THE LIFE HISTORY AND HABITS OF THE SOLITARY WASP, PHILANTHUS GIBBOSUS

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[With 3 plates.]

Should the ordinary entomologist that tramps the field with collecting net and cyanide bottle catch sight of the small black and yellow wasp known to scientists as *Philanthus gibbosus*, he would probably pass it by as a specimen scarcely worth a sweep of his net. True, it is an insect not rare, nor even handsome, nor deserving of much comment when pinned in a cabinet. But, like all the solitary wasps, it lives a life of extraordinary interest, fascinating for the biologist and the layman alike.

The habits of this Philanthus have previously been studied to some extent by the Peckhams[1] in Wisconsin (1897) and by the Raus[2] in Missouri (1918). These veteran observers have made known the general behavior and the most conspicuous features in the life history of the wasp. The observations described in this paper disagree in no essential point from those of the older writers. The present writer's aim has been to supplement our knowledge and to remove lacunae, so as to present the life history of Philanthus as a nearly complete biography rather than as a cursory sketch.

DESCRIPTION, SYNONOMY, DISTRIBUTION.

Philanthus gibbosus is a small but robust wasp, 10 to 12 millimeters in length (pl. 1, fig. 1). She has a broad head that seems almost too large for the dwarfed body. Her coat of chitin is shiny black with spots of yellow on the head and yellow bands on the thorax and abdominal segments. The very large and deep punctures on the abdomen of this insect make it an easy species to recognize. These conspicuous punctures suggested Say's name of *Philanthus punctatus*. Under this title the wasp has commonly been referred to, but Mr. S. A. Rohwer has recently examined into the synonomy of

[1] Peckham, G. W. and E. G. Instincts and Habits of the Solitary Wasps. Wisconsin Geol. and Nat. Hist. Survey. Bull. 2, Sc. Ser. 1, pp. 117–124.
[2] Rau, P. and N. Wasp Studies Afield. Princeton University Press, pp. 109–116.

this species and believed it necessary to change the name to *P. gibbosus* Fabricius, a synonym that was intimated by Dalla Torre but was not generally followed in America.

The male of *gibbosus* resembles the female very closely, but differs mainly in having less yellow on the head (*fig.* 1). This is the opposite of the usual sexual diversity in Hymenoptera. Most male wasps and bees have more light-colored markings on the face than the female.

Philanthus gibbosus is a common and widely distributed Sphecid of North America. Specimens in the United States National Museum collections show a habitat that extends from Washington, Colorado, Arizona, and Texas in the West to Georgia, Virginia, New York, and Massachusetts in the East. There are specimens in

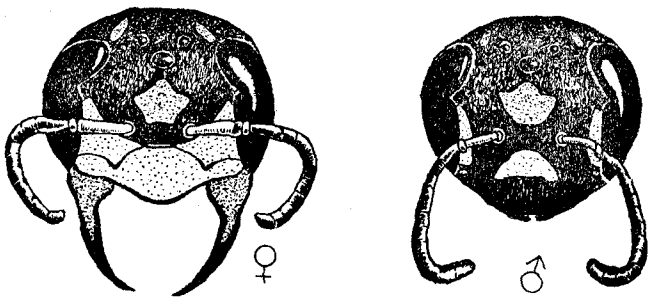


FIG. 1.—Philanthus gibbosus. Heads of male and female.

the collections of the National Museum from 21 States, as well as from Canada and Mexico.

THE ANNUAL CYCLE.

In Maryland *Philanthus gibbosus* goes through two generations a year. The early pioneers begin prospecting for a nesting site during the second week of June; but some laggards do not start to dig until two weeks later. By the end of June the establishment is in full swing. For about three weeks each wasp applies herself to the task of provisioning and egg laying, and then, her season over, she dies.

During the middle of July the progeny of this first brood begin to make their appearance, and the gradual emergence continues until almost the end of August. The major number of this second generation have provided for their young and died before the beginning of September. A few stragglers, however, keep on with their task until more than a fortnight later. The larvae pass the winter in their cocoons, change to pupae in April, and emerge during May and June, and thus one annual cycle is complete.

NESTING SITES.

An uncemented brick walk which surrounds the main building of Woodstock College, Woodstock, Md., was a favorite nesting site for *Philanthus gibbosus*. The wasps tunneled down between the bricks and built their cells in the sand beneath. The greater number had selected a portion of the path which was sheltered from the rain by a wide, projecting balcony. Though it was on the northern side of the building and received only the late afternoon sun, this section of about 35 yards was strewn with the excavated sand of nearly a hundred burrows. It was a curious instance of phototaxis that the mouth of every burrow opened toward the light; not a single doorway was found which faced the side of the building. This colony was kept under observation for two years, and it was here that most of the information for the present paper was gathered.

Under the broad eaves of another building a second group of nearly 30 Philanthi had settled close together in tenement fashion in a spot of hard ground which bore a scant growth of chickweed and foxtail grass.

A smaller colony, numbering about a score of nests, had also become established in the hard-packed clay of a tennis court; another group chose a bare slope in an open grove of trees.

Isolated nests were likewise found, one in the midst of a lawn, and several others along the bank of a roadway.

THE BURROW.

During the season of the wasp's activity, from the middle of June to the middle of September, small scattered heaps of sand upon the loose bricks of the path betray the entrance to the storerooms of Philanthus. One might at first credit the heaps to the home building of the ubiquitous ant, but these piles of sand are flat and spreading and do not form such a neat architectural dome as the ants are wont to erect. Should you chance to find Philanthus at work on her burrow you would see her backing out of the earth with a load of moist sand, which she pushes clear of the tunnel and then spreads over the heap with queer little jerks of her front legs. During the proceedings she stands on her four hind feet, the last two spread widely apart, and with the front ones scoops up the sand and shoots it backward beneath the arch of her body. It falls far in the rear in rapid, dusty jets, and with each strenuous dig and toss the wasp teeters sharply up and down like a toy rocking-horse. The front tarsi are often the main fossorial tools of a wasp, and those of Philanthus (fig. 2), with their spadelike calcaria, are well equipped for their work.

