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A REVIEW OF THE NEARCTIC SPECIES OF *CRABRO* (HYMENOPTERA: SPHECIDAE)

BY

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To Wojciech
with best regards
Dick Bohart

A REVIEW OF THE NEARCTIC SPECIES OF *CRABRO* (HYMENOPTERA: SPHECIDAE)

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The genus *Crabro* was described by Fabricius in 1775. Subsequently, most of the wasps presently contained in the subfamily Crabroninae as well as many rather unrelated sphecids were ascribed to it by early workers. It was not until the present century that *Crabro* was restricted by general agreement to those species in which the lower edge of the male foretibia is expanded into a thin shield and to a few additional close relatives with other leg modifications. The presence of the tibial shield is diagnostic but for males without a shield and for females the following combination of characters sets them apart from other crabronines: mandible unnotched externoventrally, ocellar triangle considerably broader than long, scapal basin ecarinate, palpal formula 6-4, abdomen not pedunculate, verticaulus (L-shaped carina in front of midcoxa) undeveloped but sometimes represented by a tooth or an angle, female pygidial plate flat, jugal lobe shorter than hindwing submedian cell.

The presence of a shield in the male was probably what attracted the attention of Ray (1710:255) who gave the first description of a *Crabro*, probably the same species called *cribrarius* by Linnaeus (1758). Ray's description was simple but to the point: "*Vespa ichneumon antennis reflexis, pedibus anterioribus velut clypeatis*".

Shieldlike expansions of the male foreleg occur in a number of other crabronine genera such as in *Ectemnius cyanauges* Pate with a femoral shield and many *Crossocerus* and *Lestica* with tarsal shields. *Crabro* is the only genus with a tibial shield and it occurs in about 75 percent of the known species.

The shield of *Crabro* with its elaborate spots and stripes, its variable shape, and the frequently associated complexities on other foreleg segments is particularly significant to the taxonomist since it appears to be an absolutely specific character. However, the purpose of the shield is of interest to the morphologist and the behaviorist. As a matter of conjecture, a logical role can be seen

in the clasping of the female during mating. This does not explain the great variety in shape and ornamentation of the shield according to species and I have suggested (Bohart, 1976) that there may also be a display function for the benefit of females.

In descriptions and in the key, height and length of the shield are based on its position at rest, during which it covers most of the mesopleuron. To adequately see the details on the inner side of the forefemur (basoventral forefemoral spine (a), posterior forefemoral angle (b), fig. 11) it may be necessary to pull the shield forward and outward.

The genus is essentially holarctic but species of one group penetrate the Central American tropics as far south as Costa Rica. About 85 species are now recognized, and the 47 New World forms can be divided into six groups. Only one of these, the *cribrarius* group (=*Crabro* s.s.) is known to occur in both Palearctic and Nearctic Regions. It contains the generotype, *cribrarius* (Linnaeus), 1758, a common palearctic species. The other five nearctic groups, with the subgeneric names which have been accorded to some of them, are: *hilaris* group (=*Paranothyreus*), *tumidus* group (=*Synothyreopus*), *thyreophorus* group, *conspicuus* group and *advena* group.

Differences among the species groups are mostly found in male antennae, mandibles, forelegs and pygidium. On the basis of these characters it would be possible to divide *Crabro* into several subgenera as has been done in the past, or even into genera. However, females are not so definitive and often cannot be assigned to group by structural features without reference to males. It is for this reason that I prefer to use the informal group categories rather than the more formal subgeneric names.

In studying *Crabro* from a world standpoint, I have been fortunate in obtaining critical palearctic species through exchange or on loan from Marshakov V., W. J. Pulawski, J. Leclercq and J. Beaumont. The species are *alpinus* Imhoff, *filiformis* Radoszkowski, *lapponicus* Zetterstedt, *lowei* Dahlbom, *mocsaryi* Kohl, *peltarius* Fabricius, *peltatus* Fabricius, *scutellatus* Scheven, *sibericus* A. Morawitz, *signaticrus* F. Morawitz, *tuberculiger* Kohl, and *uljanini* Radoszkowski.

Systematic papers of special value on American *Crabro* are

those of Packard (1867), who presented the first key, W. Fox (1895), who revised the species known at that time, Krombein (1951), who catalogued the genus, and Bohart (1976) who presented a revised group classification and a synonymic list.

Nesting biology has been reported for several species in each of the American species groups except for the *thyreophorus* and *conspicuus* groups. References are given under the species concerned. In general *Crabro* make ground nests of one to many cells and stock them with flies of various sorts, but particularly Muscoidea and Orthorrapha. The egg is laid on the first fly in the cell. Evans (1960) has discussed differences in habits among the species.

Characters of particular significance at the species level can be divided into four categories: markings, pubescence, microsculpture, and macrostructure. These pertain to both sexes although the more striking modifications are in the males.

Markings of considerable use are the extent or absence of pale areas on mandibles, scape, legs, metanotum, abdominal dorsum and abdominal venter. Details of markings of the male foretibial shield are diagnostic. Wing infuscation is an important characteristic.

Pubescence in both sexes offers differentiating characters in the length and color of erect hair on the clypeus, frons and thorax; and length as well as breadth of the inner orbital silver border. In males a fringe of hair beneath the flagellum, a curled tuft beneath flagellomere I, and a silvery mat on the mesopleural venter may be present and significant.

Microsculpture has specific value as in most other wasps. The size and density of punctures, especially on the head and scutum are useful. The development of microridging on the frons, scutum and mesopleuron is particularly helpful in females. The sculpture of the propodeal enclosure is a basic key character in females.

Macrosculpture takes many forms, especially among males. The fundamental differences are listed for the species groups. More specific characters are antennal proportions and clypeal shape in both sexes. In males the most notable points are the occasional continuation of the occipital carina to the oral fossa by a definite ridge, shape of the forelegs, shape of the midtrochanter

and midbasitarsus, and length of the latter compared with the rest of the tarsus.

Overall size is variable as in other wasps. Yet, certain species can be ranked as small (length less than 9 mm) and others qualify as large (length over 11 mm). Females are sometimes a little longer than males and are always more robust.

In the following key the more numerous structural characters available in males as well as the diagnostic nature of the tibial shield (when present) give a relatively high predictability confidence in identification. The female key has a lower confidence value because of reliance on color pattern, hair color, punctation density and development of microstructure. Furthermore, it suffers from the fact that the female sex is unknown in five of the named species.

KEY TO CRABRO OF NORTH AMERICA — MALES

(13 antennal articles, pygidial plate rounded when present)

1. Foretibia without a shield, (fig. 37) and/or mandible simple at apex 2
   Foretibia with a shield, (fig. 57) mandible bifid at apex 18
2. Mandible bifid at apex (fig. 10), no foretibial shield (*C. hilaris* group) 3
   Mandible simple at apex (fig. 9), foretibial shield well developed (fig. 34), sculpture of mesopleuron laterally rather uniform both on prepectus and behind mesopleural sulcus, mesopleuron nearly always with a sharp precoxal angle, flagellum with short and quite inconspicuous hair ventrally (*C. tumidus* group) 9
3. Mesopleuron ventrally with long thick white hair, midbasitarsus flattened and with much long hair beneath, flagellum fringed beneath with long hair 4
   Mesopleuron without long hair, midbasitarsus not unusually flattened or with long hair beneath, flagellar hair moderate 6
4. Forefemur not flattened and with relatively little hair, much less prominent than on mesopleuron; foretibia all yellow ..... *cognatus* W. Fox
   Forefemur flattened, expanded, somewhat concave beneath, bearing long hair as on mesopleuron; foretibia with a ventral subapical black spot 5
5. Forefemur strongly flattened ventrally on basal four-fifths, ventral hair brush strong, forefemur in ventral view slightly more than twice as long as broad ..... *cingulatus* (Packard)
   Forefemur weakly flattened ventrally on basal one-half, ventral hair

brush weak, forefemur in ventral view about 2.7 times as long as broad ..... species "B"

6. Midbasitarsus practically straight, prepectus usually with a large pale spot, markings mostly yellow (southern Florida form with red markings = ssp. *rufibasis* Banks) ..... *hilaris* F. Smith

Midbasitarsus distinctly curved, prepectus without a large spot 7

7. Midbasitarsus stout, shorter than rest of tarsus, propleuron without unusual hair ..... *snowii* W. Fox

Midbasitarsus slender, as long as rest of tarsus, propleuron with rather long tuftlike hair 8

8. Pronotal collar and tubercle yellow marked, foretibia black spotted beneath toward apex, tergum IV and usually V with a pair of transverse yellow spots ..... *aequalis* W. Fox

Pronotal collar and tubercle red, foretibia not definitely spotted beneath, terga IV-V or at least V dark ..... species "A"

9. Mandible dark, not marked with yellow or white; forebasitarsus not much if any broader than length of tarsomere V (figs. 34, 36) 10

Mandible marked with yellow or white, forebasitarsus broader than length of tarsomere V (figs. 33, 39) 13

10. Long and dense pale hair present on dorsum of forefemur or on mesopleuron ventrally 11

Long and dense pale hair absent on foreleg and mesopleuron 12

11. Mesopleuron with long dense pale erect hair ventrally, dorsum of forefemur reflexed distally but without unusual hair, foretibial shield produced beyond tibia distad, forebasitarsus stout (fig. 34) .... *tenuiglossa* Packard

Mesopleuron without long dense hair ventrally, dorsum of forefemur with abundant long semierect pale hair, foretibial shield not produced beyond tibia distad, forebasitarsus slender (fig. 40) .... *alpestris* Cameron

12. Foretibia with a shield (fig. 36), forefemur with a recurved basoventral projection, wings essentially water clear .... *lacteipennis* Rohwer

Foretibia slightly expanded but without a shield (fig. 37), forefemur without a basoventral projection, wings stained light brown .... *parmatulus* R. Bohart

13. Mesopleuron with much long pale hair laterally, foretibia proper with a black apical spot (fig. 38) 14

Mesopleuron with short and rather bristly hair laterally, foretibia without a black apical spot (figs. 33, 35) 15

14. Foretrochanter with a strong subapical spine, midfemur with long dense hair on basal half beneath ..... *alticola* Cameron

Foretrochanter with at most a small toothlike projection, midfemur with ventral hair much shorter than midtarsomere II .... *venator* Rohwer

15. Foretrochanter with a definite ventral tooth or spine 16
Foretrochanter without a ventral tooth or spine 17
16. Markings whitish, hindfemur all dark .... *grisselli* R. Bohart
Markings yellow, hindfemur narrowly yellow at apex .....
..... *tumidus* (Packard)
17. Midbasitarsus broadly expanded just beyond middle (fig. 8); scutum fairly closely but somewhat unevenly punctate, interspaces shiny ....
..... *peltista* Kohl
Midbasitarsus slender; scutum densely and closely punctate, dull .....
.... *costaricensis* Cameron
18. Foretarsomere V simple (figs. 45, 46) 19
Foretarsomere V with a small to large lateral projection (figs. 54, 58) 29
19. Thoracic hair very long, erect, yellowish; pygidial plate present but weak; mandible and clypeus black, shield mostly yellow; mesopleuron laterally with fine dense sculpture; no inner forefemoral spine; foretibia with a delicate and straight inner basal spine (*C. thyreophorus* group) 20
Thoracic hair not uniformly long and erect, not yellowish (*C. advena* group) 21
20. Shield with a strong posterior edging of brown (fig. 48), yellowish hair tuft from middle of clypeus directed forward .... *thyreophorus* Kohl
Shield with faint and narrow posterior edging of brown (fig. 45), tuft from middle of clypeus directed forward and upward .....
..... *helvocrinus* R. Bohart
21. Foretibia proper without a distinct black spot at or near apex in outer or inner view (fig. 49) 22
Foretibia proper with a distinct black spot at or near apex in outer or inner view (fig. 41) 24
22. Outer forefemoral angle sharp but not projecting posteriorly, basoventral forefemoral spine a sharp but small denticle, foretrochanter with a large and stout apical lamellate projection .....
..... *nigriceps* R. Bohart
Outer forefemoral angle strongly and sharply prolonged backward, basoventral forefemoral spine absent or well developed, foretrochanter without an apical projection 23
23. Shield mostly yellow (fig. 42), foretrochanter triangular in profile, no forefemoral spine, pygidial plate present but weak, scutum nearly without microridging ..... *bruneri* (Mickel)
Shield with many pale spots and stripes (fig. 49), foretrochanter not triangular in profile, ventral forefemoral spine well developed and subbasal, no pygidial plate, scutum with essentially complete microridging ..... *nigrostriatus* R. Bohart
24. Outer forefemoral angle produced backward into a long, curved, needlelike spine 25

Outer forefemoral angle stout, sharply pointed or obtuse 26

25. Shield brown with yellowish stripes; black spot near apex of foretibia proper distinct on outer side (fig. 46), mesopleuron mostly polished laterally, upper frons and scutum extensively microridged .... *henrici* Krombein

Shield with prominent alternating black and white stripes (fig. 51), black spot near apex of foretibia proper indistinct on outer side, mesopleuron densely shagreened laterally, upper frons and scutum not clearly microridged ..... *vernalis* (Packard)

26. Plain brown area at posterior tip of shield nearly reaching black spot near apex of foretibia proper (fig. 41) 27

Plain brown or grey area at posterior tip of shield far removed from black spot near apex of foretibia proper (fig. 44) 28

27. Outer forefemoral angle obtuse and not produced backward, basoventral forefemoral spine rather straight and needlelike, lower edge of shield minutely and irregularly serrate (fig. 52), sternaulus a complete line of well formed pits ..... *advena* F. Smith

Outer forefemoral angle produced backward and short but sharp; basoventral forefemoral spine broadened basally and curved, lower edge of shield smooth; sternaulus weakly indicated .... *virgatus* W. Fox

28. Shield with translucent spots on a grey background (fig. 47), abdomen all black or practically so, microridging of scutum mostly posterior, flagellomeres not beadlike ..... *hispidus* W. Fox

Shield with translucent spots overlaid with greenish yellow (fig. 44) abdomen with obvious yellow maculation, microridging of scutum rather general, flagellomeres somewhat beadlike .... *florissantensis* Rohwer

29. Foretarsomere V with a small lateral projection (figs. 53, 54) (*C. conspicuus* group) 30

Foretarsomere V with a large lateral projection ending in a curved spine (figs. 56, 57), foretarsus broadened and somewhat deformed (*C. cribrarius* group) 33

30. Mesopleural venter with abundant erect pale hair which does not form a white or silvery mat, tegula dark 31

Mesopleural venter with thick mat of white or silvery hair, tegula partly yellow 32

31. Flagellum conspicuously nodose in profile (fig. 23), mandible and hindleg all dark, tibial shield with many opaque yellow spots and overall largely yellow with yellow at tip (fig. 50), foretibia proper without an apicoventral dark spot ..... *flavinubis* R. Bohart

Flagellum not nodose in profile, mandible and hindleg partly yellow, tibial shield mostly dark in front and dark at tip (fig. 54), foretibia proper with an apicoventral dark spot ..... *conspicuus* Cresson

32. Flagellomere I with a conspicuous ventral hair tuft; shield whitish,

brown and greenish (fig. 55) ..... *dietrichi* R. Bohart

Flagellomere I with inconspicuous ventral hair; shield overlain with grey and bluish (fig. 53) ..... *denningi* R. Bohart

33. Silver border along inner orbit of compound eye broadened above to three or more midocellus diameters 34

Silver border along inner orbit of compound eye narrow, less than three midocellus diameters 36

34. Flagellum pectinate (fig. 31), mesopleuron with a mat of white ventral hair but no stout spines, ventral forefemoral spine far removed from base, tibial shield completely spotted and striped (fig. 68) ..... *argusinus* R. Bohart

Flagellum not pectinate, mesopleuron with moderate white hair on venter of mesopleuron and with a pair of stout spines anteriorly, ventral forefemoral spine arising close to base, tibial shield evenly brown toward apex below (fig. 67) 35

35. Foretibia proper all white to yellow on outer side (fig. 67), foretrochanter merely angled or minutely spined apically, mesopleural venter densely silvery posteriorly ..... *opalescens* R. Bohart

Foretibia proper with a large black apical spot on outer side (fig. 62) foretrochanter with a distinct apical spine, mesopleural venter not densely silvery posteriorly ..... *spinuliferus* R. Bohart

36. Shield yellow or whitish toward posterior tip which consists of a discrete membranous area which may be broken into a fringe (fig. 69) 37

Shield color variable toward posterior tip but latter without a discrete membranous area (fig. 65, 70) 38

37. Shield mainly with three longitudinal brown stripes (fig. 69), mesopleuron with a strong cross carina ventrally, foretrochanter not spined, flagellomere I with inconspicuous ventral hair ..... *latipes* F. Smith

Shield with lower half mostly brown, a yellow subapical spot, upper half with some fine clear lines (fig. 64); no cross carina on mesopleuron; foretrochanter with an erect, needlelike subapical spine ventrally; flagellomere I with a large ventral tuft of curled hairs ..... *deserticola* R. Bohart

