1998. The Journal of Arachnology 26:133–141

CUPIENNIUS REMEDIUS NEW SPECIES (ARANEAE, CTENIDAE), AND A KEY FOR THE GENUS

Friedrich G. Barth[1] and **Detlev Cordes**: Biozentrum, Institut für Zoologie, Universität Wien, Althanstr. 14, A-1090 Wien, Austria

ABSTRACT. A new representative of the neotropical genus *Cupiennius* Simon 1891 (Araneae, Ctenidae) was found in the highlands of central Guatemala. ***Cupiennius remedius*** new species is the ninth species established for the genus. Like all other species of *Cupiennius*, *C. remedius* is a hunting spider living in close association with monocotyledonous plants where it hides in a retreat during the day and is active at night. *C. remedius* is of medium size (carapace length *ca.* 8 mm) compared to the other species of the genus and is the only *Cupiennius* species known to live sympatrically with *C. salei*. Live animals show a spotted coloration pattern unusual for the genus. The distinctive features of the male bulbi and female epigyna are described and an example is given of the species-specific courtship vibrations. In addition, we provide a revised key for the genus *Cupiennius*.

RESUMEN. Hemos encontrado un nuevo representante del género neotropical *Cupiennius* Simon 1891 (Araneae, Ctenidae) en las regiónes montañosas del centro de Guatemala. ***Cupiennius remedius*** nueva especie es la novena especie establecida para el género. Como todas las otras especies de *Cupiennius*, *C. remedius* es una araña cazadora que vive en estrecha asociación con plantas monocotiledóneas, en las que se oculta durante el día en un refugio y es activa durante la noche. En comparación con las otras especies del género, *C. remedius* es de tamaño intermedio (alrededor de 8 mm de longitud del caparazón) y es la única especie de *Cupiennius* que se sabe que vive en simpatría con *C. salei*. Los animales vivos presentan un patrón de coloración manchado que no es habitual en el género. Describimos las características distintivas de los bulbos de los machos y de los epiginos de las hembras e incluimos un ejemplo de las vibraciones de cortejo específicas de la especie. Además, incluimos una clave revisada del género *Cupiennius*.

When we first revised the genus *Cupiennius* Simon 1891 (Lachmuth et al. 1984) the genus contained 21 nominal species. Seven species from Central America (including northern Columbia, Cuba, Haiti, and Jamaica) were recognized by the structure of their genital organs. Six of the seven species (the exception being *C. granadensis* (Keyserling 1877)) have been bred successfully in the laboratory.

Among the species excluded from the genus in our previous revision was *C. celerrimus* Simon 1891. The main reason for the exclusion was the lack of a holotype, the locality in Brazil which appeared unlikely for the genus, and the fact that *C. celerrimus* had not been found since 1891. However, Brescovit & von Eickstedt (1995) recently redescribed *C. celerrimus* from Brazil; and we have therefore included it in our revised key as the ninth species of the genus *Cupiennius*.

[1]To whom correspondence should be addressed.

A particular incentive for the clarification of the taxonomy of *Cupiennius* is the importance of some of its representatives in studies in sensory and behavioral physiology (Barth 1985, 1993; Barth et al. 1993a,b, 1995; Humphrey et al. 1993; Lachmuth et al. 1984; Land & Barth 1992; Strausfeld & Barth 1993). An extensive study of problems in reproductive isolation of the species (Barth 1993) also prompted a PCR-analysis of DNA-sequences which provided evidence for the polyphyly of the family Ctenidae to which the genus *Cupiennius* is assigned (Huber et al. 1993).

Cupiennius remedius new species was found in 1992 while searching for *C. salei* (Keyserling 1877) in the highlands of central Guatemala at the Finca Remedios (Fig. 1). *C. remedius* is the only species of the genus known to live sympatrically with *C. salei*. The present study describes the new species and in addition provides a revised key for the genus. The key also considers some new aspects

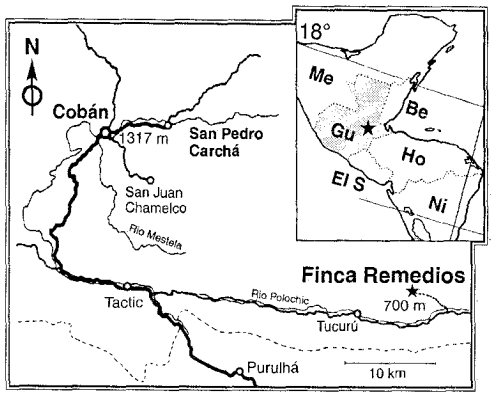


Figure 1.—The location of Finca Remedios in Guatemala (Alta Verapaz) where ***Cupiennius remedius*** new species was found.

which have emerged from many years of research in the field and in the laboratory as well as from breeding most of the species.

