

Notes on the Behavior of Four Subspecies of the Carpenter Bee, *Xylocopa (Notoxylocopa) tabaniformis*, in Mexico¹

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ABSTRACT

Host plants and behavior of males and females of 4 subspecies of the carpenter bee *Xylocopa (Notoxylocopa) tabaniformis* (*illota* Cockerell, *melanosoma* O'Brien and Hurd, *rufina* Maidl, and *tabaniformis* Smith) are discussed and a nest site (bracket fungus) of *illota* is figured. Males of *melanosoma* were found to establish a

territory, and the activity of *illota* and *rufina* males suggests territoriality. These bees are active in the evening and early morning; this fact is reflected by their rarity in collections and should be considered by the collector in Mexico.

In connection with a study (O'Brien and Hurd 1964) of the taxonomic problems among the subspecies of *Xylocopa tabaniformis* Smith, observations were made on the behavior of 4 of the subspecies (Fig. 1) in Mexico during the summer of 1962. Little is known of the bionomics of the *X. tabaniformis* subspecies group. The published information concerning *X. tabaniformis* has been summarized in Hurd (1955, 1958) and Hurd and Moure (1963). These publications discuss nest substrate and behavior of *X. t. orbifex* Smith and *X. t. androleuca* Michener (southern California, New Mexico, and Arizona), and in lesser detail *X. t. rufina* Maidl and *X. t. tabaniformis* Smith (Mexico and Costa Rica). It is hoped that the following account will inspire more intensive collecting of these bees in Mexico and Central America.

Xylocopa tabaniformis illota Cockerell

Between July 4 and July 19, 1962, 21 specimens were taken in the deciduous thorn scrub 4 miles west of Campo Cotaxtla (Cotaxtla Experiment Station), which is 20 miles west of Veracruz, Veracruz, Mexico. One ♂ was collected at a nest site, and 3 ♂ and 17 ♀ were taken on or above the flowers of *Cuphea (Parsonia) ciliata* (Sw.) Koehne. This woody shrub formed an oval clump about 300 square feet in area and 7 feet in height. Smaller and lower, isolated shrubs of *C. ciliata* were scattered over several thousand square feet of tall grass at one end of the main clump. The blue-petaled, campanuliform flowers of this plant are about 8 mm in length and appear singly but abundantly in the upper portion of the shrub. This aggregation of *C. ciliata* was on the border between a periodically burned pasture and thorn scrub, and therefore fully exposed to sunlight. Other plants were in bloom in the immediate

vicinity (Passifloraceae, Leguminosae, Boraginaceae); these flowers were often visited during the daylight hours by *Xylocopa*, *Centris*, *Megachile*, *Apis*, and *Euglossa*. *X. t. illota* were never observed at these flowers, nor were they observed at flowers in other areas despite intensive bee collecting. *C. ciliata* was visited throughout the daylight hours by the above-mentioned bees, with the exception that *X. t. illota* were seen only during the early morning and dusk hours.

On clear days, the first female *X. t. illota* appeared within 10 minutes after sunset ("sunset" refers to the actual disappearance of the sun from sight). The approximate frequency of other bees on *C. ciliata* flowers at this time was: *Apis mellifera* L., 1 per square yard and becoming scarcer; megachilids and *Centris*, 1 per 2 square yards; and no other species of *Xylocopa* during the last half hour. By ½ hour after sunset, only *X. t. illota* and a small sphinx moth (*Sesia titan* Cramer) remained at the flowers. If undisturbed, female bees stayed for 20 to 40 minutes; departure was at the time of complete dark (about 50 minutes after sunset). They appeared to make only one visit each evening because once a group of bees had arrived within a half hour after sunset, no more arrivals were noted before complete dark; no bees were observed to leave before complete dark unless disturbed. During the first 10 to 20 minutes of their activity, while it was still light enough to see the white abdominal bands, they distinctly avoided the exposed flowers of the shrub and worked entirely below the canopy on the flowers that projected below. From about ½ hour after sunset until complete dark, the females worked the fully exposed flowers and thus were easier to collect though more difficult to observe. Post-collection examination showed clean scopae which indicates that they were collecting nectar. It is possible that pollen collecting took place elsewhere later in the evening, but because of the intensive bee collecting in the area dur-

