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ADDITIONAL NOTES ON THE CLASSIFICATION AND KNOWLEDGE OF STINGLESS BEES (MELIPONINAE, APIDAE, HYMENOPTERA) BY THE KAYAPÓ INDIANS OF GOROTIRE, PARÁ, BRAZIL[1]

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ABSTRACT

This work presents additional data regarding the knowledge of meliponines by the Gorotire-Kayapó Indians of Brazil. Factors determining the Indian taxonomic system for stingless bees include: habitat; preferred substrate or niche; external nest form; texture, material, and shape of entrance structure; flight patterns; defense behavior; size, form, and color of adults; and smell of bees. Detailed ethnobiological descriptions of the following species are included: *Tetragona clavipes*, *Partamona* cf. *cupira*, *Scaptotrigona*

[1] This work is the result of one phase of the Projecto Kayapó, an interdisciplinary project to study the ethnobiology of the Kayapó Indians, financed by the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) and the World Wildlife Fund–U.S. The entire project involves 14 scientists from different fields of expertise and is conducted by the Laboratório de Etnobiologia, Universidade Federal do Maranhão, São Luís, MA, Brazil.

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polystica, Melipona rufiventris flavolineata, Melipona melanoventer, Tetragonisca angustula angustula, Tetragona dorsalis cf. *beebei, Trigona fulviventris.* Indigenous concepts of ontogeny, division of labor, castes, odor trails, defense activity, swarming, and general behavior are discussed. Bee management, or "semi-domestication," methods of collection, and use of bees' wax, cerumen, resin, pollen, larvae, and honey are discussed. Suggestions for future research generated from this ethnobiological investigation include: use of chemical properties (odors) in species identification; division of labor within bee colonies; generation of odor trails by Trigonini; symbiotic relationships between acarine mites and meliponines; habitat sharing and specificity; and the role of *Apis mellifera* in the modification of stingless bee behavior. The work concludes with a discussion of the symbolic importance of bees to the Gorotire-Kayapó as "natural models" for social organization and the importance of ethnobiological research in the creation of a world science.

INTRODUCTION

Initial research by Posey (1983*e*) recorded 56 named folk species of stingless bees that are recognized and classified by the Kayapó Indians from the village of Gorotire (7°48′S, 51°7′W) in the Brazilian state of Pará. Of these, nine species are considered "semi-domesticated" or "manipulated" by the Indians.

Many of these meliponine bees are of economic importance to the Kayapó. Wax, cerumen, and resin are used for artifacts; honey, pollen, and larvae are used for food; pupae are used for food and medicine; and pollen and bee parts are important in medicinal preparations (Posey, 1983*e*). Even nonutilitarian species are known and classified by the Kayapó, who consider all social insects to be of epistemological importance. The Indians believe that an ancient shaman (*wayanga*), who studied social *Hymenoptera* behavior, taught their ancestors how to live, work, and defend themselves like social insects (Posey, 1983*f*). This "natural model" for society is symbolically represented by the nests of *Polybia* spp. wasps (*amuh*) and ceremonially manifested in a special meliponine beeswax (cerumen) hat called mẽkutôm (Posey, 1983*c*, 1983*d*).

This paper presents additional data on the complex knowledge of the Kayapó Indians to further document the folk science of these extraordinary experts on Amazonian biology and ecology. Our intent is not to compare our science with theirs, but rather to show how our own science can be enriched and how insightful hypotheses can be generated through the study of ethnobiology.

MATERIAL AND METHODS

Previous research by Posey (1981, 1983*e*, 1983*f*) was conducted in 1977–1979 during 14 months of field research with the Kayapó. During that period, data were collected while accompanying the Indians to the forest, savanna, and garden during annual ceremonial and seasonal cycles. Two bee "experts" served as principal cultural consultants, Kwyrà kà and his son Irã.

During the field period that resulted in this report (21 days during the months of August and September 1983), the original consultants were used and earlier materials were cross-checked by the oldest shaman of Gorotire, Beptopoop. Although Posey's previous fieldwork had met with few problems in acquiring data on bees, the presence of Camargo created unexpected complications. The Indians feared that his desire to collect bees would lead to the disturbance or destruction of their valued nests. Thus, it initially appeared that there had been a drastic drop in beekeeping, beekeepers, and bee nests in Gorotire since 1977–1979. However, this did not prove to be the case. In 1983, the Kayapó were simply distrustful of our curiosity about their stingless bees and reluctant to provide information or show us their nests.

Eventually, when we realized the source of complication, we were able to explain more specifically our intent and assure our hosts that their bee colonies would not be destroyed by our scientific efforts. Thereby, we were able to gain access to considerably more data, and receive more cooperative responses to our inquiries.

A "generative methodology" for eliciting was utilized; that is, formal questioning was held to an absolute minimum so as not to introduce our scientific paradigms into indigenous thought, thereby prejudicing responses. We simply communicated our interest in bees and let our consultants lead us to nests and tell us what they wished regarding bees and bee behavior. When questions were necessary, the most general formulations possible were utilized: for example, "Tell us about the bee's nest," or "Tell us about bee flight," and so on. The two major informants are fluent in Portuguese and routine conversation was carried out in that language. When consultants found difficulty in explaining any subject in Portuguese, communication shifted to Kayapó. New terms or concepts were recorded in the indigenous language and initial discussions of a new subject were carried out in Kayapó.