Cupiennius remedius new species
Figs. 1–5, 13

Types.—Male holotype, two male and four female paratypes were collected at the Finca Remedios on 12 February 1992 (F.G. Barth, R. Felber). One of the spiders was collected as a juvenile and developed into an adult male in the laboratory. The holotype and one female paratype are in the arachnological collection of the Senckenberg Museum, Frankfurt am Main, Germany. The other paratypes remain in the collection of the Zoology Department of the University of Vienna, Austria.

Etymology.—The name of the new species refers to the type locality, i.e., Finca Remedios.

Diagnosis.—Morphologically, *C. remedius* forms a group together with *C. foliatus* F.P.-Cambridge 1901 and *C. panamensis* Lachmuth et al. 1984, of which it is the largest (Fig. 2). The spotted appearance of its habitus is unique among all known species of *Cupiennius* (Fig. 3). In addition, male *C. remedius* differ from male *C. foliatus* by the terminal apophysis of their bulbs which is not elevated at the embolic base (stipes-embolus) as it is in *C. foliatus* (Figs. 30, 31). Regarding the females, a prominent difference between *C. remedius* and *C. foliatus* is the shape of the lateral plates of the epigynum at their anterior end (Fig. 14a). Apart from the spotted habitus, the lateral plates of the epigynum also distinguish *C. remedius* from *C. panamensis*. In *C. remedius*, the lateral plates are not continuous with the median septum (Fig. 14a). Whereas the vulvae are strikingly similar in *C. remedius* and *C. foliatus* (Fig. 22), the shape of the seminal ducts leading to the seminal receptacles I clearly differs between *C. remedius* and *C. panamensis* (Figs. 21, 22). The strong twisting of the seminal ducts of the first receptacles in *C. remedius* and *C. foliatus* is very conspicuous but typical of *C. salei* as well (see Figs. 15, 22).

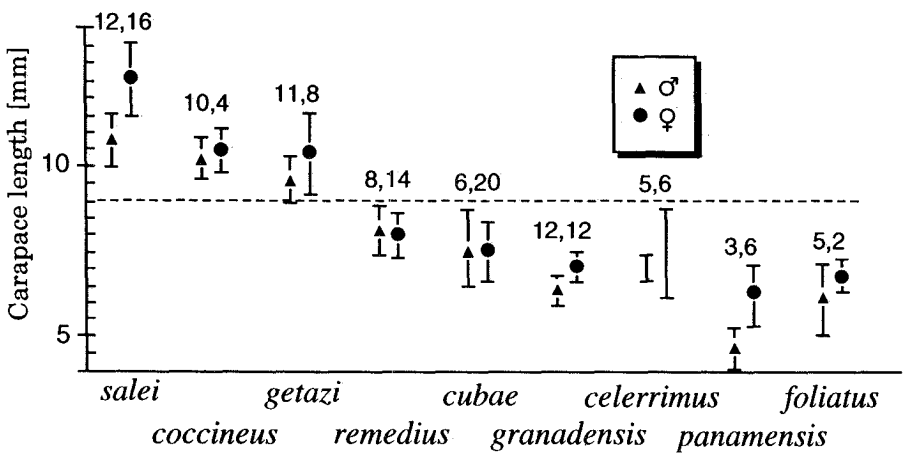
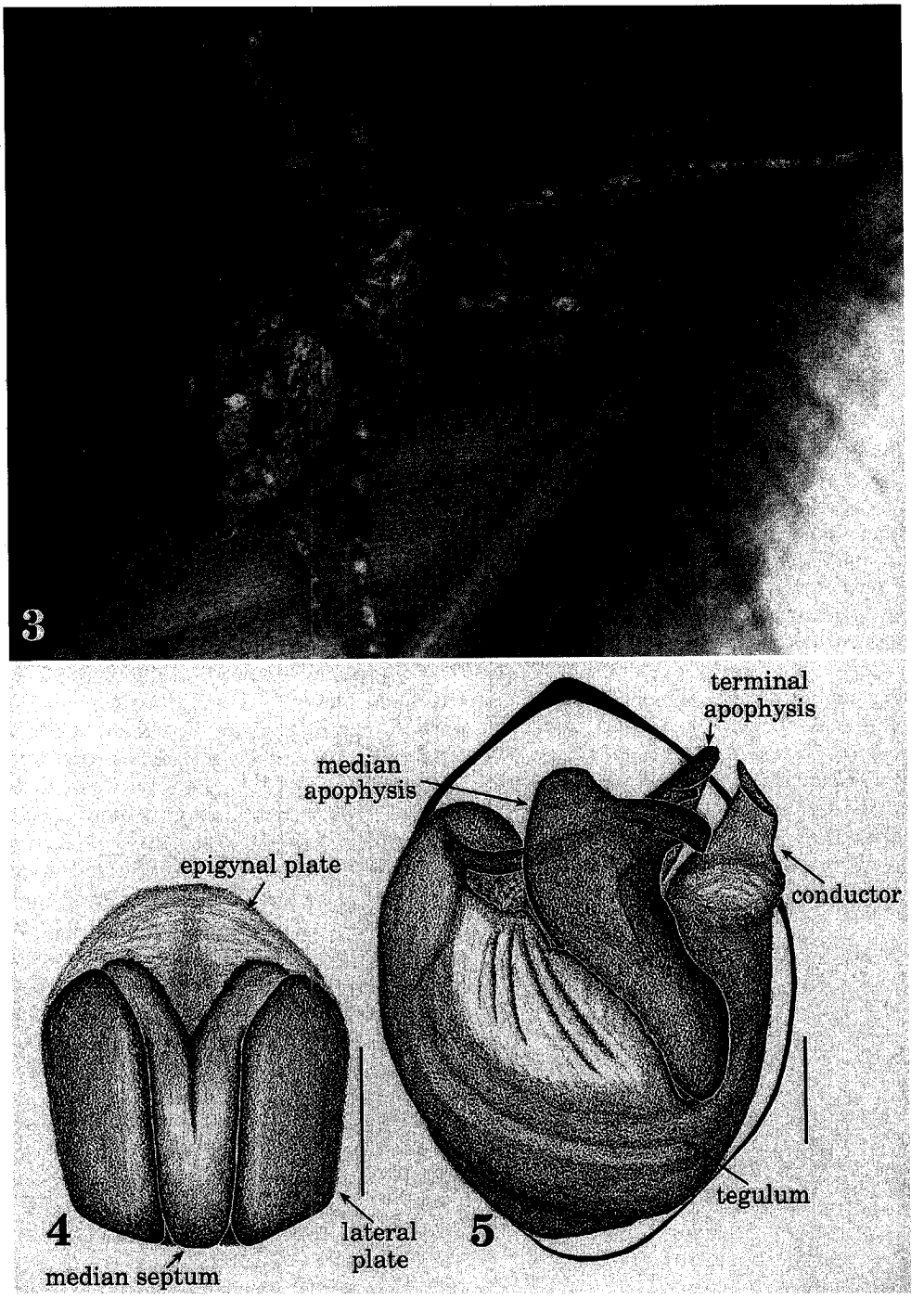
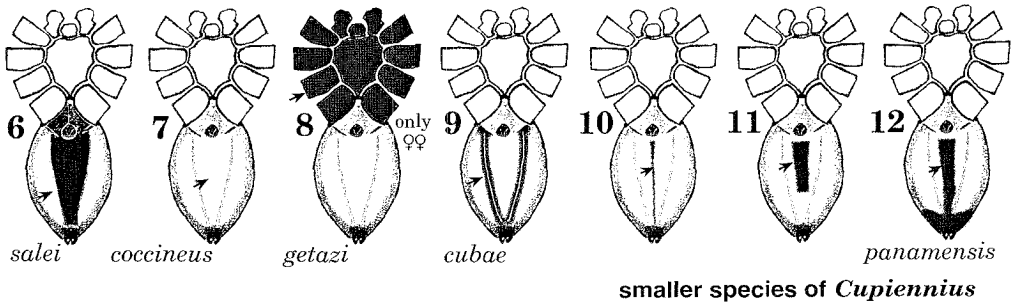