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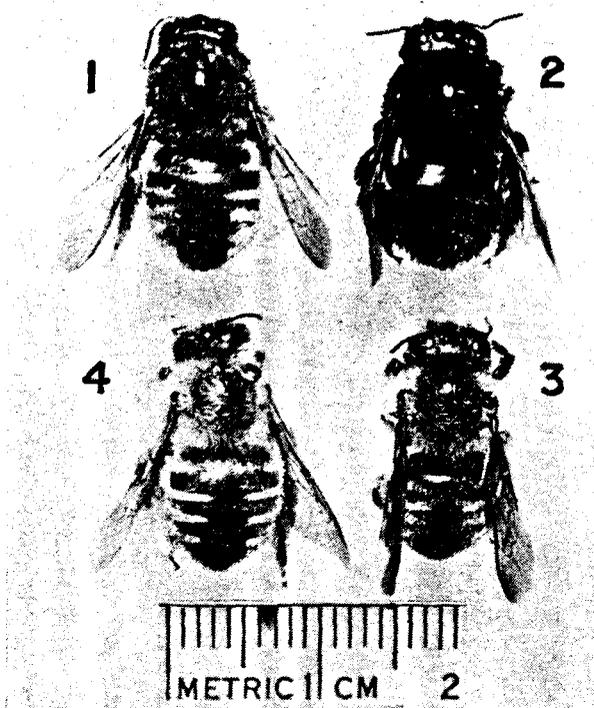


FIG. 1.—(1) *Xylocopa tabaniformis illota*, ♀. (2) *X. t. melanosoma*, ♀. (3) *X. t. rufina*, ♀. (4) *X. t. tabaniformis*, ♀.

ing the day which yielded no *X. t. illota*, it is assumed they were not visiting flowers during daylight hours.

The females were very alert and quick to notice disturbances or movement of me or my net. If not violently disturbed, they moved 4 to 8 feet away and resumed their activity; other species of *Xylocopa* encountered during the day did not remain in the area following any degree of disturbance. *X. t. illota* females were very sensitive to the presence of an inch-long asilid (*Diogmites* sp.) which was common and active in the evening. When a fly approached within 8 or 10 inches of a bee on a flower, the bee would move 1 to 2 feet away and resume nectar gathering. On cloudy days, the situation was essentially the same, except that the *X. t. illota* began their work about 1 hour earlier, departed sooner, and came in contact with a number of diurnal bees. In these contacts, the *X. t. illota* did not work flowers closer than 8 or 10 inches from those being visited by other bees. My wife and I visited this study area frequently in the early morning; Mrs. Janzen collected 1 ♀ *X. t. illota* approximately 15 minutes before sunrise on the main clump and this was the only one observed in 12 visits.

On July 4, 12, 14, 15, and 16, a single female bee was taken each evening on the main oval clump. On the 4th, 4 bees were missed early in the evening and did not return. On the 12th, 2 were missed and

on each of the next 3 evenings on which collections were made, none were missed. Observations were made on the 13th and no attempt was made to capture bees. After the 16th, no bees were observed on the oval clump during 6 evenings of observation over 11 days. Observations were made on the scattered plants at the end of the main clump during these 6 evenings. On the 17th, it was decided to collect the bees that came to a single large bush that stood to one side of the majority of the scattered, small bushes. All 6 ♀ working this bush were collected. During 5 subsequent evenings of observations over a 10-day period, no other females were observed to visit this bush; females were actively working bushes within 20 yards during 2 of these observation evenings. On the 19th, every bee that came to the scattered, small bushes was collected (5 ♀). During the next 3 evenings of observation, 1 bee per evening was seen but not captured in the scattered-bush area. All the above statements apply only to females.