In addition to the collection of biological materials, drawings of bee nests were made in the field. Internal architecture was sketched and photographed if nests were opened by the Indians. Ethnographic notation occurred during all phases of the field study. Drawings in this article are based on information provided by Kayapó consultants. Fig. 1 is a replica of a drawing done in 1979 by Pedro Kayapó. Species encountered during this period of field research are listed in Table 1. Numbers preceding the species list refer to collection numbers in the Gorotire Kayapó collection now under the care of Prof. João M. F. Camargo and stored at the Departamento de Biologia, Universidade de São Paulo, Ribeirão Preto, São Paulo, Brazil.

RESULTS

Taxonomic Categories

Bees (social Apidae) are grouped along with other social insects as *nhy* (*ñy*), which is the only superordinate (supra generic) category found for Arthropoda (Posey, 1984*a*). Adults of social insect colonies are denominated *nhy*—thus ants are called *mrum-nhy*, bees are called *mehn-nhy*, wasps are called *amuh-nhy*, and termites are called *rorot-nhy*. *Apis mellifera* (*ngài-pere'y*) is often classified with wasps (*amuh-nhy*) rather than stingless bees (*mehn-nhy*) because of its powerful sting. On the other hand, wasps that produce honey (*Brachygaster* spp.) are often classified with bees rather than wasps because of their honey production.

Nests of social insects are given the same name as Kayapó houses, *ũrũkwa*. Likewise, traditional circular villages are said by the Kayapó

Table 1.—*Species of meliponine bees encountered in vicinity of Gorotire, Para, Brazil during the current study.*

Collection numbers	Scientific name	Kayapó name
(303c)	*Tetragona clavipes* (Fabricius)	ikài-kà
(304c)	*Partamona* cf. *cupira* Smith	myre-ti
(305c)	*Melipona seminigra pernigra* Moure & Kerr	udjy
(306c) & (308c)	[*Scaptotrigona nigrohirta* Moure Ms.]	imrê ñy kamrek
(307c)	*Scaptotrigona polystica* Moure	imrê-ti
(309c)	*Melipona melanoventer* Schwarz	menhirê ujdjà
(310c)	*Melipona rufiventris flavolineata* Friese	ngài kumrenx
(311c)	*Tetragonisca angustula angustula* (Latreille)	my krwàt
(312c)	*Tetragona dorsalis* cf. *beebei* Schwarz	tôtn my
(313c)	*Trigona fulviventris* Guérin	djô

to take the cross-sectional form of conical nests of wasps and bees (Posey, 1981).

Nests of Meliponinae (mehn nhy ũrũkwa)

External characteristics.—Nests of Meliponinae are grouped by the Indians according to external structures perceived as "natural discontinuities" or "natural" morphological groupings (Hunn, 1976). Although these groups are not linguistically labeled, their saliency as covert (unnamed) categories is easily demonstrated through field recognition and informant responses. Each nest-form group is typified by a "focal species" that has idealized qualities characterizing the set. Each set may be identified or referred to by the name of the focal species (as described in Posey, 1984*a*). Fig. 1 is a drawing produced by Pedro Kayapó, a young Indian man (*menononure*) from Gorotire, and illustrates the external form and internal structure of the focal species *ku-krãi-ti* (*Trigona amazonensis*). Similar drawings by various Indians were used to construct the basic focal forms of the major nest categories summarized in Fig. 2. These focal forms are as follows: 2A, *kukrãi-ti* (*Trigona amazonensis*) constructs nests attached externally to large tree trunks or boulders; 2B, *me-nô-rà-kamrek* (*Trigona cilipes*) usually constructs nests in arboreal ant (*Azteca* spp.) colonies or termite (*Nasutitermus* sp.) nests; 2C, *mehñy-tyk* (*Trigona branneri*) prefers externally attached nests on various palm species; 2D, *imrê-ñy-kamrek* (*Scaptotrigona nigrohirta*) constructs nests in natural openings in tree trunks and builds entrance tubes of soft wax and resin (this is the largest category, encompassing a variety of genera and the species); 2E, *myre-ti* (*Partamona* cf. *cupira*) that builds in arboreal termite nests; 2F, *djô* (*Trigona fulviventris*) prefers subterranean nests, often found in termite

