent in the montane forms from California. The great majority of material examined from Washington and Oregon has abundant black pile intermixed over the thoracic dorsum, and in some cases the black pile appears to predom-

inate on the scutellum. Specimens from southern Oregon and California, however, show a marked decrease in the amount of black pile on the anterior face of the mesoscutum and a corresponding increase in the intensity of yellow body pile. Actually there are some black hairs present which extend to the lateral lobes of the pronotum but often their discernment requires microscope examination. The black pile on the scutellum of these southerly populations is restricted to anteriomedial face, giving the thoracic dorsum an appearance much similar to that of *edwardsii*. Queens and workers from the higher elevation of California usually have a larger patch of black pile on the median faces of terga 1 and 2 which is not nearly so evident on more northerly forms. Fringes of the corbicula may vary from bright yellow to black. Most California forms have these fringes either dark brown or with apical tinges of ferruginous.

Males of *f. dimidiatus* are exceedingly variable, and numbers of males previously determined as *sitkensis* are actually *f. dimidiatus*. The predominant form of *dimidiatus* in Oregon and Washington is that one having a small amount of black pile over the mesoscutum and scutellum. The black pile is usually strongly intermixed in the interalar region and over the anterior portion of the scutellum, but in some it forms a rather indistinct band or a median black patch in the interalar area. In the latter cases, the scutellar pile is yellow and the anterior face of the scutum has but a few black hairs intermixed. A more readily recognizable feature is the pattern of pile on the metasomal terga. The form resembling females of the typical *f. dimidiatus* has the 2 first metasomal terga with yellow pile and terga 3 to 7 usually covered with black pile with but a few yellow hairs on the lateral margins of each segment.

Those specimens determined as *sitkensis*, but which are felt to be males of this subspecies, have the first 4 metasomal terga completely covered with yellow pile; occasionally the fifth tergum has the basal portion, or even the entire tergum covered with yellow pile. All intergrades between typical and yellow extremes have been examined. Among the California specimens the form most in evidence has the first 2 terga with yellow and terga 3 and 4 with apical fringes of yellow pile, but none of this material has yellow, ferruginous, or pale gray pile predominating on terga 6 and 7 as is typical of *sitkensis*. An examination of the genitalia verifies the above conclusions, indicating the yellow form is *flavifrons*.

Males of *flavifrons* can usually be separated from *sitkensis* on the basis of the length of the first flagellar segment. In *flavifrons* this segment is longer than the third, and the third is longer than the second, while in *sitkensis*, the first and third segments are subequal and the second is shorter than either. The scutellum in *sitkensis* is

completely or predominantly covered with black pile whereas in *flavifrons* the peripheral margins have a broad band of yellow pile. That form of *dimidiatus* male which has the yellow pile covering the first four metasomal terga is most common in California and southern Oregon, but several specimens showing this pattern have been taken from the vicinity of The Dalles and Hood River in Oregon. North of this and over western Oregon the more typical form of *f. dimidiatus* is found.

The area in which males of *sitkensis* and *dimidiatus* are most likely to be confused is that south of the Columbia River. In this area *dimidiatus* appears to be primarily a montane species, although a number of specimens have been taken out of this habitat. On the other hand, *sitkensis* is most abundant along the coast with few records of it from the Cascades. The two species are more restrictive in California for I have no records of *sitkensis* from the inland mountains.

DISTRIBUTION: (Map 11).

BRITISH COLUMBIA:

Agassiz; Glacier; Metlakatla; Vancouver.

WASHINGTON:

Cedar Mt., King Co.; Chasel; Edmonds; Fall City; Friday Harbor; Glacier Basin; Keyport; Manchester; Meadowdale; Monte Cristo; Naselle River; Olympia; Rainier National Park; Saratoga Beach; Seattle; Snoqualmie; Tacoma.

OREGON:

Alsea; Anthony Lake, Blue Mts., 7,100'; Ashland, Dead Indian Road, 4,500' to 4,900'; Bend; Blooming; Blue River, North Powder, 3,240'; Breitenbush Springs, Marion Co., 2,000'; Cascadia; Coopers Spur, Mt. Hood, 6,000'; Cornucopia; Corvallis; Crater Lake Park, 6,500' to 7,000'; Dixie, Blue Mts., 6,000'; Dixie Butte, Grant Co., 7,400'; Elgin; Elk Creek, Jackson Co.; Griffin Creek, Jackson Co.; Halfway, 3,600'; Imnaha; Jones Creek, Jackson Co.; Kamela, 4,200'; Lake of the Woods, Klamath Co., 4,950' to 7,500'; Lobster Creek, Lincoln Co.; Lucky Boy Camp, Blue River; Marys Peak, Benton Co.; McKenzie Bridge; McKenzie Pass; Meacham; Meacham, 3,400'; Medford; Mt. Angel, Marion Co.; Mt. Baker Road; Mt. McLoughlin, 5,000' to 6,000'; Oakridge; Onion Creek Meadows, Grant Co., 7,700'; Parkdale; Portland; Rainier; Roaring River, Linn Co.; Rock Creek, Benton Co.; Roseburg; Scio; Sexton Mt., Josephine Co.; Silver Creek Falls, Marion Co.; Siskiyou Mts., Jackson Co.; Siskiyou Summit, Jackson Co.; Sulphur Springs, Benton Co.; Summit, Benton Co.; Three Sisters; Upper Ten Mile; Valsetz, Polk Co.; Wahtum Lake; Wallowa Lake, 6,700', 4,500' to 5,500'; Willow Prairie, Jackson Co., 4,500'.

CALIFORNIA:

- Alameda County: Berkeley; Fish Ranch Road; Oakland.
Alpine County: Hope Valley.
Butte County: Feather River; Yankee Hill.
Contra Costa County: San Ramon; Mt. Diablo.
Eldorado County: Echo Lake; Fallen Leaf Lake; Pollock Pines;
Pyramid Peak, 8,000'; Wade; Wright's Lake.
Fresno County: Bubbs Creek Canyon, 10,500'.
Humboldt County: Eureka; Orick; VanDuzen River.
Inyo County: Bishop; Glacier Lodge; Mammoth; Big Pine.
Kern County: Tehachapi.
Lassen County: Hat Lake, Lassen National Park; Norval Flats.
Los Angeles County: Tanbark Flat.
Marin County: Inverness.
Mariposa County: Fish Camp; Mariposa.
Mendocino County: Little River; Ryan Creek.
Merced County: Peregoy Meadow.
Mono County: Mammoth Lake; Mono Pass; Rock Creek; Sardine Creek; Sonora Pass, 9,624'; White Mountains.
Nevada County: Hobart Mills; Sagehen; Truckee.
Placer County: Five Lakes; Tahoe.
Plumas County: Bucks Lake; Graegle; Johnsville; Lake Almanor; Onion Valley; Quincy.
Santa Cruz County: Ben Lomond; Santa Cruz; Soquel Creek.
Siskiyou County: Shasta Springs.
Sierra County: Gold Lake.
Sonoma County: Glen Ellen; Petaluma; Stillwater Cove.
Trinity County: Carrville; Nash Mine.
Tulare County: Giant Forest Camp; Kaweah; Mineralking;
Sequoia National Park.
Tuolumne County: Strawberry.
The type of *dimidiatus* is in the United States National Museum and that of *ambiguus* is in the collections of Leland Stanford University.

Bombus centralis Cresson

- Bombus centralis* Cresson, 1864. Ent. Soc. Philadelphia. Proc., 3:41.
Bombus juxtus Cresson, 1878. Acad. Nat. Sci. Philadelphia. Proc., p. 187.
Bombus monardae Cockerell & Porter, 1899. Ann. Mag. Nat. Hist. (7)4:387.
Bremus centralis var. *fucatus* Frison, 1929. Amer. Ent. Soc. Trans. 55:107.
Bremus centralis var. *stolidus* Frison, 1929. Amer. Ent. Soc. Trans. 55:107.

This species is very closely related to *flavifrons* and in the southern part of its range is extremely difficult, if not impossible, to separate from that species. A discussion of the relationships of these two

species can be found in the preamble of *flavifrons*. In the northern part of the range of *centralis* (i.e. British Columbia, Washington, eastern Oregon, and Idaho) it can be separated from *flavifrons* by shorter malar spaces, sharply delimited interalar band, absence of black pile intermixed over the anterior face of the mesoscutum, and differences in the eighth ventral plate of the male genitalia. In the southwestern limits of its range this species is defined as having an absence of black pile on the scutum anterior to the tegulae; a broad, black, interalar band; the light pile of the body bright yellow or pale yellow; and the third and fourth metasomal terga covered with bright ferruginous pile. Most of the males from the mountains of southern California have the pile of the first 5 metasomal terga yellow and the black pile of the thoracic dorsum restricted to a small, ill-defined median patch. *Flavifrons* in California can be separated by the predominance of black pile on terga 3 and 4 in both sexes. These diagnostic characters have been arbitrarily assigned (see preamble to *flavifrons*) until additional information on the relationship of these California forms becomes available.

The type of *monardae* Cockerell and Porter has been examined, and on the basis of the original descriptions and material of the Frison varieties *fucatus* and *stolidus*, it is felt that all three are but intrapopulation variants of this species warranting no subspecific designation. *Monardae* was designated to represent those variants of this species that have the ferruginous pile of the terga 3 and 4 faded to a pale orange or yellow. These forms are found throughout the species range and the fading appears to be associated with age of the specimen. The variety *fucatus* is represented by a queen from Utah on which the interalar band and median triangular areas on the first and second metasomal terga were covered with ferruginous pile. While no material has been seen that corresponds precisely with the original description, a number of specimens are available that have triangular patches of ferruginous pile on the first 2 terga and traces of ferruginous intermixed in the interalar area. *Stolidus* differs from the typical *centralis* by having median triangular patches of black pile on metasomal terga 1 and 2. This color variant is common throughout the species range in western America.

The species is found in the inland Transitional and Upper Sonoran life zones of western America from British Columbia through southern California and New Mexico, skirting the more arid sections of the Great Basin. It is absent from the mainland coast and the coastal valleys.

QUEENS:

Ocelli small, placed at supraorbital line; malar spaces $1\frac{1}{2}$ times as long as apical widths; flagellum short, first flagellar segment one-half longer than third,

second flagellar segment slightly shorter than the third; tegulae brownish-black; wings pale brown; nervures dark brown.

Vertex with pile predominantly yellow, abundant black pile about anterior and lateral portions of vertex; face with abundant, erect, bright yellow pile about bases of antennae, fringes of shorter, black pile along inner orbital margins; areas behind eyes with pile black. Interlaral band broad and black; anterior face of scutum with pile long, dense, and pale yellow; scutellum with pile yellow; mesopleura, upper portions of metapleura and propodeum with pile yellow; lower metapleura and propodeum with pile black. Metasomal terga 1 and 2, yellow and often with median patches of black pile. These patches are present on at least 1 and usually on basal portions of tergum 2. Terga 3 and 4 with ferruginous pile, pile often faded to pale orange or yellow; metasomal terga 5 and 6 with pile black; metasomal sterna with apical fringes of light pile. Forelegs with pile predominantly black, a few ferruginous hairs on apices of tibiae, and abundant ferruginous pile on tarsi; midlegs with pile black except for a few ferruginous hairs on apices of tibiae and tarsi; posterior coxae, trochanters and femora with pile black, except for a few lighter hairs as fringes to coxae and trochanters; corbicular fringes with pile ferruginous to black, apices of longer hairs on posterior margins of corbicula always tinged with ferruginous, shorter hairs on margins usually black.

WORKERS:

Much as in queens but usually having a stronger admixture of black pile on face, principally above antennal bases, along innerorbital margins and along clypeo-frontal suture; malar spaces $1\frac{1}{2}$ to $1\frac{3}{16}$ times as long as apical widths; corbicular fringes with pile tending to be more black than ferruginous, particularly along posterior margins; metasomal terga 3 and 4 with pile deep ferruginous, and occasionally ferruginous pile extending to base of tergum 5.

MALES:

Ocelli located at supraorbital line; malar spaces $1\frac{1}{4}$ times as long as apical widths; first and third flagellar segments subequal; second, $\frac{2}{3}$ as long as third; tegulae brownish-hyaline; wings fuscous; nervures light brown apically, to dark brown basally.

Vertex with pile long, dense, and yellow, a few black hairs laterally; face with pile long, dense, and yellow, variable amounts of black pile along inner orbital margins. Thoracic dorsum with interlaral band of variable width, not nearly as distinct as in workers or queens; scutellum and anterior portion of scutum with pile long, dense, and yellow; mesopleura, metapleura, and propodeum with pile all yellow. Metasomal terga 1 and 2 with pile yellow; terga 3, 4, and occasionally the base of tergum 5 with pile ferruginous; apical half of tergum 5 as well as terga 6 and 7, with pile all black; metasomal sterna with weak, apical fringes of long, light pile. Forefemora black except for long, yellow, posterior fringes; tibiae with pile black; midlegs much as anterior only with fringes of trochanters and femora longer and denser; posterior femora with pile predominantly yellow; posterior tibiae with short, sparse black hairs, particularly along anterior and posterior margins, but with some black hairs over dorsal surface, longer, very light pile intermixed along anterior and posterior margins, these longer hairs approaching length of corbicular hairs of females.

Male genitalia: (figure 19). Capsule as in *flavifrons*; seventh ventral plate variable in shape and hair pattern, usually with pile longer than in *flavifrons*, but of such variability as to negate its use; eighth ventral plate usually with apical process considerably longer and more heavily sclerotized than in *flavi-*

frons and with apical hair pattern of twice the width as in that species; this character too, is highly variable in the western part of the species' range and loses its diagnostic value.

VARIATION:

Aside from the variation discussed in the preamble to *flavifrons* and *centralis*, there may be some variation in the amount of black pile on the face and vertex of workers and queens. Often black pile above the antennal bases in the worker may equal the yellow in quantity. The corbicular fringes of the females may be entirely ferruginous, entirely black, or a combination of ferruginous and black.

In the males, the interalar band may be distinct, intermixed with yellow laterally, or represented by a small, ill-defined, median patch of black. The latter condition is found particularly in those specimens having the pile of terga 3 and 4 pale orange or yellow.

DISTRIBUTION: (Map 12).

BRITISH COLUMBIA:

Chilcotin; Chopaka; Fairview; Fernie; Kaleden; Kamloops; Kaslo; Kelowna; Keremeos; Lillooet; Minnie Lake; Nicola; Oliver; Okanagan Falls; Osoyoos; Penticton; Salmon Arm; Summerland; Vaseaux Lake; Vernon; Walhachin; Westbank.

WASHINGTON:

Asotin; Colfax; Colton; Diamond Lake; Hooper; Pullman; Spokane; Wawawai; Wenatchee; Yakima.

OREGON:

Ashland; Baker, 3,440'; Blue Mts., 7,100' to 7,700'; Cornucopia, 5,900'; Cove, Union Co.; Crater Lake, 6,600'; Crater Lake, 7,500'; Diamond Lake, Douglas Co.; Dixie Butte, Grant Co., 7,400'; Drakes Peak, Lake Co., 8,218'; Dufur; Eagle Ridge; Elgin; Fall Mt. Look-out, Grant Co., 5,200' to 6,000'; Fish Lake, Steens Mts., Harney Co.; Grand Ronde, Union Co.; Granny Camp, Wallowa Co.; Grant Co.; Haines; Halfway; Hart Mt., Lake Co., 6,500'; Imnaha, Wallowa Co.; Klamath Falls; Klamath Lake; La Grande, 3,400'; Lakeview; Long Creek; Lostine; Meacham; Milton; Mt. Creek, Wheeler Co.; North Powder; Sparta, Baker Co.; Summer Lake; Summerville, 2,800'; Suttle Lake; The Dalles; Wallowa Lake, Wallowa Co.; Warner Mts., Lake Co.

CALIFORNIA:

Alpine County: Hope Valley.

Eldorado County: Fallen Leaf Lake.

Fresno County: Squaw Valley.

Imperial County: "Imperial Co."

Inyo County: Big Pine; Cottonwood Basin.

Kern County: Tehachapi.



Map 12. Map showing the distribution of *centralis*.

Lassen County: Blue Lake; Crater Lake Mt.; Summit Camp.
Los Angeles County: Mt. Wilson.

Modoc County: Alturas; Canby; Cedar Pass; Hackamore,
10,000'.

Mono County: Bear Flat; Blanco's Corral, White Mts., 10,000';
Crooked Creek, White Mts.; Grant Lake; Jane Lake; Leavitt
Meadows; Sardine Creek, 8,500'; Sonora Pass, 10,000'; San Antonio
Mts.; Silver Lake; Tioga Pass.

Nevada County: Boca; nr. Hobart Mills; Sagehen; Truckee.

San Bernardino County: Lake Baldwin; Mill Creek, San Bern-
ardino Mts.

Sierra County: Sierraville.

Sonoma County: Sobre Vista.

Trinity County: Carrville.

Tulare County: Mineralking, Three Rivers.

IDAHO:

Boise; Boulder Mts.; Central Grade, Nez Perce Co.; Challis,
Custer Co.; Craters of the Moon; Deary, 2,776'; Donnelly, Valley
Co.; Gifford, Nez Perce Co.; Lake Fork, Valley Co.; Lenore, 1,000';
Lewiston; Marshall Pass, 10,856'; McCall; Melrose; Midvale, Wash-
ington Co.; Moscow; Moscow Mts.; Paris Canyon; Parma; Pot-
latch; Rock Creek Minadoka, N. F.; Salmon River, Lemhi Co.;
Shoup, Lemhi Co.; Webb, Nez Perce Co.

UTAH:

Bryce National Park; Green Canyon, Cache Co.; Logan, Cache
Co.; Logan Canyon; Petersboro; Willow Canyon, Tooele Co.

FLIGHT RECORDS:

The species flies at the same time as *flavifrons*.

The types of *centralis* from Fort Crook, California are in the
Academy of Natural Sciences of Philadelphia; that of *juxtus* is in
the same collection; the type of *monardae* is in the collections of the
United States National Museum; and the types of the Frison va-
rieties *fucatus* and *stolidus* are in the collections of the Illinois
Natural History Survey.

Bombus caliginosus (Frison)

Bremus caliginosus Frison, 1927. California Acad. Sci. Proc., (4) 16:376.
Bremus caliginosus var. *tardus* Frison, 1927. California Acad. Sci. Proc.,
(4) 16:376.

This species bears a striking resemblance to *B. vosnesenskii* and
the workers and queens can be distinguished from that species only
with difficulty.

As mentioned in the preamble to *vosnesenskii* these two species are virtually identical in color pattern. Male genitalia offer the only certain characters for species separation with the result that numbers of this species are usually hidden with *vosnesenskii* in western collections. Frison (1929) has reported that he was able to separate both males and females on the basis of "an extension of the yellow pubescence on the anterior dorsal part of the thorax as a mesal patch on the disc of the metanotum as far backward as the end of the median stria." This character holds in a number of males and females but is certainly not applicable to all of the males on which genitalic examinations were made.

The mimicry of *vosnesenskii* by *caliginosus* plus their all but mutually exclusive ranges, immediately prompts one to assume that the two species are sibling. However, they lie at opposite ends of the subgenus *Pratobombus*, *caliginosus* belonging to the *flavifrons-centralis* complex, and *vosnesenskii* to the *ternarius-huntii-bifarius* complex.

Males of this species bear color patterns almost identical with *vosnesenskii* but can be distinguished from that species by having the sickle-shaped apices of the penis valves broadly dilated and rounded. The malar spaces in *caliginosus* are usually longer than those of *vosnesenskii* and there is a difference in comparative lengths of the first and third flagellar segments of both species. Both these characters are of limited use, however, as there is sufficient variation within each species to present a number of intermediates.

The majority of queens and workers can be separated by having malar spaces $1\frac{1}{2}$ times as long as the apical widths and by having a considerable amount of yellow pile on the apices and lateral margins of sterna 4 and 5. A number of females representing an intermediate condition between this and *vosnesenskii* have been placed provisionally with one or the other species. Several specimens have been examined that closely resemble *caliginosus* but are well out of the anticipated distribution range of that species.

This species is found in coastal regions of the Pacific Northwest and California. My records indicate that it does not extend as far north as the Puget Sound area of Washington and apparently is not found south of the San Jacinto Mountains of southern California. Intensive collecting in the San Bernardino and San Jacinto Mountains during the past ten years has failed to produce any representatives of *caliginosus*, in spite of the fact that the species was rather commonly represented in collections made during the late 1920's and 1930's from that area.

