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A new species of stingless bee Trigona (Plebeia) from Costa Rica, with descriptions of its general behavior and cluster-type nest

by

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The species described below is especially interesting because of its cluster-type nest. This type of nest architecture has been found only in *Trigona minima,* among the American *Plebeia.* A superficially similar cluster type has been also found among the Australian *Plebeia,* although basically they are quite different in structure. Data on the comparative nest architecture within *Plebeia* and their possible evolutionary significance are included. Aspects concerning the behavior of the new species were also studied.

This new species was first collected, by means of bait, in Guanacaste, Costa Rica, at the coast line. Later it was found nesting in the wood bases of several houses in the area.

DESCRIPTIVE ACCOUNTS

The measuring techniques used to describe this new species were those put forward by HURD and MOURE (1).

Trigona (Plebeia) tica,[1] n. sp.

Worker.

SIZE: Total length 3.7 mm; length of forewing 3.1 mm; head 1.5 mm in width by 1.3 mm in length; width of thorax 1.5 mm; width of abdomen 1.5 mm.

COLOR: General color black. The following parts white (sometimes ranging from cream-colored to yellowish): ventral side of scape; supraclypeal or

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1. *Tica* is the feminine gender of *tico,* nickname for a Costa Rican.

interalveolar area; a rectangular spot along middle part of clypeus; a narrow stripe on lower two thirds of paraocular area, becoming considerably wider below; a band along posterior part of pronotum, interrupted at the middle with black color; a very narrow band along lateral margin of mesoscutum; axillae; a narrow and short band, usually very faint, on posterior edge of scutellum.

PUBESCENCE: Scarce and very short, longer on scutellum, hind tibia, and ventral side of thorax. Hairs whitish.

PUNCTATION: Tegument polished, with punctation minute, sparse, and slightly granulate. Proximal areas of abdominal terga smooth and shining.

STRUCTURE: Length of eye 2.7 times breadth; inner orbits slightly concave, with faint convergence below; median interorbital distance slightly larger than eye length (62 : 58 : 65 : 48 = length of eye and upper, median and lower interorbital distances respectively[1]); malar area small, its length half width of flagellum (4:8); clypeus slightly shorter than half its width, and shorter than half clypeocellar distance (21 × 45 : 51 = length and width of clypeus and clypeocellar distance respectively), clypeus almost flat; interalveolar distance equal to alveolorbital distance and larger than transverse diameter of antennal socket (12 : 12 : Ø 9 = interalveolar and alveolorbital and transverse diameter of antennal socket respectively); vertex slightly convex, without postocellar carina; interocellar distance equal to orbitoccipital distance and almost equal to ocellorbital distance, and slightly more than twice the transverse diameter of median ocellus (20 : 20 : 19 : Ø 9 = interocellar, orbitoccipital and ocellorbital distance, and transverse diameter of median ocellus respectively); ocelloccipital distance larger than diameter of ocelli (13 : Ø 9); without preoccipital carina; scape shorter than alveolocellar distance (30 : 43) and about half length of pedicel and flagellum (30 : 67); proportional length of first four flagellar segments as follows: 4 : 4 : 5 : 5; diameter of fourth flagellar segment 8; anterior border of pronotum almost straight; scutellum short: its length less than half its width (19 × 45); length of propodeal spiracle 4 times its width (12 × 3), measured from inner border of atrial rim; length of hind tibia 2.4 times its width (70 × 29); hind basitarsus 2.1 times longer than broad (38 × 18); length of pterostigma 3.7 times its width (30 × 8); length of marginal cell 4.3 times its width (61 × 14); submarginal angle (basal angle of first R_1 cell) about 80°.

DIAGNOSTIC CHARACTERS: Especially differentiated from other related species by its small size and white markings. The white axillae are easily observed in live specimens.

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1. To convert the measurements into millimeters, each unit or scale interval = 0.017 mm.

TYPE MATERIAL: Holotype and paratypes from Playas del Coco, a resort area in Guanacaste Province, Costa Rica. The holotype and 10 paratypes are in the Entomological Museum of the University of Costa Rica, 5 paratypes in the Snow Entomological Museum of the University of Kansas, and 5 paratypes in the collection of Padre J. S. Moure, University of Panamá, Curitiba, Brazil.

Queen: gravid and preserved in Dietrich's fixative.