Figure 2.—Size distribution of the nine known species of *Cupiennius*, indicated by the carapace lengths of male and female representatives. Number of individuals measured is given above the symbols. Bars represent standard deviation of the mean; for $n < 7$ the bars instead represent the range of values. For *C. celerrimus* the range of values given is taken from Brescovit & Eickstedt 1995.



Figures 3–5.–***Cupiennius remedius*** new species. 3, Adult female, feeding on a fly; 4, Epigynum of female paratype, ventral view; 5, Bulb and terminal parts of embolus of male holotype, ventral view. Scale = 0.5 mm.



Figures 6–12.—Schematized view of the ventral body of different species of *Cupiennius* to show diversity of ornamental patterns (see arrows). 6, *C. salei*; 7, *C. coccineus*; 8, *C. getazi*; 9, *C. cubae*. 10–12. Smaller *Cupiennius* species, range of pattern variability (12, *C. panamensis*).

Description.—*Males:* Prosoma 7–9 mm long ($\bar{x}$ = 8.2 mm, Fig. 2), medium brown with a patchy pattern dorsally (Fig. 3). Opisthosoma dorsally medium brown with light brown markings along the cardiac mark; ventrally light with a slight brown indication of a narrow median stripe or with a distinct dark and narrow median stripe (Figs. 10, 11), variable. Legs light brown without ring-shaped patterns; femur clearly lighter than the other leg segments; tarsus, metatarsus, and tibia covered by conspicuous long thin hairs ventrally and laterally. Pedipalps medium brown with a short tibial apophysis typical of the genus. Bulb (Fig. 5) with its prominent median apophysis slightly curved with a round terminal and a large shovel-like lateral process; conductor largely flat and tip bent towards tegular apophysis; terminal elements (Fig. 30): embolic apophysis distinctly curved, terminal apophysis leaf-like and covering the embolic opening.