Frison (1927) erected the subspecies *caliginosus tardus* on the basis of a single male taken from Carmel, California, which lacked the

yellow pile to the fourth metasomal tergum. An abundance of material from Carmel and its proximity is available and none corresponds to his specimen. An examination of this type indicates that it is typically *caliginosus* without the yellow pile on the fourth tergum. It is therefore considered to be a population variant and subspecies status is not justified.

QUEENS AND WORKERS:

As in *vosnesenskii* but having malar spaces longer than in that species, usually $1\frac{1}{2}$ times as long as apical widths, but varying from as long as, to $1\frac{1}{2}$ times as long as apical widths. Flagellar segment 3 is usually about $\frac{3}{4}$ as long as flagellar segment 1; with metasomal sternum 5 having yellow, to whitish-yellow pile on the lateral extremities, and weak lateral apical fringes of light pile to sterna 4 and 5.

MALES:

As in *vosnesenskii*, however, they have the malar spaces usually $1\frac{1}{2}$ times as long as apical widths, but with a range from $1\frac{1}{2}$ to $1\frac{3}{4}$; the first and third flagellar segments are subequal in length.

Male genitalia: (figure 20). Differ from *vosnesenskii* in having apices of penis valves sickle-shaped and broadly dilated; apices of gonocoxites broader than long; eighth ventral plate with apex convex.

DISTRIBUTION: (Map 13).

WASHINGTON:

Bay Center; Copalis; Long Beach, Pacific Co.; Montesano; Nahcotta, Pacific Co.; Naselle River; Nisqually; Ocean Park; Oysterville; Seaview; Stackpole Harbor; Tokeland; Union City; Vancouver.

OREGON:

Alsea; Alsea Mt., Benton County; Astoria; Boiler Bay, Lincoln Co.; Cascadia; Cannon Beach; 4 mi. S. Canyonville, Douglas County; Corvallis; Eugene; Florence; Forest Grove; Goble; Gold Beach, 25 mi. S. Gold Beach; Independence; Kings Valley; McMinnville; Nashville; Lincoln Co.; Newport; Oceanside, Tillamook Co.; Oswego; Rainier; Riddle, Douglas Co.; Sand Lake Creek, Tillamook Co.; Scapoose; Silver Creek Falls, Marion Co.; Sulfur Springs, Benton Co.; Tillamook; Twin Rocks, Tillamook Co.; Vernonia; Waldport; Yachats.

CALIFORNIA:

Alameda County: Berkeley.
Calaveras County: Mokelumne Hill.
Del Norte County: Requa; Smith River Camp.
Humboldt County: Eureka, Weott; Willow Creek.
Kern County: Mohave Desert.
Los Angeles County: Claremont.



Map 13. Map showing the distribution of *vosnesenskii* and *caliginosus*.

Marin County: Fairfax; 7 mi. W. Fairfax; Lagunitos; Mill Valley; Muir Woods; Ross; Tocaloma.
Mendocino County: Little River.
Monterey County: Carmel; Monterey.
Napa County: Mt. Saint Helena.
Riverside County: Riverside.
San Bernardino County: Big Bear Valley.
San Francisco County: San Francisco.
San Mateo County: Pescadero, San Mateo.
Santa Clara County: Mt. View.
Santa Cruz County: Soquel.
Sonoma County: Sobre Vista; Stillwater Cove.
Trinity County: Carrville.

FLIGHT RECORDS:

The main flight period of the species occurs during June, July, and August. Queens have been collected from March 20 to July 9; the workers from May 1 to August 29; and males from June 13 to August 18.

The type of *caliginosus* is in the collections of the Illionis Natural History Survey and that of *caliginosus* var. *tardus* is in the California Academy of Sciences.

Bombus vagans F. Smith

Bombus vagans F. Smith, 1854. Cat. Hymen. British Mus., V. 2, p. 399.
Bombus consimilis Cresson, 1864. Ent. Soc. Philadelphia, Proc. 3:41.

This is a very common species in the central interior of British Columbia and is found sparingly distributed along the eastern and western margins of the drier valleys of the southern interior section of the province. Several specimens have been examined from the southern coastal margins and Vancouver Island but extensive collecting along the Washington coast has failed to yield this species. *Vagans* extends down the western edge of the Rocky Mountains into western Washington and northern Idaho and my records indicate that this is the southern limit of its range in western America.

The queens, and more particularly, the workers of this species may be confused with *flavifrons dimidiatus*, *frigidus* and *mixtus* and at times separation may be very difficult. Females of *vagans* differ from *f. dimidiatus* in having the pile of the face predominantly or exclusively black; the first flagellar segment just barely longer than the third, and the pile of the scutellum yellow. They differ from *frigidus* in having a circular median patch of black pile on the mesoscutum or else as an obscure interalar band, and in having the discs of terga 5 and 6 with the pile all black; from *mixtus* in having much

longer malar spaces, the pile of the face black, and little or no black pile intermixed with the yellow on the anterior face of the scutum.

The males of these species are readily separable by genitalic characters and the features cited in the key.

QUEENS:

Ocelli situated slightly below supraorbital line; malar spaces $1\frac{1}{4}$ to $1\frac{1}{3}$ times as long as apical widths; first flagellar segment slightly longer than third, third flagellar segment one-quarter longer than second; tegulae brownish-black; wings pale fuscous; nervures dark brown.

Vertex with an admixture of yellow and black pile, usually with black pile predominating; face with pile black except for a few short yellow hairs between antennal bases. Thoracic dorsum with pile long and yellow except for a circular median patch of black pile, an intermixture of black towards bases of wings and some black intermixed anterior to the median patch; scutellum with pile long, dense, and yellow; mesopleura and propodeum with pile all yellow. Metasomal tergum 1 with pile yellow except for shorter black pile on the medioanterior face of disc; metasomal tergum 2 with pile yellow; metasomal terga 3 to 6 with pile all black; metasomal sterna with weak, apical fringes of long, black, and short, pale ferruginous pile. Legs with pile black except for posterior ventral fringes of lighter pile on coxae and trochanters; corbicular fringes black.

WORKERS:

As in the queen but having pile of vertex and face all black; thoracic dorsum with stronger admixture of black pile particularly between wing bases and median patch, and anterior to this patch; scutellum often with a few black hairs at medioapical margin.

MALES:

Ocelli situated at supraorbital line; malar spaces $1\frac{1}{3}$ times as long as apical widths; third flagellar segment one-quarter longer than first; second, one-quarter shorter than first; tegulae deep brown; wings pale fuscous; nervures pale brown apically to brown basally.

Vertex with abundant, long, yellow pile intermixed with black about anterior and lateral margins; face with pile below antennal bases and over clypeus long, dense, and yellow, and with numerous long, black hairs intermixed in area above frontoclypeal suture; face above antennal bases with admixture of long black, and shorter, yellow pile. Thoracic dorsum with indistinct median patch of black pile, black pile intermixed with yellow near wing bases and in area immediately anterior to median patch; scutellum and anterior face of scutum with pile long and yellow; mesopleura and propodeum with pile long and yellow. Metasomal terga 1 and 2 with pile long, dense, and yellow, metasomal terga 3 to 7 with pile all black, weak fringes of yellow on lateral margins of terga 5 and 6; metasomal sterna with sparse, pale yellow to yellow-brown pile. Legs with abundant light pile on coxae, trochanters, and bases of femora, abundant black pile on dorsal surfaces of femora and tibiae, posterior tibiae with pile black, but many specimens having tinges of ferruginous pile on posterior tibial fringes.

Male genitalia: (figure 21). Penis valves similar to those of *flavifrons-centralis-caliginosus* complex but distinctly serrate along basolateral margins of the head; gonostyli short and flattened apically; seventh ventral plate as long as broad, sparsely haired apically.

DISTRIBUTION:

The species is common to the central interior of British Columbia extending as far south as Vancouver and Victoria along the coast, and along the mountains of moderate elevation into western Washington and northern Idaho (Map 14).

BRITISH COLUMBIA:

Adams Lake; Barkerville; Burns Lake; Canim Lake; Cedarvale; Chilcotin; Fraser Lake; Hazelton; Hudson Hope; Kamloops; Kaslo; Kitwanga; Minnie Lake; Okanagan Lake; Oliver; Penticton; Prince George; Quesnel; Salmon Arm; Salvus; Smithers; Summerland; Terrace; Vancouver; Vernon; Victoria, V. I.

WASHINGTON:

Metaline Falls; Northport; Pullman.

IDAHO:

Chatcolet; Garwood; Moscow Mts., Moscow.

FLIGHT RECORDS:

The queens have been recorded as flying between April 27 and August 23; workers from May 20 to August 26; and males from June 5 to September 6.

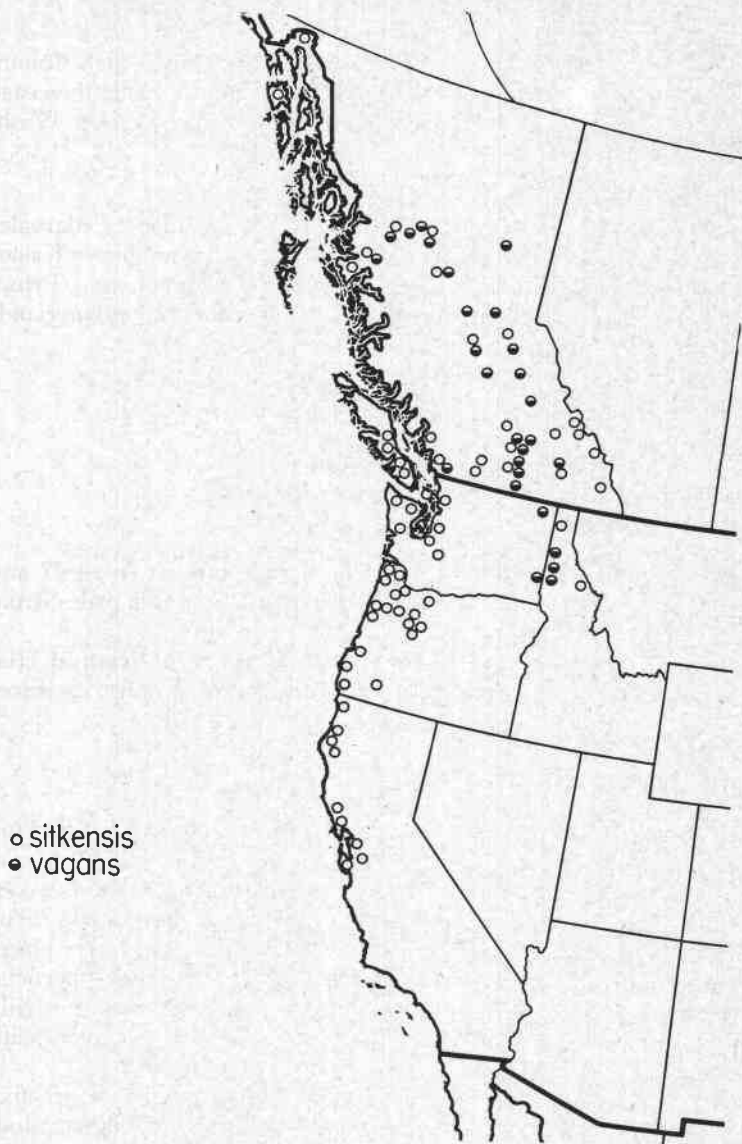
The type of *vagans* is in the British Museum of Natural History, and that of *consimilis* is in the Academy of Natural Sciences of Philadelphia.

Bombus vandykei (Frison)

Bremus flavifrons var. *vandykei* Frison, 1927. Calif. Acad. Sci. Proc. (4) 16:375.

Frison applied the varietal name *vandykei* to two workers taken on Mount Adams, Washington, but in doing so he stated: "The proper status of this form has proved a puzzle to me." His placement of the form was influenced by the fact that it bore superficial resemblance to *flavifrons dimidiatus*, that *flavifrons* was a highly polymorphic species, and that he had seen only two specimens with these peculiar characters.

The types have been examined and, in addition, there are five workers and a queen before me, closely fitting the original description. Although the form does bear some resemblance to *flavifrons*, certain characters strongly indicate that this form and *flavifrons* are not conspecific. The worker has the following characters that differ from any of the color variants of *flavifrons*: pile of the face and anterior portion of the scutum is all yellow without any black intermixed; the malar spaces are markedly shorter, being only slightly longer than the



Map 14. Map showing the distribution of *sitkensis* and *vagans*.

apical widths; the first and second metasomal terga are clothed with a predominance of black pile, some yellow is found on the extreme lateral margins of the first tergum and on the apex of tergum 2; metasomal tergum 3 is clothed with yellow pile; and the carina on the hypopygium is very weakly expressed.

The form bears great similarity to certain color variants of *caliginosus* taken from Riverside and San Bernardino Counties of California during the 1930's. These variants are much closer to the typical *caliginosus* than is the material being dealt with here; however, they too have the third metasomal tergum covered with yellow pile; traces of yellow to the peripheral margins of the scutellum; black pile predominating on the mesopleura; and malar spaces about as long as their apical widths. In addition, *caliginosus* has a weak carina to the hypopygium, although it is not nearly as distinct as in *flavifrons*. It is peculiar that no males were taken with these workers either in the higher mountains of the Cascades or in southern California. The great gap in the distribution, Mount Adams, Washington and northern Oregon to southern California, is an added deterrent to further synonymical considerations at this time. It is unfortunate that further material is not available from the Riverside area of California, the area from which the bulk of the Californian *caliginosus* variants were taken, but Mr. P. H. Timberlake informs me¹ that the area is all but denuded of the bumble bee fauna. Our collecting in the area verified his communication.

The decision to elevate this subspecies to full specific rank is influenced by the striking peculiarities mentioned above and by the fact that no intergrades between this form and the variants of *flavifrons* have been examined.

All of the material, six workers and a queen, has been taken from areas where either *caliginosus* or *flavifrons* could occur, but the absence of males of identical phenotype prevents association. It is felt rather strongly that the material at hand, determined by Frison as *flavifrons vandykei* is more likely an aberrant form of *caliginosus*. The single queen from Jefferson County, Oregon is typical of the latter species except in having the third tergum and scutellum with yellow pile and in having faint traces of yellow pile to the lateral margins of the first tergum. Additional collecting and some biological information are necessary before the status of the species can be determined with accuracy.

DISTRIBUTION:

WORKERS:

Mount Adams, Yakima Indian Forest Reservation, Washington, 3,000', June 30, 1925, (E. C. Van Dyke) holotype; paratype,

¹ Personal communication.

same data; Cloud Cap Inn, Coopers Spur, Mt. Hood, Oregon, 6,000', August 21, 1927, (H. A. Scullen); same data August 19, 1927; Mark A. Mayer Park, nr. The Dalles, Oregon, 600', July 17, 1929, (H. A. Scullen).

QUEENS:

Warm Springs, Jefferson County, Oregon, June 25, 1954, (W. H. Lange). The type is in the collection of the California Academy of Sciences.

Bombus edwardsii Cresson

Bombus edwardsii Cresson, 1878. Acad. Nat. Sci. Philadelphia, Proc., p. 184.

Bombus fernaldi Franklin, 1911. American Ent. Soc. Trans. 37:157.

Bombus lapponicus var. *insularis* Friese, 1924. Deut. Ent. Ztschr., p. 437.

Considerable confusion has existed in past years regarding the correct name for this species. Cresson erected the species on the basis of specimens from California, Vancouver Island, and Colorado. The latter localities are well outside the distribution range of this species and the material used by Cresson from these areas has been shown to be *bifarius nearcticus*. The queen from California, however, is *edwardsii* and page position and usage gives this name priority for this species. Thus the *edwardsii* of Cresson is, as Frison suggests, applicable only to this essentially Californian species. Franklin, on the basis of an examination of worker and male paratype, misassociated the name *edwardsii* for *bifarius* and applied the new name *fernaldi* to this species.

The species abounds in California and appears to replace *bifarius* in the state. It has been recorded from western Nevada and undoubtedly occurs in northern Mexico and possibly sections of Arizona.

The subspecies *edwardsii* var. *fuscifrons* Swenk was based on material from Colorado. A perusal of the original description indicates without doubt that this is a reference to the typical *bifarius*, and that Swenk followed Franklin's misapplication of the name in designating *fuscifrons* as a subspecies of *edwardsii*.

The types of *edwardsii* var. *russulus* Frison have been examined and prove to be workers of *mixtus*.

This work, although limited in scope, leads to the conclusion that *edwardsii* is a monotypic species with little variation throughout its range.

The species bears phenotypic resemblance to *bifarius nearcticus* but is much more closely related to *mixtus*. All three castes can be separated from *bifarius nearcticus* with relative ease. In the latter

there is a broad V-shaped notch of black pile extending to the posterior margin of the scutellum and the light pile of the body is grayish-white, whereas in *edwardsii* there is no black on the scutellum and the light pile of the body is bright yellow.

In *mixtus*, pile on the apical 2 to 4 abdominal terga is always ferruginous or tinged with bright golden, while in *edwardsii* the pile of the two apical terga, is black. Males of these two species can be separated without difficulty, for *mixtus* has distinct lateral fringes of pile to the basal flagellar segments.

QUEENS:

Ocelli situated slightly below supraorbital line; malar spaces as long as, or slightly longer than, apical widths; flagellum short, flagellar segment 3, two-thirds as long as 1, flagellar segment 2, three-quarters as long as 3; tegulae brown to brownish-black; wings pale brown to fuscous; nervures brown.

Vertex with pile predominantly yellow, a few black hairs intermixed above ocelli; pile of face dense and yellow, a few black hairs intermixed above antennal bases and along innerorbital margins; area behind eyes with pile black. Thoracic dorsum with broad interalar band; scutum anterior to bases of tegulae with dense yellow pile having a weak admixture of black pile, particularly laterally; scutellum with pile long, dense, and yellow, a few black hairs on the medioapical margin; mesopleura with pile long, dense, and yellow; metapleura and dorsal margins of propodeum with pile long, dense, and yellow; posterior face of propodeum with pile black. Metasomal tergum 1 with pile dense and yellow laterally, sparse yellow pile medially, with a few black hairs intermixed; metasomal terga 2 and 3 with pile all black; metasomal tergum 4 with pile long and yellow, a very narrow fringe of black pile basally; metasomal tergum 5 with yellow pile over lateral one-quarter of disc, and over lateroapical margins, median face of discal area with long, black pile; metasomal tergum 6 with pile very short, sparse, and black; metasomal sterna with pile sparse, long, and light. Anterior legs with pile all black; median legs with pile all black except for fringes of light pile on trochanters; posterior legs with pile black except for a ventroposterior fringes of light pile on trochanters and femora, corbicular fringes black, a few hairs having the terminal half tinged with golden.

WORKER:

As in the queens but with a slightly stronger admixture of black pile about the vertex, face, and anterior face of scutum.

MALES:

Ocelli situated at supraorbital line; malar spaces $1\frac{1}{2}$ times as long as apical widths; flagellum long, first flagellar segment three-quarters as long as third, second flagellar segment slightly shorter than first; tegulae brown; wings pale brown to fuscous; nervures brown.

Vertex with pile predominantly yellow; face with long, dense, bright yellow pile, strong admixture of black pile along inner orbital margins and about periphery of yellow pile on vertex; area immediately behind eyes with pile black. Thoracic dorsum with broad, black, interalar band; scutum anterior to bases of tegulae with long, dense, yellow pile weakly intermixed with black; scutellum with pile long, dense, and yellow; mesopleura, metapleura, and propodeum with pile yellow. Metasomal tergum 1 with pile long, dense, and yellow; metasomal terga 2 and 3 with pile black, occasionally traces of yellow on mediobasal portion of tergum 2; metasomal tergum 4 with pile yellow, usually a small patch of black medially; metasomal tergum 5 with long, yellow pile on

lateral one-third, median face with pile black; metasomal terga 6 and 7 with pile all black; metasomal sterna with long fringes of light to yellow pile. Anterior legs with pile black except for long, light, posteroventral fringes on femora, trochanters and coxae; midlegs much as forelegs but with tinges of golden to ferruginous pile at apices of tibiae; hind legs with trochanters and coxae with abundant light pile, femora with light pile predominating, some black pile intermixed on dorsal and anterior surfaces; posterior tibiae with pile long and dense, predominantly black but with many hairs having traces of ferruginous.

