were most suprising. Downey (1962) found that local populations of the lycaenid butterfly *Plebejus icarioides* (Boisduval) used only 1 species of the plant *Lupinus* as host at any 1 time, regardless of the number of species available. However, the insect's preference changed from species to species in different years. Taksdal (1963) discovered that populations of the tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), from different plant communities showed dissimilar feeding and ovipositional preferences.

Fourth, insects in confinement do not necessarily react in the same manner to host and nonhost plants as they do in their natural surroundings. Painter (1951) stressed that the validity of cage and greenhouse experiments must be checked in the field; usually they correlate fairly well, but he cites several instances (p. 407–8) when the results of cages or greenhouse tests were not in keeping with field results.

The 4 points, if well founded, indicate that no simple series of tests with a small number of insects, especially when the tests are conducted in artificial environments (under quarantine, etc.), will suffice for a complete understanding of the relationship of an insect to a series of plants. Thus the problem of determining plant specificity is exceedingly difficult. Hidden in these complex physiological and tropistic interrelationships between plants and insects, however, are the answers to the problems confronting those engaged in biological control of weeds. Some of the paths of future research in this field appear to be clearly indicated.

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## REFERENCES CITED

**Beck, S. D.** 1956. A bimodal response to dietary sugars by an insect. Biol. Bull. 110: 219–28.

1965. Resistance of plants to insects. Annu. Rev. Entomol. 10: 207–32.

**Beck, S. D., and W. Hanec.** 1958. Effect of amino acids on feeding behavior of the European corn borer, *Pyrausta nubilalis*. J. Insect Physiol. 2: 85–96.

**Dethier, V. G.** 1954. Evolution of feeding preferences in phytophagous insects. Evolution 8: 33–54.

**Downey, J. C.** 1962. Host-plant relations as data for butterfly classification. Syst. Zool. 11: 150–9.

**Ehrlich, P. R., and P. H. Raven.** 1964. Butterflies and plants: A study in coevolution. 18: 586–608.

**Feir, D., and S. D. Beck.** 1963. Feeding behavior of the large milkweed bug, *Oncopeltus fasciatus*. Ann. Entomol. Soc. Amer. 56: 224–9.

**Flück, H.** 1963. Intrinsic and extrinsic factors affecting the production of secondary plant products. P. 167–86 *in:* T. Swain, ed., Chemical Plant Taxonomy. Academic Press, Ltd., London.

**Force, D. C.** 1966. Reactions of the three-lined potato beetle, *Lema trilineata* (Coleoptera: Chrysomelidae), to its host and certain nonhost plants. Ann. Entomol. Soc. Amer. 59: 1112–9.

**Holloway, J. K.** 1964. Host specificity of a phytophagous insect. Weeds 12: 25–27.

**Keller, J. C., F. G. Maxwell, and J. N. Jenkins.** 1962. Cotton extracts as arrestants and feeding stimulants for the boll weevil. J. Econ. Entomol. 55: 800–1.

**Larson, A. O.** 1927. The host-selection principle as applied to *Bruchus quadrimaculatus* Fab. Ann. Entomol. Soc. Amer. 20: 37–79.

**Mayr, E.** 1963. Animal Species and Evolution. The Belknap Press of Harvard University Press. 797 p.

**McMurtry, J. A.** 1962. Resistance of alfalfa to spotted alfalfa aphis in relation to environmental factors. Hilgardia 32: 501–39.

**Merz, E.** 1959. Pflanzen und Raupen. Über einige Prinzipien der Futterwahl bei Gross-Schmetterlingsraupen. Biol. Zentralbl. 78: 152–88.

**Nayar, J. K., and G. Fraenkel.** 1963a. The chemical basis of the host selection in the Mexican bean beetle, *Epilachna varivestis* (Coleoptera, Coccinellidae). Ann. Entomol. Soc. Amer. 56: 174–8.

1963b. The chemical basis of the host selection in the catalpa sphinx, *Ceratomia catalpae*. Ibid. 119–22.

**Painter, R. H.** 1951. Insect Resistance to Crop Plants. The Macmillan Co., New York. 520 p.

**Taksdal, G.** 1963. Ecology of plant resistance to the tarnished plant bug, *Lygus lineolaris*. Ann. Entomol. Soc. Amer. 56: 69–74.

**Yamamoto, R. T., and G. Fraenkel.** 1960. Assay of the principal gustatory stimulant for the tobacco hornworm, *Protoparce sexta*, from solanaceous plants. Ann. Entomol. Soc. Amer. 53: 499–503.