The large amount of dirt carried up from below and spread before the entrance gives indication that the burrow is a long one and leads far into the earth; and, indeed, Philanthus, with her tarsi and mandibles, often digs a shaft that is 2 feet or more in length. From one edge of the pile of sand a narrow, tortuous tunnel descends obliquely into the earth for about 6 inches, then swings around to run in a horizontal direction for 15 more, and finally ends in a neatly rounded oval cell (fig. 3). Other cells are disclosed, but these have no direct communication with the main corridor. From their contents we gain a clue to the plan of the architect. The chamber closest to the entrance is strewn with the skeletons of Halictine bees, and on this heap rests the consumer's cocoon. We break into the next cell and find a full-grown larva munching its last mouthfuls of bee flesh. The succeeding cells show us larvae growing fat on their provisions, each larva a little younger and smaller than the preceding. The penultimate pocket contains the wasp's egg, while the terminal cell is as yet unprovisioned. From this arrangement it is clear that the oldest cell is the one nearest the opening of the burrow. Each cell was in turn a terminal pocket which was fashioned only when needed. After completion its connection with the main gangway was blocked and the gallery was pushed onward to form another pocket. In due time this was likewise provisioned, tenanted, and sealed, and so the work proceeded until the wasp had enough separate nurseries to house her entire offspring.

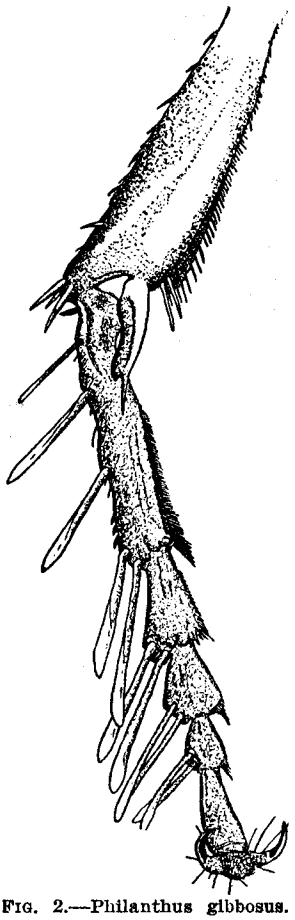


FIG. 2.—Philanthus gibbosus. Fore tibia and tarsus of female. (× 36.)

The illustration (fig. 3) is meant to represent a typical burrow. Scores of nests were excavated and all conformed more or less to this general type in inverse proportion to the stony nature of the ground. One wasp had met with so many obstacles that the terminus of her burrow was only 2 inches from the entrance—she had tunneled in a circle.

THE EGG AND LARVA.

The egg of the Philanthus (pl. 1, fig. 2) is a smooth, banana-shaped capsule, lustrous white, with a very thin, transparent chorion. Its length is between 3 and 4 millimeters; its greatest width is about

eight-tenths of a millimeter. Queerly enough, it is usually secured to the sternum of one of the smaller *Halictinae*, so that it often stretches along the bee's entire length from chin to tail. Knowing that the bees are butchered and not paralyzed, one might suspect that the egg would be laid on the first carcass brought in. We might reason that the sooner the egg is laid the sooner will it hatch and the fresher will be the food supply. But facts confound our logic. It is always on the last bee stored away, on the bee resting on the top of the heap, that we find the wasp's egg. Nor are the provisions uncommonly well preserved. Long before the Philanthus larva has ceased feeding there is a decidedly unpleasant effluvium coming from the corpses which form its food.

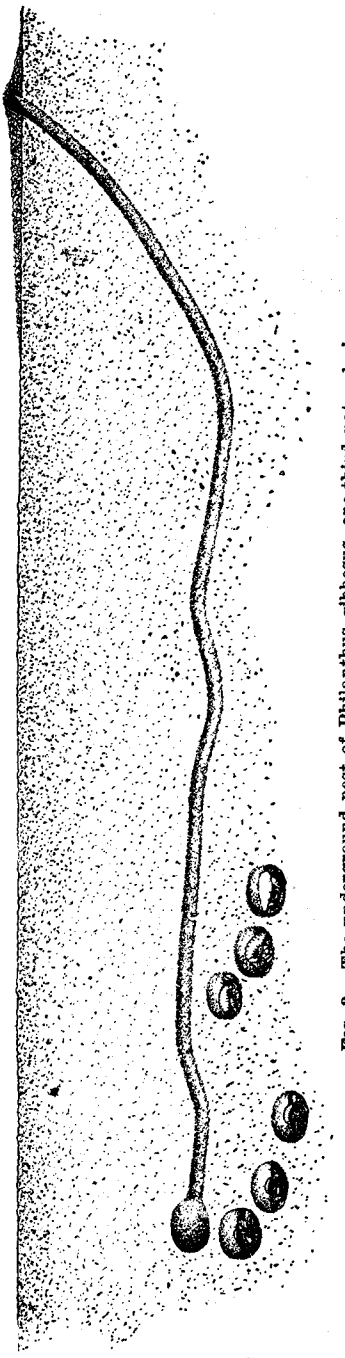


FIG. 3.—The underground nest of Philanthus gibbosus, one-third natural size.