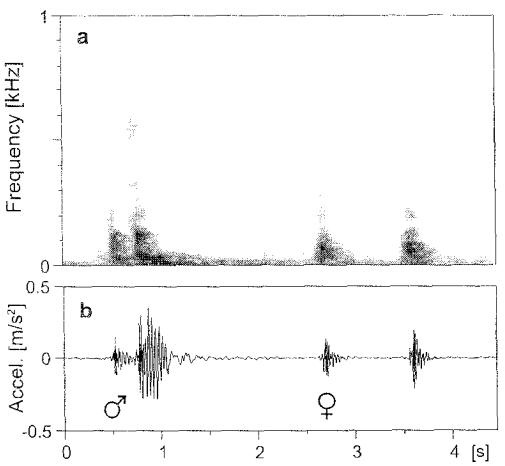


Figure 13.—Sonagram and oscillogram of representative substrate borne male courtship vibration and female vibratory response of ***Cupiennius remedius*** new species. Signals were recorded on a bromeliad using an accelerometer.

Females: Prosoma 7.4–9.3 mm long ($\bar{x}$ = 7.9 mm, Fig. 2), medium brown with a light brown, patchy pattern dorsally (Fig. 3). Opisthosoma dorsally medium brown with light brown markings along the cardiac mark; ventral side light with a dark narrow median stripe (Figs. 10, 11). Legs medium to light brown with distinct annular patterns (Fig. 3). Epigynum (Fig. 4) with narrow median septum slightly narrowing distally and dividing into two parts proximally (bordering the lateral plates), its Y-shape similar to that of *C. foliatus*; lateral plates elevating towards median septum and connecting to the border of the epigynal plate anterio-laterally; vulva with more or less ball-shaped first receptacles and seminal ducts strongly winding dorsally and proximally (Fig. 22).

Courtship behavior.—*Cupiennius remedius* is the seventh among all known species of the genus (together with *C. salei, C. getazi* Simon 1891, *C. coccineus* F.P.-Cambridge 1901, *C. cubae* Strand 1910, and *C. foliatus*) which has been shown to be a biospecies. We have bred *C. remedius* in Vienna and also observed its courtship behavior. As known from extensive studies with other species of *Cupiennius* (Barth & Schmitt 1991; Barth 1993), the vibrations exchanged between male and female during courtship are important in the reproductive isolation of the species; and it is in particular the male courtship vibration which helps the female to