# Taxonomy of the *coerulans* Group of the Genus *Chrysis* in North America (Hymenoptera: Chrysididae)[1]

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ABSTRACT

Six Nearctic species of the *coerulans* group of the genus *Chrysis* are considered, with illustrations and a key for their separation. One new species, *Chrysis parkeri*, is described, and 2 new cases of synonymy are reported. The reliability of several taxonomic characters within the genus *Chrysis* is discussed.

This paper is presented to provide a key for the separation of members of the *coerulans*-group of the genus *Chrysis*, and to give a name for use in a study of twig-nesting wasps (Parker and Bohart, in press).

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## DISCUSSION OF TAXONOMIC CHARACTERS IN THE GENUS *Chrysis*

There is often a clearly evident dimorphism between the sexes, but until the characteristics of the particular species are known, many are of little use to the taxonomist.

The sexes are most easily separated by the coloration of the third sternite (Fig. 2). Males of all species known to the author have a distinct, brownish band, about 1 ocellus diameter in width, along the apical edge of this sternite. In females the brown band is absent and the metallic green coloration extends to the distal margin.

Some of the less evident secondary sex characters are also given here, both as identification aids and to prevent their misuse as specific characters by future authors. In most species of *Chrysis* the abdomen of the female is more pointed apically than that of the male. The ratio of the lengths of flagellar segments 1 and 2 (i.e., 1:2) is often greater in the female than in the male. There is often a dense, white pile in the lower facial area laterad to the scapal basin in the males of most species, while most females lack this marker.

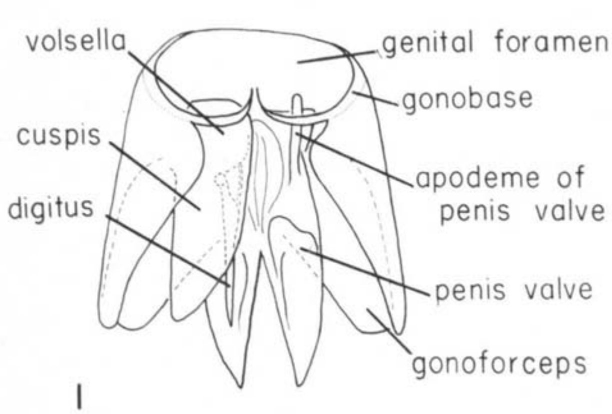
Some of the characters which have proved useful in delimiting group relationships are the frontal carina, the flagellum of the antenna, the interocular distance, the type of sculpture in the scapal basin, the sternal spots, the posterolateral teeth of tergites 1 and 2, the dorsal median keel on tergites 2 and 3 (Linsenmaier 1959), the various features toward the apex of the third tergite, and the characters associated with the male genitalia (Fig. 1).

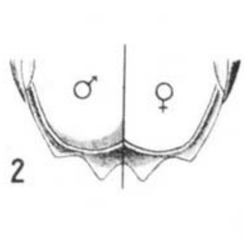
In comparing the male genitalia, I have found several structures which provide good criteria for the separation of species as well as species-groups. The gonoforceps and the eighth sternite seem to offer the greatest variety of consistent differences, most of these being constant for a particular group or species (Fig. 1; 3C,D; 9C,D). The digitus, cuspis, and sternites 5–7 occasionally possess useful specific distinctions. The shape of the particular structure is generally the most constant and the most easily seen, but setal patterns and size relationships among different structures are also quite useful. It is important to note that care must be taken in comparing size relationships in mounted genitalia, as displacement and distortion may occur from cover-slip pressure and various other factors in the mounting process.

## THE COERULANS-GROUP

This group is composed of at least 6 Nearctic species, all of which are quite similar in appearance. The striking thing about the group is the remarkable similarity of the male genitalia. Except for *C. remissa* and *C. parkeri*, these species are essentially identical in this respect (Fig. 3C,E).