Within three days the egg hatches, not suddenly, but gradually and almost imperceptibly. Inside the forward and blunter end of the egg the embryonic larval head has been forming and the segmented body begins to fill the membranous shell. Then the larva, without moving, pierces the skin of the egg directly below its mandibles and begins to draw nourishment from between the sternal sclerites of the bee. The swelling larval form at length bursts the tight envelope of the shell. It splits and shrinks away, leaving the larva a suckling at the breast of a dead bee (pl. 1, fig. 3).

The next seven days are a glorious banquet for the eupeptic grub. The tiny creature munches methodically, and methodically grows fat. Twenty-four hours after hatching it takes a short rest to shed its first moult. During the course of its growth two other sloughs are cast. The second and third ecdysis I have not witnessed, but I conjecture

their existence from a study of the changes in the shape of the larval mandibles.

After a week of feasting on honey-flavored meat the larva has reached its full growth. Nothing savory remains to be eaten. The cell is cluttered with the unpalatable legs, wings, and horny armor of the bees.

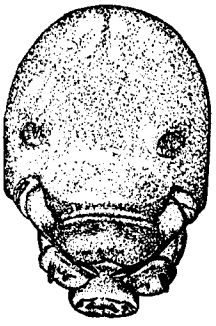


FIG. 4. — Philanthus gibbosus. Head of full-grown larva. (× 36.)

Now we can examine the larva (pl. 2, fig. 5) more carefully and correlate some of its habits with its structure. It has a body that is slender and fusiform, all covered with a stubble of short, brown bristles. The head is very small and for that reason well suited to pry into the narrow foramina of body walls to reach the food that is stored away in stout, chitinous boxes. The anal segment of the larva ends in a subcylindrical projection which is often telescoped in and out of the abdominal somites. This tail makes a handy lever for propulsion when the grub has need to shift its position. The tail is withdrawn, pressed against a fulcrum, and extended. The extension gives a propelling force to the whole body, and the grub with his caudal prolongation poles his way around the narrow confines of the cell.

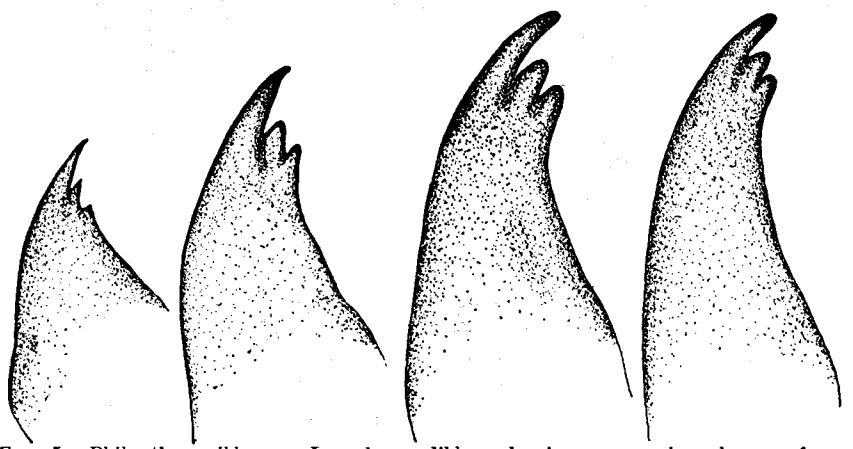


FIG. 5.—Philanthus gibbosus. Larval mandibles, showing progressive changes from newly-hatched larva to prepupal form. Drawn to scale. (× 150.)

The microscope reveals nothing exceptional about the larva's head (fig. 4). The lower margin of the clypeus is notched, and its sides shield two teeth of the tridentate mandibles—these may be characters of interest to the taxonomist.

A study was made of the mandibles from the newly hatched larva to the adult, and it showed an interesting mutation in these organs.

In figure 5 four mandibles are shown, corresponding to the four larval instars. Each stage exhibits a progressive lengthening and narrowing of the mandibular shaft, and a blunting and equalizing of the teeth. This development continues during the pupal stages (fig. 6) where two of the teeth become obsolete, and finally results in the long, acuminate mandibles of the imago (fig. 1).

THE COCOON, PUPAL PERIOD, EMERGENCE.

Thus far in its career the larva has shown no talents save those of a butcher and a trencherman. Now it will weave a silken teepee to shelter it during the critical period of the transfiguration. The cocoon (pl. 2, fig. 10) when completed is a bulbous case composed of a single ply of homogeneous, straw-colored silk. These silken walls are sometimes obscured by a white cottony flock which rubs off readily and leaves the cocoon almost as translucent as an amber bead. It has the shape of a very long pear, with its tapering neck, colored brown by the stercoral plug securely fastened to the rear wall of the cell. The blunt end is free and invariably points toward the mouth of the burrow, the corridor for exit.

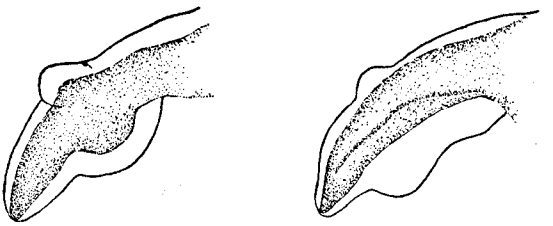


FIG. 6.—The pupal mandibles of Philanthus gibbosus. The chitinized mandibles of the adult are shown in formation within the swollen, fleshy mandibles of the pupa. Mandible of white-eyed pupa at left, of black-eyed pupa at right. (× 36.)

It takes the insect weaver 48 hours to complete its cocoon. As a sort of preliminary scaffolding the larva spins a loose, cobwebby hammock in the cell. This much, though mere preparation, requires 15 hours of labor. Then a light silk bag is spun on this support. Its tip is open and attached to the wall. Toward the end of the task the open tip is sewed up. Last of all, two days after the abode is completed, the occupant fits its faeces into the narrow neck, and with that act all larval activity ceases.