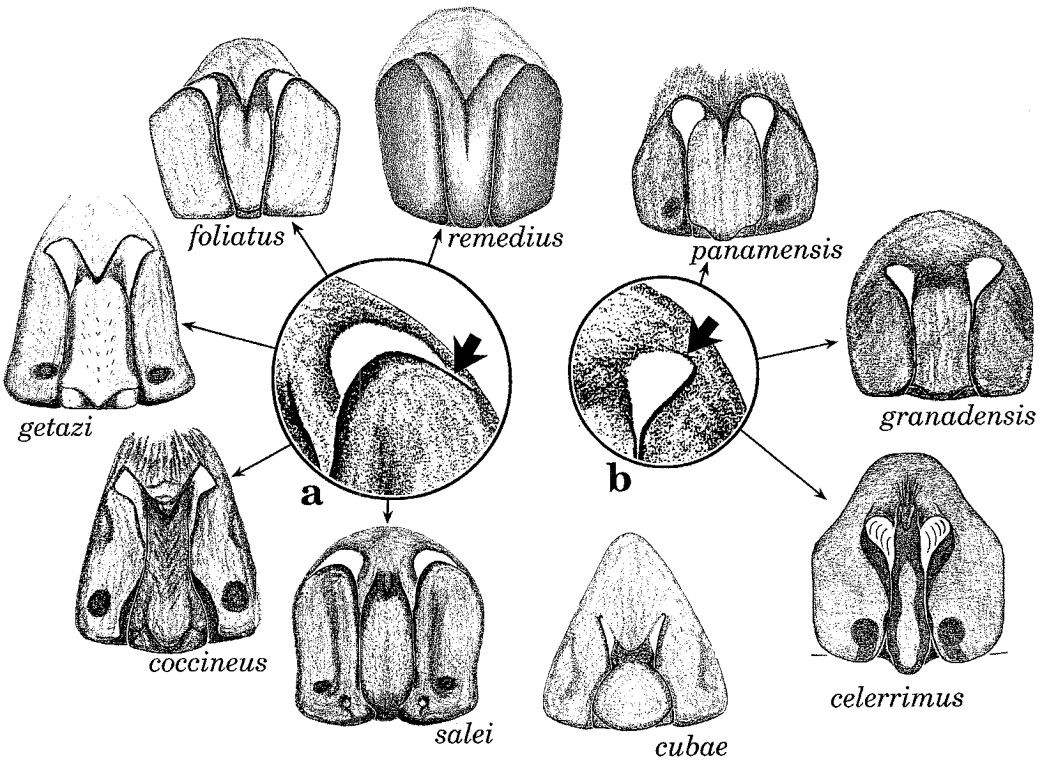
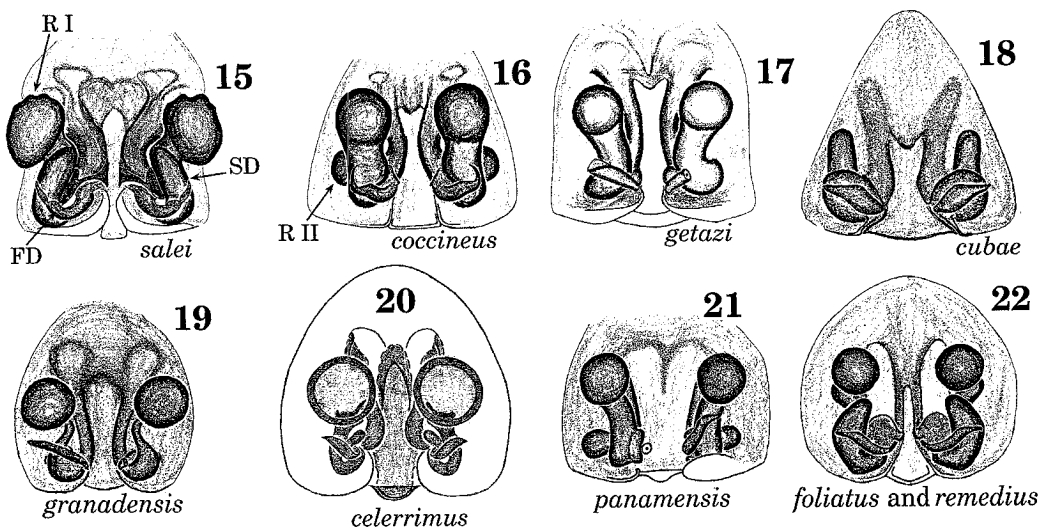
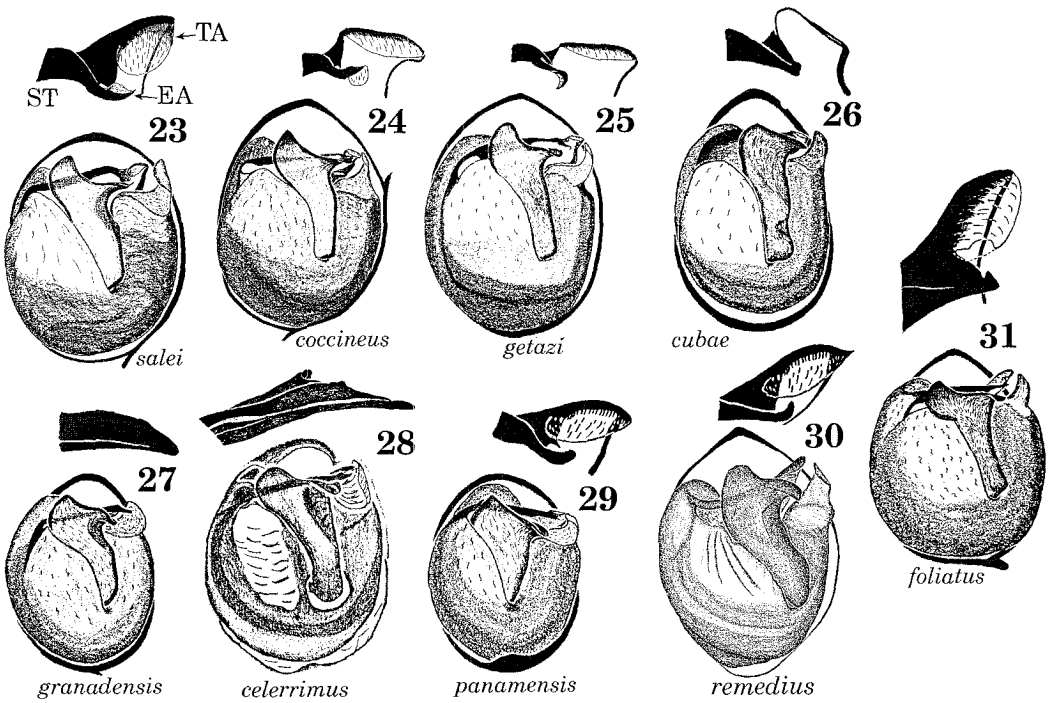


Figure 14.—Ventral view of epigyna of the females of all nine species of *Cupiennius*. Note two groups **a** and **b** which differ with regard to the way in which the lateral plates are connected to the epigynal plate anterio-laterally. See Fig. 3 for nomenclature of various parts. Modified and adapted from Lachmuth et al. 1984 and from Brescovit & von Eickstedt 1995 (*C. celerrimus*).



Figures 15–22.—Epigyna of the females of the nine *Cupiennius*-species. Seen in dorsal view (from inside) and showing the seminal receptacles I and II (RI, RII), the seminal duct (SD) and the fertilization duct (FD). Modified and adapted from Lachmuth et al. 1984 (Figs. 15–19, 21, 22) and Brescovit & von Eickstedt 1995 (Fig. 20).