Male genitalia: (figure 22). Capsule closely resembling that of *mixtus* but with apices of penis valves more uniformly rounded and of more uniform width; apices of gonostyli deeply emarginate; seventh ventral plate with narrow apical membranous extension; eighth ventral plate with apex quadrate.

VARIATION:

There is little variation in color pattern of the queens and workers of this species; however, some variation does exist in the amount of black pile on the face and vertex. An intermixture of black and yellow pile is always noted, but in some specimens the black, and in others the yellow predominates. This variability is more pronounced in females than males. The corbicular fringes are usually all black but in some specimens tinges of ferruginous appear, particularly on the terminal portion of some of the apical hairs. In males the pile color of the second metasomal tergum is usually black but in a number of specimens there are traces of yellow pile on the mediobasal margins.

DISTRIBUTION:

The species is found throughout California, the extreme western part of Nevada and extends as far north as Three Sisters, Oregon. It is apparently a very rare species north of the Rogue River in Oregon and undoubtedly occurs in northern Mexico and possibly sections of Arizona (Map 10).

OREGON:

Brookings; Crater Lake Park; Diamond Lake, 5,182'; Drakes Peak, 8,218'; Fingerboard Prairie, 3,825'; Fort Klamath, Klamath Co.; 25 mi. W. Grants Pass; Griffin Creek, Jackson Co.; Pole Bridge Meadow, 5,900'; Santiam Pass, 5,000'; Three Sisters.

CALIFORNIA:

Alameda County: Berkeley; Livermore; Niles; Oakland; Piedmont; Tesla.

Butte County: Jarbo Pass.

Contra Costa County: Antioch; Concord; Tilden Reg. Park.

Eldorado County: Camino, China Flats; Eldorado; Fallen Leaf Lake; Fred's Place; Placerville; Pollock; Pyramid; Snowline.

Fresno County: Auberry; Cedar Crest.

Humboldt County: Orick.

Inyo County: Glacier Lodge.
 Kern County: Frazier Park; Mohave R. near Deep Creek; Walker Pass.
 Lake County: Lakeport; Lucerne, 3 mi. S. Middletown.
 Lassen County: Bridge Creek Camp.
 Los Angeles County: Big Dalton Dam; Crystal Lake; Los Angeles; Mint Canyon; Tanbark Flat; West Hollywood.
 Madera County: Coarse Gold; Madera Cr., 3,000'; O'Neals;
 San Joaquin Exp. Sta.; Soquel Basin.
 Mariposa County: Fish Camp; Miami Ranger St., Yosemite Valley.
 Marin County: Mill Valley.
 Mendocino County: Ft. Bragg; Ryan Creek; Ukiah.
 Mono County: Rocker.
 Monterey County: Bixby Creek; King City; Pfeifer St. Park; Santa Lucia Mts.
 Napa County: Monticello; Mt. George; Samuel Springs.
 Nevada County: Hobart Mills, Sagehen.
 Orange County: Balboa Island; Santa Ana.
 Placer County: Alta; Colfax; Dutch Flat; Green Valley; Lake Tahoe.
 Plumas County: Buck's Lake; Johnsville; La Porte; Meadow Valley; Quincy.
 Riverside County: Banning; Cajon Valley; Cathedral City; Hemet Res., Idyllwild; Keen Camp, S. J. Mt.; Palm Springs; San Jacinto Mts.; Ribbonwood; San Bernardino; Sand Flat, 5,500'; Vandeventer Flats.
 Sacramento County: Folsom; Walnut Grove.
 San Bernardino County: Little Mohave Valley; Snowcrest Camp.
 San Diego County: Barrett Spring; Pine Valley; San Selite Valley.
 San Francisco County: San Francisco.
 San Luis Obispo County: Arroyo Grande; Caliente Mts.; Morro Bay.
 San Mateo County: Burlingame; San Mateo.
 Santa Barbara County: Santa Barbara.
 Santa Clara County: Alum Rock Park; Los Gatos; Mt. Hamilton; Palo Alto.
 Santa Cruz County: Ben Lomond; Big Basin; Mt. Herman; Waddell.
 Shasta County: Big Springs; Burney; Hat Creek; Lassen Peak, 8,500'; Manzanita Lake; Moose Camp; Redding; Shingletown; Turney Creek; Viola.

Siskiyou County: Bartle; Pondosa.

Sierra County: Gold Lake.

Solano County: Dixon; Lake Carry; Rockyville; Vacaville.

Sonoma County: Santa Rosa Mts., 7,300'; Santa Rosa; Still-water Cove.

Trinity County: Carrville, 2,400'; Salyer; Trinity River.

Tulare County: Camp Nelson, 2 mi. S. Three Rivers.

Tuolumne County: Bumble Bee; Cow Creek; Dardanelle; Eleanor Lake; Pine Crest; Strawberry; Tuolumne Meadows.

Ventura County: Santa Paula.

Yolo County: Cache Creek Canyon; Davis; Putah Canyon; Rumsey; Woodland.

NEVADA:

Dagget Pass, Douglas Co.; Mt. Rose, Washoe Co.

FLIGHT RECORDS:

The species flies throughout the warmer summer months with queens having been taken from March 4 to September 8; workers from April 14 to September 28; and males from May 29 to October 2.

HOST RECORDS:

Queens and workers of *edwardsii* have been taken from a wide variety of host plants including: *Arctostaphylos*, *Astragalus*, *Brassica*, *Ceanothus*, *Cirsium*, *Cryptantha*, *Lupinus*, *Manzanita*, *Penstemon*, *Rhododendron*, *Ribes*, *Salix* and *Solidago*. Of these, 85% of all the queens having host data, have been taken from *Arctostaphylos*. Workers, on the other hand, show a marked preference for *Arctostaphylos* and *Penstemon*.

The type of *edwardsii* is in the Academy of Natural Sciences of Philadelphia; *fernaldi* is Franklin's name for *edwardsii* Fowler (not Cresson) and Fowler's specimens were designated as the types of *fernaldi*.

Bombus mixtus Cresson

Bombus mixtus Cresson, 1878, Acad. Nat. Sci. Philadelphia, Proc. p. 186.

Bremus edwardsii var. *russulus* Frison, 1927. California Acad. Sci. Proc.

(4) 16:374 (new synonymy).

This species is very common in western America from Alaska to the mountains of California. It is found in particular abundance along the coast and in the coastal valleys of British Columbia, Washington and Oregon; in fewer numbers in the Cascades of Oregon; and is sparingly distributed along the Sierras as far south as Mineral King, Tulare County. The species is generally distributed throughout British Columbia, from whence it follows the coastal region and in-

land mountains through Idaho and Montana to Colorado. It has not been recorded from the central desert area of Washington and Oregon and there are no records of the species from either Nevada or Utah. Through a great portion of its range it appears to be strictly a boreal form although the species has been taken from sea level to 8,500 feet.

Males of *mixtus* can be readily separated from all other bumble bees in America on the basis of strong tufts of pile on the outer surfaces of the basal flagellar segments. By contrast, queens and workers are very difficult to separate from a number of species within *Pratobombus*. It is most closely related to *sitkensis* Nyl. and the females have been mistaken for *frigidus* F. Sm., *sitkensis* and *edwardsii* Cresson which they closely resemble in various portions of the species range. The females do not exhibit any major color pattern variation, and the minor variations in this and the aforementioned species are sufficient to make species determination exceedingly difficult. It is not possible to designate discriminatory value to any one of several features but the following group of characteristics is usually adequate to achieve separation: an admixture of black and yellow pile on the thoracic dorsum anterior to the bases of the tegulae; scutellum with yellow pile; face with admixture of yellow and black pile; metasomal tergum 1 and the basal one-third of tergum 2 with yellow pile; metasomal terga 4 to 6 with pile often whitish, grayish or ferruginous (in typical specimens, ferruginous is most common); often terga 4 and 6 will be covered predominantly or completely with black pile; corbicular fringes with ferruginous pile.

In the southern part of the range of *mixtus* there is a rather sharp decrease in the amount of black pile intermixed on the anterior face of the scutum. This in association with a predominance of black pile on the apical metasomal terga results in a form closely resembling the females of *edwardsii*.

Females of *sitkensis* invariably have the scutellum exclusively covered with black pile, but in a number of specimens there is a considerable amount of yellow about the posterior margin, causing the character to lose its discriminatory value. However, metasomal terga 1 and 2 are always covered with yellow pile and there are apical yellow fringes to terga 3 and 4.

Most of the material determined as *frigidus* from Washington, Oregon, and California has proven to be females of *mixtus*. The species bear close resemblance to each other but in *frigidus* the face is covered with black pile, the anterior face of the scutum is covered with yellow pile, a few black hairs are intermixed along the anterior margin of the interalar band, and tergum two is completely covered with yellow pile.

Considerable indecision is associated with the determination of certain females from the higher elevations of California, but males from these areas are so distinctive that the sex associations made in this paper are believed to have a reasonable degree of accuracy.

QUEENS:

Ocelli situated slightly below supraorbital line; malar spaces seven-eighths, to as long as the apical widths; flagellum short; first flagellar segment $1\frac{1}{2}$ times longer than third; second flagellar segment three-quarters as long as third; tegulae brown; wings light brown; nervures brown.

Vertex with an admixture of yellow and black pile, light pile usually predominating; face with an admixture of light and black pile, usually with the shorter, pale yellowish-white hairs predominating between and below antennal bases; area between bases of antennae and inner orbital margins with black pile predominating; areas behind eyes with pile black. Thoracic dorsum with strong admixture of black pile predominating; areas behind eyes with pile black. Thoracic dorsum with strong admixture of black pile over portion anterior to bases of tegulae; scutellum with an admixture of light and black pile, light pile predominating over disc and in great predominance about extreme lateral and posterior margins; mesopleura with pile pale yellow to white, a few black hairs intermixed about lateral lobes of pronotum and wing bases; metapleura with pile light yellow; propodeum with upper lateral margins having abundant yellow to white pile with black below. Metasomal tergum 1 with pile all pale yellow to white; metasomal tergum 2 with light pile over mediobasal portion of disc, light pile reduced laterally, lateral margins and apex with black pile; metasomal tergum 3 with the pile all black, (in some northerly specimens tergum 3 may have abundant apical ferruginous pile); tergum 4 usually with black pile basally and on extreme lateral margins; metasomal terga 5 and 6 with the pile predominantly pale yellow to ferruginous—in a few specimens this may be faded to white; metasomal sterna with sparse, light apical fasciae. Coxae and trochanters of all legs with an admixture of light and dark pile, whitish pile always predominating; femora of legs with pile predominantly black, occasionally very weak posteroventral fringes of pale gray pile; posterior tibiae with corbicular fringes long and bright ferruginous.

WORKERS:

Much as in the queen but exhibiting much more variation in color patterns. Pile of face and vertex varies from predominantly black in the northern part of the range to predominantly yellow in specimens from the south; propodeum with pile mainly black, a few light hairs intermixed at laterodorsal margins; metasomal tergum 2 may have yellow restricted to mediobasal portion of segment or most of the tergum may be covered with yellow pile; metasomal tergum 3 often has traces of ferruginous on apical margins.

MALES:

Ocelli situated slightly below supraorbital line; malar spaces $1\frac{1}{2}$ to $1\frac{1}{2}$ times as long as apical widths; basal flagellar segments with distinct, lateral tufts of hairs, most evident on basal five flagellar segments; third flagellar segment, $1\frac{1}{2}$ times as long as first; first and second flagellar segments subequal; tegulae brown; wings fuscous to whitish; nervures brown.

Vertex with most of the pile long and yellow, a few black hairs intermixed; face with pile long and dense, whitish to pale yellow, a few black hairs intermixed above antennal bases and along inner orbital margins. Thoracic dorsum with distinct interalar band, some black pile intermixed with yellow.

low or whitish, anterior to bases of tegulae; scutellum with pile pale yellow, usually some black hairs intermixed on anterior portion of disc; mesopleura with pile light yellow; metapleura with pile yellow or yellowish-white; propodeum with light pile on laterodorsal margins, lower surfaces with pile black. Metasomal terga 1 and 2 with pile all light, ranging from pale to lemon yellow; metasomal tergum 3 with pile black, a fringe of yellowish pile on apical margin; metasomal terga 4 to 7 with pile usually tinged with ferruginous; metasomal sterna with abundant light pile over discal surface as well as along apical margins. Legs with variably colored pile, always with distinct fringes of light pile on coxae, trochanters and femora; posterior tibiae with pile always light or tinged with ferruginous.

Male genitalia: (figure 23). Capsule closely resembles that of *sitkensis* except in the apices of the penis valves. The recurved apices in *mixtus* are proportionally longer than in *sitkensis*, of more uniform width and tend to be slightly bulbous terminally. The heads of the penis valves in *mixtus* are very nearly uniform in width from the shank of the valves to the apices, while in *sitkensis* the heads are narrow basally from the recurved portions and sharply narrowed apically. The eighth ventral plate of *mixtus* has a distinct median emargination along apical margin.

VARIATIONS:

In the queens and workers, pile of the face and vertex may vary from predominantly yellow (typical) to predominantly black, and in many specimens, the pile of the head is faded so that the yellow pile may appear to be whitish. The proportion or amount of black pile intermixed over the anterior portion of the scutum varies considerably. Representatives of this species from British Columbia appear to have equal amounts of black and yellow pile in this area while specimens from the southern part of the range have the yellow pile clearly predominating. On metasomal terga 1 and 2 the pile patterns are reasonably stable. The mediobasal portion of tergum 2 always has a considerable amount of yellow pile, but all intergrades between this, and individuals having the entire tergum covered with yellow have been examined. Metasomal tergum 3 is usually black. Several specimens, however, show traces of ferruginous or light pile on the apical margins (especially the Alaskan material). The pile of metasomal tergum 4 is usually all light but there may be considerable black pile over the basal portion of this tergum. Terga 5 and 6 always have a predominance of pale ferruginous pile although there may be a few black hairs intermixed on their lateral extremities. Many workers, particularly those from the Rogue River Valley in Oregon, appear to have the corbicular fringes with black pile predominating. Closer examination reveals that in these specimens, basal halves of the corbicular hairs on the posterior tibiae are black but the apical ends are tinged with pale ferruginous.

In the males the pile color ranges from lemon yellow, in those specimens taken from the Rogue River Valley and along the southern coast of Oregon, to a pale yellowish-gray in the northern and

eastern parts of its range. There is often an abundant black pile intermixed over the thoracic dorsum, obscuring the interalar band and giving a clouded cast to scutum and scutellum. Metasomal terga 1 and 2 are always covered with light pile. Tergum 3 is usually black, but in many there is a broad fringe of yellow pile apically. Metasomal terga 4 to 7 may be covered with bright ferruginous (typical) yellowish or whitish pile; however, in a number of specimens the pile of these terga is black with the yellow pile evident only as apical tergal fringes. All possible intergrades between these extremes have been examined.

Generally, specimens from British Columbia, and in particular those from the interior valleys, have the light pile as grayish-yellow; a stronger admixture of black pile on the face, vertex, and thoracic dorsum, and the pile on metasomal terga 3 to 6 in the females and 4 to 7 in the males always tinged with ferruginous. The variability in color patterns is much greater in material from the southern part of the range of *mixtus*, and not nearly so evident among British Columbia and Alaskan specimens.

DISTRIBUTION: (Map 15).

BRITISH COLUMBIA:

Adams Lake; Agassiz; Alberni, V. I.; Barkerville, 6,000'; Bridge Lake; Burns Lake; Canim Lake; Cedarvale; Celista; Chilcotin; Clinton; Crows Nest; Fernie; Glacier; Golden; Kaslo; Kamloops; Minnie Lake; Nanaimo, V. I.; Nicola; Penticton; Prince George; Prince Rupert; Quesnel; Radium; Revelstoke; Rolla; Saanich, V. I.; Salmon Arm; Salvus; Sidney, V. I.; Smithers; Summerland; Tyee; Vancouver; Vernon; Victoria; Yale.

WASHINGTON:

Almota; Anacortes; Arlington; Bay Center; Bear River, Bellingham; Caman Island; Chase Lake; Elbe; Friday Harbor; Green River Gorge, King Co.; Harstine Island, Messen County; Lake Tapps; Lopez Island; Mt. Constitution; Nahcotta; Naselle; North Bend; Ocean Park; Olympia; Palix River; Paradise Valley; Pullman; Puyallup; Raise Harbor; Renton; Samish; Saratoga Beach; Seabeck; Seattle; Shelton; Snoqualmie; Spanaway; Stabler; Table Rock Mt.; Tacoma; Wenatchee; Whidby Island.

OREGON:

Blue Mts., 7,850'; Alsea Mt.; Alpine; Anthony-Detroit, 7,100' to 7,650'; Anthony Lake, Blue Mts., 7,100'; Ashland; Astoria; Blue Mts., 7,850'; Briton Lake, Marion Co.; Brookings; Calama; Camelia, 4,200'; Cascadia; Clatskanie; Cornucopia, 5,900'; Corvallis; Crater Lake, 6,600'; Dallas; Devitt, Benton Co.; Diamond Lake,

° mixtus



Map 15. Map showing the distribution of *mixtus*.

5,182'; Eagle Creek; Elam; Elgin; Elk Lake, Deschutes Co., 4,600'; Eugene; Fall Mtn. Lookout, Grant Co., 5,200' to 6,000'; Fish Lake; Florence; Forest Grove; Goble; Grants Pass; Griffin Creek, Jackson Co.; Horseshoe Lake, Blue Mt., 7,500'; Imnaha, Wallowa Co.; Kamela; Kiger Island; Klamath Lake; LaGrande, 500'; Lake of the Woods, 4,950'; Long Creek; Mary's Peak; McKenzie Pass; McMinnville; Meacham, 3,400'; Medford; Mt. Hood, 6,000'; Nashville, Lincoln Co.; Newport; North Powder; Oswego; Parkdale; Pittsburg, Columbia Co., 2,000'; Portland; Prospect, 4,578'; Rainier; Roseburg; Rowing River, Linn Co.; Salem; Scapoose; Scio; Seaside, Clatsop Co.; Seaside; Silver Creek Falls, Marion Co.; Silverton, 2,500'; Sparks Lake, Deschutes Co., 5,428'; Steens Mts., 8,000'; St. Helens, 500'; Strawberry Lake, Grant Co., 6,400'; Summit Prairie; Suttle Lake, 3,435'; Three Sisters, 4,650'; Tillamook; Toledo; Triangle Lake; Union Creek, Jackson Co.; Valsetz, Polk Co.; Vernonia; Waldo; Waldport; Willama Lake, Deschutes Co.; Wallowa Co.; Wallowa Lake, 6,400'; Woodburn; Wren.

CALIFORNIA:

Alpine County: Hope Valley.

Del Norte County: Smith River Camp.

Eldorado County: Fallen Leaf Lake.

Humboldt County: Crescent City; Eureka.

Modoc County: Davis Creek.

Plumas County: Meadow Valley.

Shasta County: Moose Camp.

Siskiyou County: Horse Creek.

Trinity County: Big Flat; Carrville, 2,400' to 2,500'; Coffee Creek; Eagle Creek.

Tulare County: Mineralking.

Tuolumne County: Yosemite.

IDAHO:

Athol, Kootenai County; Crater Peak, St. Joe Nat. Forest; Donnelly, Valley County; Lowman; Moscow, 2,560'; Moscow Mts., 3,000'; New Meadows, 3,860'; Powell, Idaho County; Troy.

FLIGHT RECORDS:

This is one of the earlier flying species of Pacific America. Queens have been recorded from March 19 to September 5; workers, April 12 to September 4; and males, May 21 to September 4. In the coastal valleys and along mainland beaches this species is very abundant during the latter part of April, May, June, and July, while in the inland areas and at higher altitudes, the emergence dates are retarded, with the peak of the population occurring during June, July, and August.

The type of *mixtus* from Colorado is in the Academy of Natural Sciences of Philadelphia; that of var. *russulus* is in the collections of the University of Nebraska.

Bombus sitkensis Nylander

Bombus sitkensis Nylander, 1848. Notiser Sällskapet Fauna Fenn. Förhandl. 1:235.

Bombus oregonensis Cresson, 1878. Acad. Nat. Sci. Philadelphia, Proc., p. 185.