Eight months pass, and the larva sleeps on in its silken flask. The chemicals are mixed, the retort filled, but the flame has not yet been applied. At last the long lethargy reaches an end, and the shapeless grub is metamorphosed into a nymph. But should the grub belong to the first generation it will take only a week's siesta in preparation for the nymphosis. Then the larval wrapper is thrown off and the delicately-molded pupa (pl. 2, figs. 6, 7, 8) makes its appearance. The transitory pupae that link larva to wasp are feeble, grotesque organisms, mere ghosts of the perfect insect. They look

like uncompleted statuettes, like alabaster carvings waiting for the breath of life. The pale pupae gradually don the livery of Philanthus. Their white eyes change to brown after two days, then to black after four more days, and before another week has elapsed the coloration is complete.

The length of the pupal period varies presumably with the weather. Three male Philanthi pupated on April 15. One emerged as imago after 27 days, the other two after 28 days. In July, however, one female required but 19 days and another only 15 days to complete its transformations.

When the time has come for the emergence the wasp with her powerful mandibles attacks the blunt end of the cocoon (pl. 1, fig. 4). A few lusty strokes and the imago is free. Patient digging in the right direction will demolish the barricade between the cell and the main gallery, and before long another Philanthus is ready to ply its trade of bee butchering.

The adults of many colonial wasps emerge in a body, as if at a given signal, and then hold riotous mating flights in the sunshine. But the Philanthus clan muster their numbers only very gradually. While the oldest cell is already vacated by the fully-formed imago, the last cells of the same burrow may contain but a prepupal larva.

DOMESTIC AFFAIRS.

For some time after emerging the youthful wasps share together the ancestral cave, and on a bright morning one can see framed in the doorway the stolid yellow face of a female, or the black-barred visage of a male. When and where the couples formed could not be determined. Frequent visits to the near-by flowers showed Philanthi of both sexes feeding quietly together in large numbers, but in perfect disregard of each other. Daily observation at the nesting site failed to disclose a single endeavor at copulation. It seems probable therefore that the nuptial ceremonies are conducted within the nest, and possibly within the old nest previous to the dispersal of the clan. If this be so we wonder what provisions are made to avoid the dangers of inbreeding. The underground cave is also used as the wasp's dormitory and crypt. The matron of the nest always spends the night at home. Toward 5 o'clock or later in the afternoon she bars the door of her dwelling with a plug of sand pushed up from within. Her rest will be secure unless Harpalus or some other night-prowling beetle blunders in. The callow males at first patronize the home dormitory, but later on they sometimes dig individual lodgings of their own, whither, as the Peckhams relate, they retreat night after night for slumber. The female Philanthi have a strenuous but brief existence. For them there is no lingering senescence. It is not unusual when excavating a burrow to find in the terminal

cell a moldering harvest of bees and the harvester's corpse. Death takes Philanthus in the midst of labors.

THE PROBLEM OF THE PREY.

Previous observers had reported that Philanthus provisioned its nest with bees of the genus *Halictus* (sensu latiore). Ashmead and the Peckhams have recorded the use by Philanthus of *Helictus disparalis* Cres.; while the Raus noted that the wasp took *H. versatus* Robt., *H. pruinosus* Robt., and *H. sparsus* Robt.

More extensive investigations were undertaken by the writer to determine if possible whether Philanthus restricts her captures entirely to Halictine bees. At various intervals during the four months of the wasp's activity her burrows were ransacked and rifled of their contents. The loot of two seasons amounted to 331 bees. When these were sorted and determined they comprised 22 species, 21 of which belonged to the family *Halictidae*.

The complete catalogue is as follows:

Catalogue of the prey found in the nests of Philanthus gibbosus.

Type.	Species.	Length.	June.	July.	August.	September.	Total.
		Mm.					
A	Augochlora viridissima Vier	7–8	2	12	4	5	23
W	Augochlora fervida Sm	9	.....	.....	1	.....	1
B	Oxystoglossa pura (Say)	5–8	5	18	15	4	42
H	Halictus ligatus Say	6–8	.....	12	49	.....	61
I	Halictus lerouxi Lep	9	1	.....	.....	.....	1
D	Chloralictus sparsus Robt	3–5	15	41	16	5	77
C	Chloralictus illinoensis Robt	4–5	.....	1	2	18	21
C	Chloralictus sp. near zephyrus Sm	4–5	1	17	.....	.....	18
X	Chloralictus pilosus (Sm.)	5–6	.....	5	1	.....	6
DD	Chloralictus cressoni ? (Robt.)	5–6	.....	4	1	.....	5
E	Chloralictus obscurus (Robt.)	6–7	1	1	.....	2	4
N	Chloralictus viridatus Lov	6	.....	2	.....	.....	2
CC	Chloralictus versatus Robt	4–7	.....	2	.....	.....	2
S	Chloralictus caeruleus Robt	5	.....	1	.....	.....	1
F	Seladonia provancheri (D. T.)	6–7	.....	22	8	.....	30
G	Curtisapis coriacea (Robt.)	8	.....	.....	1	8	9
BB	Curtisapis fuscipennis (Sm.)	9	1	.....	.....	.....	1
Y	Evylaeus arcuatus Robt	7–8	2	10	.....	.....	12
J	Evylaeus pectoralis (Sm.)	5–6	.....	5	1	.....	6
AA	Evylaeus sp. ?	5	1	.....	.....	.....	1
T	Dialonia antennariae (Robt.)	4	.....	2	.....	.....	2
U	Calliopsis andreniformis Sm	5–6	.....	2	4	.....	6
							331

Specimens of all these species have been placed in the collections of the United States National Museum. Each one is designated by its respective type letter and bears the label "Prey of Philanthus gibbosus."