SIZE: Total length 6.6 mm; length of forewing 3.3 mm; head 1.3 mm in width by 1.2 mm in length; width of thorax 1.6 mm; width of abdomen 2.4 mm.

COLOR: General color ferruginous. The following parts dark brown: upper part of head, covering vertex and extending anteriorly to level of antennal sockets, and posteriorly covering most of genal area; along epistomal suture; a narrow strip at base of mandible; a small rectangular spot on malar area, which connects with dark area of epistomal suture: mesothorax, except hypoepimeral area and a very narrow band along lateral margin of mesoscutum which continues along axilla and posterior edge; scutellum (middle part of scutellum with a black and somewhat anchor-shaped figure); metanotum; an irregular ring-shaped spot on each side of pronotum; basic area of propodeum; a band on distal and ventral side of each femur, and a few narrow stripes and spots on coxae, tibiae and tarsi; a band on each basic area of abdominal sterna 2 to 5. Most of the exposed abdominal pleura appear black in color.

PUBESCENCE: Sparse and very short, longer on scutellum and hind tibia, and rather dense on last four abdominal terga.

PUNCTATION: Tegument polished, with punctation minute, sparse, and slightly granulate.

STRUCTURE: Length of eye 2.8 times breadth; inner orbits subparallel; interorbital distance larger than eye length (45 : 57 : 60 : 55 = length of eye and upper, median and lower interorbital distance respectively); malar area long, its length greater than width of flagellum (11 × 7); length of clypeus half its width and about half clypeocellar distance (22 × 44 : 45 = length and width of clypeus and clypeocellar distance respectively), clypeus almost flat; interalveolar distance shorter than alveolorbital distance, and greater than transverse diameter of antennal sockets (12: 15 : ∅ 9 = interalveolar and alveolorbital distance, and transverse diameter of antennal socket respectively); vertex slightly convex, without postocellar carina; interocellar distance three times greater than transverse diameter of median ocellus (18 : ∅ 6); ocellorbital distance equal to orbitoccipital distance (16 : 16); ocelloccipital distance greater than diameter of ocelli and equal to transverse diameter of antennal socket (9 : ∅ 6 : ∅ 9); without preoccipital carina; length of scape about equal alveolocellar distance (35 : 36) and about half length of pedicel and flagellum (35 : 71); proportional length of first four flagellar segments as follows: 5: 6 : 6 : 6; diameter of fourth flagellar segment 7; anterior border

of pronotum almost straight; scutellum semicircular in contour, its length about half its width (19 × 39); length of propodeal spiracle two times its width (10 × 5); length of hind tibia 3.2 times its width (80 × 25); hind basitarsus four times longer than broad (40 × 10); length of pterostigma 3.5 times its width (28 × 8); length of marginal cell 4.3 times its width (61 × 14); submarginal angle about 80°.

THE NESTS OF PLEBEIA

The subgenus *Plebeia (s. lat.)* is a large group of stingless bees found throughout tropical America, Africa, New Guinea, and Australia. This subgenus includes the most important types of nest architecture found among the stingless bees, along with a very primitive type, which has not been observed in any other group outside of *Plebeia*. Based on the structure and arrangement of the brood cells the types of nests found in *Plebeia* could be ordered according to their evolutionary status as follows (Fig. 1): 1) Primitive cluster type, 2) intermediate cluster type, 3) horizontal comb type, 4) irregular horizontal type, 5) specialized cluster type.

1) PRIMITIVE CLUSTER TYPE: This type has been reported as occurring in the Australian species *Trigona (Plebeia) australis* Friese[1]. According to MICHENER (2) this type of nest presents the following characteristics: a) nests in relatively large cavities. b) Cells associated in irregular clusters, with spaces in between to allow the bees to move rather freely. c) Cells spherical. d) Cells with openings oriented in various directions, not necessarily upward. e) Cells surrounded by a single sheet of thin soft cerumen, the involucrum, often with large holes, these sometimes may be absent over the growing areas of the cluster. This type of nest is regarded by Michener as the most primitive of those found among the stingless bees.

2) INTERMEDIATE CLUSTER TYPE: This type of nest was found by MICHENER (2) in *Trigona (Plebeia) cincta* Mocsáry, a bee from New Guinea. Its characteristics are as follows: a) Nests in relatively large cavities. b) Cells associated in irregular concentric layers with spaces between them, almost forming hemispherical combs. This organization, however, is gradually lost as one progresses toward the inside, where the cells are clustered much as in *T. australis*. c) Cells spherical. d) Cells open laterally at the sides of the layers and upward at the top. e) Cells surrounded by a single sheet of soft cerumen, the involucrum, which is often incomplete.