Bombus mixtuosus Ashmead, 1902. Washington Acad. Sci., Proc., 4:128.

This species is most abundant along coastal margins of British Columbia, Washington, Oregon, and California, extending a little below the Bay region of California. Several specimens have been taken from the Willamette Valley, low passes in the Cascades and three specimens are recorded from Three Sisters, Oregon. The species is found throughout British Columbia except in arid inland valleys. Two specimens from Idaho and another specimen from the Wallowa Mountains of eastern Oregon appear to be *sitkensis*. The species should be present in the higher elevations of Montana and Wyoming.

It is often difficult to distinguish males and females of this species from their close relatives within the subgenus. The males of this species are characterized as follows: pile of the scutellum is predominantly black or at least with a strong admixture of black pile; metasomal terga 1 and 2 are yellow or mostly so; tergum 3 has black pile and usually a fringe of yellow pile apically; tergum 5 may be black or have an apical fringe of light ferruginous pile, terga 6 and 7 are usually covered with ferruginous pile but at times this pile is faded to a pale gray; and flagellar segments 1 and 3 are subequal. Difficulties are encountered in trying to separate this species from either *flavifrons dimidiatus* or *frigidus*; however, both of these species usually have the pile of the scutellum almost all yellow, and neither have the distinct fringes of yellow to the apex of tergum 3. The males of *sitkensis* and *mixtus* can be readily separated by the fringe of hairs on the basal flagellar segments of the latter.

Queens and workers of *sitkensis* can be separated from most of the species in this subgenus by having the scutellum predominantly or completely covered with black pile. However, many females of *f. dimidiatus* also have abundant black pile on the scutellum and bear strikingly similar color patterns on the metasomal terga. These two species can always be distinguished by the presence of ferruginous pile on the fifth and sixth terga and the absence of a median carina on the hypopygium of *sitkensis*.

QUEENS:

Ocelli large, situated at supraorbital line; malar spaces $1\frac{1}{2}$ times as long as apical widths; flagellum short, first flagellar segment about one-third longer than third; third, one-fourth longer than second; tegulae deep reddish-brown to reddish-black; wings fuscous basally to hyaline apically; nervures deep brown basally to brown apically.

Vertex with admixture of black and pale gray pile, longer black pile predominating; face above antennal bases with a preponderance of long, black pile, many shorter, pale gray hairs intermixed medially; pile below antennal bases an admixture of long, black, and pale yellow; inner orbital margins with fringes of black pile; areas behind eyes with pile all black. Mesoscutum with admixture of black and grayish-yellow pile giving surface a clouded appearance; interalar area with black pile predominating, some pale gray pile intermixed near wing bases; scutellum with pile predominantly black, some pale gray intermixed about peripheral margins; mesepisterna with pale yellow to yellow-gray pile covering upper two-thirds, pile immediately above coxal bases brown, or brownish-black; propodeum with pile predominantly black, a few pale gray hairs intermixed. Metasomal tergum 1 with abundant, long, pale yellow pile laterally, median discal surface with large V-shaped notch of black pile; metasomal tergum 2 with pile pale yellow to yellow-gray, a median longitudinal strip of black pile extending from base to apex; metasomal terga 3 and 4 covered with black pile, usually with apical fringes of yellow to yellow-ferruginous pile; metasomal terga 5 and 6 covered with long, ferruginous to yellow-ferruginous pile; metasomal sterna with weak apical fringes of yellow to ferruginous yellow pile; hypopygium without median carina. Anterior legs with pile black, or brownish-black; middle legs with fringes of brownish pile to coxae and trochanters, femora and tibiae with pile black except for a few ferruginous hairs forming apicoposterior fringes; posterior legs as the midlegs but with pale brown to yellowish-brown fringes to coxae and trochanters; posterior tibiae with corbicular fringes long and yellow-ferruginous, a few shorter, black hairs along anterior margins.

WORKERS:

Much as queens except in having a predominance of black pile above and below antennal bases; a greater proportion of black on thoracic dorsum; malar spaces a full $1\frac{1}{2}$ times as long as apical widths; and the corbicular fringes ferruginous brown.

MALES:

Ocelli situated at supraorbital line; flagellum short; first and third flagellar segments subequal, second about three-fourths as long as first or third; malar spaces $1\frac{1}{2}$ times as long as apical widths; tegulae brownish-hyaline; wings hyaline; nervures brown.

Vertex with admixture of yellow and long, black pile, yellow predominating; face with pile a pale yellow below antennal bases and over basal half of clypeus; area above antennal bases predominantly black with some shorter, pale gray hairs intermixed; inner orbital margins with pile black; areas behind eyes with admixture of long, black, and short, pale gray hairs. Scutum with anterior portion having admixture of yellow and long, black pile, yellow predominating; interalar band black but with pale gray intermixed laterally; scutellum with black pile predominating, some pale gray hairs along peripheral margin; mesepisterna with pile yellow to pale yellow; propodeum with lateroposterior fringes of black pile.

Metasomal tergum 1 with pale yellow pile except for V-shaped notch of shorter black pile medially; metasomal tergum 2 with pale yellow to pale gray

pile except for a median, longitudinal strip of shorter black pile; metasomal tergum 3 with discal area covered predominantly with black pile, varying amounts of light pile evident as apical fringe or on apical one-third of disc, fringe most evident laterally; metasomal tergum 4 with pile predominantly black, a few pale gray hairs on apicolateral margin; tergum five with black pile or a fringe of yellow, ferruginous, or pale gray pile to apical margin; metasomal terga 6 and 7 with pile yellow-ferruginous, ferruginous or pale gray; metasomal sterna with dense fringes of long, pale gray pile, partially obscuring the surface. Coxae, trochanters, and basal portions of femora with fringes of long, pale gray pile, remainder of femora and tibiae with pile brownish-black to black, often with ferruginous tinge to pile on apical portions of tibiae; posterior tibiae with pile reddish-brown to ferruginous apically.

Male genitalia: (figure 24). Capsule resembling that of *mixtus*, differing in breadth of apices of penis valves and form of apices of gonocoxite; readily separable from *flavifrons* in breadth of penis valve apices and structure of apices of gonostyli, from *frigidus* in apices of penis valves and position of serrations on penis valves; eighth ventral plate with pair of distinct, darkened areas medially, heavily pilose over apical two-thirds; seventh ventral plate with sparse, but uniform pubescence subapically.

VARIATION:

This species does not have great variability in color pattern or structure but does exhibit sufficient variation to make it difficult to distinguish from several species within the subgenus. In the females, the pile of the face may vary from predominantly whitish-yellow above the antennal bases to almost completely black. However, there are always traces of shorter whitish pile even in the most melanistic forms. The scutellum often has sufficient yellow pile intermixed over the peripheral margins and at times even over the disc to give these specimens close phenotypic resemblance to females of *flavifrons*. The third metasomal tergum is often entirely black with a yellow fringe evident only upon microscopic examination. The fourth tergum may be all black or may be completely covered with ferruginous, yellow-ferruginous, or whitish pile. The malar spaces are usually barely longer than the apical widths but these structures vary in length from $\frac{7}{8}$ to $1\frac{1}{8}$ times as long as the apical widths. Those specimens with the longer malar spaces complicate separation of this species from *flavifrons*.

Variation in the males is restricted primarily to amount of yellow pile on the scutellum. The pile in this area is always predominantly black but there is sufficient yellow pile in many specimens to make separation from *flavifrons* difficult. In the typical form the apices of tergum 4, as well as terga 5 to 7, are covered with ferruginous or pale ferruginous pile. This pile is often faded to ferruginous-yellow or even a pale gray which may be restricted only to terga 5 to 7. The males however, can be distinguished from other species in *Pratobombus* by the peculiarities of the genitalic capsule.

DISTRIBUTION: (Map 14).

ALASKA:

Seward; Sitka; Skagway.

BRITISH COLUMBIA:

Alberni, V. I.; Agassiz; Barkerville, 6,000'; Buccaneer Bay; Burns Lake; Cedarvale; Courtenay, V. I.; Departure Bay, V. I.; Fernie; Field; Golden; Inverness; Kamloops; Kaslo; Nanaimo, V. I.; Prince Rupert; Quesnel; Radium; Revelstoke; Royal Oak, V. I.; Salmon Arm; Salvus; Sidney, V. I.; Skidgate; Smithers; Summerland; Tofino, V. I.; Tyee; Vancouver; Vernon; Victoria, V. I.; Yale.

WASHINGTON:

Forks, Clallum Co.; Fort Lewis, Pierce Co.; Friday Harbor; Hoquiam; Lake Quiniault; Lopez Island; McCleary; Mt. Rainier; Nahcotta; North Bend, King Co.; Orens Island; Paradise Valley; Port Townsend; San Juan Island; Seabeck; Seattle; Whidby Island.

OREGON:

Albany; Alsea Mt.; Astoria; Boiler Bay, Lincoln Co.; Breitenbush Springs, Marion Co.; Brookings; Cannon Beach; Cascade Locks; Cascadia; Coos Bay; Corvallis; Detroit; Dodson; Florence; Forest Grove; Gearhart, Clatsop Co.; Goble; Gold Beach; Harlan; Kellogg, Douglas Co.; Marys Peak; McKenzie Pass; McMinnville; Medford; Mt. Baker Road; Mt. Hood, 6,000'; Neskowin; Newport; Olney; Portland; Port Orford, Curry Co.; Rainier; Scio; Seaside; South Sanitam Pass; Summit, Benton Co.; Three Sisters; Toledo; Tombstone Prairie, S. Sanitam, 4,100'; Vernonia; Waldport; Woodruff, Jackson Co.; Yachats.

CALIFORNIA:

Alameda County: Berkeley; Diamond Canyon; Oakland.

Contra Costa County: Redwood Canyon.

Del Norte County: Requa.

Humboldt County: Big Lagoon; Blacksburg; Pepperwood; Scotia; Van Duzen River; Weott.

Marin County: Bear Valley; Inverness; Mill Valley.

San Francisco County: Mt. Davidson.

Santa Clara County: Palo Alto.

Santa Cruz County: Santa Cruz.

Sonoma County: Austin Creek; Cazadero; Stillwater Cove.

IDAHO:

Coolin, Priest Lake; Crater Peak, St. Joe National Forest.

FLIGHT RECORDS:

The species is one of the earlier flying of western bumble bees. Queens have been taken from March 3 to August 17; workers, from April 1 to September 4; and males from May 28 to September 30.

The type of *sitkensis* is presumed lost; that of *oregonensis* is in the Academy of Natural Sciences of Philadelphia; and that of *mixtuosus* is in the United States National Museum.

Bombus frigidus F. Smith

Bombus frigidus F. Smith, 1854. Cat. Hymen. British Mus., V. 2, p. 399.

Bombus carriei Greene, 1860. Lyc. Nat. Hist. N. Y. Ann. 7:170.

Bombus couperi Cresson, 1878. Acad. Nat. Sci. Philadelphia, Proc., p. 185.

This species has been recorded from California, Oregon, and Washington by several authors. All of the material seen by this author, however, has proved to be species other than *frigidus*. Several of Frison's records of *frigidus* from the Pacific Northwest and California are misidentifications of *B. mixtus* or *B. edwardsii*. Specimens upon which several records were based, particularly those of Scullen (1927) and Buckell (1951) were not among the specimens in my possession. The Buckell record of *frigidus* from Victoria, British Columbia, was seen, and proved to be a male of *mixtus*.

The misidentification of all material examined from California, Oregon, Washington, and southwestern British Columbia leads to the conclusion that *frigidus* does not occur in this area. Of 35,000 specimens in my possession only six are *frigidus*. These were taken at Invermere, British Columbia, and Banff and Bilby, Alberta. In addition there are 3 specimens from Colorado and 62 from Alaska and the Yukon which correspond to the Franklin (1913) redescription. It would appear then, that *frigidus* is strictly a Boreal form that occurs sparingly at the higher elevations along the continental divide as far south as Colorado.

In western America the species has most often been confused with *B. mixtus* and *B. edwardsii* although bearing little phenotypic resemblance to the latter species. Morphologically, *frigidus* appears to be an intermediate form not fitting into any species groups or complexes within the subgenus. It is instead, a species bearing a superficial similarity to several. In this unique position the species identity has often been concealed or misconstrued.

Queens and workers of *mixtus* are distinguishable from *frigidus* in having face pile with an admixture of yellow and black, the scutum anterior to the bases of the tegulae with a strong admixture of black and yellow pile giving the surface a clouded appearance, and by having the second metasomal tergum with the pile all, or mostly black. *Edwardsii* and *frigidus* are broadly allopatric and could be

separated on distribution patterns alone; however, the two species have marked phenotypic differences that make them readily separable. In *edwardsii* the pile of the face is yellow with some black intermixed above the antennal bases and along inner orbital margins; pile on the anterior face of the scutum is weakly intermixed with black; metasomal tergum 2 has the pile black except for a mediobasal patch of yellow; and pile of the apical 2 terga is black.

In addition to these two species, *frigidus*, or its variants, resembles *pleuralis*, *vagans*, and *sitkensis* but can be distinguished from these species by characters cited in the key.

Males of *frigidus* are much more readily separable from their closest relatives than are the females. The males of *mixtus* can be separated immediately by strong fringes on the lateral margins of the basal flagellar segments; those of *sitkensis* by yellow above the antennal bases and some yellow pile on the apex of tergum 3; those of *edwardsii* by yellow pile above the antennal bases and black pile on terga 6 and 7. Characters of diagnostic value can be found on the genitalia but some variants of these species exhibit sufficient genitalic polymorphism to limit their applicability. This is true of several species complexes within the subgenus *Pratobombus*.

An examination of the original description and several specimens of *B. couperi* Cresson leads me to substantiate Frison's (1929) conclusion that it is nothing more than a color variant of *frigidus*. This variant can be separated from *frigidus* only by the color of the corbicular fringes, a character found to be highly variable in populations from Alaska and the Yukon Territory. As such, it is a population variant deserving no formal taxonomic recognition.

As only one specimen of *frigidus* has been examined from the area under investigation, an elaborate description of the castes was not undertaken. For purposes of species separation a brief citation of characters of diagnostic value follow:

QUEEN AND WORKER:

Pile of the face black, or with a small patch of light pile most pronounced between the antennal bases; thorax with pile bright yellow, occasionally faded, and few, if any, black hairs intermixed with yellow anterior to bases of tegulae; interalar band black and distinct; scutellum with yellow pile, often some black intermixed on anterior median face; metasomal terga 1 and 2 with pile yellow to yellow-white, occasionally a few black hairs on median surfaces of both terga; tergum 3 with pile all black; tergum 4 with pile usually black but in a few specimens much of the tergum may be covered with ferruginous, yellow-ferruginous, or pale yellow pile; terga 5 and 6 with pile all ferruginous, yellow-ferruginous, or faded yellow.

MALE:

Pile of face below antennal bases yellow, pile above antennal bases and along inner orbital margins mainly black; thoracic dorsum with pile yellow except for broad black interalar band; metasomal terga 1 and 2 with pile all

yellow, occasionally apical margin of tergum 2 with black pile; tergum 3 with pile all black; tergum 4 with basal half covered with black pile; apical halves of tergum 4 and terga 5 to 7 with pile ferruginous, yellow-ferruginous, or faded yellow.

Genitalia, see figure 25.

DISTRIBUTION:

The species is most common in Alaska and Northwest Territories but apparently is sparsely distributed along higher elevations of the continental divide as far south as Colorado. One specimen is recorded from the area treated in this study and that from Invermere, British Columbia.

The type of *frigidus* is in the British Museum of Natural History; that of *carriei* has not been located and is assumed lost; and that of *couperi* is in the Academy of Natural Sciences of Philadelphia.

Bombus sylvicola Kirby

Bombus sylvicola Kirby, 1837. Fauna Bor.-Amer., V. 4, p. 272.

Bombus gelidus Cresson, 1878. Acad. Nat. Sci. Philadelphia, Proc., p. 184.

Bremus sylvicola var. *sculleni* Frison, 1929. American Ent. Soc. Trans. 55:108.

This species can be readily separated from all members of the subgenus *Pratobombus* except *melanopygus* Nyl. In the typical forms these two species are rather distinct with intergrades, intermediates, or hybrids existing between the two species in interior valleys of British Columbia. The typical form of *sylvicola* has the pile of the scutum anterior to the tegulae bases completely yellow, but occasionally a few black hairs are intermixed along the anterior margin of the interalar band. This typical form is found in the north, throughout northern British Columbia, Alaska, Yukon and the Northwest Territories. It also is found in Washington, Idaho, and Oregon, but in the intervening areas of British Columbia, an intergrade between this species and *melanopygus* exists.

Queens and workers are difficult, if not impossible, to separate from *melanopygus* in this area and males can be told only by genitalic examination. All three castes have a strong admixture of black and yellow pile over the anterior portion of the scutum. It is peculiar that the typical *sylvicola* does not occur in any collections from this area, for in the more southerly areas *sylvicola* is again represented by the typical form. Both *melanopygus* and *sylvicola* appear to be endemic to the interior valleys of British Columbia, whereas south of this area of intergradation, *sylvicola* appears restricted to the higher elevations of the Cascade, Rocky, Blue, and Steens Mountains and *melanopygus* is most abundant along the coast. The relationship of

these intermediates cannot be determined without biological and cytological study. On the basis of the male genitalia and the amount of black pile on the thoracic dorsum and vertex, however, it seems that these are hybrids between the typical forms of these two species, with resulting progeny resembling *sylvicola* in discriminating species characters.

The intermediate queens and workers from central British Columbia have been arbitrarily determined as *sylvicola*, since numerous males collected with them proved to resemble *sylvicola* closely in the genitalic characters and in the ecological niche from which they were taken. On the other hand, the amount of black pile on the face, vertex, and anterior face of the scutum is much more typical of *melanopygus*.

The males can be readily determined by genitalic examination. Apices of the penis valves are sharply bulbous; in *melanopygus* they are weakly pointed; apices of the gonostyli and gonocoxites are distinctive in spite of some variation, and the eighth ventral plate has a peculiar hair pattern.

Before me is a long series of queens and workers from the higher elevations of eastern California, determined as *sylvicola* and bearing a striking resemblance to that species. The absence of males prevents a positive species association, but on the basis of the known range of *sylvicola* it is very unlikely that these females belong to that species. It appears that *sylvicola* is strictly a Boreal form and is sparingly distributed along the Cascades as far south as Three Sisters, Oregon. The species is rather abundant in the Blue Mountains and Steens Mountains of eastern Oregon and has been recorded from higher elevations of the Rocky Mountains from British Columbia to Colorado. A Coos Bay record (Scullen, 1927) has proved to be a male of *melanopygus*.

Of the designated varieties of *sylvicola*, paratypes of *sylvicola* var. *sculleni* Frison and numerous specimens of *sylvicola* var. *gelidus* Cresson have been examined. The variety *sculleni* was based on a series of specimens that had ferruginous pile on terga 2 and 3 faded to either a yellow or orange-yellow. This form is rather widespread throughout the range of the species but is always taken with typical specimens of *sylvicola*. Because of this distribution and because fading of ferruginous or orange pile is common in this genus it is felt that *sculleni* does not warrant formal taxonomic recognition but be should be considered a phenotypic variant.

The variety *gelidus* was erected to accommodate queens and workers with face pile predominantly black, mesopleura with a predominance of black pile, and metapleura with pile exclusively black. Specimens from Alaska have been seen in which the pile of the metapleura and mesopleura is predominantly black, yet the pile of face

and body is like the typical form. Included in these series are specimens having $\frac{1}{2}$ to $\frac{3}{4}$ of the pleura covered with black pile; others have the face black, and the pile of the rest of the body like that of *sylvicola*. Judging from material at hand, individuals having a predominance of black pile on the face and the thoracic pleura are restricted to Alaskan populations, although there is some variation in the amount of yellow pile on the face and pleura in much of the material from the northwestern states. The variety is therefore assumed to be a population variant warranting no formal systematic rank.

QUEENS:

Ocelli situated at supraorbital line; malar spaces approximately as long as apical widths; first flagellar segment $1\frac{1}{3}$ times as long as third; third, one-quarter longer than second; tegulae deep brownish-black; wings fuscous with abundant short pile apically; veins deep brown to brownish-black.