In compiling the catalogue I have followed the classification and nomenclature of Charles Robertson. The genera are therefore used in the Robertsonian sense. According to the commoner classification, the first 20 bees on the list would be placed in the genus *Halictus*. These 20, with *Dialonia antennariae*, which is a *Sphecodes*, belong to the family *Halictidae*. *Calliopsis andreniformis*, however, belongs to the family *Panurgidae*. This latter species, of which one female and five males were found in the cells of the wasp, bears a superficial resemblance to *Halictus ligatus*.

Shall we say that the capture of these six Panurgid bees was accidental? Shall we set it down as a mistake on the part of a Philanthus who was deceived by a superficial similarity between *Calliopsis* and *Halictus*? That we should have to do if we were certain that the wasp actually selects *Halictidae*. To make such an exclusive choice the wasp must possess a remarkable instinct. Size affords no reliable guide when the bees to be chosen vary from 3 millimeters to three times that in length. Color is still more confusing. The prey of Philanthus includes bees clad in brown or dull russet; others are girdled with yellow, banded with white, adorned with hoary wool; others are bright metallic green, red, blue, ebony black, or golden green; and underneath this variety of garb and livery the wasp must recognize the invariable Halictus. Endowed with such a talent, the Philanthus would be a rival to expert melittologists; she would have more skill than our professional classifiers—a conclusion that Henri Fabre would most heartily indorse.

But the problem permits of another solution. It can be solved by saying that Philanthus takes any bees of proper size that visit the flowers during her hunting season. Halictid bees are captured in such abundance not because the huntress is a specialist on *Halictidae* but because they form the almost exclusive population of the summer field flowers. This solution is plausible enough, but requires for proof more study and experiment than I have been able to give the question.

A third suggestion is possible. In our neighborhood I have seen *Philanthus gibbosus* hunting or feeding on the flowers of Wild Carrot (*Daucus carota*), Yarrow (*Achillea millefolium*), Daisy Fleabane (*Erigeron ramosus*), Lady's Thumb (*Polygonum persicaria*), and the cultivated Gaillardia (*Gaillardia grandiflora*), and Chinese Woolflower (*Celosia plumosa*) in the garden. These are all flowers whose surgary corollas are patronized largely by *Halictidae*. It might accordingly be suggested that the preponderance of Halictid prey is an accident resulting from the partiality of Philanthus for flowers which *Halictidae* prefer. But this answer of itself scarcely solves our difficulty. It merely leads to another question: Does Phil-

anthus capture *Halictidae* because she just happens to visit the Halictid flowers, or does she visit the Halictid flowers for the purpose of capturing *Halictidae?*

But we must remember that in raising questions of this nature we are presupposing that our taxonomic groups are perfectly natural ones. Has not this discussion arisen because *to our notions Calliopsis* does not belong with the *Halictidae?* I have a suspicion that the *Panurgidae* could readily be brought together with the *Halictidae* under the same family. If these two families were merged on a natural basis it would prove a magnificent compliment to the entomological instinct of Philanthus. "Ask the beasts and they shall teach thee," and it is not improbable that Philanthus is offering taxonomy a hint which taxonomy might profitably consider.

THE MENU OF BEES.

I hasten to abandon these conjectures for the secure pathway of fact. To each cell the provident wasp furnishes a supply of from 8 to 16 bees. The contents of three cells belonging to a burrow opened on July 7 will show how varied is the menu which Philanthus supplies her offspring.

Chloralictus sparsus	10♀	Chloralictus sparsus	3♀
Oxystoglossa pura	2♀	Seladonia provancheri	2♂
Evylaeus arcuatus	2♂	Evylaeus arcuatus	1♀
Evylaeus arcuatus	1♀	Halictus ligatus	1♀
Chloralictus viridatus	1♂	Chloralictus caeruleus	1♀

Chloralictus sparsus	8♀
Chloralictus versatus	1♀
Chloralictus versatus	1♂
Dialonia antennariae	1♂

If each wasp provisions 10 cells, what a record of butcheries she must have to her credit! The colony of Philanthi under observation was responsible for the destruction of several thousand *Halictidae* every season. Because of its wholesale massacre of beneficial bees, *Philanthus gibbosus* must be classed as an injurious insect.

THE BUTCHERING OF THE BEES.

The question of the prey may be looked at from another viewpoint. The bees brought home from the hunt are often thickly powdered with pollen—a fact that would lead one to suspect that the unfortunate bee was caught and killed so quickly and skillfully that there was not even a strugggle. Such was actually the case in the encounter which I witnessed on an umbel of Queen Ann's Lace. A Philanthus was sipping nectar on the dome of florets and moving

quietly from cup to cup. Suddenly she made a dart for the edge of the umbel—the next instant I saw her standing upright, holding a small bee face to face and stinging it upwards under its chin. One dagger stroke and the fight was over. Philanthus grasped her victim and flew off. The whole operation did not take more than 10 seconds.

This capture which I observed was prettily and neatly done, but oftentimes the wasp is only a blundering bungler. She will hover over a flower and pounce on spider, fly, bug, or wasp that looks small enough to be an easy victim. I have even seen her deceived by the dark central florets in the white disk of Queen Ann's Lace, at which she would dart with amusing ferocity. Actual proximity shows her the mistake, and she makes off to fall into other errors of insect myopia.

THE RETURN FROM THE CHASE.