The males of *X. t. illota* appeared at sunset on clear days. While only 3 were captured near the *C. ciliata* plants, they were often observed hovering 1 to 10 feet above the upper surface of the main clump and coursing rapidly along the clump's margins about 4 feet above the ground. From the hovering position they made short dashes after sphinx moths (*Sesia titan*) and bees going to and from the flowers. I first noticed the female *X. t. illota* approaching from the forest side as they dropped from tree top level (20 to 30 feet) to 1 or 2 feet above the ground next to the clump, and then entered the clump; their flight was so rapid that unless silhouetted against the sky they could be followed only by their loud buzzing. When a female approached from the open grass side, she flew just as rapidly and about 2 feet above the ground from at least as far out as she could be seen to the under part of the main clump. When the females left, they flew straight from the bush to the treetop skyline. An encounter with a male was never observed.

One ♂ was taken on a flower about ½ hour after sunset; this was the only male observed visiting a flower. It should be noted that, as with the other 3 subspecies discussed below, the male's whitish clypeal area makes him readily distinguishable in flight from the black-faced females. The other 2 ♂ were taken as they repeatedly returned to a notch (2 feet wide and 2 feet deep) in the side of the main clump. They hovered about 2 feet above the ground and within 2 feet of the author; they were undisturbed by 2 near misses with the net and moved back and forth (still hovering) within the notch despite the attempts to catch them. Other males could be heard in the air over the flowers when it was too dark to see them, but by this time no females were present. During the 6 evenings that the flowers of the main clump were under observation following capture of all of the females visiting it, males were still hovering over the flowers in the dusk and dark. No males were observed in the morning, nor were any observed over the scattered *C. ciliata* bushes.

The only nest discovered was in the bracket fungus *Fomes rimosus* (Berk.) Cooke (Fig. 2.). It was 2 feet above the ground on the living trunk of a 20-foot *Diphysa robinoides* Benth. The tree was isolated in 6-inch-tall grass about 100 feet out into the pasture from the main clump of *C. ciliata*. The fungus was broken open at noon on July 12 and 1♂ *X. t. illota* fell onto the ground. It buzzed on the ground in a confused manner for at least 2 minutes before it was captured. No other bees were in the nest and the brood cells were clean. Reports in the literature indicate that 1 species of *Xylocopa* may use a nest constructed by another; it cannot be stated with absolute certainty that this nest was constructed by *X. t. illota*. However, the entrance hole was not large enough to accommodate one of the larger carpenter bees in the area, but several equal or smaller species also have been collected in the vicinity. At

the time of discovery, the fungus was still dry and hard (this is a perennial species) despite 19 days of the rainy season. On August 22 it was found to have resumed growth and obliterated the nest chambers. By this time, the grass had grown enough to cover the fungus. During the summer, many other bracket fungi in the area were examined but none showed evidence of bee activity.

Xylocopa tabaniformis melanosoma
O'Brien and Hurd²

Collections of this black-bodied subspecies were made 10.2 miles west of the Veracruz-Puebla boundary July 5 and 11, 1962 (area A), and 37 miles west of Tehuacan, Puebla, August 30, 1962 (area B). Both localities are along Highway 150. Area B is a 30-ft.-deep ravine along the northwest edge of the village of Tlacotepec.