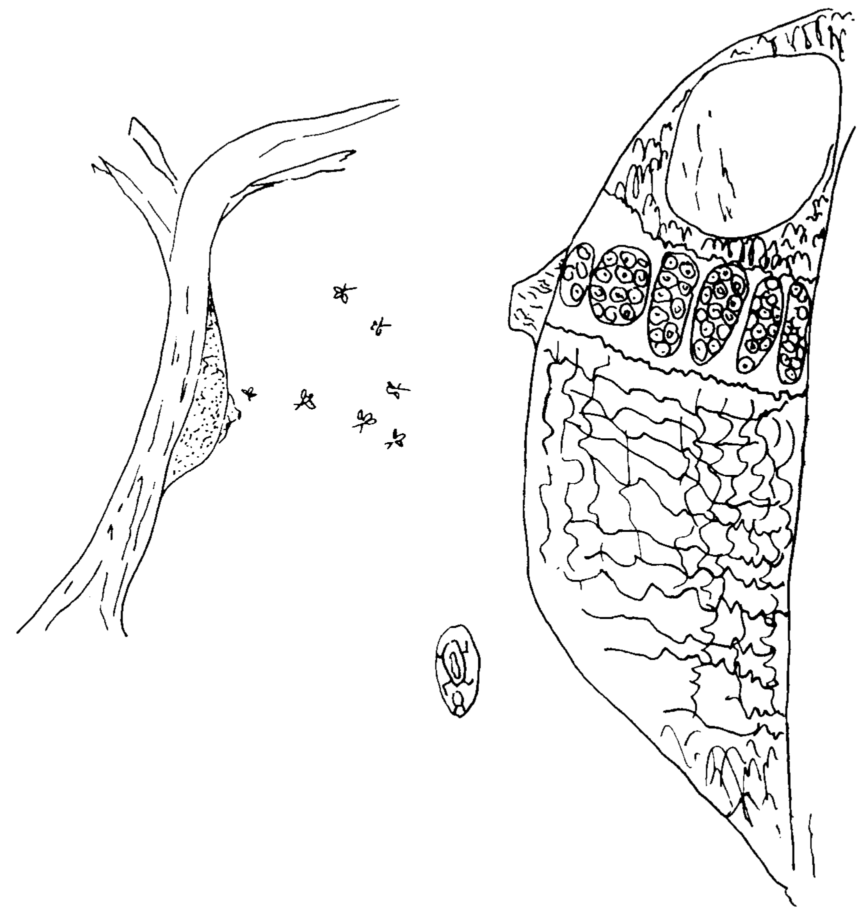

Fig. 1.—Reproduction of a drawing by Pedro Kayapó (made in Gorotire in 1979) showing the external form and internal structure of *ku-krãi-ti* (*T. amazonensis*).

nests; 2G, *puka-kam-mehn* (*Trigona recursa*) a subterranean nest-building species; 2H, *mykrwàt* (*Tegragonisca angustula*) usually found in hollow trunks of dead trees lying on the ground; 2I, *ngài kumrenx* (*Melipona rufiventris flavolineata*) found in open tree hollows, with an entrance tube hidden inside; 2J, *mehnô-djành* (*Frieseomelitta* sp.) found in hollow vines or bamboo.

A limited number of species is found in any given habitat. Certain species are habitat specific, that is, found only in savanna, or flood