It is interesting to post oneself at the galleries of Philanthus to watch the wasps return from the chase laden with their prey (pl. 3, fig. 11). Their flight is easy and unimpeded by the burden. If one looks closely one can see that the wasp carries the limp carcass of the bee tightly clasped to her breast with her middle pair of legs. Sometimes she also grabs the bee's antennae in her mandibles, so that in case of emergency, when all six legs would be needed, the bee need not be dropped. It happens sometimes in walking that the legs release their grasp, but the bee is dragged along by the grip which the wasp has of its antennae. In picking up the bee the wasp first gets a mandibular hold of its antennae and then swings it into position under her body. The wasp that is bringing home prey descends to her nest in a rapid, swinging, zigzag flight. Usually little difficulty is experienced in finding the right burrow. The wasp alights, quickly removes the barrier of sand at the entrance, and disappears down the hole. Generally Philanthus effects a neat and rapid entrance without releasing her burden, though at the moment when the wasp tumbles down the shaft she shifts the bee a bit to the rear so that its abdomen projects slightly beyond her body.

AN AUTOPSY OVER THE VICTIMS.

If we play the coroner and hold an autopsy over the victims, it becomes evident that one and all were fatally stabbed in the brain. The bees that are taken from the wasp in transport all exhibit strong reflex movements. The tarsi tremble, the legs are flexed, the abdomen twitches spasmodically, but the antennae and mouth parts are almost totally inactive. These latter organs are directly in-

nervated by the brain, or, more properly, by the suboesophageal ganglion, and would be the first to be affected by its lesion. The postmortem activity of the other parts of the body is readily understood when we remember that the abdomen, thorax, and thoracic appendages are provided with special ganglia which may, even for a short while after the brain is destroyed, still perform their function of stimulation, though no longer of coordination. The legs and abdomen quiver actively at first, but the movements gradually grow feebler and cease altogether after two or three hours. Then complete immobility ensues. Electric and chemical stimulation bring no response. Soon comes desiccation and decay.

NATURAL ENEMIES.

No wasp's history could be called complete without mentioning the concomitant ravages of those professional parasites, the Tachinids. The persecutor of Philanthus is a dapper little fly, clad in pearl gray with markings of rich seal-brown. Her eyes, red as gobs of clotted blood, border a silvery face; hence she is placed on record as *Metopia leucocephala* Rossi (det. Dr. J. M. Aldrich). Daily during July and early August several of these white-faced flies can be seen poking around from burrow to burrow in the populous colony of Philanthus. An open tunnel suits the parasite's designs. With gingerly haste she steps just inside the threshold, pauses a moment, then scurries out and makes off. Never was she seen to enter a burrow more than two or three inches. Since the hoary-headed Metopia is viviparous, I presume that she releases several live maggots at the entrance to make their way unaided into the cells of the wasp.

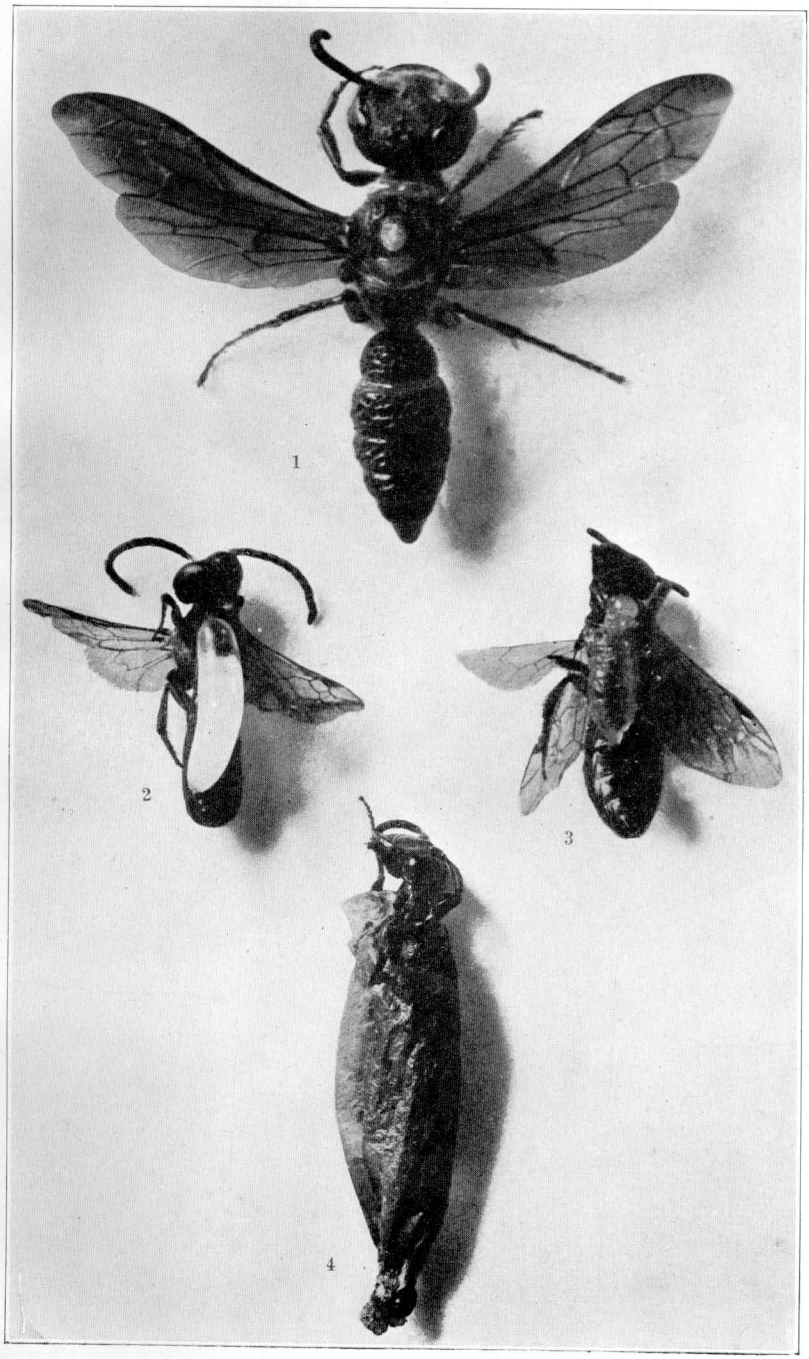
Another intruder in the burrows of Philanthus is *Senotainia trilineata* Van der Wulp (det. Dr. J. M. Aldrich), of smaller form than Metopia but no less destructive. On July 22 two brood chambers of Philanthus were discovered which were parasitized by two maggots apiece. The marauders were feasting on the store of bees, and there was no trace of the wasp's larva or egg. These maggots formed puparia within two days, and the adult Senotainiae emerged, one on August 9 and three on August 10.