Vertex with yellow pile, some black intermixed about peripheral margins; face with yellow pile between, and immediately below, antennal bases; black pile lateral to antennal bases, along inner orbital margins, and above antennal bases; a few shorter, light yellow hairs intermixed above antennal bases. Scutum with area anterior to bases of tegulae with pale yellow pile, a few dark hairs intermixed along the anterior interalar margin; interalar band broad and black; scutellum with pale yellow pile, black predominating on medioanterior face of scutellum extending as an indistinct V-shaped emargination toward the posterior margin; mesopleura with pile pale yellow, abundant black pile on lateral lobes of pronotum and immediately above coxal bases; metapleura with dorsal face pale yellow, abundant black pile intermixed above coxal bases; propodeum with admixture of pale yellow and black, pale yellow predominating. Metasomal tergum 1 with pile pale yellow, some black intermixed on median face of disc; metasomal terga 2 and 3 with pile bright ferruginous, both terga with traces of black along median, longitudinal line of disc; metasomal tergum 4 with pile pale yellow, some black intermixed medially; metasomal tergum 5 with pale yellow pile on lateral faces, median disc with black pile; metasomal tergum 6 with pile all black; metasomal sterna with a few long black hairs scattered over surface. Forelegs with pile all black; mid- and hind coxae and trochanters with fringes of pale yellow pile ventrally; femora and tibiae with pile black; some yellow on posteroventral margins of femora; corbicular fringes black, apices of some hairs with ferruginous tinge.

WORKERS:

As in queens but having pile patterns less distinct; face with less yellow pile, yellow restricted to area below antennal bases where it is intermixed with black; anterior face of scutum with a few black hairs intermixed; corbicular fringes with pile much more ferruginous.

MALES:

Ocelli situated at supraorbital line; malar spaces $1\frac{1}{3}$ times as long as apical widths; flagellar segments 1 and 3 subequal, segment 2, two-thirds as long as 1 or 3; tegulae brownish-hyaline; wings dusky with abundant, close set pile apically; nervures pale brown to dark brown basally.

Vertex with long, yellow pile and abundant, long, black pile about periphery; face with pale yellow pile between and below antennal bases and covering most of clypeus; black pile along inner orbital margins and laterad from antennal bases; area above antennal bases with admixture of long, black, and pale yellow pile giving surface a clouded appearance. Thoracic dorsum with indistinct interalar band; interalar band with black most evident medially, and at extreme lateral margins; scutum anterior to tegulae with pile long and yellow; scutellum with long, pale yellow pile, some black intermixed on antero-medial surface and extending towards posteriomedian margin; mesopleura and metapleura with pile pale yellow, ventral face of metapleura with admixture of black pile; propodeum with admixture of pale yellow and black pile. Metasomal tergum 1 with pile long and pale yellow, admixture of shorter black pile along median portion of disc; metasomal terga 2 and 3 with pile ferruginous, some black pile intermixed along median line; metasomal tergum 4 with pale, orange-yellow pile over lateral one-third of disc, median one-third with shorter black pile; metasomal tergum 5 much as tergum 4 but with greater amount of black pile; terga 6 and 7 with pile black; metasomal sterna with long, pale yellow, apical fringes. Forefemora and tibiae with pile predominantly black, except for posteroventral fringes of light colored pile on femora; midfemora with black pile dorsally and pale yellow pile ventrally; midtibiae with pile black, some long, yellow to yellow-ferruginous pile along posteroventral margins; posterior femora with pile a pale yellow, some shorter black pile intermixed along anterior and posterior margins.

Male genitalia: (figure 26). Apices of penis valves sharply bulbous; eighth ventral plate resembling *melanopygus* but with triangular hair pattern apically; seventh ventral plate as in *melanopygus* but with apex more uniformly rounded and a denser hair coverage.

VARIATION:

The pile of the face is typically yellow below the antennal bases and black above, but a number of specimens throughout the species range have abundant yellow above the antennal bases while others have the pile below the bases predominantly black. Specimens from the northern part of the range usually have a weak notch of black pile on the anteriomedian face of the scutellum; this notch is less obvious, or absent, in southern material. Black pile on the mesopleura varies randomly through the range; in some, the lower half of the mesopleura and the entire metapleura are covered with black; in others, pile of the pleura is exclusively yellow. All intergrades between those two extremes have been seen. The ferruginous pile on terga 2 and 3 is intense in most of the material from northern British Columbia and Alaska, but this pile tends to be more orange-ferruginous in Washington and Oregon representatives of the species. In a number of specimens the color of the pile on these two tergites is faded considerably, so that only traces of orange-ferruginous pile are present, and in others the pile on both tergites could be better described as light orange-yellow. Throughout the greater part of its range typical members of the species have metasomal tergum 4 and the lateral one-third of metasomal tergum 5 covered with yellow

pile. There are exceptions to this even in the topotypical region where metasomal tergum 4 has an admixture of black and yellow pile over the median face of the segment and metasomal tergum 5 is predominantly or exclusively black.

DISTRIBUTION:

The species is common throughout Alaska and northern British Columbia. It is sparsely distributed at the higher elevations along the Cascades as far south as Three Sisters, Oregon, but is much more common along the Rocky Mountains and subsidiary chains in the eastern part of western America. (Map 16).

ALASKA:

Mt. McKinley Nat. Forest, 4,000'; Naknek Lake; Nome; Nuni-vak Is.; Pt. Barrow; Savonoski; St. Paul Is.; Pribiloffs.

BRITISH COLUMBIA:

Barkerville, 6,000'; Kamloops; Kaslo; Mt. Cheam; Revelstoke; Vanderhoof; Walhachin.

WASHINGTON:

Mt. Baker Lodge, Mt. Baker.

OREGON:

Aneroid Lake, Blue Mts., 7,500'; Anthony-Dutch Flat Trail, Blue Mts., 7,100' to 7,850'; Cornucopia, 6,200' to 7,250'; Fish Lake, Steens Mts., 7,000'; Three Sisters; Wallowa Lake Trail, 6,300' to 7,000'; Wild Horse Canyon, Steens Mts. 4,270' to 5,000'.

IDAHO:

Stanley, 6,200'.

FLIGHT RECORDS:

Queens have been taken from June 4 to September 17; workers from June 14 to September 28; and males from July 3 to September 28.

The type of *sylvicola* should be in the British Museum of Natural History but has not yet been located; that of *gelidus* is in the Academy of Natural Sciences of Philadelphia; and that of var. *scullenii* is in the collections of the Illinois Natural History Survey.



Map 16. Map showing the distribution of *melanopygus* and *sylvicola*.

Bombus melanopygus Nylander

Bombus melanopyge Nylander, 1848. Notiser Sällskapet Fauna Fenn. Förhandl. 1:236.

Bombus lacustris Cresson, 1863. Ent. Soc. Philadelphia, Proc. 2:103.

Bremus melanopygus var. *washingtonensis* Frison, 1926. American Ent. Soc. Trans. 52:138.

This species is found in greatest abundance along the coast and in coastal valleys of Oregon, Washington, and British Columbia. It barely reaches into northern California, which appears to be its southern limit, and is sparsely distributed in western Washington, Idaho, and northern Rocky Mountain states. In British Columbia and Alaska, *melanopygus* is one of the most common bumble bees, distributed throughout these areas from sea level to 8,000'.

B. melanopygus can be distinguished from *syivicola* Kirby in having a strong admixture of black pile on the anterior portion of the scutum, and in having abundant black pile on vertex and face. It is difficult, and at times impossible, to separate *melanopygus* from the color variants of *syivicola* having pile on the anterior portion of the scutum intermixed with black. The dispensation of such color variants of *syivicola* is discussed more fully under that species. Males of the two species are readily separable in that apices of the penis valves of *melanopygus* are weakly pointed while in *syivicola* they are sharply bulbous.

Frison designated the variety *melanopygus* var. *washingtonensis* for specimens having the rust pile of metasomal terga 2 and 3 faded to an orange-yellow or pale yellow. The variety was based on specimens taken from Mount Rainier, Washington and Toll Gate, Blue Mountains, Oregon, but identical phenotypes are found to some extent throughout the range of the species. Most material that could be classified with this variety has been taken from the higher elevations of the Pacific Northwest but several have been recorded from lower elevations. It would appear in lowland areas at least, that var. *washingtonensis* represents those specimens of prolonged life in which a fading of the pile has occurred. This, plus the fact that typical and faded individuals are endemic to all regions of the range, indicates the varietal name does not warrant formal nomenclatorial status.

QUEENS:

Ocelli situated slightly below supraorbital line; malar spaces as long as apical widths; third flagellar segment $\frac{3}{4}$ as long as first; second flagellar segment $\frac{3}{4}$ as long as third; tegulae deep brown; wings brown to fuscous; nervures brown to black basally.

Vertex with an admixture of black and yellow pile, black usually predominating; face with admixture of yellow and black pile, yellow concentrated in an area immediately below and above antennal bases; area lateral from antennal bases to inner orbital margins with pile mostly black. Scutum with strong admixture of yellow and black pile giving surface a clouded appearance, equal

quantities of black and yellow on anterior portion of scutum; scutellum with pile long, dense, and light yellow, a few black hairs intermixed on antero-median discal area; mesopleura with admixture of black and yellow pile on dorsoanterior surface, yellow predominating; remainder of mesopleura with pile yellow; metapleura with upper surfaces having abundant yellow pile, pile on lower surfaces black; propodeum with some yellow pile at extreme latero-dorsal margins, pile below, black. Metasomal tergum 1 with long, dense, yellow pile laterally, median discal area with sparse, short, black pile; metasomal terga 2 and 3 with pile a rust to pale orange or even light yellow; metasomal tergum 4 with pile usually black, but in some specimens it may be completely yellow, always extreme apical and lateral yellow fringes to this tergum; terga 5 and 6 with pile black, lateral fringes of light pile to these 2 terga when yellow predominates on tergum 4; metasomal sterna with apical fringes of long, light pile. Forelegs with pile all black; midlegs with pile black, except for fringes of light pile on trochanters and weak fringes on femora; posterior coxae and trochanters with pile black except for long, light, ventroposterior fringes; hind femora with pile black on upper surfaces, long fringes of light pile on ventro-posterior margins; corbicular fringes variable, with pile ranging from mostly black, to predominantly ferruginous, anterior margins of corbicula with fringes always black or at least much darker than posterior fringes.

WORKERS:

As in the queen, but having malar spaces 1 to $1\frac{1}{2}$ times as long as apical widths. Variation in pile color on the head and thorax reaches greater extremes in the worker than in the queen; the pile of the head is completely black in some but in others yellow predominates; for the most part the head pile is predominantly black. In a number of specimens the black pile of the interalar band infringes on the scutellum with the medioanterior portion of the disc having abundant black pile.

MALES:

Ocelli situated at supraorbital line; compound eyes small; malar spaces $1\frac{1}{2}$ to $1\frac{1}{2}$ times as long as apical widths; flagellum long, flagellar segments 1 and 3 subequal; segment 2, two-thirds as long as 1 or 3; tegulae brown; wings light brown to fuscous; nervures light brown to dark brown basally.

Vertex with admixture of yellow and black pile, yellow usually predominating but some specimens will have equal quantities of yellow and black; face with pile mainly yellow below antennal bases and over clypeus, strong admixture of yellow immediately above antennal bases; area from lateral margins of antennal bases to inner orbital margins with pile black. Thoracic dorsum with strong admixture of black and yellow pile; scutum anterior to tegulae with yellow and black pile in equal quantities; scutellum with pile long, dense, and yellow, about lateral margins, weak admixture of black pile on anteriomedian portion of disc; mesopleura with pile primarily yellow, a few black hairs intermixed below lateral lobes of pronotum and immediately above coxal bases; metapleura with pile light, a few dark hairs on ventral surfaces; propodeum with abundant light pile on laterodorsal margins, lower faces with pile black.

Metasomal tergum 1 with long, dense, yellow pile over lateral one-third of disc; median portion of disc with shorter black hairs; metasomal terga 2 and 3 with pile rusty-ferruginous (rust often faded to light orange and in some, even to orange-yellow); metasomal tergum 4 with pile variable colored, tergum always with some yellow pile laterally and apically; in some, the entire tergum is covered with yellow, while in others black predominates and only lateral extremities are yellow; metasomal tergum 5 with some yellow pile on lateral and apicolateral margins, median portion of disc with erect, black pile; terga 6 and

7 with pile all black; metasomal sterna with long, light, apical fasciae. Femora of all legs with posteroventral fringes of light pile, upper surfaces with dark pile; tibiae of fore- and midlegs with pile all dark; posterior tibiae with long fringes of pile on anterior and posterior margins, pile varying from all light in some, to all black in others. All intergrades between these two extremes have been examined.

Male genitalia: (figure 27). This species closely resembles *B. sylvicola*. It can be readily distinguished from that species since the apices of the penis valves are weakly pointed, while in *sylvicola* these apices are sharply bulbous (figure 26). There are certain constant differences in apical portions of the gonocoxites and the apices of the gonostyli. The hair pattern on the eighth ventral plate is continuous over the apical half, while in *sylvicola* the pilosity is restricted to a triangular apical pattern.

VARIATION:

Both sexes of this species undergo considerable variation in color patterns of the pile. In the females pile of the face and vertex may vary from all black to mostly yellow. The black pile on the mesopleura may be restricted to regions about the lateral lobes of the pronotum or may be intermixed with yellow halfway to the coxal bases. Yellow pile on fourth metasomal tergum may be present only as lateral and apical fringes (typical) or may completely cover the tergum. Specimens exhibiting the latter pattern have varying amounts of yellow on the apical margins of terga 5 and 6. The pile of corbicular fringes ranges from all black to a preponderance of ferruginous. This variation is more marked in workers than in queens.

Males exhibit color pattern variations much as in females. A few specimens have the pile of the face and vertex almost all yellow but the majority have some evidence of black intermixed. The fourth metasomal tergum may be completely covered with yellow pile or may have black pile over much of the discal area. Those specimens having yellow pile on the fourth tergum also have yellow pile predominating on the fifth. It is noteworthy that in these extreme yellow forms the apex pile of tergum 7 is tinged with ferruginous. Pile on the posterior tibiae of males varies much as in females, grading from totally black to all ferruginous. The typical rusty pile of terga 2 and 3 is often faded to orange, or yellow-orange, presumably due to prolonged exposure to the environment.

DISTRIBUTION: (Map 16).

BRITISH COLUMBIA:

Agassiz; Barkerville; Buccaneer Bay; Celista; Clinton; Crows Nest; Departure Bay, V. I.; Golden; Jesmond; Kamloops; Kaslo; Lake Cowichan, V. I.; Lillooet; Milner; Nanaimo, V. I.; Nicola; Penticton; Prince Rupert; Radium; Revelstoke; Salmon Arm; Sidney, V. I.; Skidgate; Stanley Park; Straiton; Vancouver; Vernon; Victoria, V. I.

WASHINGTON:

Aberdeen; Chace Lake; Echo Lake; Ellensburg; Elma; Everett; Forks, Clallam Co.; Friday Harbor; Gig Harbor; Lake Quinalt; Leska; Manchester; Mercer Island; Mt. Baker; Mt. Rainier; Paradise Valley; Pullman; Rainier, over 5,000'; Seattle; Snoqualmie Falls; Sumner; Yakima.

OREGON:

Alsea Mt.; Anthony Lake, 7,100'; Astoria; Blue Mts., 7,500'; Breitenbush, Marion Co.; Canyonville, Douglas Co.; Clatskanie; Corvallis; Crater Lake, 7,100'; Detroit; Elk Lake, Deschutes Co., 5,600'; Eugene; Gold Beach; Grants Pass; Hood River; Kellogg; Klamath Lake; Marion; Marys Peak, 1,750'; McKenzie Pass; Meadows; Mt. Hood, 6,000' to 7,000'; Mt. Jefferson; Monroe; Myrtle Creek, Douglas Co.; Newport; Obsidian Trail, Lane Co.; Olney; Parkdale; Portland; Prospect; Summit, 650'; Suttle Lake, 3,435'; Talent; Three Sisters, 4,650'; Tillamook; Vernonia; Waldport; Willow Prairie, 4,500'; Yachats.

CALIFORNIA:

Meadow Valley, Plumas Co., 6,000' to 7,000'; Trinity Co.

IDAHO:

Coolin, Priest Lake; Elk Summit, Idaho Co.; Moscow; St. Joseph National Forest.

FLIGHT RECORDS:

Queens have been taken from April 13 to August 13; workers from June 18 to September 15; and males from June 23 to September 5.

The location of the type of *melanopygus* is unknown. The type of *lucustris* is in the Academy of Natural Sciences of Philadelphia and that of var. *washingtonensis* is in the collection of the Illinois Natural History Survey.

Bombus huntii Greene

Bombus huntii Greene, 1860. Lyc. Nat. Hist. N. Y., Ann., 7:172.

Bombus rufosuffusus Cockerell, 1905. Ent. News 16:271.

The species is found throughout the Transition Zone east of the Cascades in the Pacific Northwest, but extends well into the Upper Sonoran Zone on one side and the Canadian Zone on the other. It is one of the most common species in Utah and Nevada and is rather abundant along eastern slopes of the Cascades and Sierras as far south as Inyo County in California. Three specimens have been examined from Fernie and Crows Nest, British Columbia, and this is

believed the northern extent of its range in western America. Franklin's (1913) records from Vancouver Island and Fort McLeod are far removed from its known range and extensive collecting in both of these areas has failed to turn up additional representatives of this species.

Huntii is very closely related to *ternarius* and *bifarius* and more distantly related to *vosnesenskii*. It can be separated from *ternarius* by the yellow pile of face and vertex, completely yellow scutellum and slightly longer malar spaces; from *bifarius* by yellow pile on the face and vertex, black corbicular fringes, and completely yellow scutellum; and from *vosnesenskii* by striking differences in coloration.

Cockerell's *B. rufosuffusus* was reduced to varietal rank by Franklin in 1913, as the differences between it and *huntii* were restricted to a lighter pile color, particularly on the second and third terga. Color intensity differences have been recorded in several species having orange or ferruginous pile on the metasoma and in most it has been shown that fading of the red and yellow pile proceeds rapidly after adult emergence. Cockerell's original description records other factors tending to verify the age of his type specimen for he states that considerable pile has been lost from the thoracic dorsum, pile on the second and third terga show traces of ferruginous laterally, and the light pile of the thorax is pale yellow. Several specimens from Utah and Oregon show equal, or greater, fading than that recorded by Cockerell, whose name *rufosuffusus* appears to have been applied to an age variant of this species, warranting no formal taxonomic recognition.

QUEENS:

Ocelli situated at supraorbital line; malar spaces as long as apical widths; first flagellar segments one-quarter longer than third; third segment one-quarter longer than second; tegulae brownish-black; wings light brown; nervures brown to dark brown.

Vertex with pile yellow, a few dark hairs laterally; face with pile dense and yellow; scutum with a broad, black, interalar band, pile anterior to band dense and yellow; scutellum with pile very long, dense and yellow; mesopleura with abundant yellow pile over the upper two-thirds, yellow pile not extending to coxal bases; pile on ventral portion of mesopleura, on metapleura and propodeum black or strongly mixed with black. Metasomal terga 1 and 4 with pile yellow, or faded to whitish-yellow; metasomal terga 2 and 3 with pile orange-red or faded to a pale orange-yellow, all intergrades have been recorded; metasomal terga 5 and 6 with pile all black; metasomal sterna with weak apical fringes of long pale pile; pile of legs all black; corbicular fringes black.

WORKERS:

Much as in the queen, but having a few dark hairs intermixed along the inner orbital margins and along frontoclypeal margin; mesopleura with yellow pile extending down to coxal bases; very little or no black pile on posterior portions of mesopleura, metapleura, or propodeum.

MALES:

Ocelli small, situated at supraorbital line; malar spaces $1\frac{1}{2}$ to $1\frac{3}{4}$ as long as apical widths; tegulae brownish-hyaline; wings tawny to dusky-hyaline, nervures light brown.

Vertex with pile long, dense and yellow; face with pile yellow, a few dark hairs along inner orbital margins; area behind the eyes with fringes of long, black pile. Thoracic dorsum with a distinct black interalar band; anterior face of thorax and scutellum with pile long, dense, and light yellow; mesopleura, metapleura, and propodeum with pile yellow. Metasomal terga 1 and 4 with pile yellow; metasomal terga 2 and 3 with pile orange-red or faded to light orange; metasomal tergum 5 with some yellow pile laterally but black pile predominating over median face of disc; terga 6 and 7 with pile all black; metasomal sterna with sparse, long, light pile. Femora of all legs with abundant, long, yellow to white pile ventrally; tibiae of fore- and midlegs with pile black; posterior tibiae with numerous, long, golden hairs forming anterior and posterior fringes, a number of shorter, coarser, black hairs on upper surfaces.

