Rev. Biol. Trop., 18(1, 2): 89-98, 1971

Nesting habits and nest symbionts of Polistes erythrocephalus Latreille (Hymenoptera Vespidae) in Costa Rica

by

By John M. Nelson*

(Received for publication February 12, 1970)

There are few published observations on the ecology of the social wasps in the genus *Polistes* in Central America. Both the taxonomy and distribution of the group have been based largely on museum specimens. RAU'S report (12) of his observations of the habits of *Polistes canadensis panamensis* Holmgren and *P. versicolor* (Olivier) on Barro Colorado Island, Panama, during the months of August and September, 1928, is probably the most detailed account of *Polistes* in this region. Since most of the published data on this mainly tropical genus have been from the temperate region, it is hoped that these notes will stimulate others to make and to share their studies of *Polistes* in the American tropics.

This report is based on observations made in the dry season months of February and March, 1967. Data are from two sites in Costa Rica: Finca Taboga, 6 miles south and 6 miles west of Cañas, Guanacaste Province; and Rincón, Puntarenas Province, on the Osa Peninsula.

According to BEQUAERT (3, 4), who considers it a subspecies of *Polistes canadensis, P. erythrocephalus* Latreille is common in Costa Rica and Panamá, and is also found in Nicaragua, Colombia, and southern Brazil. This species was apparently omitted by YOSHIKAWA (16) in his list of species of *Polistes* of the world.

In addition to *P. erythrocephalus,* four other species of *Polistes* are recorded from Costa Rica. They are: *P. instabilis* Saussure, (BEQUAERT, 3); *P. modestus* F. Smith, (BEQUAERT, 2); *P. testaceicolor* Bequaert, (BEQUAERT, 2, 5; RICHARDS and RICHARDS, 14); and *P. versicolor* (Olivier), (BEQUAERT,

* Zoology Dept., Southern Illinois University, Carbondale, Illinois 62901. Present Address: Glenville State College, Glenville. West Virginia 26351, U.S.A.

1, 5). In the author's collection are specimens of a sixth species, *P. carnifex* (Fabricius), from Costa Rica. The distribution records of three other species, *P. canadensis* (Linnaeus), *P. major* Palisot de Beauvois and *P. pacificus* Fabricius, indicate that they are present in Costa Rica.

NESTING HABITS: The nesting habits of *P. erythrocephalus* in Costa Rica are very similar to those of *P. annularis* (L.) in the United States (RAU, 10, 11, 13; NELSON, 9). RAU (12) described the same habits for *P. canadensis panamensis* in Panama. Active nests of *P. erythrocephalus* were common both at Finca Taboga and on the Osa Peninsula. Nests were nearly always found in cleared areas in the proximity of a reliable water source, usually a small stream. Neither nests nor wasps were seen in the forest. Nests were common on the trunks of large solitary trees in river bottom pastures at Finca Taboga. Often there were three or four nests on the same tree, usually between three and twenty feet off the ground; under the roofs of cattle salt feeders; and under bridges. the trunks of trees which had been felled in land clearing; under the eaves and roofs of buildings and sheds; under the floors of buildings more than five feet off the ground; under the roofs of cattle salt feeders and under bridges. About twenty nests were under a boat dock on the bay at Rincón. Only two small nests were found on leaves, in both cases the undersides of large *Heliconia* leaves. No nests were found in direct sunlight during this study, in contrast to RAU's (12) report that *P. canadensis panamensis* nests were fully exposed to the sun.

Active nests were found in all stages of development, from a single cell to a senescent nest of 461 cells. This seems to verify Rau's conclusion that *Polistes* wasps nest continuously throughout the year in the tropics, particularly since he found *P. canadensis panamensis* nests in all stages and of all sizes in August and September. However, other investigators inform me that nests of *P. erythrocephalus* could not be found in June and July at Finca Taboga nor at Rincón. Carlos Valerio (pers. comm.) reports that he found a few nests in the Taboga area during August and September, although they were not as common as in the dry season). It will be necessary to make continual observations for at least a year to determine if there is a resting period, and if so, the duration of such a period.

The largest wasp nest taken was inactive and had nearly 1000 cells. The location, cell number, activity, and symbionts associated with each nest collected has been tabulated elsewhere (8). The size of the nests when they are abandoned by the wasps varies considerably as do the nests of *P. annularis* (7), but they average about 450 cells each. This variation in size is probably due, at least in part, to the nests being started either by a single queen or by a number of queens. As indicated by the excreta at the bottom of the cells, some were used three times, but the majority of cells were used only twice. YOSHIKAWA (17) also found that in Japan, *P. fadwigae* uses the cell three times during a season. Thus, there appears to be some factor that limits the size and duration of use of a nest even though the wasps may nest continually during the year.