Area A is a 2-acre cornfield bounded on the east by a rocky ditch which in turn is bounded by uncultivated dry rocky land with sparse, deciduous, xerophytic vegetation (*Opuntia*, *Yucca*, *Agave*, microphyllous Leguminosae, and short-lived herbaceous annuals). This area is approximately 15 miles west of the pine-oak forests which line the edge of the central plateau in this area. *Tecoma stans* (L.) HBK. (Bignoniaceae) formed an open hedge about 4 feet high along the western edge of the ditch and was scattered over the uncultivated area. It is a thin shrub with yellow, convolvuloid flowers about 2 inches long. A few white-flowered acacias were scattered among the *T. stans* and were visited during the day by other bees and cetoniid scarabs. *T. stans* was often visited during the day by *Centris*, other *Xylocopa*, and several species of eucerine bees. On the 2 days that this site was visited, the activity of these bees came to a gradual halt 15 to 30 minutes before sunset (cloudless, cool, and windy) with some bees "sleeping" (eucerine males, *Centris*) in the flowers and the others terminating their visits. On the 5th, being unaware of the evening habits of *X. t. melanosoma*, collecting was stopped at sunset. On the 11th, 15 minutes before sunset, a female *X. t. melanosoma* was taken while visiting *T. stans* flowers on the ditch edge, and at sunset a second female was taken in these flowers. Twenty-five minutes after sunset, in light still strong enough to see the bee in the air, 2 females were taken in *T. stans* flowers in the uncultivated area. It should be noted that both males and females buzzed so loudly in flight that they could be heard easily 20 to 40 feet away. No other females were observed and none of those collected had pollen loads.

Between sunset and 10 minutes later 2♂ began to patrol the hedge of *T. stans* along the ditch edge. Pausing occasionally to enter a flower, each patrolled a section about 30 yards long. However, the extremes of the ranges overlapped to form an area about 10 yards long where if they encountered each

² See O'Brien and Hurd (1963) for the description of this subspecies.

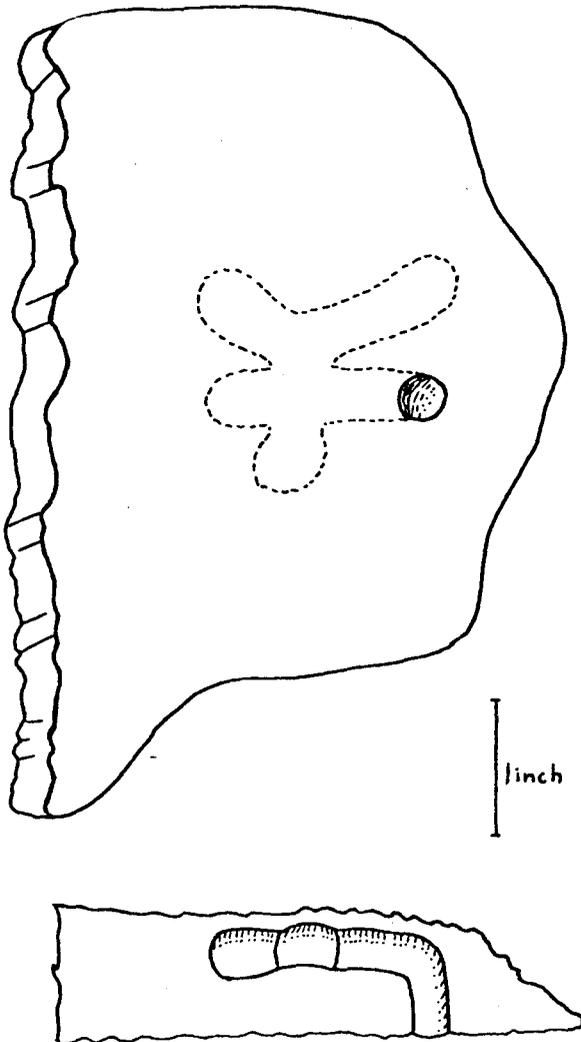


FIG. 2.—*Xylocopa* nests in *Fomes rimosus* (Berk.) Cooke (bracket fungus) in which a male *Xylocopa tabaniformis illota* was found. The entrance hole was on the lower side of the fungus.