The adult wasp also falls a victim to predatory enemies. A female Philanthus was found lying on the florets of goldenrod with a yellow spider (*Misumena vatia*) sucking at her abdomen.

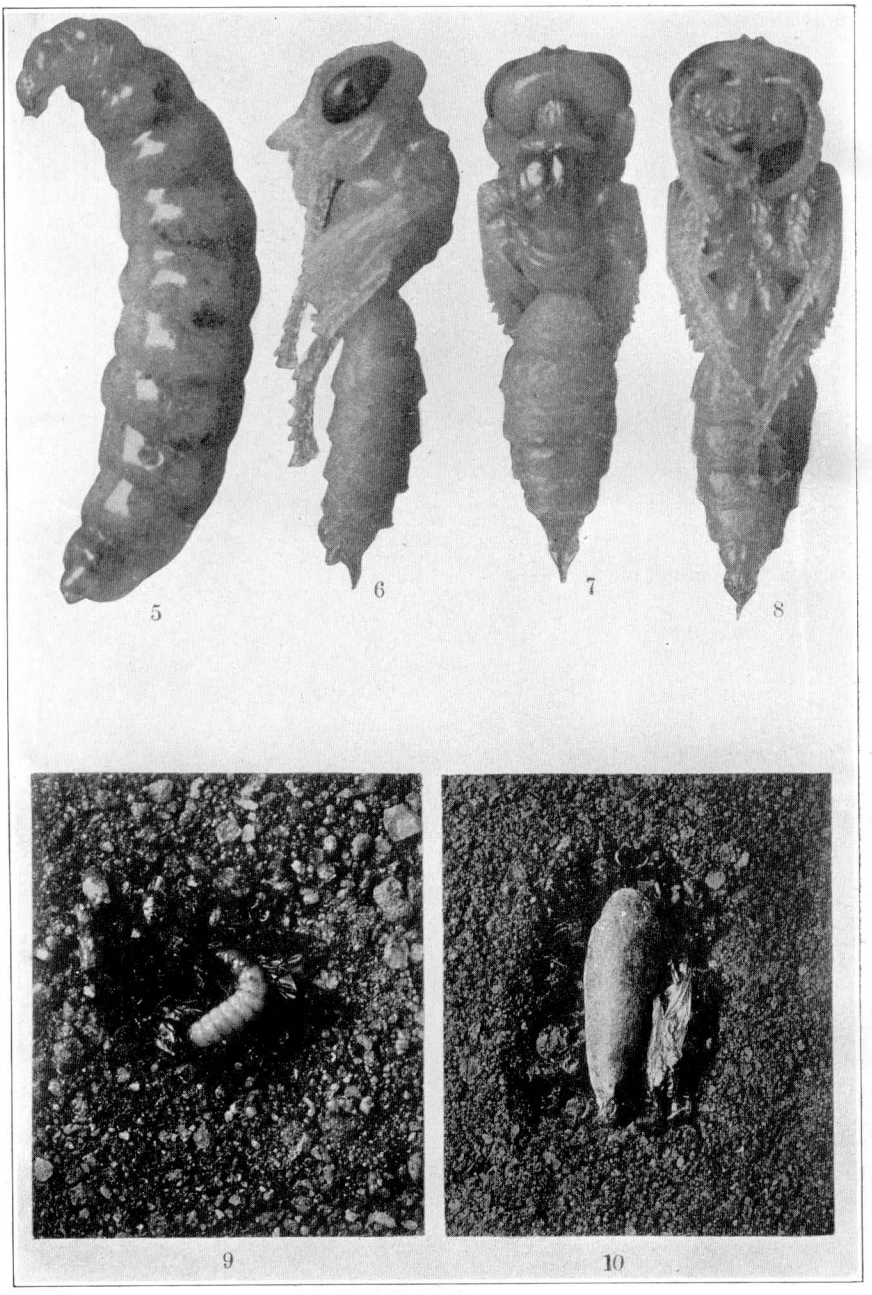
At Fordham University, during August, 1923, after the foregoing notes were completed, I observed another enemy of Philanthus. The incident occurred in a colony of *P. gibbosus* that had settled in a characteristic nesting site under the brick pavement of an open auto shed adjoining the Fordham faculty building. A large brown Asilid had discovered that this Philanthus colony was a profitable spot for

piracy. Frequently the robber-fly would come and crouch motionless near the nests, alert for booty. Whenever an unsuspecting wasp drew near, swiftly the Asilid would rise and strike at it hawk-like with legs extended; but most often the intended victim escaped. The home-coming Philanthi laden with their bees fell more easily into the pirate's clutches. One case in particular is worth recording. As the wasp burdened with its bee came into sight the robber-fly pounced upon it and caught both the wasp and her prey between its long spiny legs. Then with its two captives dangling from its talons the Asilid flew off. I followed to see the finish. The tableaux was remarkable. The fly hung nonchalantly by one leg from a near-by branch and with its sharp beak drained the juices of its double catch. The incident was not without dramatic irony—the assassin being despoiled by another assassin. To complete the tragedy I captured the second assassin. When its Bertillon prints were taken the robber-fly was found to be *Deromyia discolor* Loew (det. Dr. Aldrich).