Daughter nests were often started within a few inches of the mother nest, sometimes only two inches away. During daylight hours a number of wasps were active on these small nests, but most or all of the wasps returned to the mother nest at night.

Nests were of various shapes in outline. Some were very symmetrical, being round, oblong, pear-shaped, or pendant-shaped (Fig. 1). Others were very irregular in shape. There were 3½-4 cells per linear inch. Several nests were found with honey stored in the cells, usually with an egg. Occasionally two or three eggs or an egg and a larva were found in the same cell.

The wasps became active at dawn and were foraging just before sunrise. Activity appeared to be greatest before noon, with a reduction in flying in the afternoon, but some activity continued until dark.

It was difficult to find the wasps foraging. Adults were most commonly encountered flying in open fields and pastures of tall grass, and were abundant along the air strip at Osa. The wasps were also seen in second growth vegetation. Since February and March are in the middle of the dry season in Costa Rica, water sources were somewhat limited. Wasps could nearly always be found along the edges of streams and pools, as well as at watering tanks, and even laundry tubs.

All *Polistes* were conspicuously absent at San Vito near the Panamanian border. No wasps or nests of this genus were found and natives said the wasps were rare. Some had never seen a *Polistes* nest. Wasps of the genus *mischocyttarus* were occupying the nesting sites around buildings which were used by *Polistes* in other localities.

No field observations were made of food and feeding habits but larvae of *P. erythrocephalus* were found to be very starvation resistant. Six larvae were still alive in one nest after 26 days without food or water. One of the larvae was minced and fed to the others which ate it readily. Adults, however, died in two or three days when confined without food and water.

SYMBIONTS IN THE NEST: The most common symbiont found was the parasitic ichneumonid, *Pachysomoides stupida* (Cresson). Twenty percent of the nests examined contained the papery cocoon of this parasite, but adult specimens were obtained from only two nests. Previous distribution records for this species include the United States, Mexico, Panama and Venezuela and its known hosts are *Polistes annularis* and *P. exclamans* (TOWNES and TOWNES, 15).

Several abandoned nests were used by an unidentified *Trypoxylon* species. This mud-daubing sphecid uses the cells as convenient cavities to provision for its own brood. *Trypoxylon clavatum* (Say) exhibits this same behavior in the United States (9).

Nine moths, probably of the family Phycitidae, emerged from one heavily infested nest collected inside a large, standing hollow tree at Taboga. The nest had 166 cells and 54 of these had cocoons or webbing of the moth (Fig. 2). The cocoons consisted of a silk tube with a hard covering constructed across the middle of the cell. A circular opening was made for the adult moth

to emerge. A few cells had two or three such cocoons. Two of the larvae, light pink in color, were found crawling out of small holes on top of the nest.

The parasitic nature of this phycitid was not directly observed. When the nest was collected, there were a number of adult wasps, eggs, larvae, and pupae present. Capped cells in the nest were not opened until a month after it was collected. The wasp pupa in each cell was partially or entirely eaten. It is possible that the larvae were dead before being eaten, which would make the moth a scavenger, but all evidence points to parasitism by the moth larvae. RAU (12) recorded a parasitic phycitid from the nest of *P. canadensis panamensis* in Panama.

Several other microlepidoptera larvae, possibly members of the families Tineidae and Pyralidae, were found feeding on the excretory material of the wasp larvae and other detritus in the nest.

Psocids, identified as *Liposcelis* sp., were common in inactive nests. These widespread scavengers have been previously reported in *Polistes* nests in Trinidad (FITZGERALD, 6) and the United States (NELSON, 9).

A number of spiders also make use of the vacant nests. Both brooding and resting webs of salticids were found and spiderlings were often taken from the nests with the mother. Other spider families represented in the nests were Linyphiidae, Oonopidae, and Scytodidae.

KEY TO THE SPECIES OF *POLISTES* IN COSTA RICA*

1a. Abundant long, curled hairs present on gena, mesoscutum and pleurae, those of mesoscutum as long as maximum diameter of anterior ocellus, the pleurae appearing shaggy in profile. Male: eyes greatly swollen, distance between eyes and ocelli equals about 0.5 × diameter of anterior ocellus; head and thorax densely pubescent ..... *oculatus* F. Smith, 1857.