other, they engaged in a one-around-the-other fight. This carried them to a point about 30 yards out in the cornfield and 10 yards above it; they then separated and returned to the 2 ranges. It is not known if each male went back to the same area that he had occupied previously but the boundaries remained the same. They patrolled about 1 foot above the hedge and dove suddenly into each little opening between individual bushes; here they paused as if suspended on the end of the string while they turned first one way and then another. They spent about 30 seconds in each opening, presumably looking for females. These 2♂ were collected 20 minutes after sunset. Thereafter, another male appeared at the same stretch of bushes about every 5 minutes and began to patrol. As each specimen was collected soon after its appearance, no observations were made on the occurrence of more than 2 bees in the same area at the same time. The last bee was collected 35 minutes after sunset while it was still light enough to be seen in the air. Mrs. Janzen was collecting in the uncultivated area during this period; she neither heard nor saw any males of *X. t. melanosoma* in or around the abundant *T. stans* flowers. We remained at the site 30 minutes longer and saw no further activity.

On August 30 very few *T. stans* were in flower at area A and therefore we went to area B. In contrast to the adjacent dry, uncultivated areas, area B had a lush growth of 6-foot-tall, unidentified herbs in the ravine bed, clumps of purple-flowered *Mirabilis jalapa* L. scattered along the sides of the bed, occasional large pepper trees (*Schinus molle* L.) halfway up the ravine sides, and *T. stans* fringing the upper edges. As at area A, only a few flowers remained on the bushes of *T. stans*. The ravine edges were bounded by houses, small milpas, rows of maguery (*Agave* sp.) and some uncultivated land like that surrounding area A. Small pools of water were present in the creek bed and the ravine bottom plants showed evidence of heavy flooding within the last week or two. The bees were observed along 200 yards of the ravine; no flowers were in bloom to the north, where there was a sharp rise in the creek bed, and to the south, where the ravine fanned out into a dry outwash plain. The study area is bisected by Highway 150.

Both males and females of *X. t. melanosoma* were seen taking nectar from *M. jalapa*, a blue-flowered *Salvia* at the water's edge, and a single bush of *Anisacanthus quadrifidus* (Vahl.) Standl., while only 1♀ was observed to visit *T. stans*. Sunset was at 5:40 PM CST and by 7:00 PM it was too dark to distinguish between a bee and a small sphinx moth. The arrival of the bees at the flowers was as follows: 5:47, observed 1♂ on *M. jalapa*; 5:50-6:25, observed 1♀ and 1♂ on *A. quadrifidus*, took 1♂ on *Salvia* and 2 on *M. jalapa*; 6:25-6:35, observed 1♀ on *T. stans*, took 1♂ and 1♀ on *M. jalapa*; 6:35-6:45, took 1♂ and 3♀ on *M. jalapa*; 6:45-7:00, took 1♂ and 2♀ on *M. jalapa*. It seemed certain that the

bees were taking nectar from *M. jalapa* and *A. quadrifidus* because they straddled the corolla tube, head toward the plant, cut into the base of the tube, and inserted their mouthparts. The male taken on *Salvia* was inserting his mouthparts into the individual flowers. The bee that entered *T. stans* could have been collecting pollen, but all bees captured had clean scopae.