38. Shield with spots or stripes extending practically to posterior apex (figs. 56, 70) 39

Shield with spots or stripes stopping well short of plain pale or dark apex (figs. 59, 66) 40

39. Shield longer than high, lower edge smooth (fig. 70), ventral forefemoral spine subapical (fig. 11a), outer forefemoral angle prolonged backward and ending in an oblique truncation (fig. 11b), flagellomere I broader than long, precoxal angle of mesopleuron evident but not sharp, a large species ..... *pleuralis* W. Fox

Shield higher than long, lower edge irregularly serrate (fig. 56), ventral

forefemoral spine basal, outer forefemoral angle not prolonged backward, flagellomere I longer than broad (fig. 29), precoxal angle of mesopleuron a sharp tooth, a small species ..... *leopardus* R. Bohart

40. Midtrochanter and midfemur on ventral (inner) surface all or nearly all yellow to whitish 41

Midtrochanter and midfemur on ventral (inner) surface mostly or all dark 43

41. Tuft of curled hairs under flagellomere I weak, sparse, and white; basoventral forefemoral spine slender and curved ..... *velitaris* R. Bohart

Tuft of curled hairs under flagellomere I well developed 42

42. Flagellomere I considerably broader than long, ventral tuft dark; basoventral forefemoral spine slender and curved; midtrochanter forming an angle or tooth at inner base ..... *flavicrus* R. Bohart

Flagellomere I only a little broader than long, ventral tuft pale; basoventral forefemoral spine rather stout and straight; midtrochanter not angled or toothed at inner base ..... *pallidus* W. Fox

43. Scape all black or almost so ..... *cribrellifer* (Packard)

Scape extensively pale in front or laterally 44

44. Flagellomere I nearly as long as broad to longer than broad (figs. 30, 32) 45

Flagellomere I about 1.5 times as broad as long (fig. 24) 47

45. Outer forefemoral angle with a fingerlike projection perpendicular to flattened inner face (fig. 14a), propodeal areolae unusually deep ..... *digitatus* R. Bohart

Outer forefemoral angle without a fingerlike projection 46

46. Flagellomere I with a prominent ventral tuft of curled hairs, w. of 100th meridian ..... *largior* W. Fox

Flagellomere I with a weak ventral tuft of decumbent hairs, e. of 100th meridian ..... *monticola* (Packard)

47. Dark lower part of shield sharply separated from yellow spotted and clouded upper three-fifths (fig. 65) ..... *villosus* W. Fox

Dark lower part of shield merging gradually into upper part 48

48. Central third of shield with many small, round, well separated spots (fig. 61), outer forefemoral angle subdentate on inner side ..... *tenuis* W. Fox

Central third of shield dark (fig. 54), outer forefemoral angle thin and slightly twisted ..... *comosiceps* R. Bohart

KEY TO CRABRO OF NORTH AMERICA — FEMALES

tenuis not included

(12 antennal articles, pygidial plate flat and triangular)

1. Mandible simple apically (fig. 9), mesopleuron with a sharp point or angle a little in front of midcoxa, metanotum pale banded (*C. tumidus* group) 2

Mandible bidentate apically (fig. 10) 10

2. Wings milky transparent, orbital pale hair band much broadened above and densely silvery to top of vertical area of face as seen in front view 3

Wings stained, orbital pale band rather sparsely yellowish silvery above, not reaching to top of vertical area of face as seen in front view 4

3. Mesopleuron laterally rather shiny between well separated macropunctures, mandible broadly whitish toward base, tergum V with four pale spots which may be connected ..... *grisselli* R. Bohart

Mesopleuron laterally shagreened between well separated macropunctures, mandible black basally but reddish to dull yellow medially, tergum V with lateral spots only ..... *lacteipennis* Rohwer

4. Mandible black toward base 5

Mandible pale toward base 6

5. Mesopleuron in front of midcoxa somewhat bulging and with punctures 1-5 diameters apart, corner of pronotal ridge sharp but not prominent ..... *tenuiglossa* Packard

Mesopleuron in front of midcoxa evenly rounded and with punctures 1-2 diameters apart, corner of pronotal ridge prominent and sharp ..... *alpestris* Cameron

6. Prepectus with very few and widely spaced punctures ..... *tumidus* (Packard)

Prepectus with many irregularly spaced punctures 7

7. Mesopleural side with rather fine hair, some longer than an ocellus diameter 8

Mesopleural side with bristly hair, shorter than an ocellus diameter 9

8. Carina from humeral angle to pronotal lobe distinct ..... *alticola* Cameron

Carina from humeral angle to pronotal lobe obsolescent ..... *venator* Rohwer

9. Pronotal corner sharp but small, tergum V banded or rarely spotted medially, side of mesopleuron and propodeum more shiny ..... *peltista* Kohl

Pronotal corner sharply projecting, tergum V dark medially, side of mesopleuron and propodeum more shagreened and dull ..... *costaricensis* Cameron

10. Mesopleuron with a sharp point or angle a little in front of midcoxa (usually seen without difficulty in oblique dorsal view) 11

Mesopleuron slightly swollen in front of midcoxa but without a sharp point or angle [1] 21

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[1] A dull point is often visible on *cribrellifer* and on *largior*, both rather large species.

11. Pubescent border of inner orbit densely silvery, roughly triangular, extending well above top of scape 12
Pubescent border of inner orbit narrowly silvery, sometimes weakly diverging inwardly above, not extending above top of scape 13
12. Terga I-V with yellow bands, clypeal bevel broad and transversely impressed, metanotum yellow banded ..... *opalescens* R. Bohart
Terga II-III with narrowly separated yellow spots; clypeal bevel flat and polished, strongly concave; metanotum dark ..... *spinuliferus* R. Bohart
13. Enclosure with rather regularly spaced longitudinal ridging, terga I-V usually with complete yellow bands ..... *pleuralis* W. Fox
Enclosure areolate rather than longitudinally ridged; tergum III, at least, not banded 14
14. Tegula rather sharply bent downward anteriorly, declivous part grooved; lateral angle of pronotal collar projecting forward as well as outward, clypeal free edge medially somewhat lobate and deeply but not broadly impressed ..... *leopardus* R. Bohart
Tegula rather evenly and weakly convex overall, lateral angle of pronotal collar projecting a little outward, clypeal free margin not medially lobate 15
15. Anterolateral area of scutum (behind pronotal angle) with dense close punctation which tends laterally toward microridging 16
Anterolateral area of scutum with punctures distinctly separated by small smooth areas 17
16. Prepectus black or with a tiny yellow spot, microridging of upper frons plainly reaching lateral ocelli, wings nearly clear except for a brown spot near apex of marginal cell ..... *cognatus* W. Fox
Prepectus nearly all yellow (or red) including a narrow edging in front of omaulus, microridging of upper frons becoming granulate near lateral ocelli, wings extensively stained; markings mostly yellow (markings mostly deep red in southern Florida subspecies *rufibasis* Banks) ..... *hilaris* F. Smith
17. Wings nearly clear except for usual subapical spot 18
Wings extensively stained 19
18. Prepectus nearly always with a small to moderately large yellow spot, metanotum with a pair of yellow spots or sometimes a band, hindtarsomeres II-V not much darker than basitarsus ..... *cingulatus* (Packard)
Prepectus and metanotum dark, hindtarsomeres II-V much darker than the yellow basitarsus ..... species "B"
19. Area in front of midocellus extensively polished, not dull and granulate, posterior propodeum mostly shiny and not deeply areolate, prepectus sometimes with a small yellow spot ..... *snowii* W. Fox
Area in front of midocellus granulate or submicrostriate, posterior propodeum deeply areolate, prepectus dark 20

20. Pronotal collar and tubercle yellow, terga III-V usually marked with yellow ..... *aequalis* W. Fox
Pronotal collar and tubercle orange red, terga IV-V dark, III usually dark ..... species "A"
21. Mandible and/or scape all dark, but in any case scape not all pale in front 22
Mandible and scape pale marked, *or* scape all pale in front 30
22. Clypeus and thorax with unusually long golden hair 23
Clypeus and thorax without long golden hair 24
23. Flagellum greatly broadened (fig. 17), clypeal tuft directed upward, mesopleuron completely dull ..... *helvocrinus* R. Bohart
Flagellum slender (fig. 16), clypeal tuft directed forward, mesopleuron somewhat shiny ..... *thyreophorus* Kohl
24. Mesopleuron finely sculptured and dull, scutal punctures fine and well separated 25
Mesopleuron at least partly polished 26
25. Forebasitarsus and midbasitarsus mostly whitish, clypeal bevel usually narrow and low ..... *vernalis* (Packard)
Forebasitarsus and midbasitarsus brown, clypeal bevel broad ..... *bruneri* Mickel
26. Scutum not microridged in front of scutellum, upper frons not microridged, clypeus extensively yellow, mandible with a yellow spot ..... *cribrellifer* (Packard)
Scutum with longitudinal ridges in front of scutellum, upper frons microridged, clypeus all or nearly all black 27
27. Hair of frons dark brown to black, tergum IV and usually rest of abdomen black, metanotum black, wings rather deeply brown stained 28
Hair of frons pale to light brownish 29
28. Clypeus with a small triangular bevel ..... *hispidus* W. Fox
Clypeus practically without a bevel (fig. 1) ..... *nigrostriatus* R. Bohart
29. Hair of frons fulvous to light brownish, wings lightly but distinctly stained, metanotum usually marked with yellow, tergum IV often yellow marked ..... *florissantensis* Rohwer
Hair of frons whitish, wings practically clear, metanotum dark, tergum IV and often I-III all dark ..... *flavinubis* R. Bohart
30. Enclosure with rather straight, or slightly curving, regular and nearly parallel longitudinal ridges 31
Enclosure with ridges irregular, unevenly curved, often enclosing small or large areolae 35
31. Scutal punctures very close throughout, hair of frons and mesopleuron brown to dark brown 32
Scutal punctures mostly close but separated by a diameter or more toward middle of scutum 33
32. Pronotal ridge with prominent lateral angles; clypeal bevel distinct,

low and broad; metanotum dark, large species with length about 12 mm ..... *largior* W. Fox

Pronotal ridge with weakly raised lateral angles; clypeal bevel weakly impressed, not broad; metanotum yellow marked, length about 10 mm ..... *villosus* W. Fox

33. Frons and mesopleuron with brown to fulvous hair, respectively, body markings yellow to whitish ..... *latipes* F. Smith

Frons and mesopleuron with white or slightly off-white hair 34

34. Tergum I with extensive yellow markings, spots on II large and nearly touching, propodeal enclosure finely and closely carinate ..... *comosiceps* R. Bohart

Tergum I all dark, spots on II reduced and well separated, propodeal enclosure rather coarsely carinate ..... *deserticola* R. Bohart

35. Scutum with strong longitudinal microridging in front of scutellum, ridges mostly as long as tegula; mandible often all dark 36

Scutum without strong longitudinal microridging in front of scutellum, ridges when present shorter than tegula 37

36. Erect hair of frons pale, scutum anterolaterally with somewhat separated punctures and oblique microridging ..... *henrici* Krombein

Erect hair of frons dark brown, scutum closely punctate anterolaterally ..... *virgatus* W. Fox

37. Forewing with submarginal cell almost water clear, veins mostly pale reddish; erect hair of frons white 38

Forewing with submarginal cell distinctly stained 39

38. Clypeal bevel broad and sharply creased, forebasitarsus usually with at least 3 rake setae before apex ..... *pallidus* W. Fox

Clypeal bevel weakly impressed, about twice as broad as high; forebasitarsus usually with 2 rake setae before apex ..... *dietrichi* R. Bohart

39. Flagellomeres I-II about equal in length; clypeus with free edge of median lobe nearly straight and sharply angled laterally, orbital silver border broadly diffusing toward center of frons ..... *argusinus* R. Bohart

Flagellomere I much longer than II, orbital silver border narrow 40

40. Scutum without or with hardly any polished areas of 2 puncture diameters in extent, erect hair of frons brownish ..... *advena* F. Smith

Scutum with several polished areas of 2 puncture diameters or more in extent 41

41. Inner orbital silver line prominent and extending to apex of scape ..... *velitaris* R. Bohart

Inner orbital silver line weakly developed and not extending to apex of scape 42

42. Femoral hair brownish, large species about 12 mm long, ~~scape and~~ hindfemoral apex dark ..... *monticola* (Packard)

Femoral hair pale, moderate sized species about 9 mm long, scape and hindfemoral apex often yellow ..... *conspicuus* Cresson

Crabro hilaris Group

Both sexes with mandible bidentate apically, upper frons often microridged, postspiracular carina joining omaulus and both strong, mesopleuron with a sharp precoxal tooth. Male characters: head not unusually hollowed beneath, occipital carina ending some distance from oral fossa, flagellum rather slender and with a ventral fringe of hairs which is usually long (shortest in *hilaris*), foreleg rather simple except for long white hair in several species, no tibial shield, foretarsomere V essentially simple, mesopleural venter often with long and dense white hair, sternum VII with slender and sharp posterolateral projections, no pygidial plate.

The group can be divided into two subgroups on male characters as follows:

C. hilaris subgroup. — Flagellum with rather short pubescence and about as dark beneath as above, mesopleural venter without conspicuously long and dense white hair, midbasitarsus nearly cylindrical and straight or curved but without a fringe of hair. Included species are *hilaris, snowii, aequalis* and species "A".

C. cingulatus subgroup. — Flagellum with rather long pubescence and lighter beneath than above, mesopleural venter with conspicuously long and dense white hair, midbasitarsus flattened and straight as well as fringed with hair. Included species are *cingulatus, cognatus* and species "B".

In studying the *hilaris* group, I have been fortunate to have the advice of Mr. R. C. Miller and to have access to a detailed key which he prepared. Species "A" and "B" are Miller's manuscript species.

Crabro aequalis W. Fox

Crabro aequalis W. Fox, 1895:164. Holotype ♀, Georgia (ANSP).

Paranothyreus rugicollis Viereck, 1904:241. Holotype ♂, Riverton, New Jersey (ANSP).

Thyreopus knoxensis Mickel, 1916:424. Holotype ♂, Knox, North Dakota (University of Nebraska Museum).

Recognition. — Male *aequalis* have the flagellum about as dark below as above and with only a few articles flattened beneath, mesopleural venter without a brush of white hair, foretibia flattened and with a ventral subapical black spot, midbasitarsus cylindrical and curved, forewing brownish, and tergum IV with transverse or reddish yellow spots. Female *aequalis* have the upper frons somewhat striatopunctate, upper part of prepectus transversely sculptured and sometimes with a small yellow spot, scutal punc-

tures mostly about a diameter apart, forewing brownish, and tergum IV with transverse yellow or reddish yellow spots.

Distribution. — I have seen a total of 9 specimens from New Jersey to northern Florida and east to Texas, Kansas and Michigan.

Crabro cingulatus (Packard) (Fig. 2)

Thyreopus cingulatus Packard, 1867:366. Lectotype ♂, Illinois (ANSP).
Crabro clarconis Viereck, 1906:213. Holotype ♀, Clark Co., Kansas (KU).

Recognition. — Male *cingulatus* have the flagellomeres long haired as well as flattened and more lightly colored beneath, foretibia with a ventral subapical black spot, forefemur strongly flattened ventrally, mesopleural venter with dense long white hair, midbasitarsus flattened and straight, and terga IV-VI with yellow maculae. Female *cingulatus* have the upper frons striatopunctate, prepectus shining and not ridged above but sometimes with a yellow spot, scutal punctures mostly about a diameter apart, forewing nearly clear, and terga IV-V yellow banded.

Distribution. — The 34 specimens which I have seen were broadly distributed in the United States east of the 100th meridian. They occur also in Manitoba but I have seen none from Florida.

Biology. — Rau and Rau (1918:96-101) studied a large community of nests in Missouri. Burrows were simple, left open during provisioning and ended in a single cell. Provisions were a single species of ephydrid fly, *Paralimnus punctipennis* (Wiedemann), 14 to 20 per cell.

Crabro cognatus W. Fox

Crabro cognatus W. Fox, 1895:178. Lectotype ♀, Montana (ANSP).

Recognition. — Male *cognatus* have the flagellomeres conspicuously flattened and lighter colored beneath than above, foretibia all yellow, forefemur rounded beneath in posterior view, mesopleural venter with dense long white hair, and midbasitarsus flattened and straight. Female *cognatus* have the forewing nearly clear except subapically, upper prepectus unspotted and striatopunctate, and terga IV-V spotted or more often banded.

Distribution. — *C. cognatus* is probably the most widespread species in its group. I have seen 87 specimens from most of the United States west to Idaho, Utah and northern Arizona. It also occurs in southern Canada from Alberta to Manitoba.

Crabro hilaris F. Smith, *sensu stricto*

Crabro hilaris F. Smith, 1856:416. Holotype ♀, St. John's Bluff, Florida (BMNH).