1b. Neither sex unusually hairy, longest mesoscutal hairs of female shorter than maximum diameter of anterior ocellus; male eyes much less prominent, separated from ocelli by at least an ocellar diameter 2

2a. Occipital carina well defined to base of mandible; "prepectal carina" present; median mesepisternal groove reduced or absent 3

2b. Occipital carina usually not present below level of lower eye margin; if obscurely present, "prepectal carina" absent; median mesepisternal groove present, entire 5

3a. Large species, forewing 15-20 mm long; thorax moderately shiny, pleurae with scattered distinct punctures; genae, in profile, wider than eyes; head and thorax yellowish, at least apical abdominal segments blackish ..... *testaceicolor* Bequaert, 1937.

3b. Smaller species, forewing 10-14 mm long; thorax dull, granularly punctate; genae, in profile, narrower than eye; entire insect black, variously maculate with yellowish and/or reddish areas 4

*Key constructed by Mr. Roy R. Snelling. Los Angeles County Museum of Natural History, Los Angeles, California 90007. Snelling has definite records for *Polistes carnifex, erythrocephalus, instabilis, major, pacificus modestus, testaceicolor,* and *versicolor* from Costa Rica with *apicalis, canadensis, dorsalis, oculatus,* and *pacificus pacificus* expected to be present. All twelve species are included in the key.

4a. Second tergite, at least, with conspicuous reddish areas; reddish areas usually present on following tergites and sides of pronotum ..... *pacificus pacificus* (Fabricius, 1804).

4b. Second tergite black, with apical yellow fascia; following tergites and sides of pronotum without reddish areas ..... *pacificus modestus* F. Smith, 1862.

5a. Entire insect black, head with narrow yellowish stripe on lower inner orbits and a reddish stripe along upper outer orbits; wings blackish, with conspicuous whitish apices ..... *apicalis* Saussure, 1858.

5b. Body usually conspicuously maculate with yellowish; if thorax and abdomen immaculate, head reddish; wings, if blackish, without whitish apices 6

6a. Thorax and abdomen (except occasional apical fascia on first tergite) immaculate, blackish or dull ferruginous or both; head immaculate reddish; first tergite distinctly longer than wide at apex 7

6b. Thorax and/or abdomen conspicuously maculate with yellowish; head with yellow maculae; first tergite variable 8

7a. Thorax, wings and abdomen black, contrasting with uniformly dull ferruginous head ..... *erythrocephalus* Latreille, 1813.

7b. Thorax and abdomen extensively ferruginous, not contrasting with head; wing color often much lighter ..... *canadensis* (Linne, 1758).

8a. Small species, wing length less than 15 mm; first tergite no longer than broad at apex, abruptly sloping basally; second sternite abruptly convex basally, male last sternite with mediobasal tubercle; tergites with narrow apical yellowish fasciae ..... *dorsalis neotropicus* Bequaert, 1940.

8b. Larger species, wing length exceeding 15 mm; first tergite often distinctly broader than long; second tergite often not abruptly convex, evenly and gently curved; male last sternite without mediobasal tubercle; tergal maculae variable 9

9a. Tergites and sternites with conspicuous broad apical yellow fasciae; first tergite as broad at apex as long; pronotum wholly or largely yellow; propodeum with numerous very coarse transverse striae 10

9b. Tergites either narrowly fasciate or with spots; sternites either spotted, immaculate, or with narrow apical fascia on second and third; first tergite longer than wide at apex; pronotum mostly reddish, with yellow marginal stripes; propodeum finely, often indistinctly, striate 11

10a. Very large species, wing length 20-28 mm; malar space about half as long as eye, in frontal view; mesopleura with conspicuous scattered fine punctures. Male: clypeus separated from eye by less than diameter of anterior ocellus and strongly convex from side to side; with bluntly pointed apex ..... *carnifex* (Fabricius, 1775).

10b. Smaller species, forewing 16-23 mm long; malar space one-third, or less, eye length in frontal view; mesoploura granular, without evident punctures. Male: clypeus separated from eye by more than diameter of anterior ocellus, flat apical margin broadly and gently convex ..... *major* (Beauvois, 1818).

11a. Tergites with narrow apical fasciae; sternites black, immaculate or with apical fasciae on second and third segments; male clypeus touching eye for distance about twice length of malar area ..... *instabilis* Saussure, 1853.

11b. Tergites and sternites spotted rather than fasciate; male clypeus touching eye for distance about equal to length of malar area ..... *versicolor* (Olivier, 1790).