The structure and organization of this type of nest may suggest, as pointed out by MICHENER (3), a possible mechanism through which the vertical

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1 According to MICHENER (2) this species has usually been called *Trigona cassiae* Cockerell.

comb type, with horizontal cells (as in *Dactylurina)* and the horizontal comb type, with vertical cells (as in most *Trigona),* have been evolved.

3) HORIZONTAL COMB TYPE: Most *Plebeia* present this type of nest architecture: a) nests in relatively large cavities. b) Cells arranged in horizontal layers with space between them. c) Cells vertically elongated. d) Cells open upward. e) Involucrum usually present, but can also be absent, sometimes appearing only in small patches.

4) IRREGULAR HORIZONTAL COMB TYPE: This type of nest architecture is found in *Trigona (Plebeia) schrottkyi* Friese from South America. The nest characteristics are as follows: a) Nests in relatively large cavities. b) Cells arranged in irregular horizontal layers, and in small groups with independent combs. c) Cells vertically elongated. d) Cells open upward. e) Involucrum absent.

According to its evolutionary status based on its architecture, the nest could be classified as an intermediate type between either the comb and intermediate cluster type makers or the former and the specialized cluster makers. In this work the second alternative has been chosen because of the presence in the nest of vertically elongated cells. As will be discussed later, the derivation of the specialized cluster type from the horizontal comb type is suggested, among other things, by the vertically elongated cells similar to those commonly crowded into combs.

5) SPECIALIZED CLUSTER TYPE: This type of nest has been found in the American species *Trigona (Plebeia) minima* Gribodo (SCHWARZ, 4), a bee reported as occurring in Panamá, Venezuela, Perú, Bolivia and Dutch Guiana. To this species the new form described in this work, *Trigona (Plebeia) tica,* can be added. Nests of this species are characterized by a specialized cluster type with the following features: a) Nests in very small cavities. b) Cells associated in irregular clusters, with spaces between them to allow the bees to move rather freely. c) Cells vertically elongated. d) Cells open upward. e) Involucrum absent.

This type of nest is very distinct from the primitive cluster, from which it differs in items a, c, d, and e. The specialized cluster type is considered as derived from the comb type. This is in opposition to the well established thought which considered the comb-type as a derivation of the specialized cluster type. MICHENER (3) has proposed a new theory which assumes that the combs can become partly or entirely disorganized to form clusters of cells, as an adaptation to small cavities as nesting sites. The basic factors to this theory are: 1) The specialized cluster type of nest is found in some but not in all species of *Plebeia, Scaura, Tetragona,* and *Lestrimelitta,* and in all species of *Hypotrigona* and *Trigonisca* (American *Hypotrigona).* If the old interpretation was correct, in other words, that this type of nest is actually primitive, then the combs should have arisen independently in *Plebeia, Scaura, Tetragona,* and *Lestrimelitta,* and this seems unlikely. 2) On the other hand, disorganization of combs to produce the cluster type can easily have occurred independently in several groups, as an adaptation to the use of small and irregular cavities as nesting sites. 3) This

is further supported by the fact that the cells of these clusters are vertically elongated and their openings are upwards, like those crowded into combs. 4) Furthermore, lack of nest places could be an important factor limiting the spread of stingless bees; under these conditions, an adaptation to use small and irregular cavities would be advantageous. A significant observation is that the specialized cluster type of nest is found normally in small cavities. The absence of an involucrum is a further adaptation to small spaces. 5). The comb type of nest, however, must have arisen from an unspecialized cluster type. The nest of *Trigona (Plebeia) australis* presents that type. It is found in relatively large cavities, presents an involucrum, and its cells are spherical with openings in various directions.

THE NEST OF *TRIGONA TICA*

This species, locally called bocareno, is very common in Playas del Coco, a resort area in the Province of Guanacaste. Frequently the nesting sites are the house wood bases (Figs. 2, 3), made from logs of *Gliricidia sepium* and *Caesalpinia eriostachys*. These trees belong to the Leguminosae and have a reputation of being extremely durable when in contact with the ground. The wood is strong and rather coarse-textured, and with an irregular grain; when dry, long and narrow internal gaps may form. These cavities are not more than a few centimeters in diameter and may be up to one meter in length. These are the spaces used by *Trigona tica* to build nests. The colony of *T. tica,* on which the following description is based, occupied an oval cavity 55 cm in length with a diameter of 2 to 5 cm. Some areas of this long but narrow hole were lined with cerumen, and the bottom was closed with batumen plate measuring 2 × 9 cm, its thickness varying from 0.5 to 1.5 mm.