Recognition. — The typical subspecies in the male has the flagellum only a little flattened beneath and not lighter than above, flagellomeres I-II dark or nearly so, no white brush on the mesopleural venter, midbasitarsus nearly cylindrical and straight as well as being about as long as rest of tarsus, terga III-IV yellow spotted and V-VI usually so. The female has flagellomere I essentially black, upper frons weakly striatopunctate, scutum densely punctate with most punctures less than a diameter apart, forewing extensively brownish, prepectus all yellow and with this color extending onto anterior side of omaulus, tergum V maculate, and other tergal markings yellow to reddish yellow.

C. hilaris occurs in two color forms, the pale markings yellow and the markings yellowish red. However, the distinction is not clearcut since specimens from northern Florida, such as the holotype, are intermediate.

Distribution. — I have seen 120 specimens from Massachusetts to northern Florida and west to the 100th meridian. Records in Florida extend south to Alachua and St. Johns counties.

Crabro hilaris rufibasis (Banks)

Thyreopus rufibasis Banks, 1921:17. Holotype ♀, Gulfport, Florida (MCZ).

Recognition. — The male of *rufibasis* agrees with that of *hilaris* s.s. except in its more restricted and more reddish pale markings. Most significant are the extensively reddish flagellomeres I-II, reddish macula on tergum III, and all dark terga V-VI. The female differs from that of *hilaris* s.s. especially by having flagellomere I mostly red, prepectal spot and much of tergum I red, and tergum V black.

This subspecies is similar in appearance to species "A", which is in manuscript by C. D. Miller. The male of *rufibasis* differs by the straight rather than curved midbasitarsus and the female by the more dense punctation anterolaterally on the scutum.

Distribution. — Central and southern Florida from Alachua County to Dade County. I have seen 51 specimens.

Crabro snowii W. Fox

Crabro snowii W. Fox, 1896:79. Lectotype ♀, Douglas Co., Kansas (ANSP).

Recognition. — The male of *snowii* has the flagellum weakly flattened beneath and not more lightly colored than above, forefemur with a sharp

inner basal carina, mesopleural venter without a white brush, midbasitarsus curved and rather stout as well as shorter than rest of tarsus, and pale markings yellow. The female *snowii* has the upper frons shining and not striatopunctate, scutal punctures fine and moderately close, upper prepectal area finely punctate and not ridged but sometimes yellow dotted, posterior face of propodeum with few or no transverse ridges, and terga I-V usually maculate.

Distribution. — *C. snowii* occurs from Florida to New York and west to Minnesota and eastern Kansas. In southern Canada it is found in Saskatchewan and Manitoba. I have seen 101 specimens.

Crabro tumidus Group

Both sexes with mandible simple apically (fig. 9), inner orbital silver border usually much broadened above; erect pubescence of upper frons shorter than an ocellus diameter (except *alticola* and *venator*); prepectal carina and omaulus continuous and both strongly developed; mesopleuron with a sharp precoxal angle (absent in male *costaricensis* and weak in female), tergum I unusually narrow and definitely humped toward apex. Male characters: flagellum rather slender and not fringed beneath, foretibia with a rather small shield (tibia merely broadened in *parmatulus*), foretarsomere V essentially symmetrical, pygidial plate absent, sternum VII with large and blunt posterolateral projections.

Two subgroups can be discerned on the basis of the male forelegs. In the *tumidus* subgroup the shield is produced downward well beyond the apex of the tibia proper. Also, the forebasitarsus is strongly broadened or shortened so that the length is only about twice the greatest breadth (figs. 33, 34). Included are *alticola, costaricensis, grisselli, peltista, tenuiglossa, tumidus* and *venator*. In the *lacteipennis* subgroup the shield is not appreciably produced downward beyond the apex of the tibia proper, and the forebasitarsus is more than three times as long as broad (figs. 36, 37). Included are *alpestris, lacteipennis* and *parmatulus*.

Crabro alpestris Cameron (Fig. 40)

Crabro alpestris Cameron, 1891:152. Holotype ♂, Tepetlapa, Guerrero, Mexico (BMNH).

Recognition. — Both sexes have the mandible basally dark, scutal punctures less than a diameter apart and wings stained. Male *alpestris* have the forefemur with unusually long pale hair above and basoventral projection rather long and slender, shield not produced downward below apex of tibia proper, and forebasitarsus slender (fig. 40). The female has the precoxal angle of the mesopleuron strong and surrounded by bristly setae.

Distribution. — The species is known only from Mexico. I have seen 24 specimens from Nayarit, Jalisco, Veracruz, Hidalgo, Morelos, Guerrero and Oaxaca.

Crabro alticola Cameron (Fig. 38)

Crabro alticola Cameron, 1891:152. Lectotype ♀, Ciudad Durango, Mexico, here designated (BMNH no. 21.992)

Recognition. — Both sexes have the mandible basally whitish, erect hair of upper frons longer than an ocellus diameter, scutal punctures mostly about a diameter apart, mesopleural side with fine hair which is in part longer than an ocellus diameter, and wings stained. Male *alticola* have a stout and prominent ventral spine on the foretrochanter, basoventral forefemoral spine stout and short, and hindfemur with rather long basoventral hair. In this feature as well as the hair of the frons and mesopleuron it resembles *venator*. The foretrochanteral spine of *alticola* and the midcoxal tooth of *venator* afford easy separation.

Distribution. — I have seen only 5 specimens, all from mountains of central Mexico: Durango (Durango), Hidalgo (Pachuca) and Michoacan (Angangueo).

Crabro costaricensis Cameron

Crabro costaricensis Cameron, 1891:148. Holotype ♀, Rio Sucio, Costa Rica (BMNH).

Recognition. — Both sexes have the mandible basally pale, markings generally a pale yellow, scutal punctures less than a diameter apart, precoxal angle of mesopleuron not spinose (weak in female), and wings stained. Male *costaricensis* have the forefemoral basoventral projection short and stout. In many respects they resemble the common *peltista* but the midbasitarsus of male *costaricensis* is simple and the scutal punctation is more dense.

Distribution. — The 12 specimens which I have seen were from Costa Rica (Turrialba, Rio Sucio, San Jose, Cartago) and El Salvador (Cerro Verde National Park, Mt. San Salvador).

Crabro lacteipennis Rohwer (Fig. 36)

Crabro lacteipennis Rohwer, 1909:150. Holotype ♀, Denver, Colorado (USNM).

Recognition. — Both sexes have the mandible basally dark, silvery orbital hair band much broadened above and in front view reaching to top of

vertical facial area, scutal punctures mostly a diameter or more apart, and wings milky transparent. Male *lacteipennis* have the basoventral projection of the forefemur short and stout, shield not produced downward beyond apex of tibia proper, and forebasitarsus slender. Female *lacteipennis* on tergum V have lateral whitish spots only rather than a band.

Distribution. — The species has been collected from the central Rocky Mountains of the United States well into Mexico. Records are: Colorado (Denver, Colorado Springs, Ft. Morgan, Florence), New Mexico (19 mi. n. Gallup, Cubero, Millard, Silver City, 10 mi. w. Elk, Cibola National Forest), Arizona (Patagonia, Nogales, Canelo, Williams), Texas (Salado Creek in Bexar Co.), Durango (Ceballos), and Nueva Leon (15 mi. w. Monterey). Altogether, I have seen 46 specimens.

Crabro grisselli R. Bohart, new species (Figs. 7, 9, 15, 35)

Male holotype. — Length 9 mm. Black with ivory markings as follows: basal two-thirds of mandible, scape except for large inner black spot, apex of forefemur, tibia proper mostly, dull stripes on shield (fig. 35), humeral dot, pronotal lobe, metanotal dot, outer surface of midtibia, outer spot on hindtibia, detached lateral spots on terga I-VI; wings lightly stained and a little milky. Pubescence pale, silvery on clypeus and frons, erect hair inconspicuous except beneath hindcoxa where it is thick and 1.0-1.5 ocellus diameters long, orbital silver lines greatly broadened above where they are nearly contiguous and reach well above scapes. Upper frons, top of head, and scutum irregularly punctate, some punctures well separated; enclosure with about 20 moderately deep areolae, rest of propodeum rough; mesopleuron subshiny, punctures irregularly spaced. Antennal shape, tibial shield and foretarsus shown in figs. 15, 35; clypeus with a well impressed apical bevel which is about half as high as broad; humeral angle sharp but obtuse; foretrochanter with a flattened angle anteroventrally and a small slender tooth posteroventrally; foretibia with a flattened, recurved, apically blunt basal process; midbasitarsus simple, about as long as rest of tarsus; precoxal angle of mesopleuron forming a sharp tooth; sternum VIII concave on apical margin, protruding as a blunt process laterally.

Female. — Length about 10 mm. Maculation about as in male, pronotum with one large or two small spots, metanotum mostly and scutellum sometimes partly ivory, hindfemur all dark (as in male), tergum V with four separated spots or sometimes two kidney-shaped ones. Hair of frons extensively silvery and appressed, erect hair of vertex and scutum quite short, latter fulvous. Scutum with most punctures a diameter apart, more widely spaced on mesopleuron. Mandible simple, fig. 9; apical truncation of clypeus with five weak lobes flanked by a tooth; clypeal bevel, mesopleural precoxal angle and areolation of enclosure as in male.

Male holotype (UCD), 0.5 mi. w. San Lorenzo, Grant Co., New Mexico, August 22, 1971 (E. E. Grissell, R. F. Denno). Paratypes, 15 males, 9 females, July 3-October 24, ARIZONA: Snowflake, McNeal, Kansas Settlement; NEW MEXICO: nr. Silver City, 20 mi. nw. Deming, 19 mi. n. Gallup, Moriarty, 13 mi. ne. Cimarron, Hachita, Nutt; TEXAS: 44 mi. n. Van Horn; 17 mi. e. Balmorrhea; CHIHUAHUA: 10 mi. n. Jimenez, 9 mi. and 60 mi. s. of Hidalgo del Parral; DURANGO: Cuencame; ZACATECAS: 9 mi. s. Fresnillo.

The pale-marked mandible, broadened male forebasitarsus, and denticulate male foretrochanter relate this species to *tumidus*. Male *grisselli* can be separated by the whitish rather than yellow markings, a spine rather than a sharp angle or tooth on the foretrochanter, and a difference in the pattern of the shield. In *grisselli* the middle dark stripe is obviously enlarged (fig. 35), but not in *tumidus* (fig. 33). Females are best separated by color. In addition to the whitish markings of *grisselli,* the wings are somewhat less stained and there is a black inner medial spot on the scape. Also, the prepectus is more coarsely punctate. The species is named for E. E. Grissell, who has taken many aculeate wasps during his collecting trips for Chalcidoidea.

Crabro parmatulus R. Bohart, new species (Fig. 37)

Male holotype. — Length 8 mm. Black with yellow markings as follows: scape mostly, humeral spot, pronotal lobe, outer band on foretibia, mid and hindtibia, metanotum, separated tergal spots on I-VI, band across VII; wings light brownish. Pubescence silvery and appressed on clypeus and frons; orbital stripes expanded above scapes; erect hair on frons, vertex, scutum and mesopleuron very short, that of scutum fulvous; hindcoxa without unusual pubescence. Upper frons, top of head and scutum with rather close punctation; some punctures separated by a diameter; enclosure with about 20 shallow areolae, rest of propodeum closely punctate and obscurely ridged posteriorly; mesopleuron subshiny, some punctures 1-2 diameters apart. Flagellum about as in fig. 15; mandible simple at apex; clypeus with a well impressed apical bevel which is two-thirds as high as broad; humeral angle sharp but obtuse; foretrochanter simple, foretibia slightly flattened but without a basoventral projection; midbasitarsus simple, a little shorter than rest of tarsus; precoxal angle of mesopleuron forming a sharp tooth.

Male holotype (UCD), Huajitlan, Morelos, Mexico, September

27, 1957 (R. and K. Dreisbach).

This is the only species of the group in which the male has no shield. In other respects, except for the black mandible and simple midbasitarsus, it resembles the common and widespread *peltista*.

Crabro peltista Kohl (Figs. 8, 39)

Crabro peltista Kohl, 1888:586. Lectotype ♂ here designated, Orizaba, Veracruz, Mexico, Bilimek Coll. (NHMV).

Crabro incertus W. Fox, 1895:174. Lectotype ♀, Texas (ANSP).

Recognition. — Both sexes have the mandible basally pale, orbital silvery line moderately expanded above, scutal punctures mostly about a diameter apart, and wings stained. Male *peltista* have the basoventral projection of the forefemur short and stout, and midbasitarsus flattened and posteromedially expanded (fig. 8). This last feature is diagnostic. Females usually have tergum V banded but occasionally spotted or all dark.

Distribution. — *C. peltista* is the commonest *Crabro* in Mexico where it assumes the position of *latipes* north of the border. I have seen 594 specimens from almost every state in Mexico, and in Guatemala (Panajachel, Antigua, Guatemala City). It also extends northward into Texas (Eastland Co., Twin Sisters, Roosevelt, Cherry Springs, Palmetto State Park, Del Rio, Davis Ranch) and Arizona (Apache, Portal, Ruby, Patagonia, Sonoita, Nogales, Douglas).

Crabro tenuiglossa Packard (Fig. 34)

Crabro tenuiglossa Packard, 1866:98. Holotype ♀, "Illinois, (Coll. Mr. Norton)" (type depository?).

Thyreopus discifer Packard, 1867:363. Holotype ♂, no locality in original description but "Ill." on label (ANSP).

Thyreopus tenuiglossus "Packard" of Provancher, 1889:292, emendation.

Recognition. — Both sexes have the mandible basally dark, scape all yellow, silvery orbital hair band (golden in male) moderately broadened above, scutal punctures less than a diameter apart, and wings stained. Male *tenuiglossa* have the basoventral projection of the forefemur rather slender, forebasitarsus short and stout (fig. 34), mesopleuron with sparse punctation and somewhat undeveloped, mesopleural hair fine and sparse laterally but forming a thick brush on the concave ventral surface. This last feature is diagnostic. Female *tenuiglossa* are unique in having distinct microridging on the prepectus. Also, the mesopleuron is unusually bulging in front of the precoxal angle.

Distribution. — I have seen 86 specimens from east of the 100th meridian in the United States and as far west as Alberta in Canada.

Crabro tumidus (Packard) (Fig. 33)

Thyreopus tumidus Packard, 1867:364. Lectotype ♂, Pennsylvania (ANSP).

Recognition. — Both sexes have the mandible basally yellow, scape all yellow, silvery orbital line moderately broadened above, scutal punctures separated by about a diameter, prepectus mostly smooth with fine and well separated punctures, and wings somewhat stained. Male *tumidus* have the basoventral projection of the forefemur short and stout, and foretrochanter with a sharp ventral angle or small spine.

Distribution. — *C. tumidus* is widely distributed in the United States east of the 100th meridian. I have seen 47 specimens.

Crabro venator Rohwer

Thyreopus venator Rohwer, 1911:565. Lectotype male, Meadow Valley, Chihuahua, Mexico (USNM).

Recognition. — Both sexes have the mandible basally pale, markings generally ivory colored, erect hair of upper frons mostly longer than an ocellus diameter, scutal punctures mostly about a diameter apart, mesopleural hairs fine and longer than an ocellus diameter, and wings stained. Male *venator* have the basoventral projection of the forefemur rather slender, shield mostly black but shaped like that of *alticola* (fig. 38), and midcoxa with a stout inwardly directed tooth. This last feature is diagnostic. Female *venator* have the carina from the humeral angle to the pronotal lobe obsolete. Also, the prepectus is densely microsculptured between coarse punctures.

Distribution. — Known only from the type series of 11 specimens from Chihuahua and a nesting female collected by H. E. Evans 35 kilometers west of Toluca, Mexico (state).

Biology. — Evans (1964) described the burrow as open surrounded by a ring of tumulus, 14 cm long and ending in three cells. Provisions were 30 to 36 flies per cell of Empididae, Anthomyidae, Muscidae, and Sarcophagidae.

Crabro thyreophorus Group

Both sexes with mandible bidentate apically, without postspiracular carina or omaulus, mesopleuron without a sharp precoxal angle, sculpture

of head and thorax coriaceous but not significantly microridged, hair on head and thorax long and erect, pronotal collar with blunt humeral angles. Male characters: head not hollowed beneath, flagellum moderately stout but cylindrical and without a ventral hair fringe, forefemur ending in a curved and spinelike projection, foretibia with a well developed shield and a basoventral spine, foretarsomere V essentially simple, sternum VII without posterolateral projections, pygidial plate present.

Crabro helvocrinus R. Bohart, new species (Figs. 17, 18, 45)

Male holotype. — Length 9 mm. Black with yellow markings as follows: scape; a pair of irregular spots on pronotal collar; femora distally; tibiae and tarsi except faint dark lines and narrow edging on shield (fig. 45), inner and outer dark spots apically on hindtibia, brown last midtarsomere and brown last three hindtarsomeres; large disconnected spots on terga I-IV, connected on V-VI; broad bands on sterna II-V; wing veins brown, membrane lightly brown stained. Pubescence on head, thoracic pleura and propodeum mostly long, erect and brownish; clypeus with coarse appressed silvery hair as well as a median porrect tuft of brown hair; inner orbital silver stripe ending near scapal apex. Frons and top of head completely and finely granulate, dull, without microridging; scutum closely microsculptured, not ridged, dull; pleuron and propodeum similar but enclosure weakly, irregularly, obliquely ridged. Antennal shape, tibial shield and foretarsus shown in figs. 18, 45; clypeal apex with a faint and narrow bevel; humeral corner blunt; foretrochanter simple, two-thirds as long as femur, forefemoral spine absent, posterior forefemoral projection a large, curved, sharp, posterior process; foretibia proper with a short needlelike, nearly erect, subbasal spine; midbasitarsus about as long as rest of tarsus; pygidial plate rather well defined, granulate.