CLAVE PARA EL GENERO *POLISTES* EN COSTA RICA*

1a. Pelos largos crespos y abundantes en las genas, el mesoscuto y pleuras; longitud de los del mesoscuto igual al diámetro máximo del ocelo anterior; perfil de las pleuras irregular. Ojos del macho muy abultados; distancia entre los ojos y los ocelos igual

* Clave elaborada por el Sr. Roy L. Snelling, del Museo de Historia Natural del Condado de Los Angeles, Los Angeles, California, E.U.A.

a 0.5 del diámetro del ocelo anterior; cabeza y tórax muy pubescentes ..... *oculatus* F. Smith, 1857.

1b. Ninguno de los dos sexos muy velloso; los pelos más largos del mesoscuto de la hembra son más cortos que el diámetro máximo del ocelo anterior; ojos del macho mucho menos prominentes, separados de los ocelos por un diámetro ocelar cuando menos 2

2a. Carina occipital bien definida hasta la base de la mandíbula; con "carina prepectal"; ranura medial mesepisterna reducida o ausente 3

2b. Carina occipital generalmente ausente por debajo del margen inferior del ojo; si se presenta indistinta, hay ausencia de "carina prepectal"; presencia de ranura medial mesepisterna, entera 5

3a. Especie grande; longitud del ala delantera 15-20 mm; tórax ligeramente brillante; pleuras con puntos marcados diseminados; ancho del perfil de las genas mayor que el de los ojos; cabeza y tórax amarillentos, segmentos apicales abdominales negruzcos cuando menos ..... *testaceicolor* Bequeart, 1937.

3b. Especie más pequeña; longitud del ala delantera 10-14 mm; tórax opaco, con puntos granulados; ancho del perfil de las genas menor que el de los ojos; insecto totalmente negro, maculado con areas amarillentas y/o rojizas 4

4a. Areas conspícuas rojizas, al menos en el segundo tergito; áreas rojizas generalmente en los tergitos siguientes y costados del pronoto ..... *pacificus pacificus* (Fabricius, 1804).

4b. Segundo tergito negro con bandas apicales amarillas; sin áreas rojizas en los tergitos siguientes y costados del pronoto ..... *pacificus modestus* F. Smith, 1862.

5a. Insecto negro en su totalidad; cabeza con raya amarilla en las órbitas inferiores internas y raya rojiza a lo largo de las órbitas superiores externas; alas negruzcas de ápices visiblemente blancuzcos ..... *apicalis* Saussure, 1858.

5b. Cuerpo generalmente con manchas conspícuas amarillentas; si el tórax y el abdomen son inmaculados, la cabeza es rojiza; si las alas son negruzcas los ápices no son blancos 6

6a. Tórax y abdomen inmaculados (a veces con bandas apicales en el primer tergito), negruzcos o ferruginoso-opacos o de ambos colores; cabeza inmaculada rojiza; primer tergito marcadamente más largo que ancho en el ápice 7

6b. Tórax y abdomen conspicuamente manchados de amarillento; cabeza con manchas amarillas; primer tergito variable 8

7a. Tórax, abdomen y alas negras que contrastan con el color ferruginoso opaco uniforme de la cabeza ..... *erythrocephalus* Latreille, 1813.

7b. Tórax y abdomen extensivamente ferruginosos, no contrastan con color de la cabeza; a veces color de las alas mucho más claro ..... *canadensis* (Linné, 1758).

8a. Especie pequeña, longitud de alas menos de 15 mm; longitud de primer tergito no mayor que el ancho de la base en el ápice; visiblemente inclinado hacia la base; segundo tergito marcadamente convexo basalmente; tubérculo mediobasal en el último esternito del macho; bandas angostas apicales amarillentas en los tergitos ..... *dorsalis neotropicus* Bequaert, 1940.

8b. Especie más grande; longitud de alas excede 15 mm; primer tergito a veces visiblemente más ancho que largo; segundo tergito generalmente sin convexidad marcada, más bien curveado levemente; tubérculo mediobasal ausente en el último tergito del macho; máculas tergales variables 9

9a. Tergito y esternitos con bandas amarillas apicales anchas y conspícuas; ancho y longitud del primer tergito iguales en el ápice; pronoto casi o totalmente amarillo; propodeo con estrías transversales muy ásperas 10

9b. Tergitos con listas angostas o manchas; esternitos manchados, inmaculados o con listas angostas apicales en el segundo y tercero; primer tergito más largo que ancho en el ápice; pronoto generalmente rojizo, con rayas marginales amarillas; propodeo con estrías finas, casi imperceptibles 11

10a. Especie muy grande; longitud de alas 20-28 mm; espacio malar aproximadamente la mitad de la longitud del ojo, en vista frontal; mesopleuras con puntos finos diseminados; en el macho el clípeo está separado del ojo por un espacio menor que el diámetro del ocelo anterior; marcadamente convexo de lado a lado; ápice con punta roma ..... *carnifex* (Fabricius, 1775).