Each male which established a territory will be discussed separately. At 5:48 a male established a territory above the flowers of the *A. quadrifidus* bush growing on the lip of the ravine. He dove at me twice and then assumed the characteristic hovering attitude noted previously. He remained about 8 inches above the flowers and was almost motionless for 10- to 30-second intervals while turning on a vertical axis. Twice he dodged the net but did not displace more than 2 feet with each swing; both times he returned immediately to the previously occupied position. His presence was checked periodically and he was still there 32 minutes later. At 6:05, 2♂ were located by their loud buzzing above a bare area about 8 feet in diameter that was enclosed by a low-hanging pepper tree, 6-foot-tall herbs, and the ravine wall. Both males were almost motionless in the air, about 3 feet apart, and 3 feet above the ground. After about 1 minute of hovering flight, they drifted toward each other slowly and when about 1 foot apart suddenly engaged in a one-around-the-other fight which carried them about 10 feet above the foliage, where they separated and returned to their previous positions. Both specimens were taken with one sweep of the net. At 6:15, a loud buzzing was heard within the stand of tall unidentified herbs. This buzzing was produced by a male, hovering in the characteristic manner about 3 feet above the ground between the stems. Every 10 or 15 seconds he would alight on one of the leaves, run quickly over its surface and around the cluster of axillary leaves and buds, and then resume the hovering flight. Occasionally he remained motionless on a leaf for a few seconds before resuming flight. His total range was about 1 cubic foot. At 6:25, another male was similarly engaged except that it hovered about 6 feet above the ground and therefore was at the tops of the herbs rather than the base. At 6:20, Mrs. Janzen took a male which had been hovering about 1 foot above a clump of *M. jalapa* for several minutes; it held its ground despite some near misses with the net. With the exception of this male and the one over *A. quadrifidus*, all the hovering bees were at least 40 yards from the nearest flowers.

At 6:25, I crossed the highway and entered the southern half of area B. One ♂ was observed patrolling above a clump of *M. jalapa* about 10 feet in diameter. He held an altitude of 2 feet. This placed him immediately above the flower heads; he moved slowly back and forth over the flower patch, turning in the air as he moved. He maintained this position and activity for 10 minutes until collected. Fifteen yards away on the other side of the ravine, there

was a patch of a broad-leaved herb without flowers, about 8 feet long, 3 feet wide, and 2 feet high. This was under the canopy of a pepper tree whose branches reached within 10 feet of the ground and it was surrounded by trampled grass and sand. At each end of the patch a male bee hovered about 1 foot above the shoot tips. During the 4 minutes of observation the 2 bees did not leave the patch except when fighting. Occasionally they would start toward the middle of the patch at the same time. When they were about 1 foot apart, they entered into the typical one-around-the-other fight, which carried them about 15 feet above the ground before they separated and returned to hover over the ends of the patch. If one passed the center before the other reached it, the slower one attacked the "intruder" immediately. After 4 minutes of this activity, 1 ♂ was taken and the sweep of the net did not cause any visible reaction on the part of the other. However, the captured bee escaped; it went straight from the mouth of the net to the end of the patch (about 3 feet). The second time, it was again lost and again it returned. They then started a fight and both were collected with 1 sweep of the net.

The outwash plain area was examined and no bees were observed. At 6:35, another male was found to have taken up a territory beneath the above-mentioned pepper tree. It was over bare ground with a few scattered herbs 2 to 6 inches high. No physical landmarks appeared to be associated with his area; while he held a steady altitude of about 1 foot, the boundaries of his movement were much less definable than those of the bees observed previously and associated with physical prominences.

At 6:40, upon returning to the other side of the highway, a third male was taken while engaged in the peculiar movements noted earlier on the tops of the foliage of the tall herb growing in the ravine bottom. Area B was examined until complete dark and this was the last male associated with a definable territory. During the entire evening no bees were observed or heard at the flowers after 6:55 though we remained for 30 minutes. It might be noted that nectar-collecting bees remained at a flower clump (*M. jalapa*) for 5 to 15 minutes if undisturbed. Because of this, it is believed that every bee that came to the flowers or established a territory was located; this assertion is strengthened by the fact that their loud buzzing is distinctly audible 30 to 40 yards away. The only other bees observed were 2 *Ptiloglossa* sp. taken on the *Salvia*. A few minutes after sunset the sky became overcast, a light wind appeared (which did not reach the ravine bottom), and it became quite cool. At noon on a cloudy day (July 5, 1962), a single female *X. t. melanosoma* was collected as a part of a long series of *Xylocopa*, *Centris*, and *Bombus* from *T. stans* on the side of this ravine.