The nest entrance was at the upper end of the wood base, and found its way down through a crack in the wood (Fig. 5). The aperture was a small hole 2.5 mm in diameter (Fig. 4), lined with a dark brown waxy material, without an external tube entrance, common in other types of nests. This opening continued as an internal tube extended down on the inside wall of the nest cavity for a distance of 15 cm, ending at the level of the food pots. This tube was made of cerumen, with a diameter of 6 to 8 mm and a thickness of 0.5 to 1 mm.

The food pots were located in the upper part of the nest cavity while the brood was below. Nevertheless, three food pots were found among the brood and two small groups of cocoons above the food pots. Figure 6 illustrates the nest as it was exposed by splitting the trunk. Upon examination of another nest, a basically similar distribution was observed.

The food storage consisted of a large irregular cluster of pots (Fig. 7), which measured 22 cm in length by 2 to 3 cm in thickness. This section was anchored either by contact with the surrounding walls or by short connectives allowing passage space around the cluster. The pots were oval in shape and measured 4 × 6 cm, dark brown, with thin walls (less than 0.50 mm.) and soft

texture. The individual pots were essentially distinct in spite of the fact that their walls were fused, and several patches of cerumen present on the surface (Fig. 7). Although the pollen and honey pots were alike and mixed, most of the honey pots were located in the lower part of the cluster. The honey varied in color from rather translucent and clear to light yellow or light red. It was viscous and sweet with a slight acid taste.

The brood consisted of clusters of cells and cocoons arranged irregularly (Figs. 8, 9, 10). It was located in the lower part of the nest cavity, and extended for 23 cm from the batumen plate at the bottom, to the food pots (Fig. 6). An alternation between the clusters of cocoons and cells was observed. At the bottom there was a group of cocoons (4 cm in length) immediately followed above by a cluster of cells (3 cm). These cells were in turn also followed by a group of cocoons (5 cm), above which another assemblage of cells (5 cm) was found, leaving some empty space at the sides. Finally a cluster of cocoons was found above the latter; and right under the food pots, between these and the cells, an empty space (2 cm) existed. Two small isolated groups of cocoons were also found above the food pots. The cells and cocoons were irregularly associated in the clusters, contiguous or sometimes connected by short pillars of wax, with spaces in between, allowing the bees to enter the cluster rather freely. Cells and cocoons were oval in shape (Fig. 10) and measured 2.5 × 4 mm.

NOTES ON THE GENERAL BEHAVIOR OF *TRIGONA TICA*

Like most *Plebeia,* these bees are very timid and are easily attracted to honey baits. It was observed that after the arrival of the first bee an increasing number of them appeared. This behavior suggests that they are able to communicate the existence of a food source to other members of the colony.

The nest on which the following observations were made had a population of 612 individuals. The colony was located in a wooden house base (Fig. 3) that was in the shade most of the day. According to the house owner the nest was first noticed some three years before. Another nest opened had a population of about 50 bees. This colony was known to be a month old and it occupied a narrow cavity 26 cm long with plenty of empty space at the sides and in between the cluster of cells and food pots.

The bees start their activity between 6:30 and 7:00 AM; occasionally a bee may be observed leaving the nest at 6:15. First they open the nest, which was closed overnight. To accomplish this, a bee makes a small slit in the wall of wax which closes the entrance, and then the slit is progressively enlarged to a round hole. The nest activity increases in a gradual manner from 7:00 AM on. During the morning the activity never reached its maximum, as is the case with most bees. The peak of activity was reached between 12:45 to 2:55 PM, diminishing afterwards considerably. At 4:30 PM or later the bees started to close the nest entrance by depositing waxy material around the perimeter. In this way a low turret with a small outward rim was formed; the rim was then pulled inward and more wax added until the entrance was closed.

It was interesting to note that the bees, after leaving the nest, were never observed to make any noticeable type of orientation flight, and in spite of this never had any apparent difficulty in returning. A guard bee may be found at the entrance of the nest during all hours of the day. Every time a worker bee arrived or left the nest the guard bee was observed to move backward, to where the diameter of the entrance is slightly wider.