10b. Especie más pequeña; longitud de ala delantera 16-23 mm; espacio malar un tercio o menos que la longitud del ojo, visto frontalmente; mesopleura granular, sin puntos evidentes; en el macho el clípeo está separado del ojo por un espacio mayor que el diámetro del ocelo anterior; margen apical plana, extensa y levemente convexa ..... *major* (Beauvois, 1818).

11a. Tergitos con listas apicales angostas; esternitos negros, inmaculados, o con bandas apicales en el segundo y tercer segmentos; clípeo del macho bordea el ojo aproximadamente a lo largo del doble de la longitud del área malar ..... *instabilis* Saussure, 1853.

11b. Tergitos y esternitos maculados; clípeo del macho bordea el ojo a lo largo de casi la misma longitud del área malar ..... *versicolor* (Olivier, 1790).

ACKNOWLEDGEMENTS

This study is a result of a research problem for a course in Insect Ecology in the Tropics offered by the Organization for Tropical Studies in February and March, 1967. I am indebted to OTS and the National Science Foundation for the opportunity to work in Costa Rica. Appreciation is expressed to Dr. Daniel H. Janzen, instructor and course coordinator, for his suggestions during the study. Dr. John C. Downey, Northern Iowa University, critically read, and offered suggestions for improvement of the manuscript.

I am also grateful to Dr. E. L. Mockford, Illinois State University, for determination of psocids and Dr. L. M. Walkley, U. S. Department of Agriculture, for determination of ichneumonids. Specimens were borrowed from the U. S. National Museum through Dr. A. S. Menke, U. S. Department of Agriculture. Photographs were made by Mr. Donald Phillips, Glenville State College.

A particular note of appreciation is given to Mr. Roy R. Snelling, Los Angeles Country Museum of Natural History, for use of his key to the Costa Rican *Polistes*, and for additional distribution records.

SUMMARY

Observations of nest size, shape, and habitat of *Polistes erythrocephalus* Latreille were made during the months of February and March, 1967, in Costa Rica. Eighteen abandoned nests and 31 active nests were examined. Two parasites, the ichneumonid *Pachysomoides stupida* (Cresson) and an unidentified phycitid moth, were reared from the nests. A mud-daubing sphecid, several species of spiders, and members of the psocid genus *Liposcelis* were found in the abandoned nests. Several unidentified microlepidoptera larvae were also observed feeding on detritus in the nests.

RESUMEN

Durante los meses de febrero y marzo de 1967 se hicieron observaciones sobre el tamaño, la forma y el habitat de 18 nidos abandonados y 31 activos de la avispa *Polistes erythrocephalus* Latreille en Costa Rica. Se criaron dos parásitos, el icneumónido *Pachysomoides stupida* (Cresson) y una polilla ficitida sin identificar, de larvas encontradas en los nidos. En los nidos abandonados se encontró un esfecido albañil, varias especies de arañas y varios individuos del género *Liposcelis*. También se observó a varias larvas no identificadas de microlepidópteros alimentándose de detritus en los nidos. Se incluye una clave de las especies y subespecies de *Polistes* de Costa Rica.

LITERATURE CITED

1. BEQUAERT, J. C.
1934. Color variation in the South American social wasp, *Polistes versicolor* (Olivier) (Hymenoptera: Vespidae). *Rev. Entomol.*, 4: 147-157.

2. BEQUAERT, J. C.
1937. The American *Polistes* with prepectal suture. Their structural characters, distribution and variation. *Arch. Inst. Biol. Veg.*, 3: 171-205.

3. BEQUAERT, J. C.
1940. An introductory study of *Polistes* in the United States and Canada with descriptions of some new North and South American forms (Hymenoptera: Vespidae). *J. N. Y. Entomol. Soc.*, 48: 1-31.