Members of the *coerulans*-group may be recognized



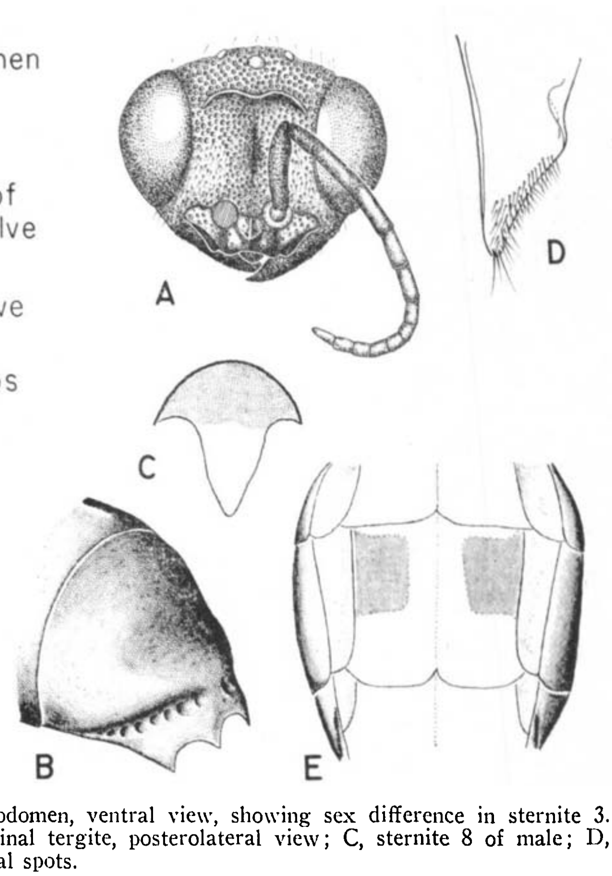




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FIG. 1.—Male genitalia of Chrysididae. FIG. 2.—Abdomen, ventral view, showing sex difference in sternite 3. FIG. 3.—*Chrysis coerulans*. A, head; B, third abdominal tergite, posterolateral view; C, sternite 8 of male; D, gonoforceps; E, abdomen, ventral view, showing sternal spots.

by the following external characters: (1) Frontal carina present; dorsal carinal arms generally absent or, if present, less than 1 ocellus diameter in length (Fig. 3A, 4A, 5A, 6A, 8A, 9A). (2) Flagellomere 1 always longer than pedicel or other flagellomeres. (3) Scapal basin smooth or punctate (Fig. 3A, 6A, 9A); subhorizontal striae, if present, always accompanied by large pits (Fig. 4A, 5A, 8A).

## KEY TO THE NEARCTIC SPECIES OF THE COERULANS-GROUP

1. Tergite 2 without a dorsal median keel; median teeth usually blunt (Fig. 8B) .................. 2
   Tergite 2 with at least a short keel; median teeth of tergite 3 often sharply pointed (Fig. 3B, 4B) .... 3
2. Sternal spots well separated medially; median notch of tergite 3 narrowly bicarinate; eastern U.S. westward to New Mexico (Fig. 9) ........ ............................... ***remissa*** Mocsáry
   Sternal spots fused medially or nearly so; median notch of tergite 3 simple; western U.S. (Fig. 8) ............................ ***parkeri,*** new species
3. Tergite 3 inflated laterally as seen in dorsal view (Fig. 7); tergite 2 often with posterolateral teeth (posteriorly directed extensions of tergum); malar space usually greater than 0.5 times length of flagellar segment 1 (Fig. 5) .......... ***inflata*** Aaron
   Tergite 3 not so inflated; posterolateral teeth absent on tergite 2; malar space usually less than 0.5 times length of flagellar segment 1 ............. 4
4. Length of tergite 2 along lateral edge less than 0.5 times greatest abdominal width; large, robust species ....................................... 5
   Length of tergite 2 along lateral edge greater than 0.5 times greatest abdominal width; small, slender species (Fig. 6) ............. ***cembricola*** Krombein
5. Tergite 3 with a bright gold or copper band along the pit row (Fig. 4B) .................. ***nitidula*** F.
   Tergite 3 without such a band (Fig. 3B) ......... ..................................... ***coerulans*** F.

### *Chrysis coerulans* F.

(Fig. 3)

*Chrysis coerulans* Fabricius, 1805. Systema Piezatorum p. 172. Type lost.
*Chrysis bella* Cresson, 1865. Proc. Entomol. Soc. Philadelphia 4: 312. Type ♀, "Col." (ANSP).
*Chrysis conserta* du Buysson, 1891. Rev. Entomol. (Caen) 10: 37. Type ♀, "Tex." (PARIS).
*Chrysis praticola* Mocsáry, 1914. Ann. Mus. Nat. Hungar. 12: 50. Type ♀, Texas (MH). NEW SYNONYMY.

MALE.—Length 7–9 mm; color metallic green and blue, except flagellum beyond segment 2, tarsi beyond segment 1, and sternal spots, which are dark brown to black; antenna with basal flagellar segment 2.0–2.5 times as long as wide; malar space, subantennal space, and interantennal distance all nearly equal; scapal basin with a small, median pit; punctures of thorax evenly distributed; dorsum of thorax slightly rounded in profile; propodeal enclosure mostly filled by pits, foveae restricted to base and lateral margins; punctation of abdominal tergite 2 becoming sparse apically, keel present; tergite 3 flatly sloped to convex in profile; teeth of tergite 3 usually with at least the outer pair sharply pointed; tergal pits usually well separated, rounded; sternal spots large, rectangular, extending from base half-way to apex, well separated medially (Fig. 3E); edge of gonoforceps concavely sloping basad from outer edge to inner edge (Fig. 3D); sternite 8 rounded basally, more or less triangular toward apex (Fig. 3C).