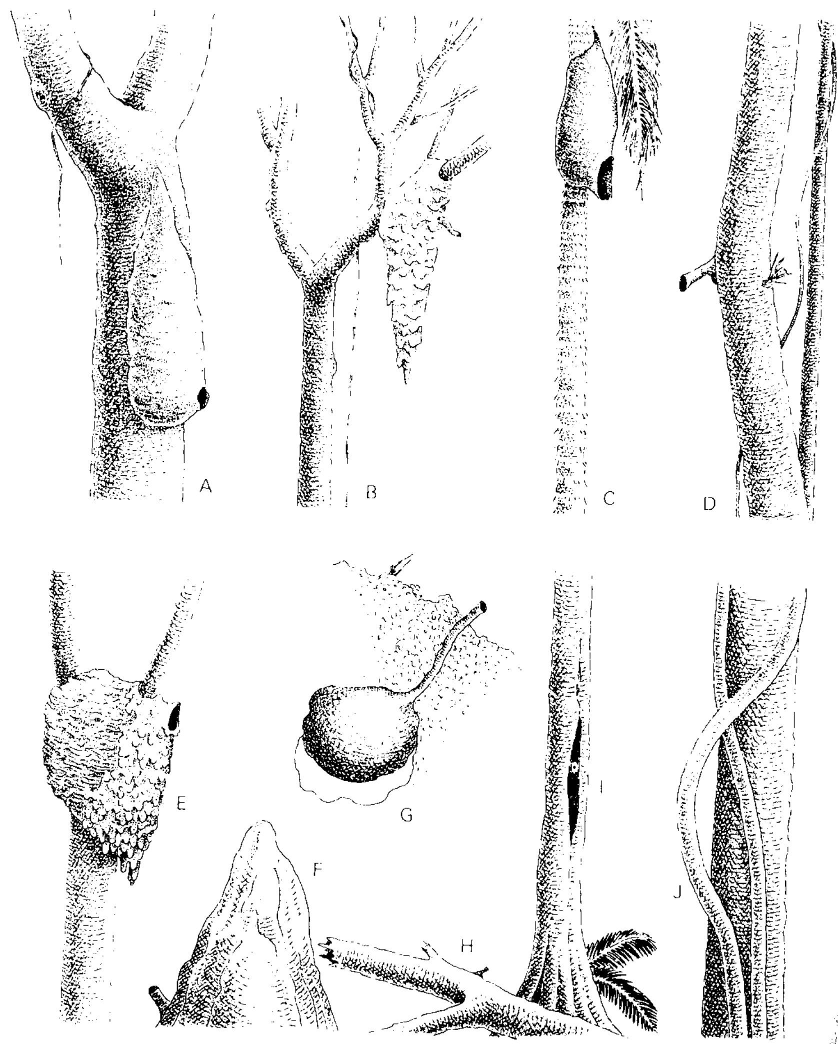

Fig. 2.—Nest types of Meliponinae focal species recognized by the Kayapó: (A) *Trigona amazonensis* (*ku-krãi-ti*); (B) *Trigona cilipes* (*me-nô-rà-kamrek*), inside termite nest; (C) *Trigona branneri* (*mehñy-tyk*); (D) *Scaptotrigona nigrohirta* (*imrê-ñy-kamrek*); (E) *Partamona* cf. *cupira* (*my-ti-re*), in termite nest; (F) *Trigona fulviventris* (*djô*); (G) *Trigona recursa* (*puka-kam-mehn*); (H) *Tetragonisca angustula* (*my-krwàt*); (I) *Melipona rufiventris flavolineata* (*ngài-kumrenx*); (J) *Frieseomelita* sp. (*mehn-nô-djành*).

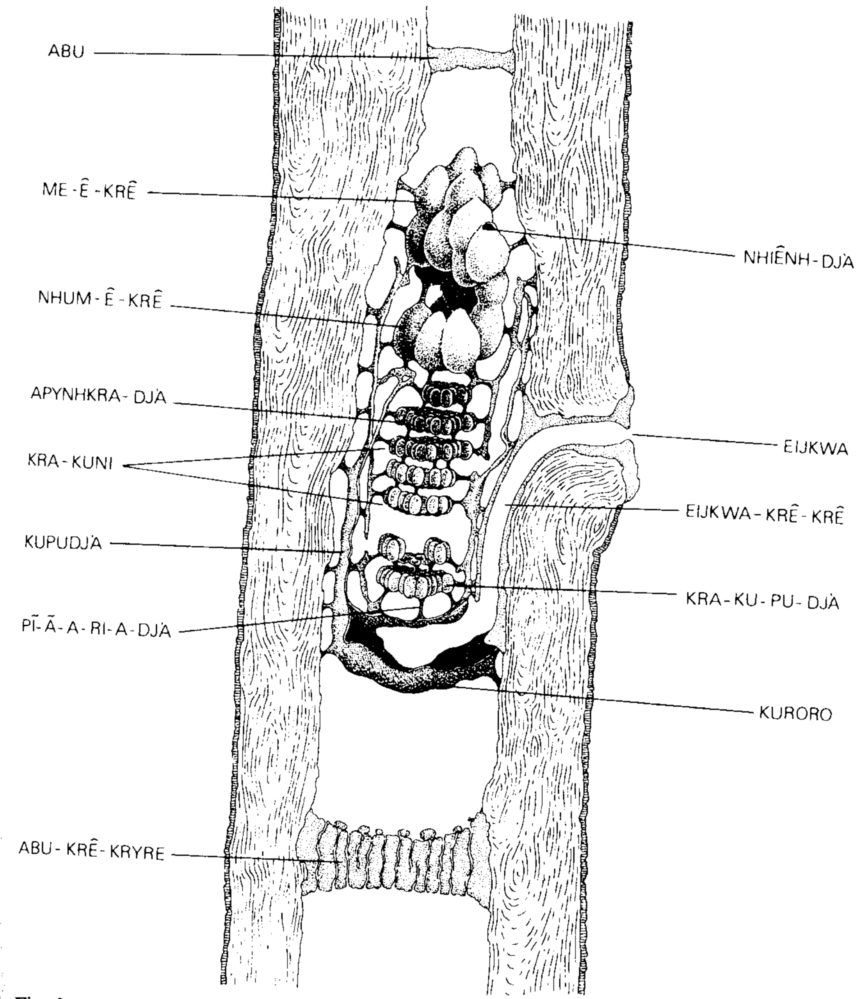

Fig. 3.—Schematic structures of *Melipona* nests with Kayapó nomenclature: *abu* (batumen), *me-ê-krê* (honey pot), *nhum-ê-krê* (pollen pot), *apynh kra-djà* (brood cell), *kra kuni* (brood comb), *kupu-djà* (involucrum), *pĩ-ã-ari-a-djà* (pillar), *abu-krê-kryre* (lower batumen with drainage channels), *nhiênh-djà* (pot opening), *eijkwa* (entrance structure), *eijkwa-krê-krê* (entrance gallery), *kra-ku-pu-djà* (cocoon), *kuroro* (shell of nest).

forest, or high forest, and so forth. Thus when an Indian enters a specific habitat, he already knows, which species might be found, thereby facilitating visual scanning for morphological nest types.