Figures 23–31.—Bulbi genitales and terminal parts of the embolus of the males of all nine species of *Cupiennius*. For the terminology of the various parts see Fig. 3; TA = terminal apophysis, SE = stipes embolus, EA = embolic apophysis. Modified and adapted from Lachmuth et al. 1984 (Figs. 23–27, 29, 31) and from Brescovit & von Eickstedt 1995 (Fig. 28).

recognize its conspecific partner. In *C. remedius* the male vibration results from up and down movements of the opisthosoma (without touching the substrate; Dierkes & Barth 1995) and does not come in series of syllables as in *C. coccineus, C. getazi,* and *C. salei* (Barth 1993). Instead it is a single syllable resulting from a short bang of the pedipalps onto the dwelling plant followed by just one or two cycles of the opisthosomal movement (Fig. 13). The main frequency components are around 30 Hz in case of both the male vibration and the female response.

Distribution.—Until now, *C. remedius* was known only from the type locality. The Finca Remedios is located in the Departamento Alta Verapaz near Coban at an altitude of about 700 m (Fig. 1) and with the climate typical of the "tierra templada" (Barth & Seyfarth 1979; Barth et al. 1988). All animals were collected at the edge of a banana plantation 4 km east of the finca house and close to a small brook and an unpaved road. The spiders all sat behind the trough-shaped basal parts of banana leaf sheaths which are typical retreats of other species of *Cupiennius* as well (Barth et al. 1988).

KEY TO THE SPECIES

The following key includes the description of the coloration patterns, typical of living representatives of the species. In the larger species, this permits determination of the species even for subadult specimens. The coloration may be indistinct or even absent in preserved specimens. Then the shape of the epigynum, vulva and bulbal sclerites is of major importance. Especially the smaller species of *Cupiennius* have an indistinct or variable coloration pattern on their body and legs. Their determination is possible only by dissecting the vulva (females) or looking at small details of the male bulb. The key includes all important features of the genitalia already described in Lachmuth

et al. (1984). Besides including *C. remedius* and *C. celerrimus*, it extends the previously published key by considering body size and additional characters of the coloration pattern and of the genitalia. The definition of the colors used in the key is taken from a color table of color-pencils from Faber-Castell, Germany.

Adult Females:

1. Large spider (carapace length > 9 mm) (Fig. 2); legs and/or body with conspicuous markings or color pattern 2
   Medium sized spider (carapace length < 9 mm) (Fig. 2); legs and/or body uniformly brown or with comparatively indistinct or variable markings 4
2.(1) Legs brown with conspicuous dark markings 3
   Femora I–IV bright carmine-red ventrally; prosoma and opisthosoma medium to dark brown dorsally with a darker median band; ventral opisthosoma without any dark markings (Fig. 7); epigynum with narrow median septum, widening distally; distal part of septum with strongly sclerotized hook (Fig. 14a) ..... *coccineus*
3.(2) Femora I–IV with distinct black annular patterns; prosoma dorsolaterally with light grayish-brown pattern contrasting the darker median band; coxae densely covered with terra cotta red hairs ventrally; ventral opisthosoma always with broad black median stripe (Fig. 6); in some specimens pairs of yellowish to whitish spots disto-laterally on both sides of the cardiac mark; epigynum with narrow median septum of uniform width (Fig. 14a); body length up to 45 mm (largest species, Fig. 2) ..... *salei*
   Femora I–IV on the ventral side with many small black spots; either sternum or sternum and coxae (variable) dark brown to black (Fig. 8); dorsally, body coloration distinct and species-specific: median dark band on prosoma, colored areas laterally on the body; dark cardiac mark (opisthosoma); dark inverse V-shaped stripes, distal to cardiac mark; ventral opisthosoma light brown (populations from Barro Colorado Islands and from Panama were observed to have only a dark median ventral opisthosomal band, and no speckled femora). A grayish morph and an orange morph exist. Epigynum with broad median septum of roughly uniform width, but widening distally (Fig. 14a); distal part of septum with sclerotized nose-like process ..... *getazi*
4.(1) Epigynal plate oval or trapezoid 5
   Epigynal plate distinctly triangular (Fig. 14b); median septum of epigynum strongly widened distally forming a sphere; seminal receptacle I cone-like; body color in general uniformly grayish to brownish, ventral opisthosoma with outlines of a dark median band, consisting of a series of short dark reddish hairs (Fig. 9) ..... *cubae*
5.(4) Lateral plate of epigynum directly connected to the median septum forming a loop (Fig. 14b) 6
   Lateral plate of epigynum not directly connected to the median septum and extending to the anterior-lateral border of the epigynal plate (Fig. 14a) 8
6.(5) Epigynum with narrow median septum, seminal receptacles I with seminal ducts of different shapes: S-shaped, twisted, winding or rolled 7
   Epigynum wider than long (Fig. 14b); median septum broad and leaf-like; vulva: seminal receptacles I ball-shaped with seminal ducts sturdy and slightly curved laterally (Fig. 21); prosoma light brown; opisthosoma darker brown, with narrow dark-shaded median band ventrally (Fig. 11); smallest species (Fig. 2) ..... *panamensis*
7.(6) Median septum with parallel borders, distally ending broad, and with a small hook (Fig. 14b); vulva: seminal receptacles I with distinctly S-shaped seminal ducts (Fig. 19) ..... *granadensis*
   Median septum long, narrow and slightly widening distally (Fig. 14b); vulva: seminal receptacles large and ball-shaped, seminal ducts rolled dorso-ventrally (Fig. 20); body orange to brown with darker brown median band, legs I–IV yellow ventrally on coxae and femora ..... *celerrimus*
8.(5) Lateral plates of epigynum ending rounded before connecting to the epigynal plate (Fig. 14a), median septum of epigynum narrow and continuously narrowing distally (Fig. 14a); vulva with ball-shaped seminal receptacles, seminal ducts strongly winding (Fig. 22); medium large spider (carapace length 7–8 mm); annular patterns on femora, and body remarkably spotted (Fig. 3); tarsi of legs I–IV with long dark hairs both dorsally and ventrally ..... ***remedius*** new species
   Lateral plates of epigynum ending as indicated in Fig. 14a before connecting to the anterior-lateral end of the epigynal plate, median septum of epigynum as in Fig. 14a; seminal receptacles I ball-shaped, seminal ducts as in Fig. 22; spider smaller (carapace length up to 7 mm); body