FEMALE.—Same as male except length 7–10 mm; metallic coloration of flagellum extended to segment 3; tergite 3 generally flat to medially depressed in profile.

*Systematics.*—This species is quite closely related to *C. nitidula* and *C. cembricola.* Male genitalia of these 3 species are essentially alike. *C. coerulans* can be separated from *nitidula* by its lack of reddish and brassy markings on tergite 3, by the shape of the teeth of tergite 3, and by its generally smaller size; it can be separated from *cembricola* by its relatively robust body and the more definite frontal carina.

*Chrysis coerulans* var. *nanula* Rohwer, 1909, is a synonym of *C. canadensis* du Buysson, which is not a member of the *coerulans* group and is not treated in this paper.

*Biology.*—*C. coerulans* has been recorded from the following hosts. Sphecidae: *Sceliphron cementarium* (Drury). Eumenidae: *Eumenes fraternus* Say; *Ancistrocerus antilope* (Panzer); *A. tigris* (Saussure); *A. catskill* (Saussure); *A. tuberculocephalus sutterianus* (Saussure), new record; *A. spilogaster* Cameron, new record; *Euodynerus foraminatus* (Saussure); *Symmorphus meridionalis* (Viereck), new record.

*Distribution.*—This species is widely distributed throughout the entire United States, and extends northward into Canada at least to Nova Scotia, New Brunswick, Quebec, Manitoba, and Alberta. It has been taken at altitudes from 50 to 15,000 ft.

*Material Examined.*—About 500 specimens, from 36 States of the United States and 5 provinces in Canada.

### *Chrysis nitidula* F.

(Fig. 4)

*Chrysis nitidula* Fabricius, 1775. Systema Entomol. p. 359. Type ♀, "Habitat in America" (BMNH, damaged specimen).
*Chrysis cyanea* Villers, 1789. Caroli Linnaei Entomol. 3: 257.
*Chrysis cessata* du Buysson, 1891. Rev. Entomol. (Caen) 10: 36. Type ♀, "Nat. Bridge, Virginia" (PARIS). NEW SYNONYMY.

MALE.—Length 6.5–9.2 mm; color metallic green, except from flagellum beyond segment 1, tarsi beyond segment 1, and sternal spots, which are brown to black; tergite 3 with purple reflections and narrow gold to copper band along pit row; basal flagellar segment 2.6 times as long as wide, and 1.4 times as long as segment 2; malar space, subantennal distance, and interantennal distance in the ratio of 10:18:13; scapal basin finely punctate, punctation becoming coarse medially, median pit present; frontal carina weak to moderately well developed; median length of pronotum 0.7 times median length of head in dorsal view; propodeal enclosure mostly filled by pits, foveae restricted to base and margins; keel present on tergite 2, absent or very faint on tergite 3; tergite 2 without posterolateral teeth; sternal spots large, subquadrate, well separated medially, extending laterally to margin; length of tergite 2 along lateral margin 0.5 times greatest width of the tergite; tergite 3 convex above in profile; median notch about as wide as lateral notch; genitalia as in *coerulans* (Fig. 3C, 3D).

FEMALE.—Same as male except length 7.5–11.0 mm; flagellum brown beyond segment 2; tergite 3 flatly sloping above in profile; median notch much wider than lateral notches.

*Systematics.*—There is a lack of evidence to demonstrate conclusively that *C. nitidula* is a species distinct from *C. coerulans*. The only certain characteristic known to this author is the color band on the third tergite of *nitidula* (Fig. 4B). Other characters, such as the flatly sloped tergite 3 and the broad median notch, are also found in specimens of *coerulans*. It has become obvious that a more concentrated study of more material will be necessary for the solution of this problem.

In the past, several European species (*C. iris* Christ, *C. cyanochroa* Förster, and *C. soluta* Radoskowski) have been synonymized with *nitidula*. Linsenmaier (1959) pointed out that *nitidula* is an American species, while *iris, cyanochroa,* and *soluta* are European only. They are also considered as separate species in the present paper.

*Biology.*—*C nitidula* has been recorded from *Ancistrocerus catskill* and *Euodynerus foraminatus*.

*Distribution.*—The range is from North Carolina to Quebec, westward to Ontario and Wisconsin, and from British Columbia south to California. More adequate sampling of the Canadian fauna probably will show a northern connection between Ontario and British Columbia.

*Material Examined.*—14 ♂, 42 ♀, from California, Colorado, Connecticut, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Nova Scotia, Pennsylvania, Quebec, Rhode Island, Vermont, Virginia, Wisconsin, and Wyoming.

### *Chrysis cembricola* Krombein

(Fig. 6)

*Chrysis cembricola* Krombein, 1958. Proc. Entomol. Soc. Wash. 60: 53. Holotype ♀, Lost River St. Park, West Virginia (USNM, Type-no. 63508).