Internal nest structure—Architecture and entrance structure.—Ter-

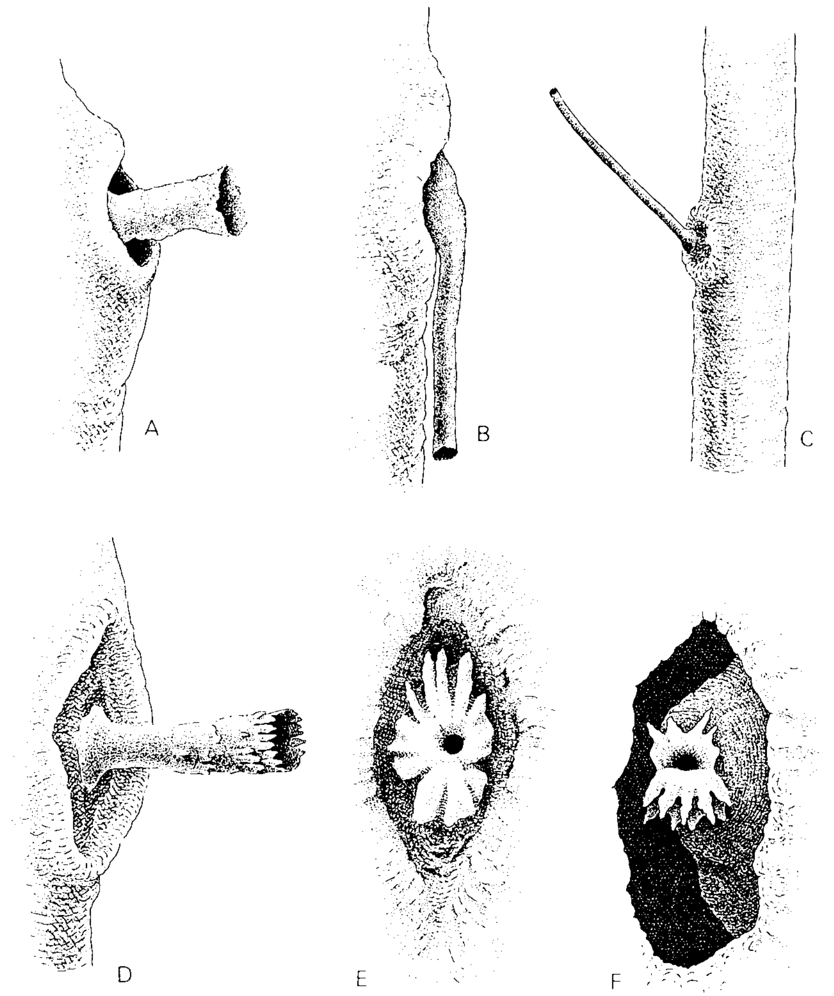

Fig. 4.—Types of Meliponinae entrance tubes recognized by the Kayapó with their respective "focal species": (A) *imrê-ñy-kamrek* (*Scaptotrigona nigrohirta*), (B) *imrê-ti* (*S. polystica*), (C) *õ-i* (*Tetragona truncata*), (D) *udjỳ* (*Melipona seminigra pernigra*), (E) *menhire-udjà* (*M. melanoventer*), (F) *ngài-kumrenx* (*M. rufiventris flavolineata*).

minology for structures of Meloponinae nests (*ũrũkwa*) is quite complete. Two types of nests, based on internal structure, are recognized by the Kayapó—nests with horizontal, parallel combs; and nests with dispersed caches of combs. The latter is represented in Fig. 1 and the former is reconstructed in Fig. 3.

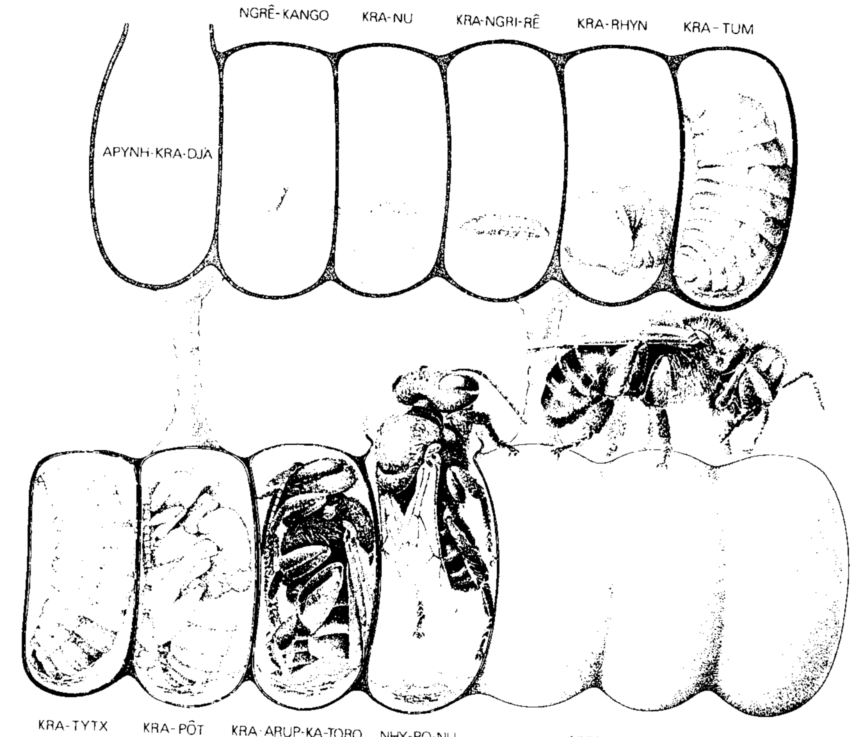

Fig. 5.—Ontogenetic stages of Meliponinae (represented in this figure by *Melipona compressipes fasciculata, ngài-re*) recognized by the Kayapó; *apynh-kra-djà* (brood cell); *ngrê-kango* (egg, egg liquid); *kra-nu* (larva of 1° instar); *kra-ngri-re* (larva of 2° instar); *kra-rhyn* (pre-defecant larva); *kra-tum* (post-defecant larva); *kra-tytx* (pre-pupa); *kra-pôt* (unpigmented pupa); *kra-arup-ka-toro* (pigmented pupa with movement); *nhy-pô-nu* (imago, emerging adult); *nhy-jaka* (newly emerged adult).