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SUMMARY

A new species of *Plebeia, Trigona tica,* from the province of Guanacaste, Costa Rica, is described. A general survey of the nest architecture of *Plebeia,* including a classification of the same and its possible evolutionary significance, is presented. Also a detailed description is given of the cluster type nest of *T. tica,* and the general behavior of these bees outside the nests.

RESUMEN

El presente trabajo consiste en un estudio sobre una especie nueva de abeja melipónida, *Trigona (Plebeia) tica,* de la provincia de Guanacaste en Costa Rica. Se presentan los siguientes aspectos: 1) Descripción de las obreras y la reina. 2) Un estudio general sobre los nidos de *Plebeia,* incluyendo su importancia evolutiva y una clasificación de los mismos. 3) Descripción detallada del nido de *T. tica:* nido que se encuentra principalmente en las cavidades angostas que existen en las vigas y bases de las casas en Playas del Coco, Guanacaste. El nido está compuesto de vasillos de miel y polen en la parte superior y de celdas de cría en la parte inferior. Las celdas de cría están dispuestas en grupos irregulares, sin formar panales horizontales. 4) Observaciones sobre el comportamiento general de la abeja fuera del nido.

Fig. 1. Evolutionary trends of brood cell architecture in nests of *Plebeia.*
1. Primitive cluster type, as in *Trigona (Plebeia) australis.*
2. Intermediate cluster type, as in *Trigona (Plebeia) cincta.*
3. Horizontal comb type, as in most species of *Trigona (Plebeia).*
4. Irregular horizontal comb type, as in *Trigona (Plebeia) schrottkyi.*
5. Specialized cluster type, as in *Trigona (Plebeia)* and *T. (P.) tica.*