Female. — Markings, sculpture and pubescence about as in male. Clypeus with median lobe protruding, truncate, not silvery but with a mass of porrect reddish brown hair. Head, thorax and legs extensively covered with long, erect brown hair. Pronotal ridge and lobe mostly yellow, scutellar band and all of hindtibia yellow, broad yellow bands narrowly interrupted on terga I-III, complete on terga IV-V and sterna II-IV, VI. Flagellum greatly broadened (fig. 17).

Male holotype (UCB), Keen Camp, San Jacinto Mountains, Riverside County, California, April 28, 1955. Paratypes, two males, one female topotypes, May 25-28, 1955 (C. D. MacNeill, D. Burdick, UCB, CAS, UCD); one male, Desert Center, Riverside County, April 28, 1955 (D. J. Burdick, UCB); one female, Mariana, Riverside County, May 15, 1946 (UCD); one pair, Sheep Creek near Phelan, San Bernardino County, April 21-24

(A. L. Melander, UCR); one female, Holcomb Valley Public Camp, San Bernardino County, June 1, 1957 (A. Menke, USNM).

Crabro thyreophorus Kohl (Figs. 16, 48)

Crabro thyreophorus Kohl, 1888:585. Lectotype ♂ here designated, Nevada, Morrison Coll., 1880 (NHMV).

Recognition. — This species agrees closely with *helvocrinus* except for a few important details. In both sexes the prominent golden hair tuft on the clypeus is directed forward but not upward. The male shield has a much stronger edging of brown (compare figs. 45, 48). In the female the flagellum is relatively slender (compare figs. 16, 17); the frons, mesopleuron, and scutum are somewhat more shiny; tergal yellow spots are smaller, especially on IV; sterna are dark; and wings are not quite so pale.

Distribution. — I have seen 47 specimens: Nevada (type series), California: Walker Pass (Kern Co.), Arroyo Seco (Monterey Co.), near Truckee (Nevada Co.), Independence Lake and Sierraville (Sierra Co.), Blairsden (Plumas Co.), Hot Lake (Lassen Co.), Big Spring (Shasta Co.), and Alturas (Modoc Co.). Oregon specimens are from Riddle, Dairy, Redmond and Steens Mountains.

Crabro advena Group

Both sexes with mandible bidentate apically, upper frons often microridged, postspiracular carina present but omaulus weak or absent in males and some females, mesopleuron without a precoxal tooth. Male characters: head not unusually hollowed beneath, occipital carina ending some distance from oral fossa, flagellum slender to moderately stout and at most with short and straight hairs beneath, foreleg rather simple except for femoral modifications and well developed tibial shield, foretarsomere V essentially simple, sternum VII with obliquely truncate posterolateral projections which may be sharp at apex, no pygidial plate.

Crabro advena F. Smith (Fig. 52)

Crabro advena F. Smith, 1835:421. Lectotype ♀, Nova Scotia, here designated (BMNH type no. 21.990).

Crabro succinctus Cresson, 1865:479. Lectotype ♀, Colorado Territory (ANSP).

Thyreopus pegasus Packard, 1867:362. Syntypes ♂ ♀, "Mass.", not extant.

Thyreopus signifer Packard, 1867:361. Lectotype ♀, "Massachusetts, Packard Coll.", here designated (MCZ).

Thyreopus advenus "F. Smith" of Packard, 1867:368, emendation.

Crabro discretus W. Fox, 1895:470. Holotype ♀, Washington, D.C. (USNM).

Recognition. — Both sexes have the scape extensively yellow, mandible yellow toward base, most scutal punctures separated by less than a diameter, and propodeal enclosure rather deeply areolate. Male *advena* have fulvous hair on the upper frons, practically no microridging on gena, basoventral spine of forefemur nearly straight, posterior forefemoral angle obtuse and not produced backward, shield with a dark spot near apex of foretibia proper, lower edge of shield denticulate (fig. 52), and sternaulus a complete line of well formed pits. Female *advena* have a broad clypeal bevel, dark fulvous hair on upper frons, and yellow markings on scutellum but not metanotum. The shield (fig. 52) resembles the illustration given for *korbii* Kohl from Spain (Kohl, 1888, fig. 12) and raises the possibility that the *advena* group may occur in the Old World.

Notes on synonymy. — This species has been commonly known as *advenus,* an improper emendation by Packard (1867) of the noun *advena.*

Distribution. — *C. advena* is perhaps the commonest species in eastern North America. It is widespread in southern Canada and the United States from the east coast to the Rocky Mountain crest. In Canada it occurs also in British Columbia and extends south into Washington. Of the 193 specimens examined, none came from Florida or Mexico.

Biology. — Evans (1960) described nesting habits observed near Ithaca, New York. One female constructed a simple burrow in hard clay loam. It ended in eight cells stocked with Rhagionidae, Tabanidae, Otitidae, Muscidae, Calliphoridae, and Sarcophagidae.

Crabro bruneri (Mickel)

Thyreopus bruneri Mickel, 1916:422. Holotype ♂, Sioux County, Nebraska (University of Nebraska Museum).

Recognition. — The male shield of *bruneri* is diagnostic (fig. 42). Together with the tibia proper it is all yellow and without spots or stripes. This distinguishes the species from *vernalis,* a similarly small species (about 7 mm. long) with a small shield. Other similarities to *vernalis* are the triangular foretrochanter, absence of a basoventral forefemoral spine, and a curved, spinose posterior forefemoral projection. Also, the mandibles are all dark, there is a dark basal ring on the scape, and the scutum and mesopleuron are microsculptured overall. Both species have the scutellum of the male and metanotum of both sexes extensively pale, although yellow

in male *bruneri* and white in *vernalis*. Association of the sexes in *bruneri* is based on a collection in the U.S. National Museum from Horse Lake, near Three Sisters, Cascade Mountains, Oregon, July 22, 1909 (J. C. Bridwell), and a pair from Camp Wilderness in southern Idaho. Males are typical and females closely resemble *vernalis*. Differences are in color of the *basitarsi* (brown in *bruneri*) and breadth of the clypeal bevel as given in the key. Otherwise, the two species are closely similar: all black head (except a little white at apex of scape), white hair on frons, microsculptured scutum and mesopleuron, small size (7-8 mm. long), pale metanotum, and slightly yellowed wings.

Distribution. — This species is known from three collections, the type locality in Nebraska, the Oregon record given above, and a pair from Camp Wilderness, southern Idaho, June 28, 1961 (G. F. Knowlton, UCD). I have seen a total of 21 specimens.

Crabro florissantensis Rohwer (Fig. 44)

Crabro florissantensis Rohwer, 1909:149. Holotype ♂, Florissant, Colorado (USNM).

Recognition. — Both sexes have the scape and mandible black, scutum with punctures mostly a diameter or more apart and interspaced with microridges in several areas, strong ridging in front of the scutellum, metanotum yellow spotted, deeply areolate propodeal enclosure, only slightly stained wings, and hindtibia all black. Male *florissantensis* have a fine hair fringe under the flagellum, off-white to brownish hair on frons, basoventral spine of forefemur slender and curved, posterior forefemoral angle projecting stoutly backward, shield with a dark spot near apex of tibia proper, posterior fifth of shield contrastingly dark (fig. 44), and scutellum nearly always yellow marked. The male shield resembles that of *virgatus* but is larger and overcast with greenish on the anterior four-fifths. *C. nigrostriatus* is similar, also, but it has no dark spot near the apex of the tibia proper, and its wings are much darker. Female *florissantensis* have approximate or somewhat remote yellow spots on the first four terga at least. Hair of the frons varies in color as in the male.

Distribution. — The 222 specimens studied are all from the Rocky Mountains and more western mountainous localities. It ranges as far south as the west central mountains of Arizona (Greer) and as far north as Alberta (Banff, Waterton) and British Columbia (Blackwall). I have seen only a single male from California, which I collected in the Santa Cruz Mountains of San Mateo County at an altitude of 2,000 feet. In the United States

it is usually found at elevations of 4,500 to 8,000 feet but I have taken it near Cameron Pass, Colorado at 11,000 feet.

Crabro henrici Krombein (Fig. 46)

Thyreopus vierecki Rohwer, 1910:50. Holotype ♂, Da Costa, New Jersey (USNM). Nec *Crabro vierecki* H. Smith, 1908, now in *Crossocerus*. *Crabro henrici* Krombein, 1951:1016. New name for *vierecki*.

Recognition. — Both sexes have the mandible dark, scape and hindtibia all or mostly yellow, hair of upper frons pale, scutal punctures separated by a diameter or more and extensively overlain with oblique microridging, scutellum and metanotum completely microridged, propodeal enclosure deeply areolate, paired yellow spots on terga I-IV, and a band on V. Male *henrici* have the basoventral projection of forefemur slender and curved; outer angle projecting posteriorly as a long, sharp, curved, slender spine; shield with a dark spot near apex of tibia proper (fig. 46); sternaulus formed by a complete row of pits; and scutellum and metanotum black. The shield pattern in combination with the spinose posterior projection of the male forefemur are diagnostic. Female *henrici* have the mesopleural side nearly all polished.

Distribution. — I have seen 21 specimens from Manitoba, Pennsylvania, New York, New Jersey, Washington (D.C.), and Virginia.

Crabro hispidus W. Fox (Fig. 47)

Crabro hispidus W. Fox, 1895:192. Holotype ♀, Mt. Hood, Oregon (ANSP).

Recognition. — Both sexes have the head all black and thorax mostly so, hindtibia black, hair of frons dark, scutal punctures separated by considerable polished areas and scattered microridging which is strong in front of scutellum, wings stained, and propodeal enclosure with moderately impressed areolae. Male *hispidus* have a very long and slender curved basoventral projection on forefemur, posterior forefemoral angle projecting backward sharply but stoutly, shield with a black spot near apex of tibia, proper, this spot far removed from a small plain area near posterior apex, between the two with translucent spots on a grey background (fig. 47), and abdomen all black. Female *hispidus* have a small triangular clypeal bevel, mesopleural side polished between medium sized scattered punctures, scutellum mostly polished, and terga all dark or with lateral spots on I-III.

Distribution. — The species occurs in mountainous areas of the far western states from Tulare County, California to British Columbia. I have also seen females attributable to this species from

Catron County, New Mexico; San Juan County, Colorado, Lemhi County, Idaho; and Laggan, Alberta. In the absence of males these records must be viewed with caution. Altogether, I have seen 76 specimens from the Pacific Coast states.

Crabro nigriceps R. Bohart, new species (Figs. 20, 43)

Male holotype. — Length 9 mm. Black with yellow markings as follows: outer stripe on foretibia, shield mostly (fig. 43), outer surface of mid and hindtibiae extensively, lateral spots on terga II-III; wings lightly brown stained. Erect hair on upper frons, top of head, scutum and mesopleuron brownish; orbital silver line narrow and extending short of scapal apex; no unusual hair under flagellomere I. Upper frons closely microreticulate and obscurely microridged; top of head more shiny with setal punctures and microreticulation; pronotum transversely microridged; scutum with some close and some well separated punctation as well as extensive longitudinal microridging which extends over all of scutellum; enclosure with about 20 moderately deep areolae, rest of propodeum with somewhat irregular transverse ridging posteriorly and longitudinal ones laterally; mesopleuron subshiny but covered overall with areolae (in front) and curving microridges. Antennal shape, tibial shield and foretarsus shown in figs. 20, 43; clypeal apex with four small lobes, no bevel; humeral corner compressed and acutely projecting; foretrochanter with a large, stout, lamellate apical projection; ventral forefemoral spine small and subbasal; shield nearly triangular, higher than long, practically no posterior bulge; midbasitarsus a little shorter than rest of tarsus.

Male holotype (UCD), the Pas, Manitoba, Canada, July 3, 1917. Paratype, one male, Aziscoos Lake, Maine, July 8 (C. W. Frost, MCZ).

The two known males are superficially similar to those of *virgatus* but the forelegs are entirely different. The rather small shield with essentially straight dorsal edge (fig. 43) is unique. Also notable is the slightly obtuse outer forefemoral angle which does not project backward.

Crabro nigrostriatus R. Bohart, new species (Figs. 1, 19, 49)

Male holoype. — Length 9 mm. Black with yellow markings as follows: stripe along front of foretibia proper and stripe on forefemur beneath; wings brown stained. Pubescence silvery on clypeus, inner orbital line obscure, flagellum with a fine pale fringe beneath, erect hair on upper frons and elsewhere brown. Upper frons closely punctate, becoming longitudinally microridged toward ocelli, vertex partly shiny; pronotum transversely

microridged, scutum with extensive microridging which extends over all of scutellum, enclosure with about 20 moderately deep areolae, rest of propodeum subshiny and coarsely ridged; mesopleuron laterally with complete longitudinal microridging. Antennal shape, tibial shield and foretarsus shown in figs. 19, 49; clypeal apex a little incurved, narrow, bevel polished and transversely linear; humeral corner projecting as a rounded flange; foretrochanter without spines or other projections; ventral forefemoral spine long, slender, curved, subbasal; posterior forefemoral angle recurved and sharply projecting backward; midbasitarsus slightly longer than rest of tarsus.

Female. — Markings, sculpture, etc. about as in male (front legs missing). Clypeal bevel narrowly transverse (fig. 1), scutum with curving longitudinal microridging from anterior margin; mesopleuron mostly polished medially.

Male holotype (UCB), Echo Lake, El Dorado County, California, July 23, 1955, W. W. Middlekauff. Paratypes, 12 males, 1 female, May 15 to July 27; CALIFORNIA: Echo Lake, Glen Alpine Creek and Strawberry (El Dorado Co.), NEVADA: Incline Village; OREGON: Pamelia Lake (Mt. Jefferson), Anthony Lake, Grant County (female), British Columbia: Robson.

The species has many features in common with *hispidus* and females may be difficult to distinguish. Males of *nigrostriatus* have the shield about as high as long instead of longer than high, and there is no dark spot near the apex of the foretibia proper. Also, there is no cloud of grey over the shield.

Crabro vernalis (Packard) (Fig. 51)

Thyreopus vernalis Packard, 1867:369. Holotype ♀, Illinois (ANSP).
Crabro brachycarpae Rohwer, 1908:252. Holotype ♂, Florissant, Colorado (USNM).
Crabro gillettei Rohwer, 1908:418. Holotype ♀, Larimer County, Colorado (USNM).

Recognition. — Both sexes have the mandible dark, hair of frons pale, head without appreciable microridging, scutum finely but irregularly punctate, mesopleural side finely microsculptured and dull, scutellum mostly smooth, metanotum white marked, propodeum finely sculptured and dull, wings lightly stained, abdominal spots or bands whitish, and size small. Male *vernalis* have the scutellum mostly white, foretrochanter triangular, ventral forefemoral spine absent, posterior forefemoral projection a long curving spine, and a small white banded shield with a black ventral spot near apex of tibia proper. A close relative is *bruneri* which is yellow

marked and with an unbanded and unspotted shield. Differences are discussed under *bruneri*. Female *vernalis* have a small clypeal bevel which is about as high as broad. Also, the basitarsus is white on the fore and midlegs.

Distribution. — I have seen 84 specimens (42 of each sex) of this widely distributed boreal species. Localities are in the following states and provinces: Colorado (high altitudes), Wyoming (Foxpark, Medicine Bow Range), Minnesota (Carlton County), Illinois (holotype), New Jersey (Clementon, Cassville), Alaska (Mt. McKinley Park, Naknek, Richard Highway mile 249), Yukon (Watson Lake, Whitehorse), Northwest Territories (Ford Lake), British Columbia (Ft. Nelson, Cranbrook), Alberta (Morley), Manitoba (Churchill, Gillan), Quebec (25 mi. w. Gaspé, Mistassini Post), and Newfoundland (Codroy Pond).

Crabro virgatus W. Fox (Fig. 41)

Crabro virgatus W. Fox, 1895:174. Holotype ♂, Nevada (ANSP).
Crabro veles Carter, 1925:134. Holotype ♂, Edmonton, Alberta (CNC).