Fig. 3 shows the principal architectural structures with associated Kayapó names. A glossary of Kayapó terms and their English or scientific equivalents is found at the end of this article.

For the Indians, entrance structures (*eijkwa*) of meliponine nests are important diagnostic characters because each stingless bee species produces a specific structure. Shape, size, composition, color, position, and smell of the *eijkwa* are all characteristics used by the Indians for field identification. Fig. 4 shows the major *eijkwa* focal categories. These are covert categories, but as with nest forms, they are frequently identified by referring to the name of the focal species that typifies the category.

Onotogeny, Life Cycle, and Castes of Mehn-nhy *(Meliponinae)*

The Kayapó believe that bees, like Indians, have a life cycle associated with the social space of their villages (*kri-metx*) and houses (*ũrũkwa*). A bee's life begins in "a growing up thing" called *apynh-kra-djà* or "child sleeping place" (*kra-no-ro-djà*) (see Fig. 5). Combs are called *kra-ỳ-trỳ* and are filled with various stages of life, including the egg (*ngrê*). According to the Indians, however, bees do not have "true eggs" (*ngrê-kumrenx*) because they have no hard shell (*kà*). Instead, bee eggs are composed of a liquid deposited in the cell. This liquid is called *ngrê-kangô* (egg liquid) and becomes "new (bee) children," *kra-nu,* that in turn grow into "small children," *kra-ngri-re.* Subsequent stages of larval development are denominated by the Indians as follows: *kra-rhyn* ("round, thick children" that occupy the whole cell—known scientifically as predefecating larvae); and *kra-tum* ("old children" that stand up vertically in the cell—known scientifically as postdefecating larvae). When the shells (*kà*) of the "children" (*kra*) harden (*arup-tytx*), the bee child is thought to be fully grown and is called *kra-tytx* ("tough," or, in this context, "grown," "children"—scientifically known as prepupae). When the bee child takes on the appearance and size of an adult, it is called a *kra-pôt* ("grown child" that still cannot walk or move like an adult [*kra-pôt-ket-rã-ã*]). This is the primary pupae, just prior to eclosion. When the grown child begins to walk like an adult (*kra-arup-ka-toro*) after leaving its cell, the bee is known as *nhy-pô-nu.* Newly emerged adults are called *nhy jaka* (unpigmented or "white" bees) or *nhy rêrêk* ("weak bees"). As pigmentation begins to appear in the newly emerged adults, they are then called *nhy-ngri-re* ("small" or "callow" bees).

According to informants, adult bees have different activities and functions in the nest and are given different names. These types, based upon behavioral differences, are:

mehn akrê—"warrior bees" that defend the nest (aggressive bee species have more warriors than non-aggressive species).

mehn-ôkabin-djwynh—"scout bees" that search for food, water, or mud, as well as for new nest locations should the colony need to move or divide; these also help guard the nest and alert the "warriors" should there be any threat of danger.

mehn-ô-petx-djwynh—"worker bees" that collect pollen (*a-ũ*), nectar (*rã-kangô*), and resins (*kunõ*), as well as other materials necessary for the colony.

benadjwyrà-ratx—this is the "principal chief," who lives in the center of the comb. He is always larger than the rest and is said to eat differently than other bees (he eats pollen, *nhum,* and honey, *rã-kangô,* whereas other bees eat only honey). He is responsible for coordinating and ordering all of the activities of the colony. In times of danger, he always hides in the interior of the nest at a safe distance from the brood comb. (The *benadjwyrà ratx* corresponds to the physogastric queen known to our science.)

benadjwyrà—these are the sub-chiefs whose duty it is to transmit the orders of the principal chief. Each of these (there may be several to many depending on the size of the nest) is in charge of a group of bees made up of individuals from each of the categories (or "castes"). (These correspond to virgin queens in bee biology literature.)

benadjwyrà-pron—these are the wives of the chiefs and are in charge of the egg-laying and care of children. These bees remain close to the combs and have a slightly enlarged abdomen, thereby giving the impression that they are larger than other worker bees. (Scientifically these are known as nurse bees.)

benadjwyrâ-nhõ-kra—these are the young children of the chiefs. They receive special food and always are found in the periphery of the comb. (These are queen larvae and pupae.)