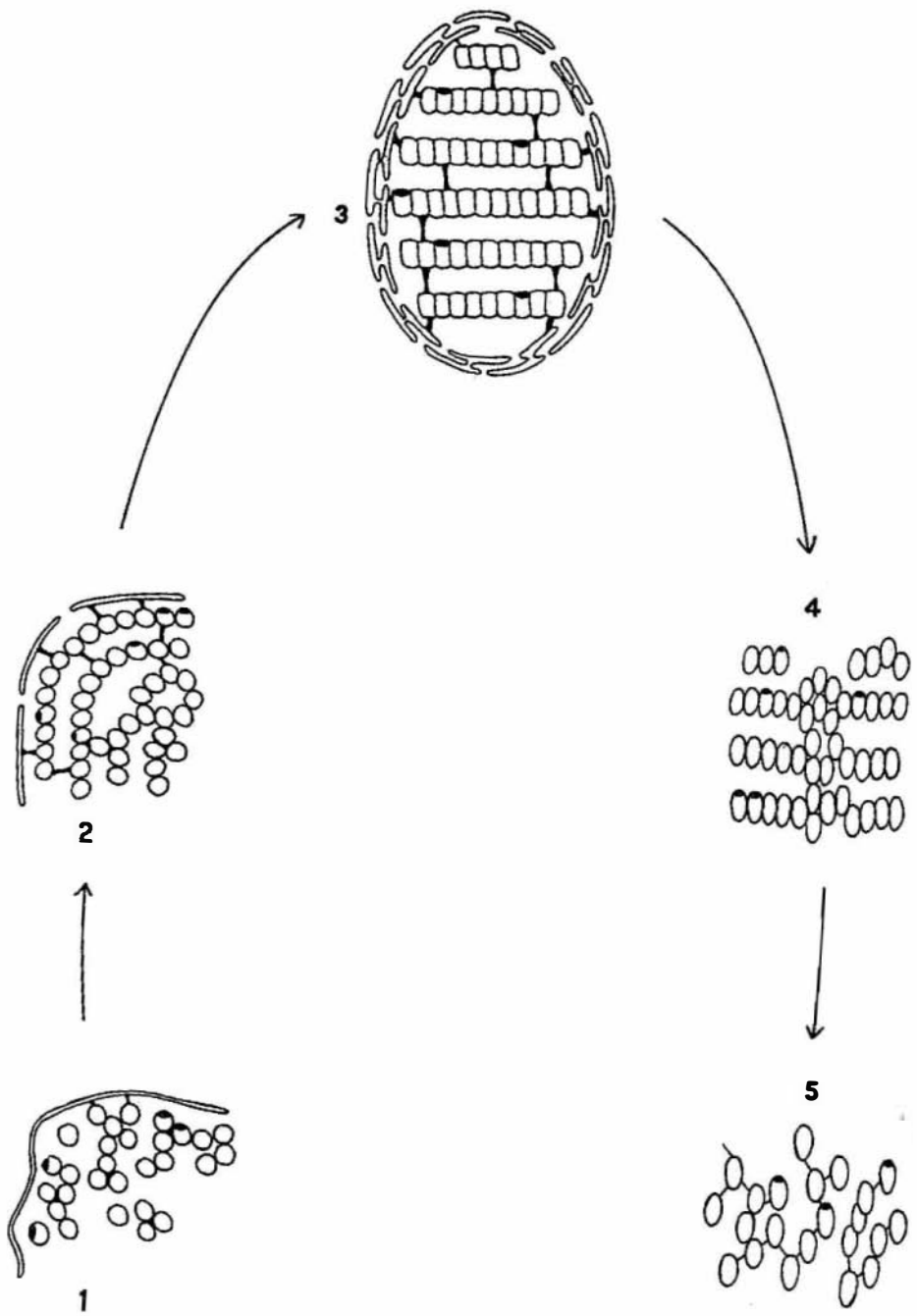

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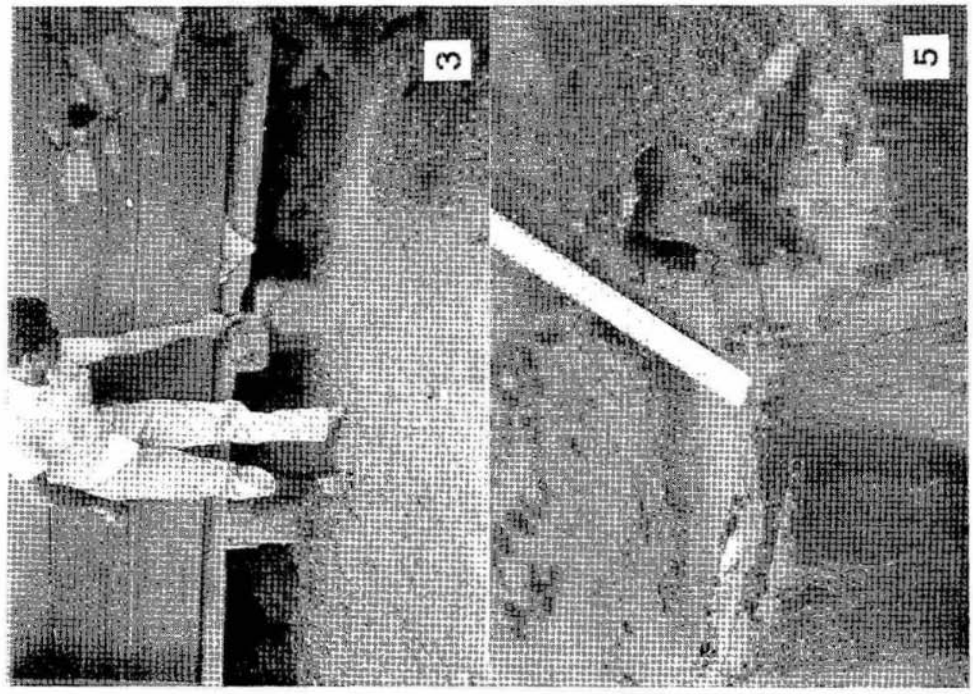
Fig. 2. Frame house in Playas del Coco, Guanacaste, C. R., in whose wooden bases were found nests of *Trigona (Plebeia) tica.*
Fig. 3. Detail of the same house, showing entrance to a nest.
Fig. 4. Wax entrance to a nest.
Fig. 5. Entrance to another nest in the same house. The actual entrance is in the dark crack to the right of the scale ruler.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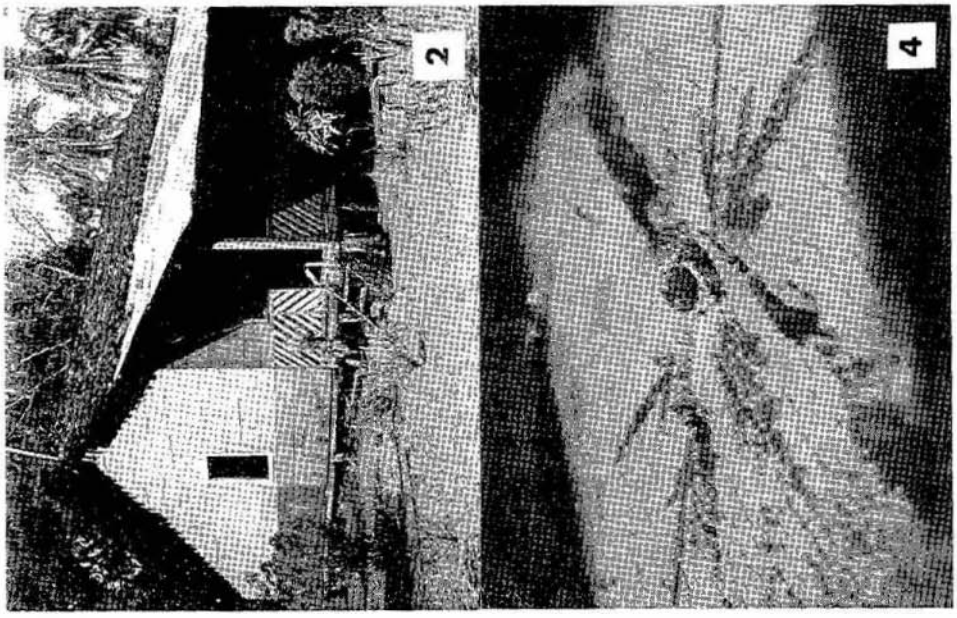
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Figs. 6 and 7. Two views of a nest, in a wood house base split open to allow study. Scale measures 15 cm.