Recognition. — Both sexes have the mandible dark basally but sometimes yellow subbasally, erect hair of frons brown, prepectus rough and microridged, scutal punctures less than a diameter apart and partly covered with microridging which is strong in front of scutellum, metanotum and scutellum black and wings stained. Male *virgatus* have the clypeus as in fig. 4 but the median lobe a little broader, basoventral forefemoral spine slender and curved, outer forefemoral angle broad and curved but only slightly projecting backward, shield with a dark spot near apex of tibia proper (fig. 41), sternaulus marked by a series of shallow furrows and complete or incomplete. Female *virgatus* have the scutellum polished in front, scape with considerable yellow, hindtibia mostly yellow, and yellow spots on terga I-V (sometimes bands on I and V). Markings in this species seem to be unusually variable. Tergal spots of males may be reduced to traces or on IV-VI may be absent. The shield has a prominent dark spot which differentiates it from that of *nigrostriatus*. Also, there is no grey cloud as in *hispidus*, and the shield is shorter. Further, the clypeus of male *virgatus* has a more protruding median "snout" than in *hispidus*.

Distribution. — I have studied 50 specimens of which five were females. These were taken in mountainous localities from the central Sierra in California and the Cascade range of Oregon and Washington to Rocky Mountain localities in Colorado, Wyoming,

Montana and Alberta. A single female is from Ontario (Finland) which indicates a more easterly distribution in Canada.

Crabro conspicuus Group

Characters as in *cribrarius* group but male with a small angular projection from inner apex of foretarsomere V (figs. 50, 53-55), and mesopleuron without a sharp precoxal angle. In the four known species the scutellum is always dark in males and usually so in females. Also, the propodeal enclosure of females is shallowly and longitudinally areolate, and the mesopleural side is partly polished. Both sexes have the scutal punctures separated by several diameters of polished integument toward the middle.

On the basis of males two subgroups can be distinguished, each with two species. In the *conspicuus-flavinubis* subgroup the orbital silver stripe is shorter than the scape, the basoventral forefemoral spine is long and curved, the posterior forefemoral angle projects backward, the foretibia proper is black marked, coxae and trochanters are black, and the mesopleural venter is without matted hair. In the *dietrichi-denningi* subgroup the orbital silver stripe reaches the end of the scape, the basoventral forefemoral spine is rather short and nearly straight, the posterior forefemoral angle does not project backward, the foretibia is all pale, coxae and trochanters are extensively pale, and the mesopleural venter is covered with a thick mat of silvery hair.

Crabro conspicuus Cresson (Fig. 54)

Crabro conspicuus Cresson, 1865:480. Lectotype ♀, Colorado Territory (ANSP).

Crabro medius W. Fox, 1895:167. Lectotype ♂, Washington (ANSP).

Crabro viciniformis Viereck, 1907:381. Holotype ♀, "Base of Humphrey's Peak, 9,500 feet, Coconino Co., Arizona" (KU).

Recognition. — Both sexes have the mandible and scape marked with yellow, orbital silver stripe not reaching end of scape, microridging weak or absent in front of scutellum, wings somewhat stained, and terga and usually some sterna yellow spotted or banded. Male *conspicuus* have a double concavity on the gena ventrally and an intervening ridge which nearly connects the end of the occipital carina with the mandible base. Also, the flagellum is concave and most dark beneath, basoventral spine of forefemur long and curved, posterior forefemoral angle projecting stoutly backward, shield with some dorsal lines but ventrally and posteriorly black (fig. 54), mesopleural venter with moderately long and erect grey hair, and coxae as well as trochanters black. Female *conspicuus* often have the pedicel partly or all yellow. The dorsally lined but mostly dark shield is diagnostic in the group.

Distribution. — *C. conspicuus* is the second most common far

west species after *latipes*. I have studied about 300 specimens from northern Arizona, California and Nevada north to British Columbia. It occurs from sea level to 9,000 feet in central California. Southern California records are from 100 feet altitude near the coast in Ventura County to 3,500 feet in the San Bernardino Mountains.

Biology. — I collected a female at Sagehen Creek in Nevada County, California carrying a medium sized female rhagionid fly, July 5, 1966.

Crabro denningi R. Bohart, new species (Figs. 21, 53)

Male holotype. — Length 7 mm. Black with whitish yellow markings as follows: mandible mostly, clypeus, scape, most of foreleg including tibia proper and associated spot on shield as well as a posterior one; yellow are: midleg, hindleg mostly except dark inner surfaces and tarsomeres II-IV posteriorly, broad bands partly interrupted medially on terga I-VI, lateral spots on sterna II-V; wings nearly clear; flagellum dull yellow beneath. Pubescence pale fulvous on frons, top of head and notum, silvery and forming a mat beneath mesopleuron, a small and weak curled tuft under flagellomere I. Upper frons moderately punctate and shagreened, becoming microridged in front of midocellus; pronotum partly shiny; scutum and scutellum with most punctures separated by a diameter or more, no microridging; enclosure weakly and shallowly areolate, some tendency toward longitudinally oblique carinae; mesopleural side partly ridged anteriorly, mostly polished medially. Antennal shape, foretibia and foretarsus shown in figs. 21, 53; median lobe of clypeus broadly rounded between lateral teeth, no perceptible bevel; forecoxa ending in a small posterior tooth; foretrochanter simple; basoventral forefemoral spine straight and subbasal, outer femoral angle obtuse and not prolonged posteriorly; midbasitarsus slender, a little shorter than rest of tarsus.

Male holotype (Univ. Minnesota), Lisbon, North Dakota, May 30, 1940 (D. G. Denning). Paratypes one male, (UCD), same data as holotype; one male, Elbow, Saskatchewan, June 10, 1960 (A. R. Brooks, CNC).

This species, known only from the male, is closely related to *dietrichi* as indicated in the discussion of group and subgroup characters. It differs in three main respects: It is smaller, only 7 mm long; flagellomere I has only a weak ventral tuft; and rounded spots of the shield stop well short of the posterior apex (best seen from inside).

Crabro dietrichi R. Bohart, new species (Figs. 22, 55)

Male holotype. — Length 8 mm. Black with yellow as follows: mandible, clypeus, scape, most of foreleg proper, clouds on shield, much of mid and hindlegs (including coxae and trochanters) except for extensively dark hindfemur and hindtarsomeres II-IV; narrow tergal bands (connected spots) on I, IV-VI; approximate spots on terga II-III; lateral dots on sterna II-III; wings practically clear; flagellum dull yellow beneath. Pubescence of clypeus and venter of mesopleuron dense and silvery, matlike; upper frons and propodeum with white hair; flagellomere I with a definite curled tuft of white hair beneath; inner orbital silver line narrow but reaching to apex of scape. Upper frons punctate to microridged, top of head rather closely sculptured, scutum punctate and with extensive polished discal areas but with no posterior microridging, enclosure with about 20 areolae, rest of propodeum rough or microridged, mesopleural side sculptured in front, largely polished medially. Antennal shape, tibial shield and foretarsus shown in figs. 22, 55; clypeal apex undulate, lateral corners acute, no perceptible bevel; flagellum not nodose in profile; occipital carina continued forward as a sharp ridge almost to mandible base; humeral corner an obtuse ridge, ventral forefemoral spine curved and basal; outer forefemoral angle practically a right angle, not recurved nor projecting backward.

Female. — Length 8-9 mm. Markings whitish, pronotum and scutellum usually maculate, coxae and trochanters often dotted, metanotum with two dots, tergal spots usually separated, tergum I sometimes all dark, sternal ones sometimes absent. Clypeal apex broadly truncate, apical margin a little wavy; bevel rather weak, about 3 times as broad as high; ridges of propodeal enclosure coarse but obliquely longitudinal.

Male holotype (Cornell Mus.), Prince Edward Island National Park, Ontario, Canada, October, 1958 (A. and H. Dietrich). Paratypes, 20 males, 10 females, May 25, June 14, July 19, August 22, September 7 and October; Ontario: Prince Edward Island National Park; Saskatchewan: Pike Lake, Canora; Manitoba: Onah. One female (not a paratype), Rock Springs, Wyoming, June 19, 1920 (AMNH).

The close relationship of this species to *denningi* is emphasized in the previous discussion on subgroups. Both species have the male coxae and trochanters extensively pale and females of *dietrichi* show a tendency in this direction, also. Most obvious differences are the rather well developed hair tuft beneath flagellomere I of male *dietrichi* and the presence of rounded spots near the dorsoposterior apex of the shield.

Crabro flavinubis R. Bohart, new species (Figs. 23, 50)

Male Holotype. — Length 8 mm. Black with yellow as follows: spot on outer side of forefemur, broad stripe on foretibia proper, shield extensively in spots and an overall cloud, outer stripe on midtibia and basitarsus, narrowly separated tergal spots on I-VI, closest on I; wings almost clear. Pubescence silvery to whitish, flagellomere I without a hair tuft, inner orbital silvery line narrow and ending before apex of scape, hair beneath mesopleuron moderate and erect. Upper frons and top of head moderately and irregularly punctate, microridging weak, scutum punctate and microridged, latter extending over scutellum, enclosure with about 20 areolae, rest of propodeum rather shiny but with irregular sculpture, mesopleuron rather completely punctate and microridged. Antennal shape, tibial shield and foretarsus shown in figs. 23, 50; clypeal apex weakly truncate, with a distinct low bevel; flagellum strongly nodose in profile; occipital carina not continued toward mandible base; humeral corner a small flange; ventral forefemoral spine curved and basal, posterior forefemoral angle somewhat recurved and broadly projecting backward.

Female. — Length 9 mm. Abdomen all black or with small submedian spots on one or more of terga I-IV, foretibia with an outer streak of yellow, midtibia with a basal dot, legs otherwise dark. Clypeal apex not protruding, bevel distinct and about half as high as broad; ridges of propodeal enclosure 12-15 and moderately to widely separated, oriented longitudinally.

Male holotype (UCB), Mono Pass, Inyo County, California, August 13, 1957 (J. Powell). Paratypes, 18 males, 24 females, July 7 to August 30; CALIFORNIA: EL DORADO COUNTY: Angora Peak (E. Essig, UCB); ALPINE COUNTY: Carson Pass (E. Grissell, UCD); MONO COUNTY: Duck Lake (R. Bohart, UCD), INYO COUNTY: Mono Pass (D. Linsdale, J. Powell, USNM, ANSP, UCB, UCD) Ruby Lake (D. Linsdale, J. Powell, UCB), Upper Rock Creek (M. Tauber, C. Toschi, UCB); TUOLUMNE COUNTY: Sonora Pass (C. Toschi, M. Irwin, UCB, UCD); FRESNO COUNTY: Lone Indian Lake (E. Schlinger, UCD), Pioneer Basin, 10,000 feet (E. Schlinger, UCD).

A relationship with *conspicuus* is indicated by the previous subgroup discussion. However, in several respects *flavinubis* differs from any of the other three species in the group. Both sexes have the head, notum and hindleg all black; and prescutellar microridging is well developed. In males the gena is not concave or ridged, the flagellum is conspicuously nodose beneath, the shield has many spots on the ventral half and is largely overcast with

yellow, and the mesopleural side is rather completely microsculptured. In females the abdomen may be all dark or at least dark on tergum V and following.

Crabro cribrarius Group (= nearctic *latipes* Group)

Both sexes with mandible bidentate apically, upper frons often microridged, postspiracular carina present but omaulus tending to be weak or absent in some species, mesopleuron sometimes with a sharp precoxal angle. Male characters: head in ventral genal area with two hollows separated by a weak or sharp ridge from end of occipital carina toward mandible base, outer hollow serving as a foretibial receptacle if leg is brought forward, flagellum often broadened (fig. 27) and first article sometimes with a ventral tuft of curled hairs. Foretrochanter sometimes spinose, forefemur complex, foretibial shield well developed, sternum VII with sharp and slender posterolateral projections, no pygidial plate.

In males of most species the outer posterior angle of the forefemur projects stoutly backward and together with the strong but flexible basoventral spine appears to form a sort of clamp. It may be supposed that this apparatus fits over the female forefemur during copulation with downward pressure being exerted on the male foretibia positioned in the outer genal hollow. Also, the remarkable foretarsal process of the male may engage the female foretarsus. This is pure speculation and certainly there are no corresponding structures in females.

Several small subgroups can be distinguished. *C. argusinus* stands alone on the basis of the pectinate male flagellum (fig. 31) and short flagellomere I in the female. Two species, *opalescens* and *spinuliferus* are notable for the pair of anteroventral mesopleural spines in the male. Also unusual is the presence of a sharp precoxal angle in the female of these two species but not in the male. A somewhat less cohesive subgroup is formed by those species in which the longitudinal ridges of the propodeal enclosure of the female are rather close, fine and parallel. This includes *deserticola, latipes* and *villosus*.

Crabro argusinus R. Bohart (Figs. 3, 13, 31, 68)

Thyreopus argus Packard, 1867:359. Lectotype ♂, Brunswick, Maine, here designated (MCZ specimen with antennae). Nec *Sphex argus* Christ, 1791 (= *Crabro cribrarius* Linnaeus).

Crabro argusinus R. Bohart, 1976:407. New name for *argus* Packard.

Recognition. — Both sexes have the orbital silver line rather diffuse and greatly broadened above, submarginal cell with posterobasal veinlet only a little longer than posterodistal veinlet, propodeal enclosure deeply areolate and markings yellow. Male *argusinus* have the flagellum broadly pectinate (fig. 31), a strong ventral genal ridge, ventral forefemoral spine arising

near middle of femur (fig. 13), shield with numerous spots which reach almost to posterior tip (fig. 68), mesopleural venter with a dense mat of silvery hair which obscures punctation, midleg almost entirely yellow, and a row of four to six stiff bristles across apex of sternum III. Female *argusinus* have two unique features: flagellomere I less than 1.5 times as long as wide and shorter than II, and clypeus very broadly and sharply truncate (fig. 3). In addition the scutal punctures are rather small and mostly about a puncture diameter or less apart.

Notes on synonymy. — Since *Thyreopus argus* Packard and *Sphex argus* Christ are both now in *Crabro,* it was necessary to change Packard's name. The many peculiarities of *argusinus* led Pate (1947) to erect a separate subgenus for it, *Norumbega.* Considering the male foreleg morphology, this seems unnecessarily divisive.

Distribution. — *C. argusinus* is widespread and rather abundant in eastern United States but more rare in the west. Of the 212 specimens I have studied, only 3 are Californian: Antioch and Auburn. The species occurs also across the continent in southern Canada and there is one record from Fort Smith in the Northwest Territories (CNC).

Biology. — Evans (1960) observed about 25 nests in a New York sand bank. The open burrows ended in one to four cells at a distance from the entrance of 18 to 35 cm. Cell provisions averaged 15 flies in the families Dolichopodidae, Ephydridae and Muscidae.

Crabro comosiceps R. Bohart, new species (Figs. 5, 24, 54)

Male holotype. — Length 11 mm. Black with yellow as follows: Mandibular spot, clypeus except across apex, scape, pronotal ridge, spot on pronotal lobe, scutellar band, tibiae outwardly (shield spots whitish), midbasitarsus, bands on terga II-VI, those on II-III broken medially, wings brown stained. Venter of head with dense, rather long, pale, curled, mat-like pubescence; hair of frons pale fulvous and long, orbital silver streak narrow and ending below top of scape. Upper frons with strong microridging; scutum coarsely, closely and somewhat rugosely punctate, longitudinal microridges in front of scutellum; propodeal enclosure with eight strong and nearly longitudinal ridges with some finer ridges interspersed; mesopleuron rugosopunctate in front of episternal sulcus, polished between irregularly spaced punctures behind it. Flagellum (fig. 24) with a small curled hair tuft beneath flagellomere I, apical clypeal margin with strong submedian

corners; pronotal angle prominent, lobular; foreleg with trochanter edentate; forefemur with thin, stout, backward projecting outer angle, basoventral forefemoral spine curved, tibia (fig. 54); midbasitarsus rather stout, as long as rest of tarsus.

Female. — Length 12 mm. Venter of head with long, erect, pale hair. Clypeal bevel about twice as broad as high (fig. 5); pronotal angle small, scutal punctures separated by 0.5 to 1.5 diameters.

Male holotype (UCD), Rustler Park, Chiricahua Mts., Arizona, June 18, 1969 (R. M. Bohart). Paratypes, male topotype, June 22, 1955 (A. Anderson, M. Statham, AMNH); female, Onion Saddle, Chiricahua Mts., Arizona, September 13, 1955 (G. E. Bohart, UCD); male, 13 mi. e. Zitacuara, Michoacan, Mexico, June 1, 1953 (E. I. Schlinger, UCB).

The furry pubescence beneath the head of the male is distinctive. The all dark tergum I in both sexes is also unusual among species with otherwise maculate terga. The Mexican male has a well developed black spot on the foretibia proper. The broadened male flagellum and the longitudinal ridging of the propodeal enclosure relate this species to *latipes* but the shield is more like that of *cribrellifer*. However, the latter has a strong ventral tuft on male flagellomere I and a deeply areolate propodeum.

Crabro cribrellifer (Packard) (Fig. 60)

Thyreopus cribrellifer Packard, 1867:358. Lectotype ♂, Illinois (ANSP).
Thyreopus sinuatus Provancher, 1883:664. Holotype ♀, Toronto, Canada (type depository?). Nec *Crabro sinuatus* Fabricius, 1804.
Crabro provancheri W. Fox, 1895:168. New name for *sinuatus* Provancher.