Male genitalia: (figure 28). Capsule with apices of gonostyli having U-shaped emargination, median process sharply defined; seventh ventral plate more quadrate than semilunar; eighth ventral plate narrowed apically. weak apical emargination, and with dense pile coverage over apical three-eighths of plate, pile distributed uniformly to lateral margins.

DISTRIBUTION: (Map 17).

BRITISH COLUMBIA:

Crows Nest; Fernie.

WASHINGTON:

Almota; Azwell; Emerald; Grand Coulee; Hooper; Medical Lake; Pullman; Soap Lake; Wawawai; Wenatchee; Yakima.

OREGON:

Andrews; Antelope; Baker; Bend; Bly, 4,500'; Burns; Catlo Valley; Corvallis; Elgin; Fish Lake, Wallowa Mts., 5,400'; French Glen; Hereford; Huntington; Klamath Falls; La Grande; Lakeview, 4,400'; Langdon Lake; North Powder; Ontario; Prairie City; Richland; Sparks Lake, Deschutes Co.; Sparta; Steens Mountains; Union.*

CALIFORNIA:

Inyo County: Owens Valley.

Lassen County: Hallelujah Junction.

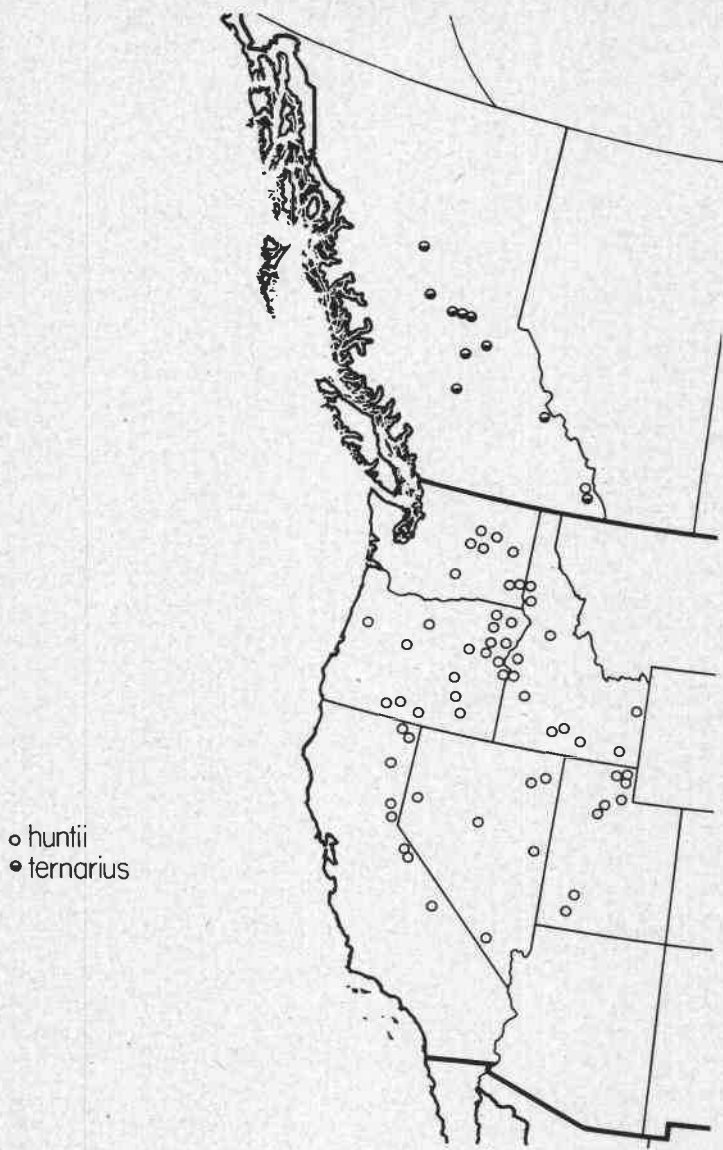
Modoc County: Canby; Cedarville; Lake City; Modoc; New Pine Creek.

Mono County: Blanco's Corral, White Mts., 10,000'; Mammoth; Topaz Lake.

Nevada County: Boca; Hobart Mills.

Sierra County: Calpine; Sierraville; Sonora Pass, 9,000' to 10,000'.

* A single specimen has been recorded from the coastal valleys west of the Cascades, at Corvallis, Oregon. This specimen was collected in 1900 and the label is somewhat obscured. It seems reasonable to assume an error in labeling.



Map 17. Map showing the distribution of *huntii* and *ternarius*.

IDAHO:

Ashton; Boise; Clover, Twin Falls County; Dixie; Downey; Fruitland; Lava Hot Springs; Lenore; Lewiston; Malta, Cassia County; Midvale, Washington County; Moscow; Parma; Shoshone Falls, Twin Falls County;

UTAH:

Beaver; Blacksmith Fork Canyon; Collinston; Echo, Summit Co.; Green Canyon, nr. Logan; Logan; Newton; Petersboro; Providence; Salt Lake City; Smithfield; Vernal; Wellsville Mts.; S. Willow Canyon, Tooele Co.; Zion Canyon.

NEVADA:

Austin, 6,400'; Charleston Mts., 7,500'; Clark Co.; 27 mi. E. Elko, 5,200'; Ely, 6,400'; Kingston Forest Camp, SE Austin, 7,200'; Pyramid Lake, Washoe Co.; Wells, 5,400'.

FLIGHT RECORDS:

Queens have been collected from April 12 to September 28; workers from June 6 to September 12; and males from July 3 to October 1.

The type of *huntii* is assumed lost; that of *rufosuffusus* is in the collections of the United States National Museum.

Bombus bifarius Cresson

This highly variable species has undoubtedly caused more consternation to bumble bee taxonomists than any other species in western North America. It is the most common western species, found from Alaska to California and southern Utah and has been taken from sea level to 10,500'.

Several varietal names and synonyms designate one or more of the color forms found throughout the range. These varietal designates plus the confusion arising from misidentification of this species have obscured infra- and interspecific relationships of *bifarius* and its close relatives. In addition to the typical form of the species, Burks (1952) has recognized three distinct varieties; var. *vancouverensis* Cresson, var. *kenoyeri* Cockerell, and var. *nearcticus* Handlirsch. Within localized areas represented by limited collections, 3 of these 4 color forms can readily be separated, and from such series Buckell (1951) among others has concluded "it is remarkable how these 3 color forms of one species occur so constantly in separate geographical areas with so little intermingling." However, in spite of this statement, he recorded all 3 forms from the same locality and taken at the same time in rather widespread areas throughout the province. For example, all 3 forms occur at Victoria and Alberni on Vancouver Is-

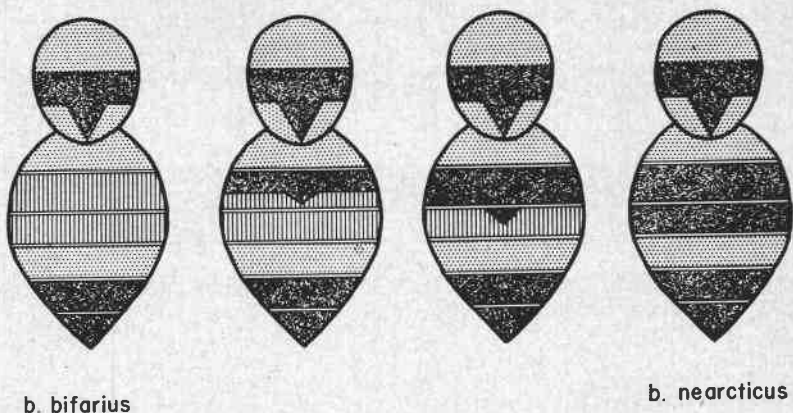


Figure 5. Illustrations showing the intergradation of color patterns between *b. bifarius* and *b. nearcticus*. In these illustrations the bee colors are indicated in the following way: black is equivalent to black; stippled areas indicate yellow; and vertical lines are used for red-orange sections.

land, at Vernon and Kamloops in the central interior, and at Fernie and Golden in the far eastern part of the province.

On the basis of original descriptions, plus material determined as homotypes by Frison, it is felt that of these 4 primary color forms only 2 warrant taxonomic discrimination (figure 5). Within this paper only *bifarius bifarius* and *bifarius nearcticus* are recognized as taxonomically valid. The variety *vancouverensis* is identical with the typical *bifarius* in all respects except in having the bright ferruginous pile of metasomal terga 2 and 3 faded to an orange, yellow-orange or even a pale yellow. Specimens representing this color form have been taken in British Columbia, Oregon, Idaho, and Utah along with typical members of the species. This variety is therefore treated as individual age variants of *bifarius bifarius*.

Cockerell's variety *kenoyeri* represents a form intermediate between *b. bifarius* and *b. nearcticus* showing variation in the amount of ferruginous pile on terga 2 and 3. Some of Cockerell's material determined as *kenoyeri* has black pile predominating on both terga 2 and 3; some have tergum 3 completely covered with ferruginous pile, and others show a preponderance of ferruginous pile on both terga. Specimens having ferruginous pile predominating on the third metasomal tergum, and traces of ferruginous pile on the second have been placed with *b. bifarius*. Those having but small amounts of ferruginous only on the third tergum, are included with *b. nearcticus*.

Similar treatment has been given to material within Morrill's *cooleyi* which also includes intergrades between *b. bifarius* and *b. nearcticus*.

Examination of a cotype of *edwardsii* var. *fuscifrons* Swenk from Colorado reveals that it is conspecific with *bifarius bifarius* as found along the Great Divide.

While only 2 subspecies are recognized within the polymorphic *bifarius*, the geographical distribution of these 2 forms is difficult to account for. Franklin's contention (1913) that the typical *bifarius* is much more numerous in the southern part of the species range seems unfounded. From material at hand, which does not include the Rocky Mountain region, the typical form, although sparingly represented, is by far the most abundant in the northcentral portions of British Columbia. It occurs sporadically in Idaho, Utah, and the Steens Mountains of eastern Oregon. Several specimens from the Sierra Nevada Mountains of Fresno County are perplexing for I have not seen the typical form nor intergrades between it and *nearcticus* from the Cascades of Washington, Oregon and northern California or from the northern Sierra Nevadas. Numerically, *b. bifarius* is most abundant in the northerly latitudes and in higher elevations as far south as New Mexico. In certain portions of the species range the ferruginous form appears to be an ecophenotype associated with the higher elevations but many exceptions to this make such generalization impossible.

The subspecies *b. nearcticus* is by far the most abundant form of this species. It occurs in great numbers throughout eastern Washington, Oregon, and in the mountains of northern California.

This species was redescribed by Franklin (1913) as *edwardsii* Cresson, after he had examined the type material from California, Vancouver Island, and Colorado. The specimens from Vancouver Island were undoubtedly misplaced with this species and are probably *b. nearcticus*. In the same paper Franklin treated the true *edwardsii* under his new species name *fernaldi*.

There are only 2 species which may be confused with *bifarius* in its typical form; these are *huntii* Green and *ternarius* Say. Both *huntii* and *ternarius* resemble *bifarius* closely, but these 2 species have jet black corbicular fringes and the scutellar pile all yellow, while in *bifarius*, corbicular fringes are bright ferruginous and there is a broad V-shaped extension of black pile onto the scutellum.

B. edwardsii and *b. nearcticus* are endemic to northern California and on occasion some difficulty is encountered in separating the females of those two species. However, the bright ferruginous corbicular fringes and pale gray body pile of *b. nearcticus* usually contrast sharply with the black corbicular hairs and lemon yellow pile of *edwardsii*.

Bombus bifarius bifarius Cresson

- Bombus bifarius* Cresson, 1878. Acad. Nat. Sci. Philadelphia, Proc. p. 185.
Bombus vancouverensis Cresson, 1878. Acad. Nat. Sci. Philadelphia, Proc., p. 187.
Bombus cooleyi Morrill, 1903. Canadian Ent. 35:222 (in part).
Bombus edwardsii var. *kenoyeri* Cockerell, 1915. Ann. Mag. Nat. Hist. (8) 16:483 (in part).
Bombus bifarius var. *arctostaphyli* Cockerell, 1930. Ann. Mag. Nat. Hist. (10) 5:405.
Bombus edwardsii var. *fuscifrons* Swenk, 1938. Pan-Pacific Ent. 14:30 (new synonymy).

This subspecies is here characterized as including all specimens having the third metasomal tergum with ferruginous pile predominating, and some ferruginous pile on the second tergum; light pile of the body is a bright yellow.

QUEENS:

Ocelli situated at supraorbital line; malar spaces as long as apical widths; first flagellar segment one-eighth longer than third, one-quarter longer than second; tegulae shiny black; wings very pale brown; nervures deep brown to black.

Vertex with abundant long yellow pile; pile of face long and yellow, abundant black pile along inner orbital margins and along clypeofrontal margin; pile behind eyes all black. Thorax with pile anterior to interalar band, yellow with some black hairs intermixed, not giving a cloudy appearance; interalar band broad, black pile extending posterior to form a distinct V-shaped emargination to the posterior edge of scutellum; scutellum with pile on lateral margins long and yellow; mesopleura with long, yellow pile over upper two-thirds of surface, yellow pile not extending to coxal bases, occasionally a few yellow hairs intermixed on the lower surfaces; posterior margins of mesopleura, metapleura, and propodeum with pile predominantly black.

Metasomal terga 1 and 4 with pile yellow; metasomal terga 2 and 3 with pile bright ferruginous; terga 5 and 6 with pile black, weak fringes of yellow pile along extreme lateral margins of tergum 5; metasomal sterna with long, weak, apical fringes of light pile. Forelegs with pile all black; tibiae and femora of midlegs with pile black, occasional weak fringes of yellow pile on basal portions of middle femora, long fringes of yellow pile on midtrochanters; posterior femora with pile mostly black except for fringes of long yellow pile along posteroventral margins; coxae and trochanters of hind legs with abundant yellow pile; corbicular fringes strongly ferruginous.

WORKERS:

Much as the queen but having a stronger admixture of black pile on the vertex and on the face above antennal bases. For the most part workers lack yellow fringes to the median trochanters and femora.

MALES:

Ocelli located at supraorbital line; malar spaces $1\frac{1}{4}$ times as long as apical widths; flagellar segment 3 slightly longer than 1; segment 1, one-third longer than 2; tegulae brownish-black hyaline; wings pale brown; nervures light brown.

Vertex with abundant, long, yellow pile, some black pile about periphery; face with abundant, erect, yellow pile below antennal bases, weak admixture of

black pile above antennal bases; pile along innerorbital margins black; area behind the eyes with an admixture of black and yellow pile and black forming weak fringes immediately posterior to eyes with light pile increasing in density posteriorly and ventrally. Thoracic dorsum with broad black interalar band forming V-shaped margin to posterior edge of scutellum; pile anterior to band long, dense, and yellow with very few black hairs intermixed; scutellum with pile on lateral margins yellow; mesopleura with pile yellow to coxal bases, a few dark hairs intermixed on lower faces of metapleura and propodeum.

Metasomal terga 1 and 4 with pile yellow; metasomal terga 2 and 3 with pile orange to ferruginous; tergum 5 with black pile predominating medially, fringes of yellow pile along the lateral and apicolateral margins; tergum 6 with pile all black; tergum 7 with admixture of black and light ferruginous pile, with ferruginous pile longest and most dense at extreme apex; metasomal sterna with abundant, erect, light pile. Forelegs with admixture of black and whitish pile on femora, black and light ferruginous on tibiae, and exclusively light ferruginous on tarsi; midlegs with long, dense, white fringes on ventral faces of femora; tibiae with an admixture of dark pile above and longer, denser, light ferruginous pile on ventral and posterior margins; hind femora with pile preponderantly light, a few black hairs on anterior margins; posterior tibiae with abundance of long, light ferruginous pile.

Male genitalia: (figure 29). Capsule closely resembles those of *ternarius* and *huntii*, but has more extensive serration along lateral margins of the penis valves; apices of the gonostyli in *bifarius* are much more rounded and show slight convolution; the eighth ventral plates resemble *ternarius* closely but are more deeply emarginate apically.

VARIATION:

Some variation exists in the amount of yellow pile on the female's thoracic pleura. In most queens and workers, the yellow pile does not extend to the coxal bases, but a few have complete coverage. The eighth ventral plate shows variation closely correlated with color pattern. Typical forms have a deeply emarginate apex with the emargination becoming shallower with the decrease in ferruginous pile of terga 2 and 3, eventually ending as a quadrate apex in *b. nearcticus*.

DISTRIBUTION: (Map 18).

BRITISH COLUMBIA:

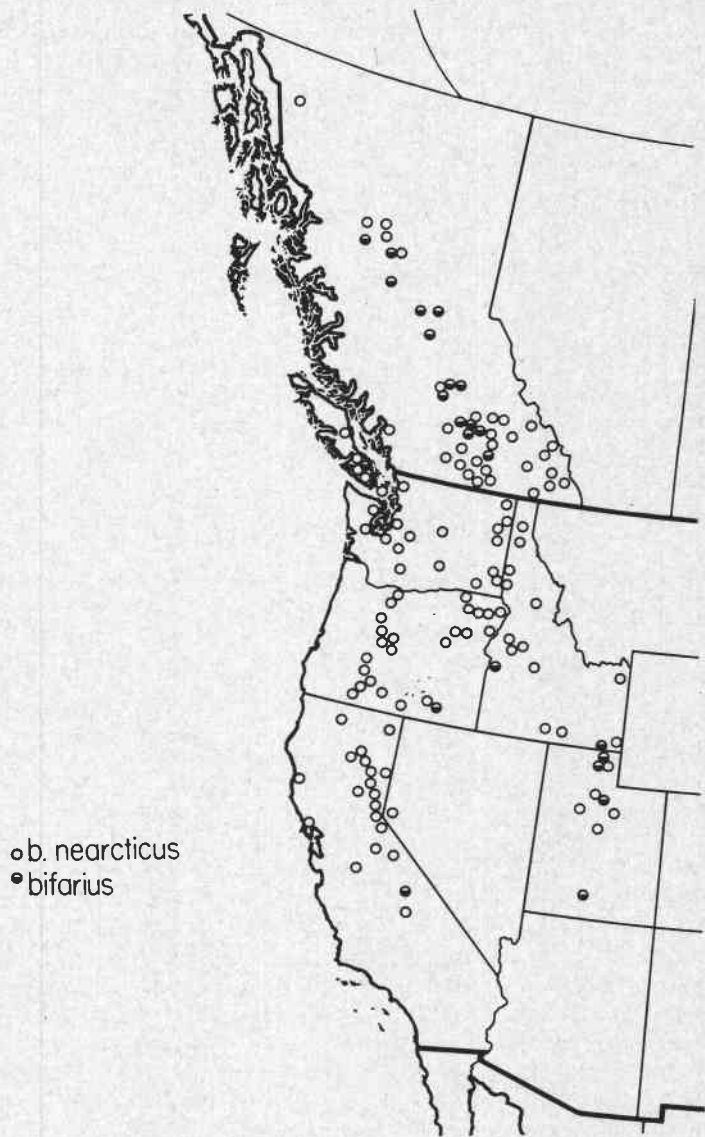
Burns Lake; Chilcotin; Clinton; Crows Nest; Fraser Lake; Jesmond; Hat Creek; Kamloops; Kitwanga; Lac du Bois; Kamloops; Lillooet; Minnie Lake; Nanaimo; Nicola; 100 mile House; Quesnel; Quick; Soda Creek; Vanderhoof; Vancouver; Vernon; Walhachin.

OREGON:

Fish Lake, Steens Mts.; Steens Mts., Harney Co.

CALIFORNIA:

Fresno County: Bubbs Creek Canyon; Bullfrog Lake, 10,600'; Huntington Lake, 7,000'; Paradise Valley, 7,000'; Sixty Lake Basin, 10,000'.



Map 18. Map showing the distribution of *b. bifarius* and *b. nearcticus*.

IDAHO:

Franklin; Parma; Rock Creek Canyon; 15 mi. s. Rock Creek.