without distinct color pattern or with a series of dark spots along the cardiac mark on the opisthosoma ..... *foliatus*

Adult Males:

1. Large spider (carapace length > 9 mm) (Fig. 2). Legs with conspicuous markings (except one case, see 2.); body light gray, light brown to medium brown or bright orange dorsally; ventral opisthosoma with or without broad dark median stripe 2
Medium sized spider (carapace length < 9 mm) (Fig. 2). Legs and/or body uniformly brown or with indistinct markings, or pro- and opisthosoma with variable arrangement of more or less isolated dark dots and lines; opisthosoma light ventrally or with a narrow dark median stripe 4

2.(1) Legs and/or body with conspicuous markings 3
Legs without conspicuous coloration; legs and body gray-brown with median band on dorsal prosoma consisting of thin dark lines; light opisthosoma with dark cardiac mark, lacking dark markings ventrally; bulb with terminal apophysis bent downwards, embolic-apophysis strongly curved and twisted (Fig. 24) ..... *coccineus*

3.(2) Femora I–IV with distinct black annular patterns ventrally; body grayish dorsally with dark lines along the length of the prosoma (= median band); sternum and coxae grayish; opisthosoma with broad dark median band ventrally; bulb with terminal apophysis large and bent downwards, embolic apophysis robust and curved (Fig. 23); body length up to 30 mm (largest species, Fig. 2) ..... *salei*
Femora I–IV with many small black spots ventrally; sternum and coxae dark brownish (variable); conspicuous species-specific body coloration: a dark median band dorsally on prosoma and opisthosoma bordered by light areas laterally; dark cardiac mark dorsally on opisthosoma, and dark inverse V-shaped stripes posterior to it; two morphs with either grayish or orange basic coloration. Bulb with terminal apophysis bent downwards, embolic apophysis strongly curved and twisted (Fig. 25) ..... *getazi*

4.(1) Opisthosoma with narrow dark median stripe ventrally (Figs. 10–12) or without ventral markings 5
Opisthosoma only with dark reddish outlines of the ventral median stripe (Fig. 9); bulb (Fig. 26) with median apophysis comparatively straight and notched in the proximal third of its length, distal process and lateral shovel-like process very small, terminal apophysis strongly domed and extending over the short embolic apophysis. Body grayish or brownish ..... *cubae*

5.(4) Bulb with embolic base (stipes-embolus) massive (Figs. 27, 28), terminal and embolic apophysis not distinct 6
Embolic base (stipes-embolus) with distinct terminal and embolic apophysis (Figs. 23–26, 29–31) 7

6.(5) Embolic base (stipes-embolus) bill-shaped and folded forming one furrow (Fig. 27); body light yellow-brown with a sparse coverage of hairs; prosoma with median line markings dorsally ..... *granadensis*
Embolic base (stipes-embolus) strongly folded forming two furrows (Fig. 28); embolic tip appears severed with a pair of short processes; body and legs orange with a brown median band on pro- and opisthosoma; ventral surface of coxae and femora yellow ..... *celerrimus*

7.(5) Terminal apophysis levels with the embolic base (stipes-embolus) (Figs. 29, 30) 8
Terminal apophysis elevates at an angle of approximately 45° at the embolic base (Fig. 31) and covers the embolic apophysis; opisthosoma with a variable line of spots along the border of the cardiac mark ..... *foliatus*

8.(6) Carapace length *ca.* 8 mm; body with spotted coloration pattern dorsally; legs long (sexual-dimorphic), covered with a "brush" of long and thin hairs along the tibia and metatarsus and with the longest hairs at the proximal part of the tibia-metatarsus joint; median apophysis with an elevation near the lateral process, tegulum with deep furrows ventrally (Fig. 5) ..... ***remedius*** new species
Carapace length *ca.* 5 mm; body without distinct coloration pattern dorsally; dorsal opisthosoma darker than prosoma and with a small dark median band ventrally, widening towards the posterior part of the opisthosoma (Fig.12) ..... *panamensis*