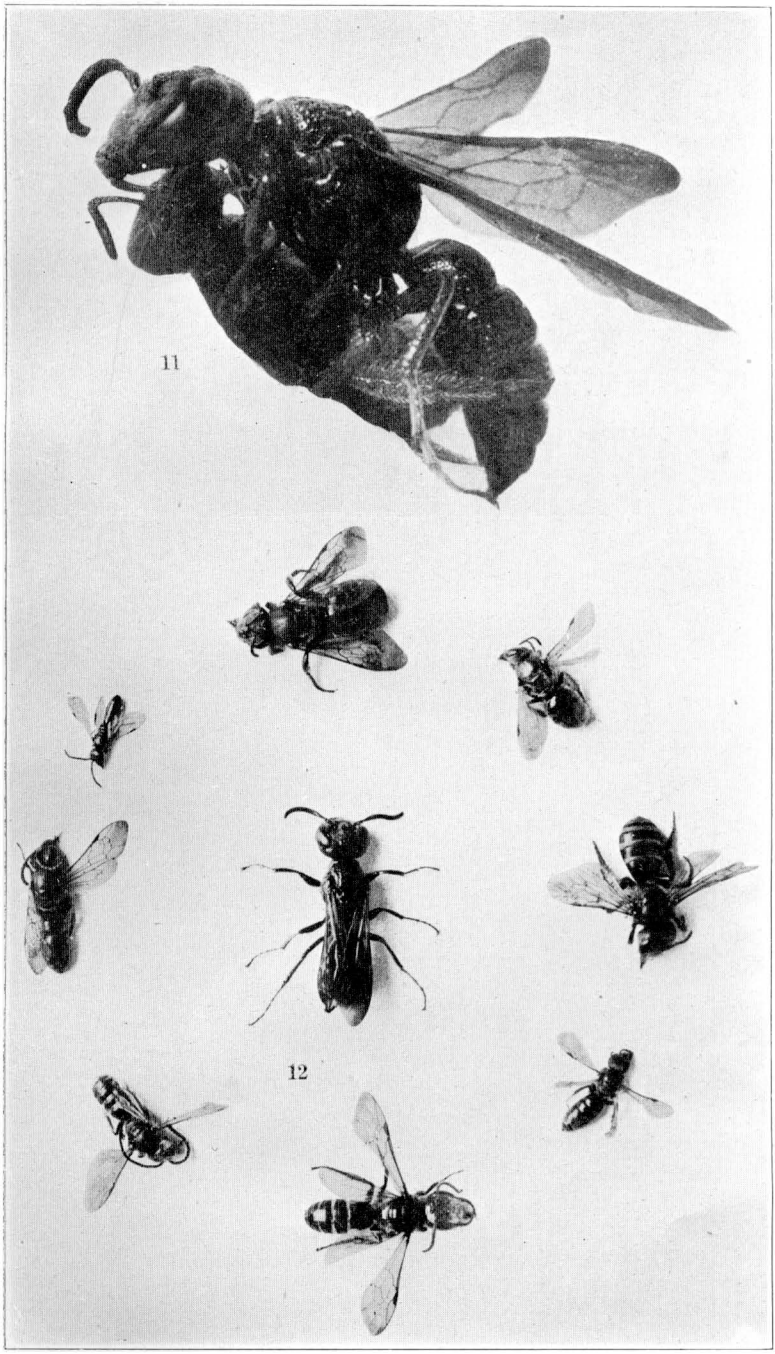
I wish to acknowledge my indebtedness to my friend, Rev. John A. Brosnan, S. J., of Woodstock College, for his valuable services in taking the photographs for this paper. To Mr. Sievert A. Rohwer, of the United States National Museum, I am also obliged for determining nearly all the species of Hymenoptera involved in this discussion and verifying my determinations of the rest. For this and other assistance which Mr. Rohwer rendered me during the preparation of this paper I am happy to express here my sincere gratitude and appreciation.



1. PHILANTHUS GIBBOSUS, FEMALE. (X5.)
2. THE EGG OF PHILANTHUS SECURED TO THE VENTRAL SURFACE OF A SMALL HALICTINE BEE. (X6.)
3. NEWLY HATCHED LARVA OF PHILANTHUS BEGINNING TO FEED. (X6.)
4. IMAGO OF PHILANTHUS GIBBOSUS EMERGING FROM COCOON. (X5.)



5. FULL GROWN LARVA OF PHILANTHUS. (X 6.)
6. PUPA OF PHILANTHUS, LATERAL ASPECT. (X 6.)
7. PUPA OF PHILANTHUS, DORSAL ASPECT. (X 6.)
8. PUPA OF PHILANTHUS, VENTRAL ASPECT. (X 6.)
9. A PHILANTHUS CELL, SHOWING THE LARVA AND ITS PROVISIONS. (NATURAL SIZE).
10. PHILANTHUS CELL, SHOWING THE COCOON AND FOOD DÉBRIS. (X 2.)



11. PHILANTHUS IN FLIGHT, TRANSPORTING HER PREY. (X 7.)
12. PHILANTHUS GIBBOSUS AND SOME SPECIMENS OF HER PREY. THE WASP IS IN THE CENTER FOR COMPARISON. THE BEES, BEGINNING WITH THE LARGEST AT THE TOP AND GOING CLOCKWISE ARE—ANGOCHLORA VIRIDISSIME ♀, EVYLAEUS PECTORALIS ♀, HALICTUS LIGATUS ♀, CHLORALICTUS ILLINOENSIS ♀, CURTISAPIS CORIACEA ♂, SELADONIA PROVANCHERI ♂, CHLORALICTUS OBSCURUS ♂, CHLORALICTUS SPARSUS ♂. (X 2.)