Food and Feeding

*Pollen (*a-ũ*)*—The Indians say that pollen (*a-ũ*) is collected from selected flowers (depending on bee species' preferences) and carried to the nests (*ũrũkwa*) where it is stored in special pots (*nhum-ê*). To obtain the *a-ũ,* bees rotate their back legs (*mêtê*) near the flower, sometimes having previously put resin (*kunõ*) on their legs to assist in securing the pollen grains to the body (*tê'a-ma*). The process of obtaining and carrying pollen to the hive is called *mêtê kam ami tê o wai ri.* When the *a-ũ* actually reaches the hive, it is mixed with drops of water from the bee's mouth and stored in the *nhum-ê*; the pollen now receives another name, *nhum,* signifying its transformation by the water mixture. *Nhum* is the food for larvae (*kra*) in general; a special mixture with honey (*mehn-kangô*) is used to feed the chiefs and their children. Pollen of some species is eaten by the Kayapó (Posey, 1983*f*).

*Honey (*mehn-kangô*)*—*Mehn-kangô* is formed from nectar of flowers (*pidgô-rã-kangô,* or "flower water"). It is carried by the bees in their mouths to be stored in special pots, *mehn-ê-krê.* The Indians say that honeys from different flowers have different tastes and consistencies and must be mixed by the bees to produce a uniform honey (*mehn-kangô-aben-kôt*). Watery honey is said to be new honey, not yet properly mixed. When a proper mixture is completed, the honey is said to be "ready" or "already good" (*arup-metx*) and the openings to the honey pots (*nhiênh-djà*) are closed with cerumen (*ãn-jê*). Honey is the principal food of adult bees (*mehn-nhy*). Honeys of many species are valued as human food and as medicinals; some honeys are dangerous and can cause stomach ache and diarrhea (Posey, 1983*f*). Some bee species (for example, *i-kài-kà, T. clavipes*) are said to throw out their old honey at the end of the dry season to make room for the new honey of the wet season. This honey, or any honey that is considered old or acid (fermented), is called *mehn-kangô-kaigo* ("honey that serves for nothing").

Bee Morphology

Morphological structures of bees receive names that, for the most part, are analogous to parts of the human body. Some names, however, are used specifically for insect morphology. Fig. 6 shows most of the major morphological structures named by the Kayapó. Names were given in the field when Kayapó collaborators were shown live specimens. The glossary at the end of this article gives English and/or scientific equivalents to the Kayapó names.

Family Groupings and Specific Determinations

The superordinate (suprageneric) grouping of social insects (*nhy*) and various covert (unnamed) categories with focal species based on idealized nest and entrance structure morphology have already been discussed. Data to date are not yet complete enough to fully outline the Kayapó notion of relatedness between folk species of bees. However, several groupings made by the Indians (*õmbiqwa*) can be elaborated—for example, *imrê* (corresponding to the genus *Scaptotrigona*), *kangàrà* (corresponding to the genus *Oxytrigona*), and *ngài* (various genera related in a system as yet undescribed). Family groupings and specific determinations are based on the following characteristics.

Ethological characteristics.—(a) Flight patterns (how the bees fly when entering the nest); (b) degree of aggressive behavior when the nest is disturbed (aggressive to docile); (c) sound produced by bees in flight or by nocturnal behavior inside nest; (d) places bees visit, including types of flowers, dead animals, feces, sand banks, mud, and other sites.

Nest structure and habitat niche.—(a) Substrate preferred (for example, tree hollows, ant nests, termite mounds, inside earth, large trees; in the case of tree nests, nest form and position of the entrance structure is also important); (b) preferred habitat (flood forest, humid forest, savanna); (c) form, texture, color, and size of the entrance structure; (d) material utilized to construct the entrance structure (for example, mud, resin, cerumen, vegetable fibers, excrement); and (e) form and texture of the batumen (nest cavity boundaries or covering).

Morphological and biochemical characters.—(a) Shape of the bee's body; (b) colors of the bee; (c) designs or markings on body; (d) size and color of wings; (e) size of the bee; (f) smell of the bee (either its