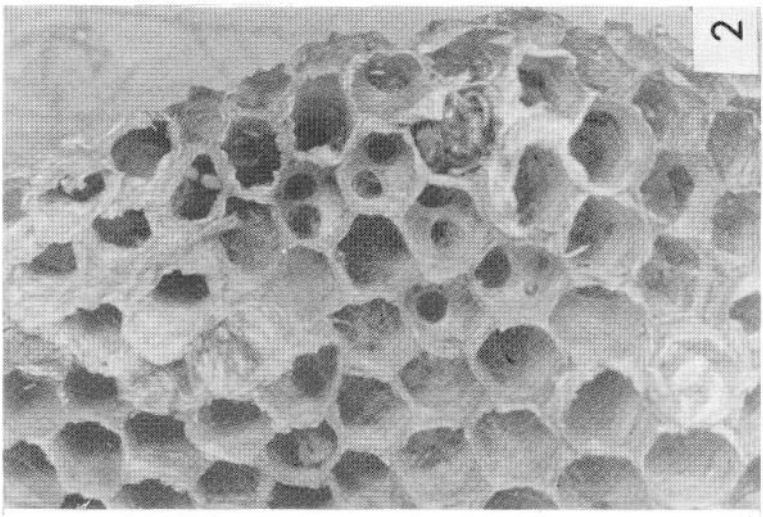
4. BEQUAERT, J. C.
1943. Color variation in the American social wasp *Polistes canadensis* (Linneaus) with descriptions of two new forms (Hymenoptera: Vespidae). *Bol. Entomol. Venezol.*, 2: 107-124.

5. BEQUAERT, J. C.
1944. The social vespidae of the Guianas, particularly of British Guiana. *Bull. Mus. Comp. Zool.*, 94: 249-304.

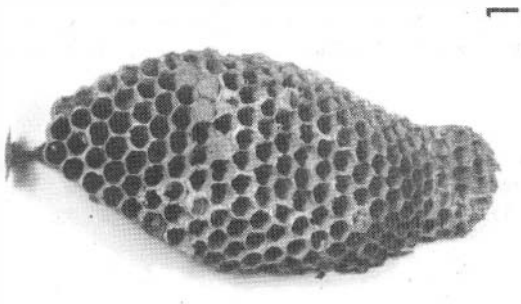
6. FITZGERALD, D. V.
1938. Social wasps (Hym.: Vespidae) from Trinidad, with a note on the genus *Trypoxylon* Latreille. *Trans. Roy. Entomol. Soc.*, 87: 181-191.

7. NELSON, J. M.
1966. *The biology and distribution of parasites and inquilines in* Polistes *(paper-wasp) nests.* Master's thesis. Morris Library, Southern Illinois University, Carbondale, Ill., 64 pp.

Figs. 1, 2. Nests of *Polistes erythrocephalus* Latreille.



2



1

8. NELSON, J. M.
1967. *Polistes* nests as host habitats in Costa Rica. *Mimeo. Student Res. Rep. OTS Adv. Zool. Course, Cd. Univ., Costa Rica:* 75-82.

9. NELSON, J. M.
1968. Parasites and symbionts of nests of *Polistes* wasps. *Ann. Entomol. Soc. Amer.,* 61: 1528-1539.

10. RAU, P.
1929. The habitat and dissemination of four species of *Polistes* wasps. *Ecology,* 10: 191-200.

11. RAU, P.
1931. The nest and nesting sites of four species of *Polistes* wasps. *Bull. Brooklyn Entomol. Soc.,* 26: 111-118.

12. RAU, P.
1933. *The jungle bees and wasps of Barro Colorado Island (with notes on other insects).* The Author, Kirkwood, Mo., 324 p.

13. RAU, P.
1940. Cooperative nest founding by the wasp, *Polistes annularis* Linn. *Ann. Entomol. Soc. Amer.,* 33: 617-621.

14. RICHARDS, O. W., & J. J. RICHARDS
1951. Observations on the social wasps of South America (Hymenoptera: Vespidae). *Trans. Roy. Entomol. Soc.,* 102: 1-170.

15. TOWNES, H., & M. TOWNES
1966. *A catalogue and reclassification of the Neotropic Ichneumonidae.* Mem. Amer. Entomol. Inst. Nº 8., Ann Arbor, Mich., 367 p.

16. YOSHIKAWA, K.
1962. Introductory studies on the life economy of Polistine wasps. VI. Geographical distribution and its ecological significances. *J. Biol. Osaka City Univ.,* 14: 19-43.

17. YOSHIKAWA, K.
1963. Introductory studies on the life economy of Polistine wasps. II. Superindividual stage. 3. Dominance order and territory. *J. Biol. Osaka City Univ.,* 14: 55-61.