Recognition. — Both sexes have the mandible yellow marked but scape all dark, orbital silvery line not reaching to end of scape, most scutal punctures about a diameter apart or less, propodeal enclosure deeply areolate, and overall markings yellow. Male *cribrellifer* have flagellomere I broader than long (flagellar outline about as in fig. 26), a strong fulvous hair tuft under flagellomere I, and mesopleuron above sternaulus almost entirely polished. The combination of yellow marked mandibles and all black scape is quite unusual in *Crabro*.

Distribution. — Records are from eastern United States at elevations below 1,000 feet and as far west as Minnesota (Grand Rapids), Indiana and Florida. It occurs also in Nova Scotia, Quebec and Ontario. I have seen about 85 specimens.

Biology. — Prey have been reported by Krombein (1951:1017) to be *Ommatius tibialis* Say (Asilidae).

Crabro deserticola R. Bohart, new species (Figs. 27, 64)

Male holotype. — Length 9 mm. Black with abundant yellow markings as follows: mandible and clypeus mostly, scape, humeral spot, dot on pronotal lobe, foretibia proper mostly, posterior spot on shield (overall pattern, fig. 64), coxa and trochanter of midleg ventrally, midfemur except outer black stripe, midtibia, mid and hind tarsi mostly, spots on terga I-VI, well separated on I, joined medially on IV-VI, small lateral sternal spots on II-IV; foretrochanter, forefemur and associated spot on shield whitish, tarsi distally reddish, wings lightly brown stained. Pubescence pale and off-silvery on frons, reddish on mesonotum, white and abundant ventrally on mesopleuron, a prominent curled tuft under flagellomere I, inner orbital silver line narrow and extending nearly to apex of scape. Upper frons and top of head with close punctation and longitudinal microridging, scutum irregularly and rather closely sculptured, some longitudinal microridging posteriorly, scutellum with many well separated punctures, propodeal enclosure moderately punctate and with nearly regular oblique microridging, mesopleuron closely microridged but with a large polished area toward metapleuron. Antennal shape, tibial shield and foretarsus shown in figs. 27, 64; clypeus truncate apically but thin and hardly beveled, submedian angle obtuse; occipital carina not extended toward mandible; foretrochanter with a small but sharp and erect spine subapically; forefemur beneath with a stout curved basal spine; outer forefemoral angle curved, apical process short and stout, similar to that shown for *digitatus* (fig. 13b); midbasitarsus slender, curved, 1.5 times as long as rest of tarsus.

Female. — Length about 10 mm. Mandible, clypeus, scape and scutellum mostly yellow; hair of frons off-white; middle of scutum with punctures separated by about a diameter or less. Corners of clypeal truncation slightly acute; clypeal bevel distinct and about one-third as high as broad; pronotal angle small; ridges of propodeal enclosure fine, close and nearly longitudinal.

Male holotype (UCD), Borrego Valley, San Diego County, California, March 26, 1959 (R. M. Bohart). Paratypes, 35 males and 20 females, February 9-June 1 and October 11-November 6, CALIFORNIA: Borrego Valley, Thousand Palms, Blythe, Andreas Canyon (Riverside County), Fresno; ARIZONA: Gila Bend, Tucson, Santa Catalina Mountains, Nogales, Grand Canyon (Phantom Ranch), "southern Arizona"; NEW MEXICO: Hot Springs.

The male is easily recognized by the distinctive shield (fig. 64)

which has a large yellow spot near the posterior tip. Also, flagellomere I is broader than long (fig. 27) and has a large ventral hair tuft. The midleg has the basitarsus unusually long and the trochanter and femur yellow with a posterior black stripe. Female *deserticola* resemble those of *latipes*, especially with respect to the propodeal enclosure. Principal differences are the white hair of the frons in *deserticola* and the more densely punctate scutum.

Crabro digitatus R. Bohart, new species (Figs. 14, 30, 63)

Male holotype. — Length 9 mm. Black with yellow markings as follows: Mandibular spot, two clypeal spots, scape in front, weak pronotal spots, forefemur partly, midfemoral dot, foretibia proper and associated spot on shield, spots and streaks on shield (fig. 63), mid and hindtibiae outwardly, basitarsi mostly, separated tergal spots on I-IV, narrowly so on IV, narrow bands on V-VI, lateral sternal dots on II-IV; wings lightly stained. Pubescence of frons and mesopleural venter pale fulvous, fairly long, not thick, inner orbital silver line not extending beyond scape, notal hair fulvous to reddish brown, a few curled hairs under flagellomere I. Upper frons and top of head granulate to weakly microridged, pronotum punctate and with some oblique microridging; scutum closely punctate and with faint posterior microridging, some microridges also on scutellum; enclosure deeply areolate, rest of propodeum rather coarsely sculptured and with transverse areolae posteriorly; mesopleural side ridged in front, mostly polished medially. Antennal shape and foreleg structure shown in figs. 14, 30, 63; clypeus rounded apically and with a low weak bevel; occipital carina not continued toward mandible base; foreleg with trochanter simple, basoventral forefemoral spine curved, outer forefemoral angle hardly projecting backward but produced into a fingerlike process at right angles to ventral femoral plane (fig. 14); midbasitarsus slender, about 1.2 times as long as rest of tarsus.

Female. — Unknown. Possibly confused with *advena* in collections.

Male holotype (UCD), Delta County, Michigan, July 2, 1955 (R. R. Dreisbach). Paratypes, 13 males, June 20 to August 7. MICHIGAN: Marquette Co. (R. Dreisbach, UCD), Cheboygan Co. (H. Hungerford, KU); MINNESOTA: Hennepin Co. (U. Minn.), Brainerd (D. Pletsch, U. Minn.), Gull Lake (F. Uhler, USNM); WISCONSIN: Clark Co. (UCD); ILLINOIS: Chicago (UCD); OHIO: Logan Co. (D. J. Borror, U. Minn.), NEW YORK: Springlake, Cayuga Co. (UCD), Ithaca (CU), Bemus Point (H. Townes); "CANA" (UCD); ONTARIO: Ottawa (CNC).

Critical characters are flagellomere I about as broad as long (fig. 30) and with a weak ventral hair tuft, the peculiar fingerlike projection near the posterior angle of the forefemur (fig. 14a), the hardly projecting posterior forefemoral angle (fig. 14b), the densely punctate scutum, and the deeply areolate propodeal enclosure. The brown shield with its well distributed yellow spots and stripes is quite distinctive (fig. 63).

Crabro flavicrus R. Bohart, new species

Male holotype. — Length 8 mm. Black with ivory white markings as follows: Sublateral spot on mandible, two large clypeal spots, scape in front, forefemur mostly, foretibia proper except for large apical brown spot, stripes on upper part of shield, midtrochanter mostly, midfemur with broad anterior and posterior stripes, midtibia except beneath, midtarsomeres I-II, long anterior and posterior spots on hindtibia, hindtarsomere I, slender separated spots on terga I-V, that on II with a continued black dot, venter all dark, wings slightly stained and with brown veins. Pubescence of upper frons and mesopleural venter white, that on dorsum of thorax short and dark, inner orbital silver line reaching to apex of scape, inner genal concavity with a dense brush of partly appressed fulvous hair, a large tuft of curled brown hairs under flagellomere I. Upper frons rather sparsely punctate, becoming microridged in front of ocelli; top of head rather closely punctate; scutum with fine and nearly even punctation, punctures mostly one to two diameters apart; enclosure broadly and shallowly areolate, rest of propodeum irregularly ridged but mostly smooth and shiny; mesopleural side microridged and with a large polished area, basoventral area of mesopleuron punctate. Antennal shape about as in fig. 30, foreleg as in fig. 61 but without either small median spots on shield or a long line on tibia proper; clypeal apex with a minute bevel; humeral corner obtusely angled; foretrochanter simple, basoventral forefemoral spine slender, curved, basal; posterior forefemoral angle projecting backward and subdentate beneath toward apex; midtrochanter with a small right-angled projection at inner base; midbasitarsus about 1.5 times as long as rest of tarsus.

Female. — Unknown, possibly confused with *tenuis* in collections.

Male holotype (CNC), Elkwater Park, Alberta, July 30, 1952 (L. A. Konotopetz). Paratypes, 5 males, June 10 to July 19; Alberta: Elkwater Park (A. R. Brooks, UCD), 15 mi. e. Morley (W. R. M. Mason, CNC, UCD), Lethbridge (E. E. Sterns, CNC); British Columbia: Vassequer (W. B. Anderson, CNC).

This species is very close to *tenuis*. Main differences are the whitish entire ventral surface of the midleg, white dorsoposterior

stripe on the midfemur, and especially the absence of round spots in the middle of the shield. The large brown hair tuft under flagellomere I is peculiar to both *tenuis* and *flavicrus*.

Crabro largior W. Fox

Crabro largior W. Fox, 1895:161. Lectotype ♀, Nevada (ANSP).

Recognition. — Both sexes are large (length about 12 mm), orbital silvery stripe does not reach end of scape, hair of upper frons is brownish, abundant markings are yellow, and sculpture of the propodeal enclosure is shallow and largely longitudinal. Male *largior* have flagellomere I longer than broad (as in fig. 32) and with a large ventral hair tuft, shield mostly dark and about as in figure 57, mesopleural venter with abundant partly erect pale hair, and scutal punctures as much as a diameter apart in ridged areas. Female *largior* have a broad, low and distinctly impressed clypeal bevel; and scutal punctures less than a diameter apart. There is no longitudinal prescutellar ridging. The species is close to *monticola*, differing in the much stronger flagellar tuft in *largior* males as well as the shallower, more longitudinal ridging of the propodeal enclosure and denser scutal punctation in both sexes.

Distribution. — The 80 specimens which I have seen were collected west of the 100th meridian. Records are from British Columbia, Alberta and all of the western States except Arizona, New Mexico and Idaho. Most easterly localities are Alberta (Banff), South Dakota (Mt. Rushmore), and Colorado (Boulder).

Crabro latipes F. Smith (Fig 69)

Crabro latipes, F. Smith, 1856:396. Holotype ♂, Nova Scotia (BMNH).
Crabro vicinus Cresson, 1865:479. Lectotype ♀, Colorado Territory (ANSP).
Thyreopus coloradensis Packard, 1867:356. Lectotype ♂, Colorado (ANSP).
Thyreopus elongatus Provancher, 1889. Holotype ♂, Cap Rouge, Quebec (type depository?).
Crabro canadensis Dalla Torre, 1897. Unnecessary new name for *elongatus* Provancher.
Crabro pratus Carter, 1925:133. Holotype ♀, Chin, Alberta (CNC).

Recognition. — Both sexes have the mandible partly and scape mostly pale, orbital silvery stripe ending before apex of scape, scutal punctures separated by two or more diameters medially, and propodeal enclosure with close longitudinal ridging (especially in female). Male *latipes* have flagellomere I broader than long but without a ventral hair tuft, forefemur with

basoventral spine long and curved, outer forefemoral angle stoutly projecting backward, foretibia proper with an apical black spot or line, shield with three pale stripes of which most ventral one reaches posterior membranous tip (usually frayed fig. 69), basal declivity of mesopleural venter polished and sharply margined posteriorly, midleg nearly all pale ventrally, midtarsomere I twice as long as rest of articles combined. Female *latipes* have clypeal bevel weakly impressed and about half as high as broad, hair of upper frons fulvous to brown, mesopleural side extensively polished, tergal bands often complete except on II-III where spots are usually close. Markings on the shield are unique and diagnostic (fig. 69).

Notes on synonymy. — The types of *latipes* and *pratus* are the white marked form of the species and represent the sort commonly found at higher altitudes or farther north. I have not seen the type of *elongatus* but the description shows it to be an intermediate color form. Both *vicinus* and *coloradensis* are the yellow variety.

Distribution. — *C. latipes* is the most abundant species in America north of Mexico, accounting for at least half of all *Crabro* in collections. I have studied more than 2,000 specimens from Transitional to Canadian life zones across the United States and Canada. Most northern records are from Alaska (Fairbanks, Anchorage) and southern ones are from California (San Jacinto Mountains), Arizona (Catalina Mountains), and Kansas (Goodland).

Biology. — Considering the relative abundance of this species, it is surprising that the biology is not well known. In July, 1972 I observed a female provisioning a nest in gravelly meadow soil at an elevation of 8,000 feet on Mt. Rose, Nevada. The burrow, which was left open, was 6 cm deep and ended in a single cell. Provisions were about 15 muscoid flies and at least some of these were *Musca domestica* Linnaeus. Unfortunately, the burrow was excavated before its completion, so there is no information on the egg or on possible additional cells.

Crabro leopardus R. Bohart, new species (Figs. 4, 29, 56)

Male holotype. — Length 8 mm. Black with yellow as follows: Dull mandibular spot, scape in front, forefemur partly, foretibia proper, adjacent area of shield, mid and hindtibiae outwardly, latter dark towards apex, lateral spots on terga I-IV, spots more widely separated anteriorly; wings brown stained. Pubescence pale and rather short on upper frons and beneath mesopleuron, some dark stubby hair on top of head and extensively

on scutum, inner orbital silver line narrow and not exceeding apex of scape but weakly diverging inwardly above, flagellum with a weak ventral fringe of hairs which become longer basad and form a small curled white tuft under flagellomere I. Upper frons punctate, reticulate and weakly ridged longitudinally, top of head closely punctate; scutum not ridged, closely punctate except medially where punctures may be a diameter apart; mesopleural side coarsely ridged in front, mostly polished elsewhere; enclosure with about 20 areolae, rest of propodeum coarsely areolate posteriorly and mostly polished laterally. Antennal shape, tibial shield and foretarsus shown in figs. 29, 56; clypeal apex projecting as a very narrow, beveled truncation, flanked by a more receding sharp tooth (fig. 4); occipital carina not continued toward mandible base; humeral corner a small flange projecting forward and outward; tegula declivous and grooved anteriorly; basoventral forefemoral spine curved; outer forefemoral angle blunt and rounded, not projecting posteriorly; shield longer than high, anterior edge serrate; projection of foretarsus V slender; precoxal angle of mesopleuron a sharp tooth; midbasitarsus slender and longer than rest of tarsus.

Female. — Length 8 mm. Mandible, clypeus, scape, hindleg, scutellum and metanotum black; terga I-IV with lateral yellow spots, those on II-IV narrow and anteriorly emarginate; erect hair of frons short and black; no microridging in front of ocelli. Clypeal apex with a narrow median lobe bearing an oval depression; propodeal enclosure with broad areolae of moderate depth.

Male holotype (UCD), Sagehen Creek, Nevada County, California, on manzanita, July 10, 1974 (R. M. Bohart). Paratypes, 1 female, same data as holotype; 3 males, CALIFORNIA: Glen Alpine Creek, Lake Tahoe, El Dorado County, July 25, 1915 (E. P. Van Duzee, CAS); OREGON: Geary Ranch, Klamath Falls, on *Prunus,* July 15, 1963 (Joe Schuh, UCD); Dixie Creek Forest Camp, Grant County, July 11, 1953 (Roth and Beer, OSU).

The male foreleg, with its peculiarly shaped and beautifully patterned shield as well as the slender projection of tarsomere V is unique (fig. 56). Also, it is the only nearctic male of the *cribrarius* group to have a sharp precoxal tooth as in the female. Other features are the relatively slender flagellomere I (fig. 29) with only a weak ventral tuft, and the obtuse outer forefemoral angle which does not project backward.

The only known female has peculiarities also. In addition to the precoxal tooth of the mesopleuron, it has an oval rather than triangular depression at the clypeal apex. Also, the hindleg is all

black, an unusual feature in females of this group. Furthermore, there is a perceptible sternaulus which has not previously been noted in females.

Crabro monticola (Packard) (Figs. 32, 57)

Thyreopus monticola Packard, 1867:367. Holotype ♀, "Pinkham Notch, Jackson, N. H." (MCZ).

Crabro monticolus Packard of W. J. Fox, 1895:163, emendation.

Recognition. — Both sexes are larger than average (length about 11-13 mm), marked with yellow, hair of frons brownish, silver orbital line not nearly reaching end of scape, and more medial scutal punctures separated by a puncture diameter or considerably more. Male *monticola* have flagellomere I longer than broad (fig. 32) and with a weak ventral hair tuft, shield mostly dark (fig. 57), moderate white hair on the mesopleural venter, and deeply areolate propodeal enclosure. Female *monticola* have the mandible with a dull yellow spot only, fairly deep but essentially longitudinal areolae in the propodeal enclosure, and an abundance of long fulvous to brownish hair on the head and thorax. Males can be separated from those of *largior* by the weak flagellar tuft of *monticola*. Except for somewhat darker markings in *monticola* and slightly less dense scutal punctation, the two species are quite similar in the female.

Distribution. — I have seen 50 specimens taken in most of the eastern seaboard states from Georgia to Maine. It occurs also in Michigan (Midland County) and Minnesota (Calhoun County, Hennepin County, Itasca County). Krombein (1951) recorded it from Canada. So far as known, its range is confined to the east and northeast on the eastern side of the 100th meridian.