MALE.—Length 5.9–7.8 mm; color metallic blue, abdominal terga 1 and 2 posteriorly, scapal basin, legs, and sternites with bright green reflections; flagellum beyond segment 1 and tarsi dark brown; frontal carina fairly weak; malar space short, 0.6 times length of antennal pedicel; propodeal enclosure mostly filled with shallow pits; abdominal tergite 2 along lateral edge more than 0.5 times greatest (dorsal) width of the tergite; tergite 3 with lateral notches and median notch subequal in width; genitalia as in *coerulans* (Fig. 3C, 3D).

FEMALE.—Same as male except length 6.0–8.8 mm; metallic color of flagellum extending to flagellar segment 2.

*Systematics.*—Krombein (1958) suggested that this species is quite closely related to *C. nitidula* (as *chalcopyga* Mocsáry), and this hypothesis appears to be true; however, it is easily distinguished from the latter by its small size. The male genitalia of all members of this group are essentially the same.

*Biology.*—This has been treated adequately by Krombein (1958). *C. cembricola* has been reared from the wood-cavity nests of *Symmorphus canadensis* (Saussure). This inquiline destroys the vespid egg and then feeds on the stored prey.

*Distribution.*—Recorded from Virginia, West Virginia, District of Columbia, North Carolina, New York, Massachusetts, Vermont, Nova Scotia, Michigan, Illinois, Indiana, Idaho, Wyoming, Colorado, New Mexico, and California.

*Material Examined.*—15 ♂, 32 ♀ (including 1 paratype) from all areas listed except North Carolina and District of Columbia.

### *Chrysis inflata* Aaron

(Fig. 5, 7)

*Chrysis inflata* Aaron, 1885. Trans. Amer. Entomol. Soc. 12: 237. Lectotype ♂, "So. Cal." (ANSP).

MALE.—Length 7.5–10 mm; color metallic green and blue, except flagellum of antenna beyond segment 1, tarsal segments 2–5, and sternal spots, which are brown to black; flagellar segment 1 short (1.8–2.8 times as long as wide), 1.0–1.2 times as long as segment 2; malar space slightly longer (1.2×) than subantennal distance; subantennal distance slightly longer than interantennal distance; scapal basin with or without a small, median pit; frontal carina strong and continuous to strong but broken; thoracic punctation coarse, fairly evenly distributed; dorsum of thorax rounded in profile; propodeal enclosure mainly filled by pits, foveae restricted to base and margins; punctation of abdomen coarse, evenly distributed; tergite 2 with or without posterolateral teeth, tergite 1 never with such teeth; keel of tergite 2 present, rarely absent; tergite 3 with a very faint keel or none at all; sides of tergite 3 expanded laterally basad to pit row; pit row well developed, some pits confluent; apical teeth constricted, with little punctation; teeth deflected slightly; sternal spots large, subovate, separated along part of lateral margin by metallic green coloration, not joined medially; genitalic structures as in *C. coerulans* (Fig. 3C, 3D).

FEMALE.—Same as male, except length 7–10 mm; metallic coloration of flagellum extended to segment 2; expansion of tergite 3 before pit row often more marked.

*Systematics.*—Superficially, *C. inflata* appears quite similar to *C. cembricola,* but is easily separated from that species by the presence of striations in the scapal basin and by the extreme inflation of tergite 3. It does, however, seem closely related to *C. coerulans,* as the range of variation in the 2 species indicates that these are more closely akin than their general appearance suggests. The male genitalia of the 2 species are essentially the same, as was discussed under the general characteristics of the group.

*Biology.*—Krombein (1960) reported a specimen of *C. inflata* emerging from a cell of *Ancistrocerus lineativentris fulvicarpus* (Cameron) in wood traps from Arizona.

*Distribution.*—*C. inflata* seems to be generally distributed throughout the western United States. It is known to occur in Mexico, and is quite common in collections from Arizona and Utah; the northernmost record is Portland, Ore. In California it ranges from Lower Sonoran through Transition Zones, and in Mexico it has been collected at altitudes up to 6900 ft.