Xylocopa tabaniformis rufina Maidl

This subspecies was collected at Cuernavaca, Morelos, and Carapan, Michoacán. At Cuernavaca

(July 10, 1962), 1 ♂ and 1 ♀ were taken on the deeply shaded west side of a north-south-oriented hedge of *Bougainvillea* sp. on a cool, clear morning about 10 minutes after sunrise (actual appearance of the sun). They were both gathering nectar and the female had no pollen load. The area is on the north edge of town, just at the base of the pine-oak woodlands bordering the old road to Mexico City.

At Carapan (September 1, 1962), a stop was made at several acres of *Crotalaria longirostrata* H. & A. (a 6-ft.-tall, yellow-flowered, herbaceous legume with dense flower spikes and garden-pealike pods) on a flat area and the adjacent hillside. The hillside flower stands were interspersed with trees and shrubs. The area is at the margin between pine-oak woodland and drier *Opuntia*-legume areas.

The sky was heavily overcast and rain had been threatening all day. There were at least 5 other species of *Xylocopa* at the flowers, along with *Apis*, *Bombus*, and some megachilids. From 3:30 to 4:00 PM CSR a single male *X. t. rufina* was taken while it was collecting nectar from *C. longirostrata* on the hillside. It worked for several seconds on the flowers on the tips of the tallest plant but remained only 5 to 10 seconds on each inflorescence. It covered 20 to 30 yards between stops and was collected after several minutes of this rapid and "nervous" flight. From 4:00 to 4:30, Mrs. Janzen collected 2 nectar-gathering males on the level area; they remained on the inflorescence up to 1 minute and flew only 4 to 5 feet between stops. At 4:30, a heavy drizzle began and in the next half hour, I collected 2 ♂ and 2 ♀ *X. t. rufina* on the hillside on flowers. The males remained nearly a minute at each inflorescence but still flew 10 to 20 feet between stops. Their flight was rapid with loud buzzing and they were very sensitive to my movements. The 2 ♀ were slower and more direct in their activity; they remained several minutes on each inflorescence while entering several flowers. Both females had partially completed pollen loads of *C. longirostrata* pollen (determined by R. W. Thorp, University of California, Berkeley). While the 2 ♂ taken on the flat area were the only *X. t. rufina* seen there, numerous males were seen on the hillside. These males poised motionless on the tips of tall inflorescences near the edges of the interspersed brush and tree clumps, and were so sensitive to my movement that I could not approach close enough to capture one. The other bees (megachilids, *Thygater*, and 5 species of *Xylocopa*) that were visiting the flowers showed a definite gradual decrease in numbers from 3:30 to 4:30. After the drizzle started, only a few *Thygater* remained; however, *X. t. rufina* were increasing in number during this time.

Xylocopa tabaniformis tabaniformis Smith

On July 9, 1962, a large bush of *Bougainvillea* on the southeast edge of Taxco, Guerrero, was watched for bee activity from complete dark AM to complete dark PM. The first visitors (*Xylocopa* sp.) arrived

1 hour after sunrise when the bush was in full sunlight. Four hours after sunrise the first *X. t. tabaniformis* was observed. It paused at a flower for a few seconds and left. During the remainder of the clear and hot day, individuals of *X. t. tabaniformis* appeared at the rate of about one per 1½ hours. Two ♀ were collected during the day and neither had pollen loads. Those that visited the bush during the day paused only a few seconds at any 1 flower, and never visited more than 4 flowers. About ½ hour before sunset, the other *Xylocopa* ceased their visits. One-half hour after sunset and 1 hour before complete dark, the first evening-flying *X. t. tabaniformis* was seen and collected. Her behavior was quite different from that exhibited during daylight hours. She went methodically from flower to flower, flying scarcely 3 inches between. She remained at each flower cluster nearly a minute. At approximately 5-minute intervals bees continued to arrive until about 20 minutes before complete dark. Every bee observed was collected, totaling 6♀ and 2♂; the sexes could not be distinguished on the flower on the basis of behavior. None of the females carried pollen. It should be noted that there were 2 other *Bougainvillea* bushes in full flower within 30 yards, and bees were never observed or heard on these plants during the evening though they were visited by other bees during daylight hours; as with the other subspecies mentioned, *X. t. tabaniformis* has a very loud, buzzing flight, which would have been clearly audible 30 yards away.