Biology. — Evans (1960) described nests observed personally in Connecticut and by H. Dietrich and wife in Maine. These were all in firm sandy soil, the entrances surrounded by tumulus. Burrows were as deep as 45 cm but some cells were only 7-11 cm from the entrance. Provisions were mostly male flies and all were tabanids (*Tabanus, Chrysops, Stonemyia*) except one therevid (*Thereva*). As in other *Crabro* the prey were apparently killed at the time of capture.

Crabro opalescens R. Bohart, new species (Figs. 26, 67)

Male holotype. — Length 9 mm. Black with whitish yellow markings as follows: Mandible and clypeus mostly, scape, forefemur and foretibia proper mostly, midfemur except posteroventral stripe, hindfemur apically,

midtibia, hindtibia except inner and outer spots, tarsi mostly except outer spot on forebasitarsus, dots on metanotum, broad bands (medially joined spots) on terga I-VI; markings on outer side of shield partly obscured by opalescent yellow cloud except for dark posterior tip (fig. 67); wings faintly brown tinted. Pubescence pale, silvery on clypeus and frons, inner orbital silver line reaching above scape and broadened above to about four mid-ocellus diameters, a moderate curled tuft of white hair beneath flagellomere I, moderate white hair beneath mesopleuron and extending onto metasternum. Upper frons and top of head with separated punctures and latter with weak microridging; scutum with punctures mostly separated by 1.0-1.5 diameters; enclosure with about 25 shallow areolae, rest of propodeum with some ridges but mostly subshiny. Antennal shape, tibial shield and foretarsus shown in figs. 26, 67; clypeal apex undulate, bevel obscure, submedian angle obtuse; occipital carina continued forward almost to mandible base; humeral corner acutely projecting; forecoxa with an inner posterior tooth; foretrochanter angled apically or with a minute spine; basoventral forefemoral spine curved and slender; posterior forefemoral projection moderate and subdentate within; mesopleuron with a pair of anteroventral, submedian, toothlike spines; midbasitarsus about 1.2 times as long as rest of tarsus.

Female. — Length about 10 mm. Pronotum, mesopleural spot or spots, anterolateral spot on scutum, scutellum, metanotum, legs extensively including broad apical ring on hindfemur, yellow. Hair of frons white, top of head with macropunctures separated by microreticulation; scutum as in male. Clypeal bevel broad and transversely impressed; a sharp precoxal angle on mesopleuron; ridges of propodeal enclosure coarse, widely separated, obliquely longitudinal.

Male holotype (UCD), 15 mi. e. Reno, Nevada, June 4, 1963 (M. E. Irwin). Paratypes, 20 males, 8 females, May 1 to June 4 and August 13 to October 3; NEVADA: 15 mi. e. Reno; CALIFORNIA: Apple Valley, Kramer Junction, "Los Angeles County", 2 mi. e. Lone Pine, Deep Springs (Inyo County); UTAH: Moab, Leeds Canyon; NEW MEXICO: Pinedale.

There is an obvious relationship between *opalescens* and *spiniliferus*. Males of the two species share the broad flagellomere I with its large ventral hair tuft, broadly expanded silvery orbital line, a sharp straight ridge from the occipital carina nearly to the mandible base, many spots medially on the shield, nearly all pale midleg except for a ventroposterior black line on the femur, wings only slightly stained, a pair of small spines anteroventrally on the mesopleuron, and rather deeply areolate propodeal enclosure.

Easy points for separation are the absence of a dark apical spot on the foretibia proper and an opalescent cloud over the shield in *opalescens*. Also, the outer posterior angle of the forefemur projects backward bluntly and weakly in *opalescens*. Females of the two species have a sharp precoxal angle on the mesopleuron and expanded orbital hair lines. In *opalescens* the clypeal bevel is rather broad and short but conventional whereas in *spinuliferus* it is deflected and the entire apical margin is concave (fig. 6). Also, the midfemur of *opalescens* is mostly yellow posteriorly and the prepectus may be also. In *spinuliferus* the midfemur is mostly black posteriorly and the prepectus is black as usual in the group.

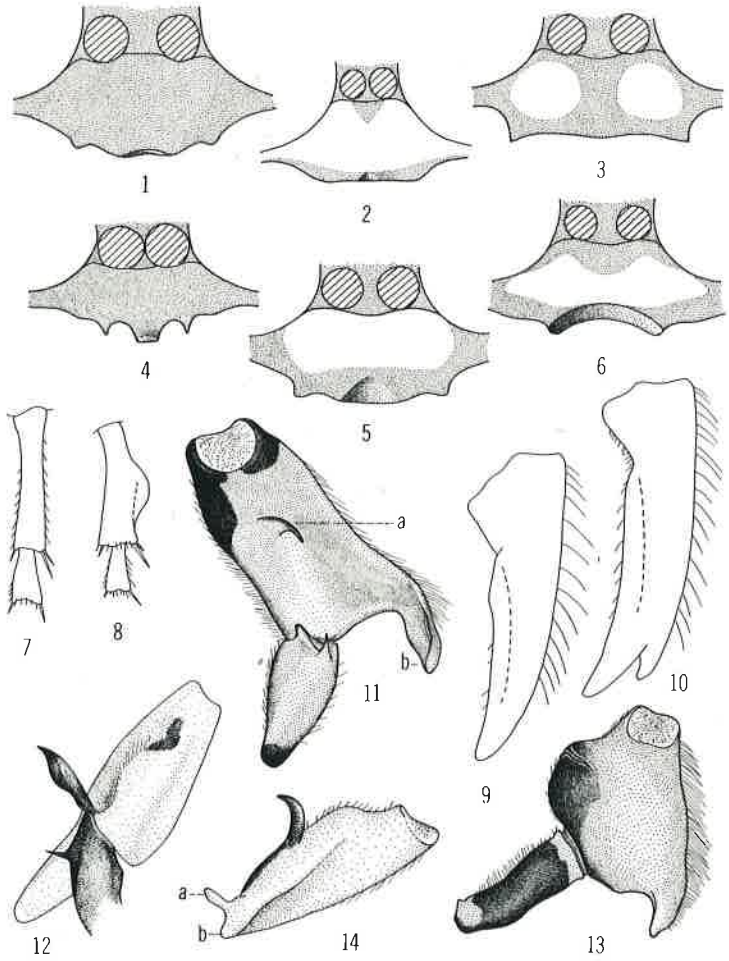
Crabro pallidus W. Fox (Fig. 59)

Crabro pallidus W. Fox, 1895:163. Lectotype ♀, Montana (ANSP).

Recognition. — Both sexes have the orbital silver line a little broader than usual but not much expanded above, erect pubescence of upper frons white, scutal punctures often widely separated by polished areas, mesopleural side extensively polished, wings nearly clear, propodeal enclosure with rather shallow and obliquely longitudinal areolae, and white markings. Male *pallidus* have flagellomere I about as long as broad and with a large ventral hair tuft, a sharp sinuate ridge from end of occipital carina to mandible base, outer forefemoral angle rounded and not projecting backward, foretibia without a black spot, shield mostly dark on lower third (fig. 59), mesopleural venter with a thick mat of silvery hair, and midleg nearly all whitish. Female *pallidus* have the clypeal bevel broad and short.

Distribution. — Records are from northern California to British Columbia and east to Saskatchewan and Wyoming. Localities are: California (Trinity County and Siskiyou County above 6,000 feet), Washington (Lake Paha, Lind, Pullman), British Columbia (Lower Post), Saskatchewan (Christopher Lake), Idaho (St. Anthony sand dunes), Utah (Dinosaur National Monument, Kanab, Natural Bridges National Monument), Wyoming (Rock Springs, 15 mi. e. Green River, Granger, Baggs).

FIGURES 1-14. — Figs. 1-6, front view of clypeus and antennal sockets of *Crabro*. 1, *nigrostriatus* ♀. 2, *cingulatus* ♀. 3, *argusinus* ♀. 4, *leopardus* ♂. 5, *comosiceps* ♀. 6, *spinuliferus* ♀. Figs. 7-8, outer view of ♂ midbasitarsus and following tarsomere. 7, *grisselli*. 8, *peltista*. Figs. 9-



10, outer view of female mandible. 9, *grisselli*. 10, *velitaris*. Figs. 11-13, ventral view of ♂ foretrochanter and forefemur. 11, *pleuralis*, (a) basoventral spine, (b) backward projecting posterior angle. 12, *spinuliferus*, inner view of ♂ forefemur and apex of trochanter to show trochanteral spine and basoventral femoral spine. 13, *argusinus*. Fig. 14, *digitatus*, inner ventral view of ♂ forefemur to show basoventral (actually medial) spine as well as fingerlike apical projection (a) and small posterior projection (b).

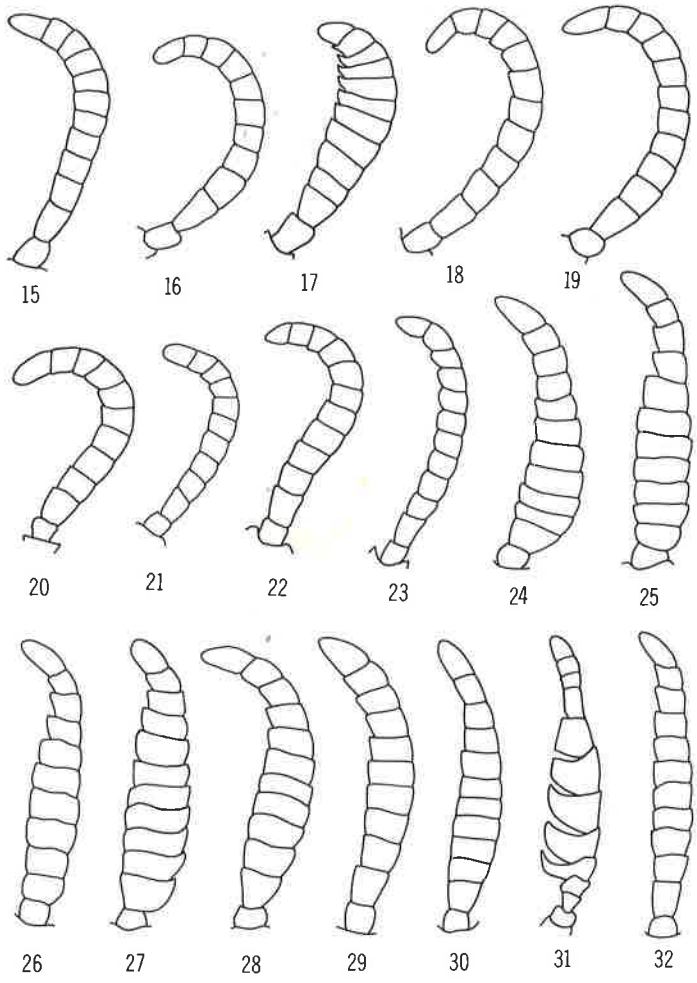
Crabro pleuralis W. Fox (Figs. 11, 70)

Crabro pleuralis W. Fox, 1895:162. Lectotype ♀, "Vancouver", British Columbia (ANSP).

Recognition. — Both sexes are rather large (about 12-14 mm long), have mandible and scape extensively yellow, orbital silver line not reaching to apex of scape, scutal punctures separated by less than a diameter, wings stained, and markings yellow or rarely whitish. Male *pleuralis* have flagellomere I broader than long (about as in fig. 24) and with a large ventral hair tuft, foretrochanter with a strong apical spine, ventral forefemoral spine nearer apex than base and rather short (fig. 11a), outer forefemoral angle projecting posteriorly as a stout and obliquely truncate blade (fig. 11b), foretibia proper with a dark apical spot which is usually small, shield with elaborate yellow spots and stripes which reach posterior tip (fig. 70), basal declivity of mesopleural venter rough and limited posteriorly by a strong carina, midleg sometimes all yellow beneath, midbasitarsus somewhat curved to a projecting apex and a little longer than rest of tarsus, propodeal enclosure moderately areolate or rarely longitudinally ridged, and tergal markings varying from thin spots to broad bands. Female *pleuralis* have the clypeal bevel well impressed and about three times as broad as high, mesopleural side polished but with extensive coarse punctation, a sharp or dull precoxal angle on mesopleuron, propodeal enclosure longitudinally ridged. The male shield is unique. The combination of a precoxal angle, large size and longitudinally ridged propodeal enclosure distinguish the female.

Distribution. — I have studied a total of 134 specimens from most of the western states and provinces: California (many localities such as Riverside, Walker Pass, Lone Pine, Antioch, Sacramento), Nevada (Charcoal Ovens State Park), Oregon (Antelope Mountain, Lake of the Woods, Mt. Hood), Utah (Logan Canyon, Parawan, Smithfield, Salt Lake City), Colorado (Mt. Evans, 9,000 feet), Wyoming (Grand Teton National Park), and British Columbia (Robson, Vernon, Vancouver, Chose). Krombein (1951) recorded it also from Alberta, Washington and Nebraska. This indicates a wide range west of the 100th meridian in a variety of life zones from Lower Sonoran to Hudsonian. I have seen one whitish marked male from Plumas County, California taken at 4,500 feet.

Biology. — Three females in the Davis Collection were collected while transporting flies: two therevids and a tachinid.



FIGURES 15-32. — Pedicel and flagellum of *Crabro* in broadest view, pubescence omitted. 15, *grisselli* ♂. 16, *thyreophorus* ♀. 17, *helvocrinus* ♀. 18, *helvocrinus* ♂. 19, *nigrostriatus* ♂. 20, *nigriceps* ♂. 21, *denningi* ♂. 22, *dietrichi* ♂. 23, *flavinubis* ♂. 24, *comosiceps* ♂. 25, *spinuliferus* ♂. 26, *opalescens* ♂. 27, *deserticola* ♂. 28, *velitaris* ♂. 29, *leopardus* ♂. 30, *digitatus* ♂. 31, *argusinus* ♂. 32, *monticola* ♂.

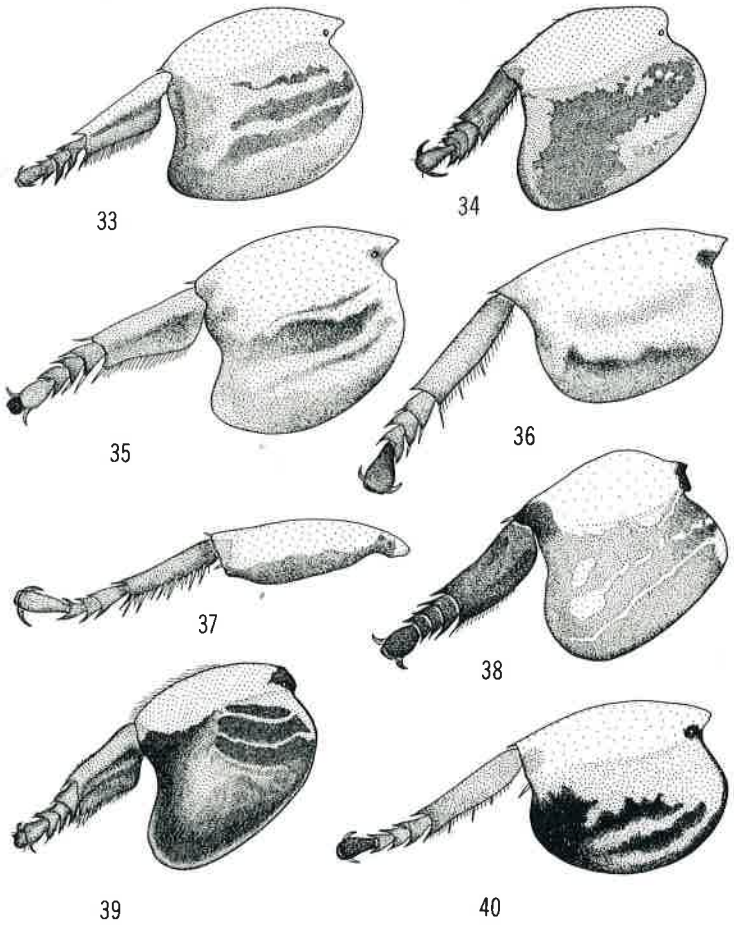
Crabro spinuliferus R. Bohart, new species (Figs. 6, 12, 25, 62)

Male holotype. — Length 9 mm. Black with lemon yellow markings as follows: Mandible and clypeus mostly, scape, forefemur and foretibia proper mostly, shield mostly toward base (overall pattern, fig. 62), midleg mostly except for anterior and posterior stripes on trochanter and femur, hindtibia and basitarsus except for outer spot and inner stripe on tibia, narrowly separated spots on terga I-III and VI, subapical bands on IV-V; wings very lightly brown stained. Pubescence pale, silvery on frons, inner orbital silver line reaching above apex of scape and broadened above to three midocellus diameters, a large curled tuft of white hair beneath flagellomere I, moderate hair beneath mesopleuron. Upper frons and top of head with complete microridging, scutum with punctures close or separated by a diameter or more medially, enclosure with about 15 large areolae, rest of propodeum irregularly sculptured; mesopleuron coarsely ridged anteriorly, finely so posteriorly around a large polished area. Antennal shape and foreleg structure shown in figs. 12, 25, 62; clypeal apex undulate, bevel small and obscure, submedian angle obtuse; occipital carina continued forward almost to mandible base; humeral corner flangelike, forecoxa with an inner posterior tooth; foretrochanter spinose apically (fig. 12); basoventral femoral spine curved and slender; posterior forefemoral angle projecting moderately as a broad flat triangle; mesopleuron with a pair of anterior, ventral, submedian, toothlike spines; midbasitarsus about 1.2 times as long as rest of tarsus.