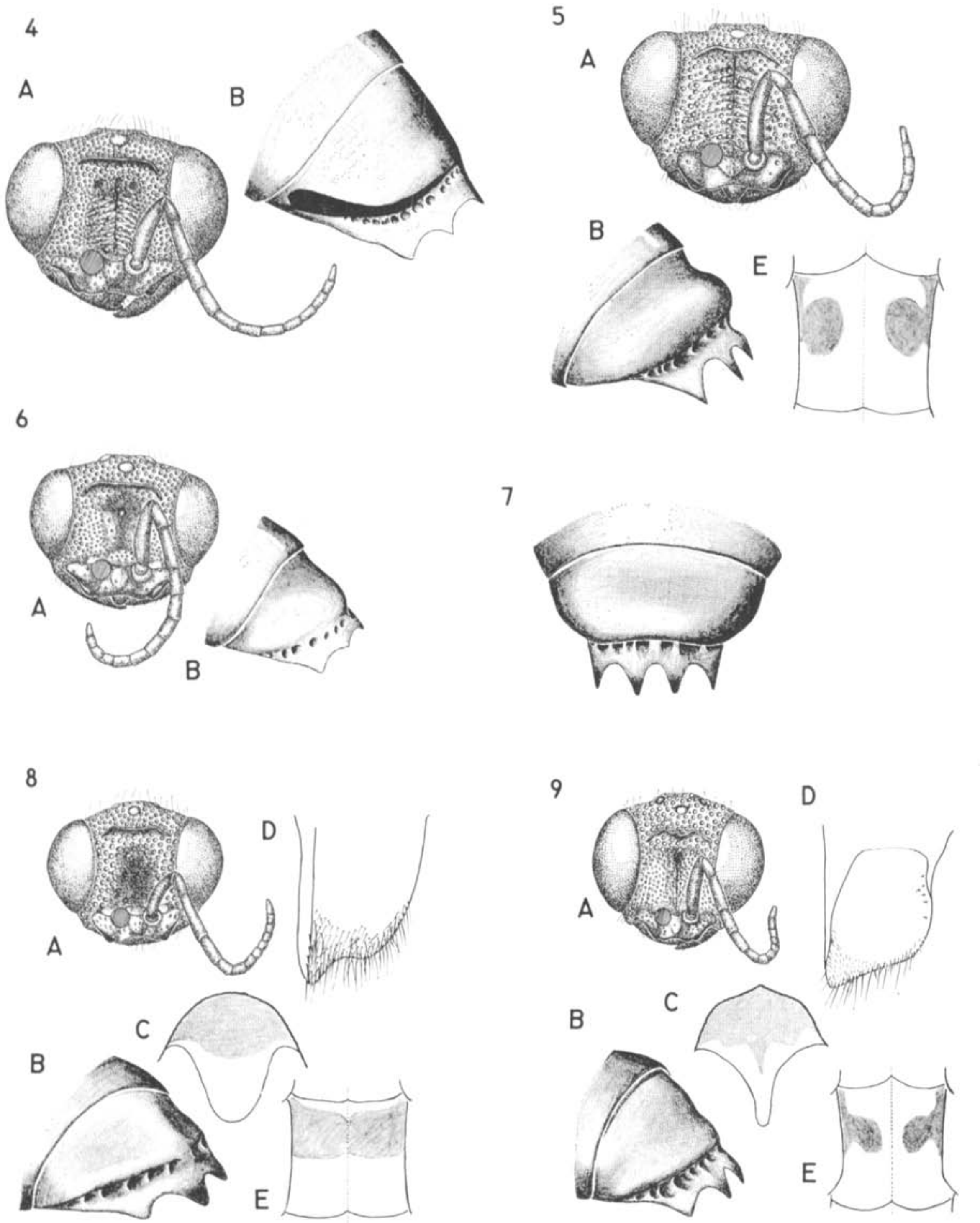


FIG. 4.—*Chrysis nitidula.* FIG. 5.—*C. inflata.* FIG. 6.—*C. cembricola.* FIG. 7.—*C. inflata,* dorsal view of abdomen. FIG. 8.—*C. parkeri.* FIG. 9.—*C. remissa.*

*Material Examined.*—11 ♂, 54 ♀, from Oregon, Idaho, Utah, California, Arizona, and New Mexico.

### *Chrysis remissa* Mocsáry

(Fig. 9)

*Chrysis remissa* Mocsáry, 1914. Ann. Mus. Nat. Hungar. 12: 52. Type ♀, Mexico: Presidio (MH).

MALE.—Length 6.0–7.2 mm; color metallic green to blue except flagellum beyond second segment, tarsi beyond segment 2, and sternal spots, which are brown to black; flagellar segment 1 1.5 times as long as segment 2; malar space, subantennal distance, and interantennal distance in the ratio of 10:9:6; scapal basin with a small, median pit; frontal carina strong, deflected laterally; smooth, pitless areas present behind posterior ocelli; punctation of thorax moderately coarse; scutellum and postscutellum convex in profile; propodeal enclosure mostly filled by distinct pits, foveae restricted to base and margins, abdominal tergites without a keel; tergites 1 and 2 without posterolateral teeth; length of tergite 2 along lateral edge 0.5 times greatest width; sternal spots subtriangular, not joined medially, partially separated from lateral edge; tergite 3 in profile convex dorsally, edge slightly sinuate ventrally (Fig. 9B); pit row with some pits fused, median pits moderate to large (1.0–2.0 ocellus diameters); apical teeth long, slightly deflected median notch narrowly to moderately carinate beneath, and more deeply incised than lateral notches; gonoforceps as in Fig. 9D; sternite 8 as in Fig. 9C.