DISCUSSION

Two recent publications (Hurd and Moure 1963, O'Brien and Hurd 1964) summarize the information to date regarding nesting habits and behavior of *Xylocopa tabaniformis*; the nest substrate varies from structural Douglas fir (*X. t. androleuca* Michener, Hurd 1958) to rotting pine (*X. t. rufina* Maidl, Hurd 1955); and adult activity is recorded as early morning to evening (*X. t. orpifex* Smith, Hurd, personal communication) and evening (*X. t. androleuca*, Hurd 1958, *X. t. rufina*, Linsley 1958). The 4 subspecies discussed in this paper had their nectar-gathering period in the evening or early morning with activity commencing 1 to 2 hours earlier in the afternoon on cloudy days; those occasional individuals taken during the midday hours probably do not represent the behavior shown by the majority of the population.

In respect to the nectar host, the females of the 4 subspecies demonstrated a host and/or area preference at any one time and place. This was in the presence of other flowers which had shortly before been visited by other kinds of bees. In one case (*X. t. rufina*) where the pollen source was located, it seemed likely that the plant serves as both nectar and pollen host. In the other cases it appeared that only nectar gathering was involved. Since the area where *X. t. illota* was taken was explored thoroughly during the daylight hours throughout the summer, there

is a good chance that if this subspecies collects pollen during the summer (as do the other carpenter bees in the area), it does so at night. However, there is always the possibility that their pollen source had not yet come into bloom. It should be noted that all the recorded *X. tabaniformis* host plants were visited during the day by other *Xylocopa* and that the slackening of this activity generally coincided with the appearance of *X. tabaniformis*.

In the 2 cases where male territorial activity was observed in the immediate area of a nectar source rather than a pollen source (*X. t. illota*, *X. t. melanosoma*), it seems possible that the nectar source is somewhat restricted or else the males adjust their activity to the area where the females are working (perhaps by being attracted to the same nectar source). Territorial behavior is definitely present in the case of *X. t. melanosoma*, while *X. t. illota* and *X. t. rufina* seem to display it but do not have such well-defined territories. In collecting all these subspecies, it should be remembered that the male territory need not be immediately above the flowers frequented by the female, but rather is likely to be associated with some physical prominence (clump of herbs, exceptionally tall plants, hedge).

The occurrence of the nest in the bracket fungus should not be surprising; it was undoubtedly excavated during the dry season when these fungi have the consistency of well-seasoned timber. Further, seasoned wood in this area is at a premium as wood-boring insects and fungi are very active during the wet months. In view of the renewed growth by this fungus later in the summer, it is not likely that the bees would continue to use the burrow.

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REFERENCES CITED

- Hurd, P. D., Jr. 1955. The carpenter bees of California. *California Insect Surv.* 4(2): 35-72.
 1958. Observations on the nesting habits of some New World carpenter bees with remarks on their importance in the problem of species formation. *Ann. Entomol. Soc. Amer.* 51(4): 365-75.
 Hurd, P. D., Jr., and J. S. Moure. 1963. A classification of the large carpenter bees (Xylocopini) (Hymenoptera: Apoidea). *Univ. California Publ. Entomol.* 29: 1-365.
 Linsley, E. G. 1958. The ecology of solitary bees. *Hilgardia* 27(19): 543-99.
 O'Brien, L. B., and P. D. Hurd, Jr. 1963. A new subspecies of *Xylocopa tabaniformis* Smith from Mexico (Hymenoptera: Apoidea). *Pan-Pacific Entomol.* 39(4): 275-6.
 1964. Carpenter bees of the subgenus *Notoxylocopa* (Hymenoptera: Apoidea). (In press.)