UTAH:

American Fork; Bryce Canyon; Green Canyon, Cache Co.; Hark City; Logan; Logan Canyon; Mt. Timpanogos; Nephi; Newton; Providence; Raft River Mts.; Smithfield.

FLIGHT RECORDS:

Queens have been taken from April 28 to June 28; workers from May to August 28; and males from July 10 to August 28.

The types of *bifarius* and *vancouverensis* are in the Academy of Natural Sciences of Philadelphia; those of *cooleyi* are in the collections of the University of Massachusetts and the United States National Museum; and the type of *edwardsii* var. *fuscifrons* is in the collections of the University of Nebraska. The types of the Cockerellian varieties *kenoyeri* and *arctostaphyli* are in the United States National Museum.

Bombus bifarius nearcticus Handlirsch

Bombus nearcticus Handlirsch, 1888. K. K. Naturhist. Hofmus. Ann. 3:243.

Bombus vancouverensis Cresson, 1878. Acad. Nat. Sci. Philadelphia, Proc., p. 187 (in part).

Bombus cooleyi Morrill, 1903. Canadian Ent. 35:222 (in part).

This is by far the most common of the two subspecies in western America. The typical form of *nearcticus* has the light body pile whitish or pale gray, and there are no traces of ferruginous pile on metasomal terga 2 and 3. Included with this subspecies, however, are all specimens having metasomal terga 2 and 3 either all black or having the ferruginous pile restricted to the third metasomal tergum. Those specimens having traces of ferruginous pile on the second metasomal tergum have been included with *b. bifarius*. There is marked intergradation in the color of the light body pile between *bifarius* and *nearcticus*. In *bifarius* the light pile of the body is lemon yellow whereas in *nearcticus* this pile is whitish to pale gray. Intermediate forms having varying amounts of ferruginous pile on the second and third terga, correspondingly show an intergradation in the color intensity of the light body pile. Those having the ferruginous pile restricted to the third tergum have the body pile pale grayish-yellow, while those having traces of ferruginous pile on tergum 2 as well as tergum 3 have the light pile of the body pale yellow.

The species is closest phenotypically to *edwardsii* but females of the two species can be separated by characters cited in the species discussion. Males are more difficult to distinguish, since the V-shaped notch of black pile on the scutellum of *nearcticus* is not nearly so

distinct and the pile on the posterior tibiae of *edwardsii* is often faintly tinged with ferruginous. Genitally, however, the species are readily separable.

QUEENS:

As in *bifarius* but having the light pile of face, vertex, and thorax almost white rather than yellow; light pile of the mesopleura extends halfway to coxal bases; metasomal terga 2 and 3 with pile black; metasomal tergum 5 with little or no yellow pile laterally, light hairs restricted to extreme lateroapical margins; pile of legs mostly black; weak fringes of white pile on posterior surfaces of the femora; corbicular fringes ferruginous.

WORKERS:

As in *bifarius* but having light pile of face vertex, and thorax almost white; coloration of metasoma and legs as in the queens; the light pile of the mesopleura extends two-thirds of the way to coxae; metasomal tergum 5 has but a few light hairs on extreme lateral margins.

MALES:

As in *bifarius* but having the pile of the head and thorax light yellow to whitish-yellow; metasomal tergum 7 with the pile exclusively black; metasomal terga 2 and 3 with pile predominantly black, a weak patch of light yellow pile on the mediobasal area of tergum 2; the apical margin of the eighth ventral plate of the external genitalia is quadrate (figure 29).

VARIATION:

Besides variation cited in the preamble to the subspecies, there are differences in the amount of light pile on the thoracic pleura. In the typical form of *nearcticus* light pile covers only the dorsal half of the mesopleura; however, this light pile may extend to the coxal bases in intermediate color forms. Similar intergradation is noted in the apical margin of the eighth sternite of the external genitalia. The apex in the typical *nearcticus* is quadrate but becomes progressively more deeply emarginate as the amount of ferruginous pile on terga 2 and 3 increases. Pile patterns on the seventh and eighth sternites show no significant variation.

DISTRIBUTION:

BRITISH COLUMBIA:

Adams Lake; Agassiz Mt.; Armstrong; Arrowsmith, V. I.; Atlin; Boston Bar; Buccaneer Bay; Burns Lake; Celista; Clinton; Copper Mt.; Courtenay, V. I.; Cranbrook; Creston; Crows Nest; Departure Bay, V. I.; Duncan, V. I.; Fairview; Fernie; Fitzgerald, V. I.; Ft. Steele; Golden; Goldstream, V. I.; Hazelton; Hedley; Hope Mt.; Invermere; Jordan Meadows, V. I.; Kamloops; Kaslo; Kelowna; Keremeos; Kitwanga; Lillooet; Lytton; Merritt; Minnie Lake; Mt. Arrowsmith, V. I.; McLean; Nanaimo, V. I.; Nelson; Nicola; Okanagan Falls; Okanagan Mission; Oliver; Peachland; Pender Harbour; Penticton; Premier Lake; Quick; Radium; Revelstoke; Royal Oak, V. I.; Saanich, V. I.; Sahtlam, V. I.; Salmon

Arm; Shawnigan, V. I.; Shuswap; Sidney, V. I.; Smithers; Summerland; Vaseux Lake; Vernon; Victoria; Westholme; Yale.

WASHINGTON:

Alder Springs; Almota; Bellingham; Blewitt's Pass; Blue Mts., Camp Lewis; Chelan; Clayton; Cushman Lake; Dartford; Friday Harbor; Grand Mound; Johnson; Long Lake; Mason Co.; Metaline Falls; Mt. Adams, 4,500'; Mt. Rainier, 6,400'; Newport; Orens Island; Ovonda; Paradise Valley; Pierce County; Pullman; Seabeck; Seattle; Shelton; Snoqualmie Pass; Spanaway; Spokane; Swank; Table Rock Mt.; Toppenish; Tucenanon; Union City; Waitsburg; Wawawai.

OREGON:

Aneroid Lake, Blue Mts., 7,500'; Anthony Lake, Blue Mts., 7,100'; Antelope Mt., Harney Co., 6,600'; Ashland, 4,900'; Athena; Austin; Baker; Bend; Bly Mt., Klamath Co.; Breitenbush Lake, 5,500'; Canyon City, 2,500'; Cayuse; Chiloquin; Cornucopia, 7,250'; Crater Lake, 6,000'; Crescent Lake, Klamath Co.; Deschutes County; Devils Lake, Deschutes Co., 5,400'; Diamond Lake, Douglas Co., 5,100'; Douglas Co., 4,100'; Drake Peak, Lake Co., 6,700'; Elgin; Elk Lake, 4,900'; Fish Lake, Wallowa Mts., 5,000', 7,000', 8,500'; Fort Klamath, 4,400'; Frog Camp; Grande Ronde, Union Co.; Granny Camp, Wallowa Co.; Grant County, 6,900', 8,200'; Griffin Creek; Halfway, Baker Co., 4,000'; Horseshoe Lake, Blue Mts.; Imnaha, Wallowa Co.; Island City; Kamela; Kelsey Valley; Douglas, 4,100'; La Grande; Lake of the Woods, Klamath Co.; Lake Ronan; Lakeview; 10 mi. S. Lakeview, 4,400'; Lava Lake, Deschutes Co., 4,800'; Lostine; McKenzie Pass; Meacham, 3,600'; Milton; Mt. Hood, 6,000'; Mt. Hood Loop; Mt. McLoughlin, Klamath Co., 6,000'; Obsidian Trail, Lane Co.; Ochoco Pass, 4,800'; Santiam Pass, Paulina Lake, Deschutes Co.; Prineville, 3,800'; Santiam Pass, 5,000'; Scott Lake; Sparks Lake, Deschutes Co., 5,400'; Sparta, Baker Co.; Steens Mts., 8,000'; Suttle Lake, 3,400'; The Dalles; Three Sisters, 4,600'; Todd Lake; Tumalo Reservoir, Deschutes Co.; Wallowa; Whitney, Baker Co.; Wild Horse Mts.; Willow Prairie, Jackson Co., 4,500'.

CALIFORNIA:

Alpine County: Hope Valley.

Amador County: 2 mi. S.W. Silver Lake.

Butte County: Butte Meadows.

Eldorado County: China Flats; Echo Lake; Fallen Leaf Lake; Pyramid; Wrights Lake.

Lassen County: Blue Lake; Bridge Creek Camp; Hallelujah Jct. ;

Hot Lake; Summit Camp; Susan River Camp; Wendel; Westwood.
 Marin County: Dillon Beach; Point Reyes.
 Merced County: Peregoy Meadows.
 Mendocino County: Fort Bragg.
 Modoc County: Cedar Pass; Hackamore.
 Mono County: June Lake; Leavitt Meadows; Mammoth Lakes;
 Sardine; Sardine Creek, 8,500'; Silver Lake; Tioga Pass, 9,600'.
 Nevada County: Boca; Floriston; Hobart Mills; 7 mi. N. Hobart Mills; Sagehen; Truckee.
 Placer County: Five Lakes; Tahoe; Baxter.
 Plumas County: Bucks Lake; Johnsville; Lake Almanor; Onion Valley; Quincy; Tobin.
 Shasta County: Big Springs; Cinder Cone, Lassen National Park; Kings Creek; Lassen Peak, 8,200'; Manzanita Lake, Lassen National Park.
 Sierra County: Calpine; Gold Lake; Independence Lake; Sierraville; Yuba Pass.
 Siskiyou County: Harris Spring.
 Tehama County: Mineral.
 Tulare County: Mineralking.
 Tuolumne County: Dardanelle; Kennedy Meadows; Lyell Canyon; Pine Crest; Sonora Pass, 9,624'; Strawberry; Tuolumne Meadows.

IDAHO:

Ashton; Camp Howard; Cascade; Deary; Donnelly; Franklin; Fume Meadows; Idaho County; Kootenai County; Lakefork; Lewiston; McCall; Minadoka N. F.; Rogerson, Twin Falls Co.; Moscow; Paris; Paris Canyon; Plummer; Potlach; Lowell, Idaho Co.; Rock Creek; Sandpoint; Slate Creek; Stanley; Starkey; Tamarack; Twin Falls County; Twin Lakes; Valley County; Waitburg Summit; West Twin Mt.

UTAH:

Colton, Utah Co.; Logan; Logan Canyon; Mt. Timpanogos; Nebo; Salt Lake City; S. Willow Canyon, Tooele Co.; Wellsville Mts.

NEVADA:

Glenbrook; Washoe Lake, Washoe Co.

FLIGHT RECORDS:

The flight records correspond closely to those of *bifarius bifarius* except that populations from the higher altitudes emerge later in the spring and begin hibernation earlier in the fall.

The present location of the type of *nearcticus* is unknown.

Bombus ternarius Say

Bombus ternarius Say, 1837. Boston Jour. Nat. Hist. 1:414.

(?) *Bombus ornatus* Smith, 1854. Cat. Hymen. British Mus. V. 2, p. 398.

This species is rather common in the north central plateau area of British Columbia and is recorded from the Rocky Mountains at Crows Nest, Fernie, and Golden. It has not been taken from the southern interior valleys of the province nor from any of the states to the south.

It is a strikingly colored species, particularly on emergence, and bears close resemblance to *bifarius bifarius*. As Buckell (1951) reports, the bright orange-red pile of the second and third metasomal terga begins to fade soon after emergence, eventually appearing as a faded orange-yellow.

B. ternarius resembles, and is most closely related to, *b. bifarius* and *huntii*, but these 3 species can be separated without difficulty. *Ternarius* and *bifarius* have overlapping distributions in the north central area of British Columbia while *huntii* and *ternarius* are markedly allopatric. Queens and workers of *ternarius* differ from *bifarius* in having corbicular fringes all black; the pile of the vertex predominantly black; and the light pile on the mesopleura extending all the way to the coxal bases. Males of these 2 species exhibit greater pile color polymorphism but can be distinguished by differences in antennal structures cited in the key and the species description.

QUEENS:

Ocelli situated at supraorbital line; malar spaces three-quarters as long as apical widths; first flagellar segment slightly longer than third, third flagellar segment one-third longer than second; tegulae shiny black; wings light brown, nervures dark brown to black.

Vertex with abundant yellow pile, an admixture of black pile laterad to ocelli; face with predominance of bright yellow pile immediately about antennal bases; pile along inner orbital margins and along clypeofrontal margin black. Thorax with broad black interalar band, black pile extending posteriorly as a shallow V-shaped emargination on to scutellum; anterior one-third of scutum with pile dense and yellow; scutellum except for V-shaped emargination with pile dense and yellow; thoracic pleura and propodeum with pile all yellow. Metasomal terga 1 and 4 with pile dense and yellow; terga 2 and 3 with pile deep orange (orange often faded to a very pale orange or even yellow); metasomal terga 5 and 6 with pile all black; metasomal sterna with weak apical fringes of light pile. Legs with pile black, fringes of yellow pile on coxae and upper portions of femora on all legs; corbicular fringes black.

WORKERS:

As in queens but having pile of vertex and face mainly black, a few short hairs intermixed in area immediately above antennal bases.

MALES:

Ocelli located at supraorbital line; malar spaces as long as apical widths; antennae strongly crenate beneath; flagellar segment 1 slightly longer than 2;

segment 3, $1\frac{1}{2}$ times longer than 1; tegulae brownish-black; wings and nervures brown.

Vertex with abundant long yellow pile, face with pile long and yellow; inner orbital margins with pile black. Thorax with pile as in queen but with a broader V-shaped emargination of black pile on to scutellum, pile longer and not as dense as that of queen; mesopleura with yellow pile to coxal bases. Metasomal terga 1 and 4 with pile yellow; terga 2 and 3 with pile deep orange to orange-ferruginous; metasomal terga 5 to 7 with pile black; metasomal sterna with sparse, long, light pile. Fore- and midlegs with pile black, except for yellow fringes on coxae and trochanters; posterior femora with abundant long, yellowish pile; posterior tibiae with fringes of light ferruginous pile.

Male genitalia: (figure 30). Closely resembles those of *bifarius* and *huntii*. Penis valves with shallow serrations subapically, apices of gonostyli uniformly concave; seventh ventral plate more semilunar than either *huntii* or *bifarius*.

VARIATION:

The workers show some variation in the amount of yellow pile on face and vertex. For the most part, pile in this region is almost all black but a few specimens resemble *bifarius* more closely in having equal quantities of yellow and black. The intensity of orange pile on terga 2 and 3 in both sexes undergoes considerable variation which is attributable to fading. In newly emerged specimens, pile on these terga is bright orange to orange-ferruginous. All intergrades between orange and pale yellow pile on these terga have been examined, and the amount of wear on the body pile indicates that this fading is directly associated with the length of time the adult has been exposed to normal activity. Such fading is not peculiar to this species for it has been noted in several other species having orange or ferruginous pile on these terga.

DISTRIBUTION: (Map 17).

BRITISH COLUMBIA:

Barkerville; Burns Lake; Chilcotin; Crows Nest; Fernie; Fraser Lake; Golden; Prince George; Quesnel; Smithers; Vanderhoof.

FLIGHT RECORDS:

Queens have been collected from April 28 to June 26; workers from June 25 to August 28; and males from August 12 to 19.

The types of *ternarius* are lost. The synonymy of *ornatus* Smith is based exclusively on his meager description as his types have not been located. It is possible that Smith may have referred to *melanopygus* but it seems more probable that *ternarius* was before him at the time.

Bombus vosnesenskii Radoszkowski

Bombus vosnesenskii Radoszkowski, 1862. Soc. Nat. Moscou Bull. 35:589.
Bombus columbicus Dalla Torre, 1890. Wien. Ent. Ztg. 9:139.

This is one of the most common and distinctive bumble bees in western America and is liable to be confused only with *B. caliginosus* (Frison). Ranges of the two species overlap slightly in coastal Washington, Oregon, and California, with *caliginosus* replacing *vosnesenskii* in these areas. *Vosnesenskii* is very common in the interior valleys and the mountains of western Oregon and California, but their numbers drop sharply east of the Cascades and north of the Columbia River. Only one specimen has been recorded from British Columbia and although the species has been recorded from Idaho, Montana and Colorado, none have been seen from those states or from eastern Washington.

This is a striking species that exhibits remarkably constant color patterns throughout its range. It is virtually identical in morphology and color pattern with *caliginosus* and the two species can be separated with certainty only on the structures of the male genitalia. In *vosnesenskii* the apices of the penis valves are sickle-shaped and pointed, the apices of the gonocoxites are much longer than broad, and the eighth ventral plate has a convex apex. In *caliginosus*, apices of the penis valves are broadly dilated and rounded, apices of the gonocoxites are broader than long, and the eighth ventral plate is truncate apically. Malar spaces of *vosnesenskii* are usually shorter than those of *caliginosus* and the first flagellar segment is shorter than the third (subequal in *caliginosus*) but without genital examination, separation can never be made with certainty.

Females of these two species are very difficult, if not impossible, to separate. The malar spaces of *vosnesenskii* range from three-quarters, to as long as the apical widths, the first and third flagellar segments are subequal and the pile on apical and lateral margins of metasomal sterna 4 and 5 is all black. In *caliginosus* malar spaces range from as long as, to $1\frac{3}{4}$ as long as the apical widths; the third flagellar segment is three-quarters as long as the first; and pile on the apical and lateral margins of sterna 4 and 5 is intermixed with white or yellow. These characters can be employed to successfully separate at least 50% of the females of both species but the remaining specimens may exhibit an intermediate condition in one or all of these features. Thus, it has been necessary to base the distribution of *caliginosus* on males, and those females exhibiting all three previously listed characters. (For additional comments see preamble to *caliginosus*.)

QUEENS:

Ocelli located at supraorbital line; malar spaces three-quarters as long as apical widths; first and third flagellar segments subequal; second flagellar segment two-thirds as long as third; tegulae black; wings deep violaceous; nervures black to violaceous.

Vertex with pile long, dense, and yellow, a few black hairs laterally; face with abundant, long, dense, yellow pile in area above clypeus and above antennal bases, a few black hairs along inner orbital margins; area behind compound eyes with pile all black. Mesoscutum with long, dense, yellow pile over portion anterior to tegulae; scutellum with pile black; mesopleura, metapleura, and propodeum with pile all black. Metasomal terga 1 to 3 with pile black; metasomal tergum 4 with pile yellow; metasomal terga 5 and 6 with pile black; metasomal sterna with pile all black. Legs with pile black; corbicular fringes black.

WORKERS:

Much as in the queens but having the light pile whitish-yellow, rather than the bright yellow of the queen, scutum with black and yellow pile not sharply delineated, a slight admixture of yellow and black pile where the two meet.

MALES:

Ocelli located at supraorbital line; malar spaces approximately $1\frac{1}{4}$ times as long as apical widths (ranging from $1\frac{1}{8}$ to $1\frac{3}{8}$); first flagellar segment two-thirds as long as third, second flagellar segment three-quarters as long as first; tegulae brownish-black; wings brown; nervures dark brown.

Vertex with pile long, dense and yellow, a few black hairs at lateral margins of vertex; face with pile long, dense, and yellow in area about antennal bases and over basal portion of clypeus, a few black hairs along inner orbital margins; area immediately behind eyes with pile black. Mesoscutum with anterior portion having abundant, long, yellow pile, yellow and black pile not sharply delimited as in queens; scutellum with pile black; mesopleura with pile predominantly black, occasionally some yellow pile just below lateral lobes of pronotum and along anterior and anterodorsal portions of mesopleura, often anterior portion of mesopleura may have admixture of black and yellow pile from wing bases to coxal bases; metapleura and propodeum with pile all black. Metasomal terga 1 to 3 with pile all black; metasomal tergum 4 with pile all yellow; metasomal tergum 5 with lateral portions having abundant yellow pile, some yellow hairs intermixed on lateroapical margins, disc with black pile; metasomal terga 6 and 7 with pile all black; metasomal sterna with pile black except for apical fringes of yellowish pile on terga 3, 4, and 5; sterna 5 and 6 with some yellow pile laterally. Legs with pile all black except for posterior-ventral fringes of light pile to coxae and trochanters of fore- and midlegs; posterior tibiae with fringes black, a number of specimens have the extreme apices of the longer hairs on the posterior fringes tinged with ferruginous, but with black predominating.

Male genitalia: (figure 31). Similar to *B. caliginosus* except with apices of penis valves sickle-shaped, sharply pointed gonostyli approximately twice as long as broad, and eighth ventral plate with apex truncate.