FEMALE.—Same as male, except length 7.0–7.4 mm; subantennal distance slightly longer than malar space (1.3×); median notch faintly carinate beneath.

*Systematics.*—Externally, *C. remissa* appears to be quite similar to *C. parkeri.* The similarities of the male genitalia also point to this conclusion. However, the 2 species are easily separated by the shape of the sternal spots. *C. remissa* seems to be a fairly rare species and is represented in few collections. Through the kind cooperation of the Hungarian National Museum, I have been able to examine the type female.

*Biology.*—Nothing is known of the habits or host of this species.

*Distribution.*—Eastern and Southwestern United States, west to Arizona, and south into Mexico.

*Material Examined.*—2 ♂, 5 ♀, including type. PENNSYLVANIA: Melerytown (Snaler), 1 ♀, MCZ. VIRGINIA: Falls Church, V–30 (N. Banks), 1 ♂, MCZ. NEW MEXICO: Loving, V–28–1945 (J. W. MacSwain), 1 ♀, CIS. ARIZONA: Robles Ranch, 25 mi. W. Tucson, Pima Co., VI–8–1952 (Gertsch & Schrammel), 2 ♀, CIS.

MEXICO.—ZACATECAS: 15 km E. Sobrerete, VII–30–1951 (P. D. Hurd), 1 ♂, CIS. VERACRUZ: Presidio, holotype ♀, MH.

### *Chrysis parkeri* Moore, new species

(Fig. 8)

HOLOTYPE MALE.—Verdi, Washoe Co., Nev., 9 January 1962 (F. D. Parker), from nest of *Ancistrocerus lineativentris* Cameron in *Sambucus* stem (UCD).

Length of forewing, including tegula, 5.8 mm; length of flagellomeres 1, 2, and 3, respectively, 488μ, 307μ, and 307μ; malar space 181μ; scapal basin with small punctation laterally, replaced by broad, shallow punctures medially; area laterad to basin with moderately coarse, evenly distributed punctation; frontal carina strong, very broadly M-shaped; a small, smooth area present laterad to each hind ocellus; lateral pronotal length equal to median dorsal length of head as seen from above; posterior pronotal width 0.9 times width of head; lateral length of abdomen about 1.7 times greatest abdominal width; all terga without dorsal median keel (compare Fig. 3B and 8B); tergites 1 and 2 without posterolateral teeth; teeth of tergite 3 bluntly rounded, adelected downward slightly; sternal spots broad, joined medially (Fig. 8E); cocoon 7.4 mm long, dark brown with 2 light-brown median patches.

PARATYPES.—18 ♂, 14 ♀, Verdi, Washoe Co., Nev.; all reared from *Sambucus* stems or artificial twig nests. Range of measurements of 4 ♂ paratypes, with means in parentheses, as follows: Forewing, including tegula, 5.0–5.9 mm (5.6 mm); flagellomere 1, 434μ–597μ (506μ); flagellomere 2, 253μ–326μ (289μ); flagellomere 3, 217μ–307μ (262μ); malar space, 172μ–199μ (183μ). Measurements of 4 ♀ paratypes: forewing, including tegula, 4.6–6.0 mm (5.4 mm); flagellomere 1, 434μ–597μ (515μ); flagellomere 2, 235μ–347μ (295μ); flagellomere 3, 217μ–289μ (253μ); malar space, 180μ–199μ (140μ). Medial fusion of sternal spots (Fig. 8E) ranging from complete to separation by a distance of about 1 ocellus diameter. Average length of cocoon, males 7.3 mm, females 7.6 mm.

Other specimens have been examined from the following localities. CALIFORNIA.—Boca, Nevada Co. (A. S. Menke), 1 ♀, UCD; N. Frk. Cache Cr-Hwy. 20, Lake Co. (F. D. Parker, R. E. Rice), 2 ♀, UCD; Mt. Diablo, Contra Costa Co. (P. D. Hurd, J. W. MacSwain, M. Wasbauer), 9 ♂, 4 ♀, CIS; Hopland Grade, Lake Co. (S. M. Fidel), 1 ♂, UCD; Pinnacles Natl. Mon., San Benito Co. (P. D. Hurd, on *Salix*), CIS; Putah Cyn., Yolo Co. (F. D. Parker), 1 ♀, FDP; Samuel Spr., Napa Co. (J. C. Downey, R. C. Bechtel, P. M. Marsh, R. M. Bohart, E. I. Schlinger), 2 ♂, 4 ♀, UCD; Sequoia Natl. Park., Ash Mt. Rd. (R. C. Bechtel), 1 ♂, UCD; Silver Creek (D. Burdick), 1 ♂, CIS; Summit Camp, Lassen Co. (E. G. Linsley), 1 ♂, CIS; Tanbark Flat, L.A. Co. (R. M. Bohart, W. O. Marshal, A. T. McClay, P. D. Hurd, J. W. MacSwain), 2 ♂, 4 ♀, UCD and CIS. NEVADA.—Galena Creek, Washoe Co., 6300 ft (R. W. Lauderdale), 1 ♂, NSDA.