Female. — Length about 10 mm. Pronotum and scutellum mostly yellow; midfemur dark except apically. Hair of frons white, top of head with macropunctures somewhat separated by microreticulation; scutum as in male. Clypeal apex incurved, bevel broad and polished (fig. 6), sharp laterally; a sharp precoxal angle on mesopleuron; ridges of propodeal enclosure coarse but more longitudinal than in male.

Male holotype (UCD), Needles, San Bernardino County, California, March 20, 1961 (C. R. Kovacic). Paratypes 29 males, 9 females, March 14 to April 29 and September 11 to November 12; CALIFORNIA: Needles, Hopkins Well, Blythe, Palo Verde, Gordon Wells, "Imperial County"; ARIZONA: 10 mi. e. Aztec, Yuma, Larker, Bullhead City, 5 and 18 mi. s. Gila Bend, Granite Reef Dam, Tucson, Ehrenberg, Roll; SONORA: Corcorit, Puerto Penasco.

The important characters of this species and its close relationship to *opalescens* are discussed under that species.



FIGURES 33-40. — Outer view of foretibia and tarsus in the *Crabro tumidus* group. 33, *tumidus*. 34, *tenuiglossa*. 35, *grisselli*. 36, *lacteipennis*. 37, *parmatulus*. 38, *alticola*. 39, *peltista*. 40, *alpestris*.

Crabro tenuis W. Fox (Fig. 61)

Crabro tenuis W. Fox, 1895:166. Lectotype ♀, Colorado (ANSP).
Crabro juniatae Krombein, 1938:469. Holotype ♀, Huntington, Pennsylvania (USNM). **New synonymy.**

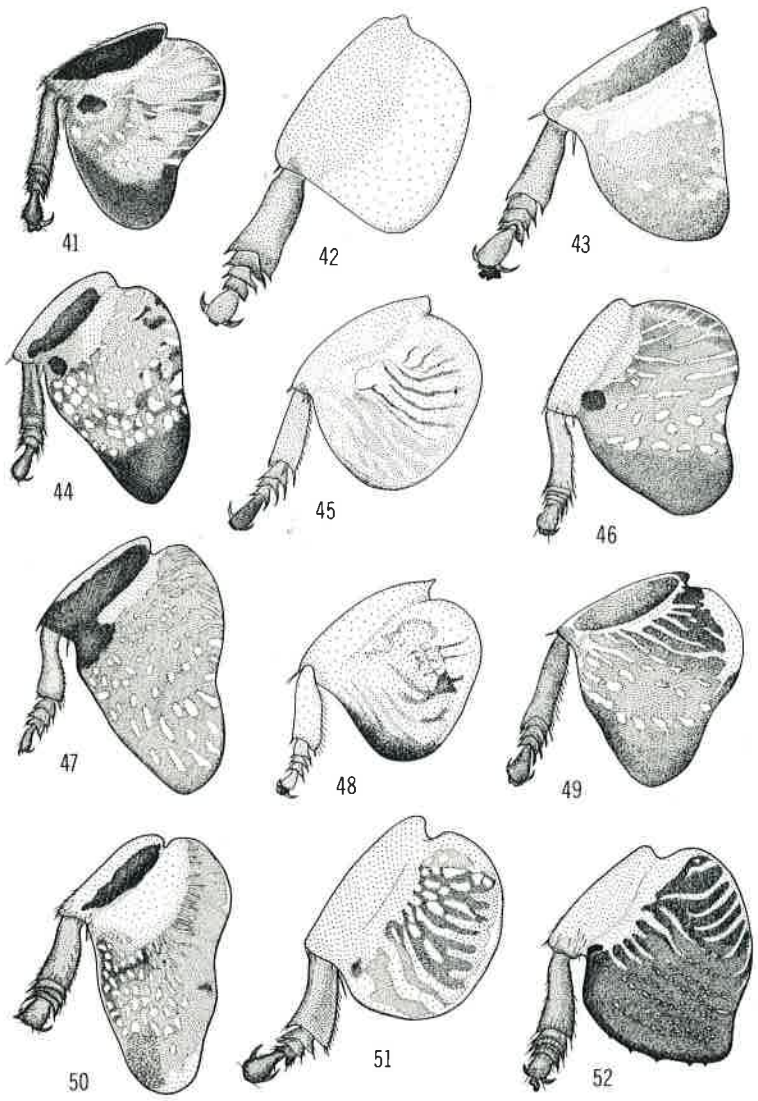
Recognition. — Both sexes have the scape pale in front, hair of upper frons whitish, orbital silvery line reaching apex of scape, scutal punctures unusually small and separated by 0.5 to 2.0 diameters, and markings yellow to almost white. Male *tenuis* have the mandible black or nearly so, flagellomere I broader than long and with a large ventral tuft of dark hair, inner genal concavity with a dense brush of partly appressed hair, basoventral spine of forefemur slender and curved, outer angle stoutly projecting backward, shield with anterodorsal stripes and many small median round spots (fig. 61), midtrochanter and femur black, propodeal enclosure with moderately deep areolae. Female *tenuis* have the clypeal apex rounded laterally and its flat bevel unusually small, flagellomere I is only about 1.2 times as long as the pedicel, propodeal enclosure shallowly sculptured except usually for central furrow. Male *tenuis* differ from *flavicrus* primarily by the numerous round spots of the shield and the much darker midlegs.

Synonymy. — I have studied the female type of *juniatae* and it seems to agree closely with female *tenuis* in my collection from Colorado, West Virginia and New Jersey.

Distribution. — I have seen 120 specimens of this widespread and relatively abundant species. More southern localities are Georgia (Fort Mountain), Oklahoma (Shawnee), Colorado (near Hayden) and Utah (Strawberry Valley). Atlantic coast localities include Washington (D.C.) and New Jersey. In the west it occurs in Washington (Lake Paha) and ranges north and east through Alberta to Quebec.

Crabro velitaris R. Bohart, new species (Figs. 10, 28, 66)

Male holotype. — Length 9 mm. Black with yellow markings as follows: Mandible and clypeus mostly, scape, fore and midfemora partly, foretibia proper (except subapical spot), associated area on shield, posterior corner of shield, mid and hindtibiae outwardly, tarsi basally, separated spots on terga I-III, bands on IV-VI, lateral spots on sterna II-III; wings brown stained. Pubescence of upper frons and scutum nearly white, inner orbital silver line narrow and reaching to apex of scape, a few pale curled hairs under flagellomere I, a thin silvery mat under mesopleuron. Upper frons punctate, becoming microridged in front of ocelli; top of head rather closely punctate and faintly microridged; scutum irregularly punctate, medially with punctures more than a diameter apart; enclosure with about



FIGURES 41-52. — Outer view of ♂ foretibia and tarsus in *Crabro*. 41, *virgatus*. 42, *bruneri*. 43, *nigriceps*. 44, *florissantensis*. 45, *helvocrinus*. 46, *henrici*. 47, *hispidus*. 48, *thyreophorus*. 49, *nigrostriatus*. 50, *flavinubis*. 51, *vernalis*. 52, *advena*.

15 moderately deep areolae, rest of propodeum mostly ridged and punctate; mesopleural side microridged and with a small polished area, basoventral swelling across mesopleuron punctate. Antennal shape and foreleg structure shown in figs. 28, 66; clypeal apex undulate, no perceptible bevel; humeral corner weak and rounded; forecoxa with an inner posterior tooth; foretrochanter not spined apically; basoventral forefemoral spine slender and curved; posterior forefemoral angle projecting backward as a blunt blade; midbasitarsus about 1.2 times as long as rest of tarsus.

Female. — Length about 10 mm. Markings ivory to yellow, scape all pale, four spots across pronotal ridge and lobes, spots on scutellum and usually on metanotum, hindfemur all dark. Hair of frons whitish. Scutum punctate but not microridged in front of scutellum; enclosure rather broadly areolate as in male; mesopleural side microridged in front, otherwise evenly and sparsely punctate but polished overall; flagellomere I about twice as long as broad; clypeal bevel well impressed, about twice as wide as high.

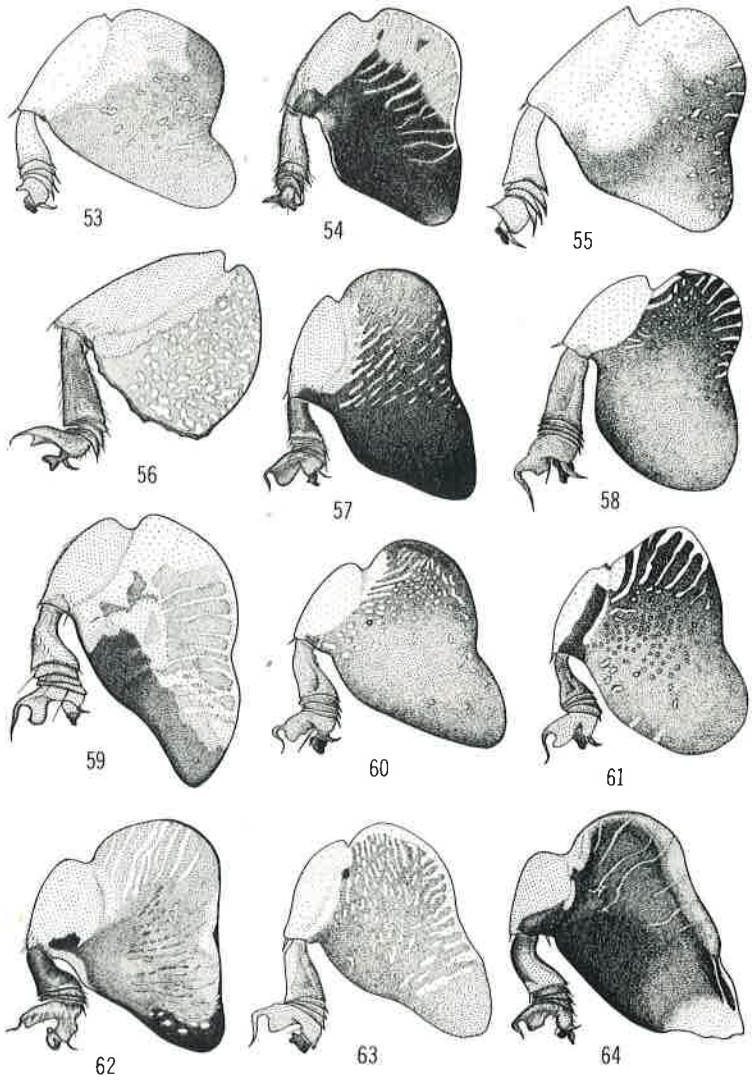
Male holotype (UCD), Hallelujah Junction, Lassen County, California, June 28, 1962, on willow (R. M. Bohart). Paratypes, 40 males, 13 females, May 25 to August 29 with various dates in June and July, OREGON: Adel, Harney Lake (Harney County); CALIFORNIA: Lake City, Cassell, Summit Camp (Lassen County), Hallelujah Junction, Antelope Springs and Deep Springs (Inyo County), 3 mi. e. Bishop, Big Pine; NEVADA: 20 mi. e. Beowawe, Beatty, Rio King, Carson Sink (Churchill County), Reno, Pyramid Lake; UTAH: Logan, Provo, Lyman, Promentory, Parowan, Delta, Smithfield, Kanesville, Salt Lake City; WYOMING: 15 mi. s. Green River. Other male specimens are from Nobleford and Chin, Alberta; Elbow, Saskatchewan (CNC); and Crook, Colorado.

This species seems to be related to *flavicrus* but it is larger, flagellomere I is longer (fig. 28) and with an inconspicuous tuft, and the shield is more completely striped although dimly so (fig. 66).

Crabro villosus W. Fox (Fig. 65)

Crabro villosus W. Fox, 1895:158. Holotype ♀, California (ANSP).

Recognition. — Both sexes have mandible and scape extensively yellow, orbital silver line stopping well short of scapal apex, scutal punctures practically contiguous, wings stained, propodeal enclosure with rather close longitudinal microridges, and terga yellow banded or nearly so on II-III in males and most females. Male *villosus* have flagellomere I broader than



FIGURES 53-64. — Outer view of ♂ foretibia and tarsus in *Crabro*. 53, *denningi*. 54, *conspicuus*. 55, *dietrichi*. 56, *leopardus*. 57, *monticola*. 58, *comosiceps*. 59, *pallidus*. 60, *cribrellifer*. 61, *tenuis*. 62, *spinuliferus*. 63, *digitatus*. 64, *deserticola*.

long (about as in fig. 27) and with a large ventral hair tuft, foretrochanter with a small apical spine, basoventral forefemoral spine strong and curved, outer forefemoral angle projecting backward as a short and thin blade, foretibia proper with a black apical mark extending basad, shield with lower two-fifths black and contrasting with spotted area above (fig. 65), posterior tip of shield membranous and sometimes frayed, basal declivity of mesopleural venter mostly polished but not sharply limited posteriorly, midleg dark beneath from coxa to halfway on femur, and midbasitarsus somewhat curved to a projecting apex and a third longer than rest of tarsus. Female *villosus* have the clypeal bevel small and weakly impressed, hair of frons and mesopleuron abundant and brownish, and mesopleural side polished but with scattered large punctures. The male shield with its many spots and contrasting dark lower area is diagnostic (fig. 65). The close and even microridging of the propodeal enclosure, extensively yellow terga, long brownish hair of the mesopleuron, and dense scutal punctation characterize the female.

Distribution. — I have seen 59 specimens, all from California and the Upper Sonoran life zone from San Diego County to Yolo County. Records from north of the Tehachapi range are all west of the Sierra Nevada. Several collections have been made on Santa Cruz Island, Santa Barbara County.

Biology. — A female carrying a tachinid was collected at Arroyo Seco, Monterey County, March 30, 1956 (D. Burdick).

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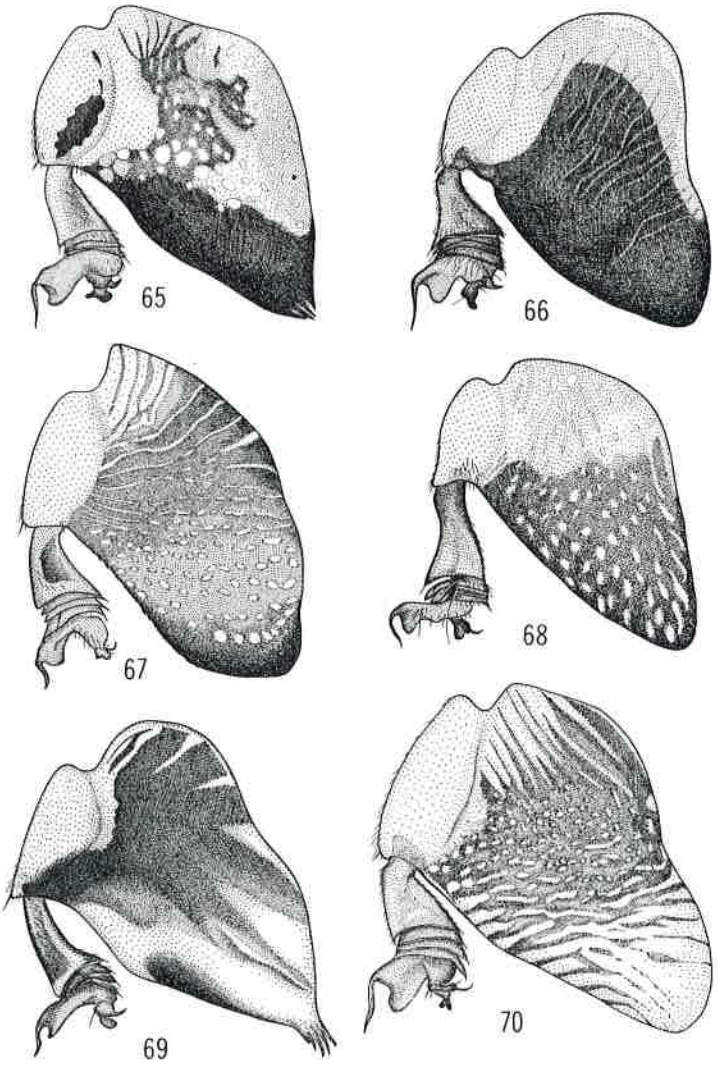

FIGURES 65-70. — Outer view of ♂ foretibia and tarsus in *Crabro*. 65, *villosus*. 66, *velitaris*. 67, *opalescens*. 68, *argusinus*. 69, *latipes*. 70, *pleuralis*.

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