Fig. 6. View of complete nest. Note brood cells below food pots.

Fig. 7. Detail of the food pots, clustered irregularly.

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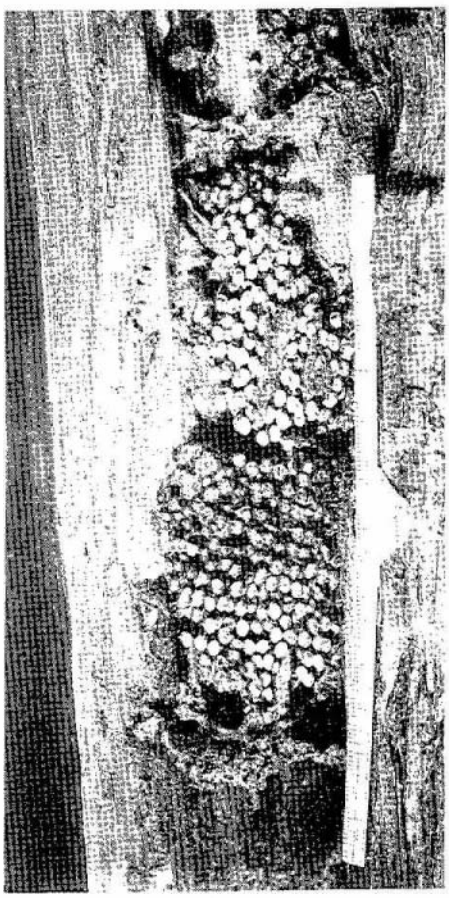
Figs. 8 - 10. Brood cells and cocoons clustered irregularly below the food pots.



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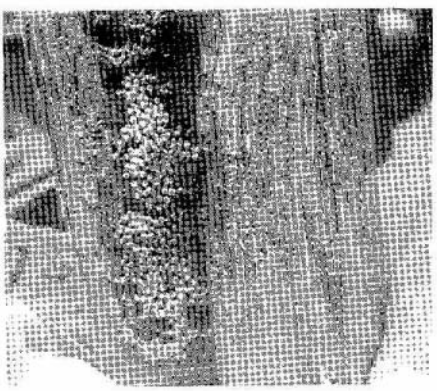

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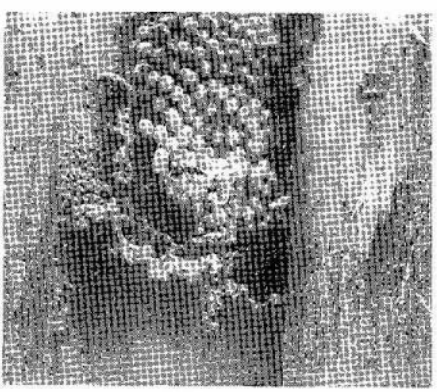

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