ACKNOWLEDGMENTS

We are very grateful to the Schleehauf family, owner of Finca Remedios, for their generous hospitality and kind assistance in Guatemala. The field work (F.G. Barth, R. Felber) in Guatemala in 1992 was made possible by financial support from the Austrian Science Foundation (FWF, P 7896B to F.G.B.). We thank Carmen Fernandez-Montraveta for translation of the abstract into Spanish. We also thank A. Brescovit and V. von Eickstedt for providing the original drawings of the genitalia of *C. celerrimus* and much appreciate the comment of a reviewer who pointed out to us the reference where these figures first appeared.

LITERATURE CITED

Barth, F.G.(ed.). 1985. Neurobiology of Arachnids. Springer-Verlag, Berlin.

Barth, F.G. 1993. Sensory guidance in spider precopulatory behavior. Comp. Biochem. Physiol., 104A:717–733.

Barth, F.G. & A. Schmitt. 1991. Species recognition and species isolation in wandering spiders (*Cupiennius* spp., Ctenidae). Behav. Ecol. Sociobiol., 29:333–339.

Barth, F.G., J.A.C. Humphrey, U. Wastl, J. Halbritter & W. Brittinger. 1995. Dynamics of arthropod filiform hairs. III. Flow patterns related to air movement detection in a spider (*Cupiennius salei* Keys.). Phil. Trans. R. Soc. London, B, 347: 397–412.

Barth, F.G., T. Nakagawa & E. Eguchi. 1993a. Vision in the ctenid spider *Cupiennius salei*: spectral range and absolute sensitivity (ERG). J. Exp. Biol., 181:63–79.

Barth, F.G., U. Wastl, J.A.C. Humphrey & R. Devarakonda. 1993b. Dynamics of arthropod filiform hairs. II. Mechanical properties of spider trichobothria (*Cupiennius salei* Keys.). Phil. Trans. R. Soc. London, B, 340:445–461.

Barth, F.G. & E.-A. Seyfarth. 1979. *Cupiennius salei* Keys. (Araneae) in the highlands of central Guatemala. J. Arachnol., 7:255–263.

Barth, F.G., E.-A. Seyfarth, H. Bleckmann & W. Schüch. 1988. Spiders of the genus *Cupiennius* Simon 1891 (Araneae, Ctenidae). I. Range distribution, dwelling plants, and climatic characteristics of the habitats. Oecologia, 77:187–193.

Brescovit, A.D. & V.R.D. von Eickstedt. 1995. Ocorrência de *Cupiennius* Simon na América do Sul e redescriçâo de *Cupiennius celerrimus* Simon (Araneae, Ctenidae). Rev. Brasiliera Zool., 12(3):641–646.

Dierkes, S. & F.G. Barth. 1995. Mechanism of signal production in the vibratory communication of the wandering spider *Cupiennius getazi* (Arachnida, Araneae). J. Comp. Physiol. A, 176: 31–44.

Huber, K.C., T.H.S. Haider, M.W. Müller, B.A. Huber, R.J. Schweyen & F.G. Barth. 1993. DNA-sequence data indicates the polyphyly of the family Ctenidae (Araneae). J. Arachnol., 21: 194–201.

Humphrey, J.A.C., R. Devarakonda, J. Iglesias & F.G. Barth. 1993. Dynamics of arthropod filiform hairs. I. Mathematical modelling of the hair and air motions. Phil. Trans. R. Soc. London, B, 340:423–444.

Keyserling, E. 1877. Über amerikanische Spinnenarten der Unterordnung Citigradae. Verh. Zool.-Bot. Ges. Wien, 26:609–708.

Lachmuth, U., M. Grasshoff & F.G. Barth. 1984. Taxonomische Revision der Gattung *Cupiennius* Simon 1891 (Arachnida; Araneae). Senckenbergiana Biol., 65:329–372.

Land, M.F. & F.G. Barth. 1992. The quality of vision in the ctenid spider *Cupiennius salei*. J. Exp. Biol., 164:227–242.

Pickard-Cambridge, F.O. 1897–1905. Biologia Centrali-Americana. Arachnida, Araneida and Opiliones, 2:1–610.

Simon, E. 1891. Description de quelques arachnides de Costa Rica communiqués par M.A. Getaz (de Genève). Bull. Soc. Zool. France, 16:109–112.

Strand, E. 1910. Eine neue cteniforme Spinne aus Guatemala. Soc. Entomol., 25:14.

Strausfeld, N.J. & F.G. Barth. 1993. Two visual systems in one brain: neuropils serving the secondary eyes of the spider *Cupiennius salei*. J. Comp. Neurol., 328:43–62.

Manuscript received 3 January 1997, revised 8 August 1997.