VARIATION:

The species does not exhibit a great deal of variation; however, a few of the characters that serve to separate this species from *caliginosus* vary sufficiently to make species discrimination difficult (see

preamble). Face pile in *vosnesenskii* is almost always yellow, but the admixture of black along the inner orbital margins will vary in quantity. The color pattern on the abdominal terga is very constant, deviating slightly in some specimens where yellow pile may be noted at the extreme apex of metasomal tergum 3, and on the lateral margins of metasomal tergum 5. The pile of the mesopleura of the males is always predominantly black, but the amount of yellow pile along the anterior margins is subject to some variation. A few specimens have only traces of yellow pile below the lateral lobes of the pronotum, while others have abundant yellow pile along the anterior portion of the mesopleura extending from the lobes of the pronotum to the coxal bases. The yellow and the black pile on the mesoscutum are usually sharply delimited, but in some the pile pattern on this structure resembles that of *caliginosus* since an intermixture of yellow and black occurs well back on the median portion of the disc. A few specimens have been noted with traces of light pile over the mesoscutum, mesopleura, and scutellum. Metasomal tergum 3 may have the apical margin fringed with yellow but in most specimens pile of this tergum is all black.

DISTRIBUTION:

The species abounds in coastal valleys and mountains of Oregon and California. It is uncommon along the coast of southwestern Washington, Oregon, and northern California, where it is apparently replaced by *caliginosus*, but in the Bay Area of California and the Puget Sound Area of Washington it is the most common of the two species. Numerically, *vosnesenskii* drops off sharply north of the Columbia River and east of the Cascade-Sierra mountains. The absence of any representatives of this species in collections from eastern Washington, Idaho, or Utah, leads to the belief that Frison's records from Montana and Colorado may be in error. Records of one specimen from British Columbia and several from western Nevada appear to be from the northern and eastern limits of its range. The species is probably the most common in western Oregon and northern California and is found in equal numbers in coastal valleys, and in the mountains to 8,000' (Map 13).

BRITISH COLUMBIA:

Osoyoos.

WASHINGTON:

Ft. Lewis; Harstine Island, Mason Co.; Long Lake; Seattle; Shelton; Stabler; Tacoma.

OREGON:

Alsea Mt., Benton Co.; Ashland, 5,400' to 5,900'; Bend; Blooming; Bly; Breitenbush, Marion County, 2,000'; Brookings; Butte Falls, 1,850'; Canyonville, Douglas Co.; Cascadia; Corvallis; Crater Lake Park, 9,500'; Diamond Lake, 5,182'; Elk Creek; Elk Lake, Deschutes Co., 4,800'; Estacada, 2,500'; Eugene; Fish Lake, Steens Mts., 7,000'; Fort Klamath; Gold Beach; Gold Hill; Grants Pass; Hood River; Jackson Co., 4,500'; Josephine Co.; Kelsey Valley, Douglas Co., 4,900' Klamath Lake, 4,200'; Lava Lake, Deschutes Co., 5,445'; Lake of the Woods, Klamath Co., 4,950'; Lakeview; Linn Co.; Marys Peak; McKenzie Pass, 3,025'; Medford; Monroe; Mosier; Mt. Hood, 6,000'; Mt. McLaughlin, 5,000' to 6,000'; Nashville, Lincoln Co.; Oak Ridge, 1,125'; Oswego; Parkdale; Paulina Lake; Pittsburgh, Columbia Co., 2,000'; Portland; Quartz Mt., 5,504'; Rainier; Roseburg; Salem; Scotts Lake; Sparks Lake, Deschutes Co., 5,428'; St. Helens; Summit, Benton Co.; Suttle Lake; Swim, 3,500' to 4,500'; The Dalles; Three Sisters; Triangle Lake; Vernonia; Willow Prairie, Jackson Co., 4,500'.

CALIFORNIA:

Alameda County: Berkeley; Livermore; Oakland; Tesla; Tilden Park.

Alpine County: Hope Valley.

Butte County: Brush Creek; Hurleton; Pentz.

Contra Costa County: Antioch; Martinez; Orinda; Richmond.

Eldorado County: Fallen Leaf; Placerville; Strawberry Valley.

Fresno County: Double Meadows, 8,000'; Florence Lake, 7,500'; Huntington Lake; Millwood; Paroche Creek; Squaw Valley; San Joaquin.

Glenn County: Artois.

Kern County: Caliente; Frazier Park; Kern Canyon; Kernville; Maricopa; Wallsee Pass.

Lake County: Kelseyville; Lakeport; Lower Lake; Lucerne; Middletown.

Lassen County: Bridge Creek Camp; Hallelujah Junction; Hat Lake; Manzanita Lake; Summit Camp.

Los Angeles County: Glendale; Gorman; Mint Canyon; Tanbark Flat.

Madera County: Mineral Summit; Soquel Basin.

Marin County: Fairfax; Lagunitas; Novato.

Mariposa County: Fish Camp; Miami Ranger St., Wawona; Yosemite, Yosemite Valley.

Mendocino County: Alder Spring; Ryan Creek.

Merced County: Dos Palos; Peregoy Meadows.

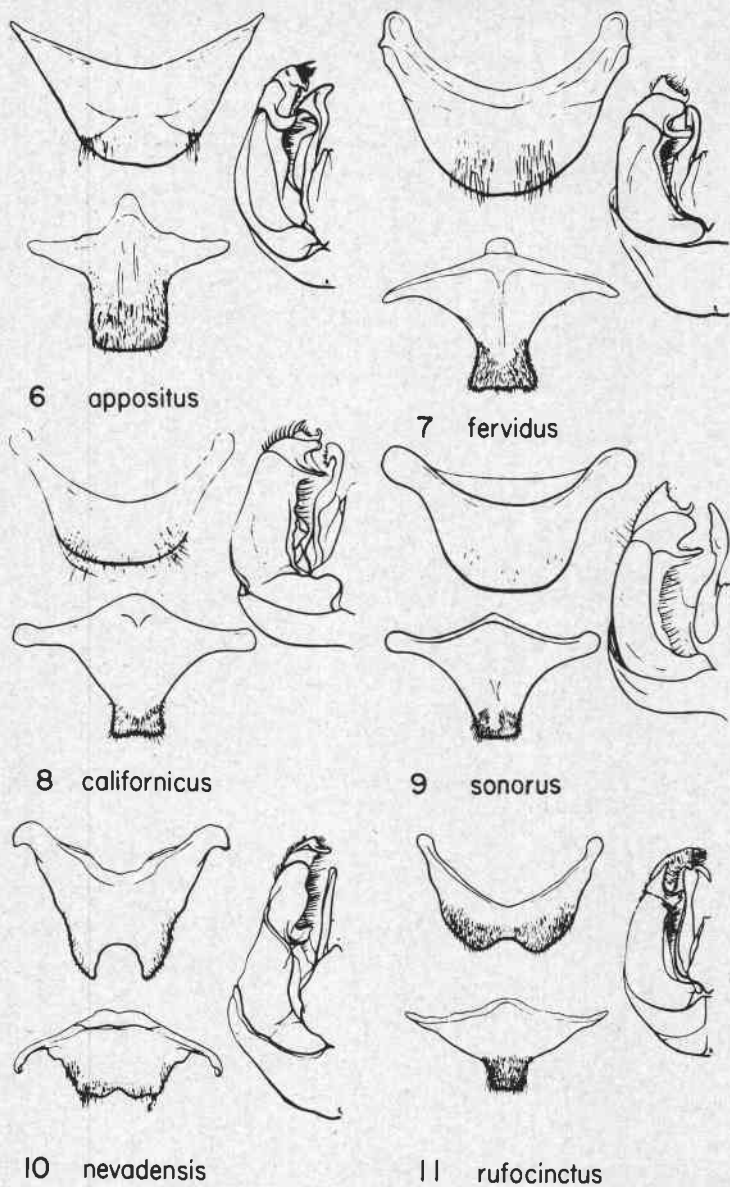
Modoc County: Cedar Pass.

Monterey County: Arroyo Seco; Carmel.
 Napa County: Samuel Spring; Walter Spring.
 Nevada County: Boca; Chicago Park; Nevada City; Red Dog;
 San Juan, Truckee.
 Placer County: Alta; Applegate; Auburn; Colfax.
 Plumas County: Nelson Point; Portola; Quincy.
 Riverside County: Hemet Res., S. B. Mts.; Idyllwild; Three
 Rivers, S. B. Mts.
 Sacramento County: Folsom.
 San Bernardino County: Barton Flats; Mill Creek, 6,000'; Mt.
 Home Creek, 5,000'; San Bernardino Mountains, 5,000'; Valley of
 the Falls.
 San Francisco County: San Francisco.
 San Luis Obispo County: Arroyo Grande; Atascadero.
 San Mateo County: Millbrae; Montara; Palo Alto; San Mateo.
 Santa Clara County: Alum Rock State Park.
 Santa Cruz County: Mt. Herman.
 Shasta County: Big Spring; Carbor; Cayton; Hat Creek; Las-
 sen Peak; Moose Camp, Old Station; Shasta City; Shingletown;
 Viola; Vista; Redding.
 Sierra County: Calpine; Sierraville.
 Siskiyou County: Bartle; Gazelle.
 Sonoma County: Glen Ellen; Maacama Cr.; Sobre Vista.
 Stanislaus County: Adobe Creek; Modesto.
 Sutter County: Marysville Butte.
 Tehama County: Mineral.
 Trinity County: Carrville; Coffee Creek; Eagle Creek; Scott
 Mtn.; Tangle Blue Lake; Trinity Ranger Camp.
 Tulare County: Kaweah; Mineralking; Sequoia Nat. Park; Tu-
 lare.
 Tuolumne County: Buck Meadow; Dodge Ridge; Eleanor Lake;
 Groveland; Kennedy Meadow; Pinecrest; Strawberry; Dardanelles.
 NEVADA:
 Lake Tahoe; Verdi; Virginia City.

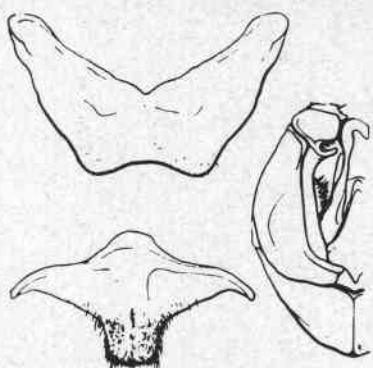
FLIGHT RECORDS:

Queens have been collected from March 6 to September 28;
 workers from April 17 to October 11; and males from May 12 to
 October 27. The peak of the flight period occurs from early June to
 late August.

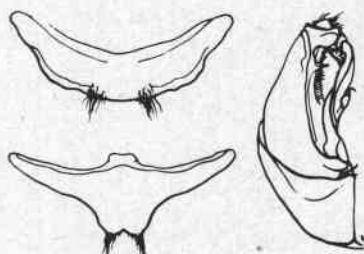
The type of *vosnesenskii* is presumably in the collections of the
 Academy of Sciences of the U.S.S.R.



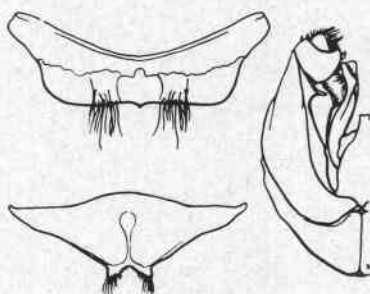
Figures 6 to 11. The seventh and eight ventral plates and right half of the capsule of the males.



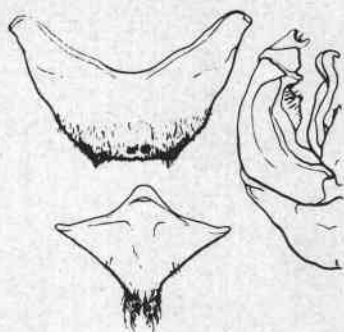
12 morrisoni



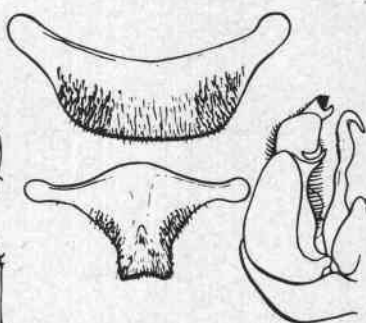
14 occidentalis



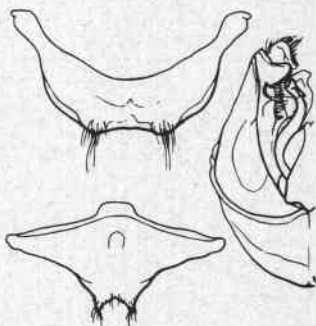
16 franklini



13 griseocollis

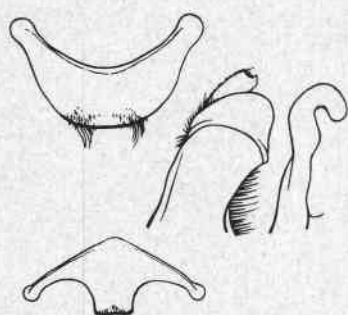


15 crotchii

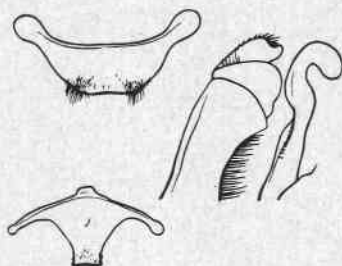


17 terricola

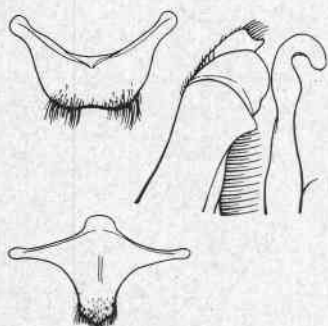
Figures 12 to 17. The seventh and eighth ventral plates and right half of the capsule of the males.



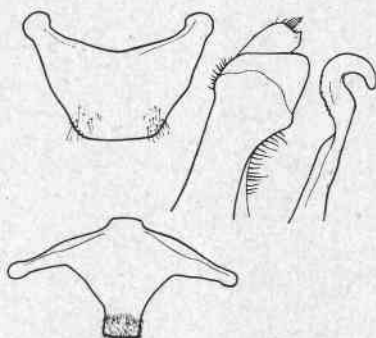
18 *flavifrons*



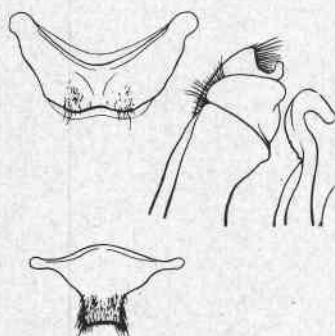
19 *centralis*



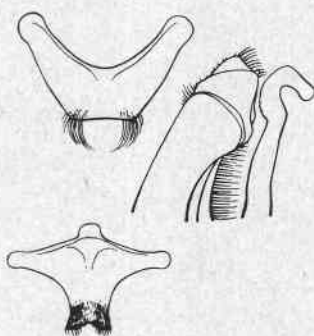
20 *caliginosus*



21 *vagans*

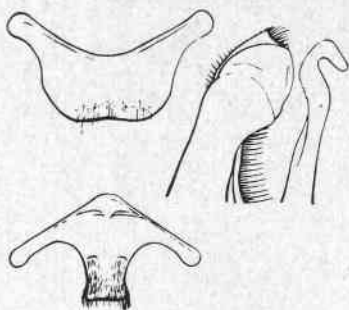


22 *edwardsii*

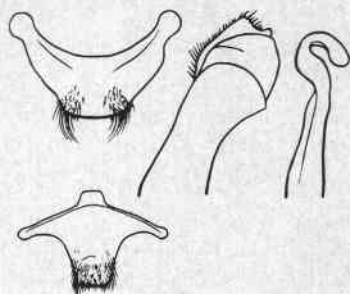


23 *mixtus*

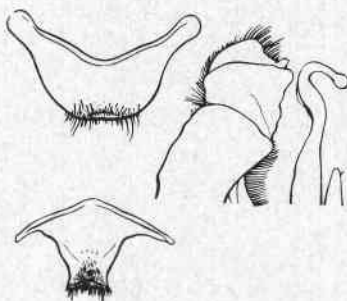
Figures 18 to 23. The seventh and eighth ventral plates and right half of the capsule of the males.



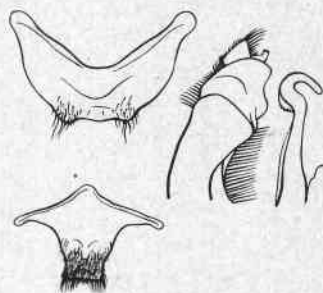
24 sitkensis



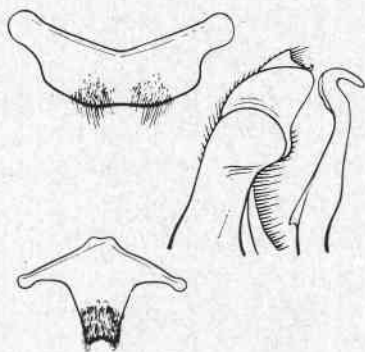
25 frigidus



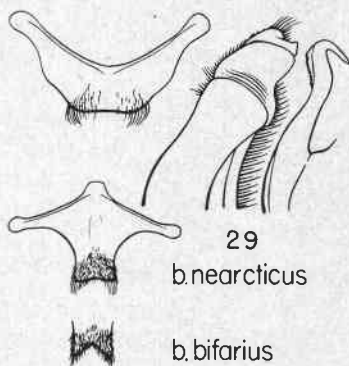
26 sylvicola



27 melanopygus



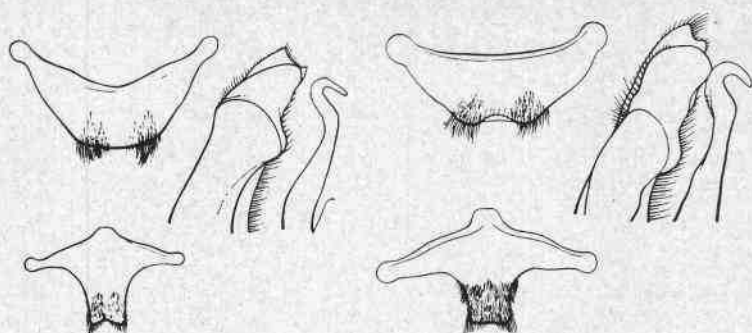
28 huntii



29
b. nearcticus

b. bifarius

Figures 24 to 29. The seventh and eighth ventral plates and right half of the capsule of the males.



30 ternarius

31 vosnesenskii

Figures 30 and 31. The seventh and eighth ventral plates and right half of the capsule of the males.

Acknowledgments

Acknowledgment is extended to the Oregon State College Graduate School Research Fund for the assistance given during the preparation of this paper. I am especially grateful to the following collectors and curators who provided their entire personal collection or collections at their disposal for examination: W. F. Barr, University of Idaho, Moscow, Idaho; G. E. Bohart, United States Legume Seed Research Laboratory, Logan, Utah; G. F. Ferris, Stanford University, Palo Alto, California; Mrs. L. K. Gloyd, Illinois Natural History Survey, Urbana, Illinois; R. H. Handford, Canada, Department of Agriculture, Kamloops, British Columbia; C. F. Harbison, Natural History Museum, San Diego, California; M. H. Hatch, University of Washington, Seattle, Washington; P. D. Hurd, University of California, Berkeley, California; M. T. James, Washington State College, Pullman, Washington; Trevor Kincaid, Seattle, Washington; A. T. McClay, University of California, Davis, California; E. S. Ross, California Academy of Sciences, San Francisco, California; J. W. Tilden, San Jose State College, San Jose, California; P. H. Timberlake, Citrus Experiment Station, Riverside, California; F. S. Truxal, Los Angeles County Museum, Los Angeles, California; and A. J. Walz, University of Idaho, Parma, Idaho. I am especially indebted to Mrs. L. K. Gloyd of the Illinois Natural History Survey, Urbana, Illinois, for the comparison of the Frison types; to H. J. Grant, Academy of Natural Sciences of Philadelphia, for the comparison of some of the Cresson types; and to P. D. Hurd, University of California, Berkeley, for the use of several maps prepared for the California Insect Survey and his efforts in obtaining several collections for my use.

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* The asterisks indicate names that are considered to be synonyms or homonyms.