*Systematics.*—*C. parkeri* is quite similar to *C. remissa* and *C. coerulans* in appearance, but is easily distinguished from both by the sternal spots; also, the first 3 flagellar segments of *coerulans* are noticeably shorter and broader than those of *parkeri.* The close resemblance between *parkeri* and *coerulans* may be purely superficial, as there is a marked difference in the male genitalia. In general structure, the gonoforceps of both *parkeri* and *remissa* (Fig. 8D, 9D) are similar to those of the *Chrysis amala* group (not discussed in this paper). Sternite 8, however, is much closer in structure to the *coerulans* type (Fig. 8C, 9C). In general, the characters of both *parkeri* and *remissa* warrant their placement in the *coerulans*-group.

*Biology*.—*C. parkeri* has been reared by F. D. Parker from nests of *Ancistrocerus* sp. and *Euodynerus* sp. in *Sambucus* stems. The pupal case is an elongate tube, slightly more than twice as long as wide, tapered at the ends, with the anterior end slightly more than twice as long as wide, tapered at the ends, with the anterior end slightly larger than the posterior. The case varies from nearly colorless to deep, opaque brown; there are 1–3 opaque, whitish areas surrounding its anterior half.

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REFERENCES CITED

**Krombein, K. V.** 1958. Additions during 1956 and 1957 to the wasp fauna of Lost River State Park, West Virginia, with biological notes and descriptions of new species. Proc. Entomol. Soc. Wash. 60: 49–64.

1960. Life history and behavioral studies of solitary wood- and ground-nesting wasps in southeastern Arizona. Year Book Amer. Philos. Soc. 299–300.

**Linsenmaier, W.** 1959. Revision der Familie Chrysididae. Mitt. Schweiz. Entomol. Ges. 32: 1–232.

**Parker, F. D., and R. M. Bohart.** 1966. Host-parasite associations in some twig-nesting Hymenoptera from western North America. Pan-Pacific Entomol. (In press.)

# Food Transmission within the *Cryptotermes brevis* Colony (Isoptera: Kalotermitidae)[1]

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ABSTRACT

Transmission of food within artificial "colonies" of *Cryptotermes brevis* (Walker) nymphs was studied, using radioactive cobalt as a tracer. Four different colony densities (25, 50, 100, and 200 termites) and 4 different intervals of exposure to a single radioactive donor (12, 24, 48, and 96 hours) were tested. As expected, the larger the colony and the longer the exposure interval, the more nymphs became radioactive. In the 25-member colony showing the fastest transmission rate, colony saturation reached virtually 100% in 96 hours, while the highest percentage reached by a 200-member colony for the same interval was 50%. The average amount of radioactivity per termite decreased significantly with increase in density, but appeared not to be appreciably affected by time. Pellet production by individuals declined significantly with time, but was not significantly affected by density.

The reciprocal exchange of nutrients or of tactile and chemical stimulation within the social insect colony, Wheeler's trophallaxis (1923), is essential for colony health and integration. The rate at which nutrients are transferred, and the extent to which all members of the colony participate in this activity may underlie certain differences in makeup which are known to exist between different termite colonies. For example, the soldier-to-nonsoldier ratio differs not only with species, but also with season and age of colony within the same species (Castle 1934, Miller 1942, Grassé and Noirot 1957). Much of this variation in caste ratio doubtless has a genetic basis, but knowledge of rates of food exchange under varying conditions might also help to clarify colony differences; in the lower termites, at least, trophallaxis is the means of distribution of factors affecting caste determination. Species differences in rate of food transmission, found in ants by Wilson and Eisner (1957), may be found in termites as well.

One means of studying food exchange is the tracer technique of radioisotopes. It has been applied increasingly in studies of social insects by such investigators as Nixon and Ribbands (1952), Oertel and his collaborators (1953), Wilson and Eisner (1957), Gösswald and Kloft (1958, 1959), Alibert (1959, 1963), Chauvin and his colleagues (1961, 1964, 1965), McMahan (1963), and others. The present paper con-

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