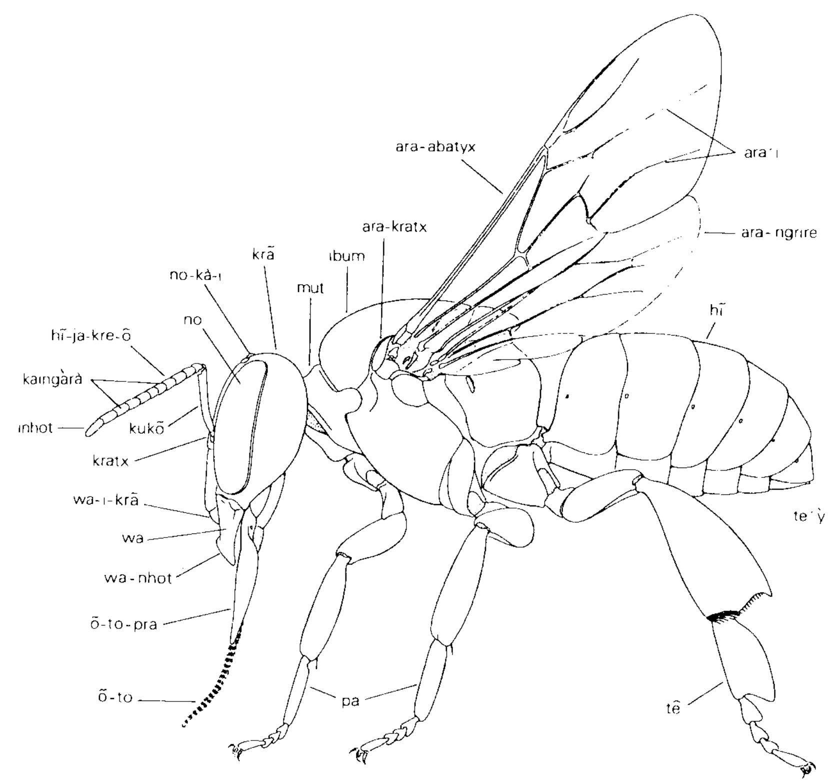

Fig. 6.—Major morphological structures recognized and named by the Kayapó: *ara-abatyx* (fore-wing), *ara-ngri-re* (small, hind wing), *ara'i* (veins), *ara-kratx* (wing joint), *krã* (head), *nô-kà-i* (simple eyes, ocelli), *nô* (compound eye), *hĩ-ja-krê-ô* (antenna), *kaingàrà* (segments of antenna), *inhot* (end point—distal), *kukõ* (base of antenna), *kratx* (joint), *wai-krã* (labrum), *wa* (mandible), *wa-nhot* (teeth of mandible), *õ-to-pra* (proboscus), *õ-to* (tongue), *mut* (prothorax), *ibum* (thorax/mesothorax), *pa* (front legs), *tê* (back legs), *hĩ* (abdomen), *tê'y* (point of abdomen).

naturally occurring smell or when the bee is crushed); (g) secretions produced for defense.

Economical factors.—(a) Quality of honey; (b) quantity of honey; (c) quality of resins; (d) quality of wax and cerumen; (e) suitability of pollen for food; (f) suitability of larvae/pupae for food.

Oxytrigona (*kangàrà*) are grouped into one family because of a liquid produced from glands in the mandibles for the purpose of protection. This liquid blisters and burns the human skin after a period of about 24 hrs, unless introduced subcutaneously, when blisters appear immediately. Texture and form of the nest entrance is also a unifying characteristic of this group, which makes long, slender slits slightly lined with cerumen, as in nest entrances. It is interesting to note, however, that *Partamona vicina* is named *kangàrà-kàk-ti* (the "big false *kangàrà*") because of its similar size and color with other *kangàrà*; it is also a very aggressive species, although it exudes no defense liquid. At the superordinate level, *Melipona* may only be grouped in covert categories, because no named groupings seem to unite the genus despite similarity in morphology. *Apis mellifera* is sometimes grouped with *Melipona* because of its size and color, although it is also frequently grouped with wasps (*amuh*) because of its sting. Other "functional" groupings include aggressiveness, as well as honey or cerumen types.

Arboreal nesting *Trigona* are always grouped together as *ku-krãi* (for example, *kukrãi-re, T. dallatorreana,* and *ku-krãi-ti, T. amazonensis*). *Scaptotrigona* (*imrê*) are grouped into the same family on the bases of similarity in honey, cerumen, and, principally, by their similar smells.

Summary of species collected.—The species described below were collected in Gorotire in 1983. They are presented with a summary of important diagnostic characteristics utilized by the Kayapó. (Note: these are some of the species most commonly mentioned by the Indians; other species can be found in Posey, 1983*g*:156). Order of characteristics is: (a) flight pattern when entering nest; (b) preferred habitat; (c) nest site; (d) smell of the bee; (e) form, texture, smell, and material utilized for entrance structure; (f) size and color of body and wings; (g) defense behavior.

Tetragona clavipes (*i-kài-kà,* "blade of knife")

a) smooth, circular flight before entering nest
b) forest where light penetrates (*bà-kamrek/bà-ràràrà*)
c) tree hollows (usually high up)
d) characteristic smell
e) large entrance tube of cerumen
f) yellow body, large wings, lightly colored
g) not aggressive (do not attack or bite); deposit resins

Observations: Throws out old honey at the end of the dry season to prepare for new, wet season honey.

Partamona cf. *cupira* (*my-ti,* "big penis")

a) rapid flight, direct entrance/exit pattern
b) savanna and forest
c) termite nests (*rorot, Nasutitermes*)
d) smell not distinctive
e) earth and resins

f) black body, white wings
g) very aggressive (bites and attacks)

Observations: Quantity of honey small, but very important for medicine.

Melipona seminigra pernigra (*udjỳ,* "witchcraft")

a) no information (not discussed by the Indians)
b) high forest (*bà-tyk*)
c) hollows of big trees
d) no information
e) entrance tube long, made of mud and resins
f) big bee with black thorax (*ibum-tyk*)
g) not aggressive

Observations: This is a "semi-domesticated" species that returns to the nest when a portion of the brood comb with honey and pollen pots are left in the old hive; this bee is also kept near the house simply to observe as a curiosity; honey is good year-round; bees are used in witchcraft.

Trigona amazonensis (*ku-krãi-ti,* "like a mountain ridge")

a) no information
b) high forest and mountains (*krãi*)
c) attached externally to tall trees and large rocks
d) no information
e) large lower structure made of same material as nest cover
f) large black body, clear wings
g) very aggressive (attacks and bites)

Observations: Honey of large quantity and good taste, taken mostly in the dry season; bees are crushed and mixed with *urucú* (*py*) to paint dogs so they will be aggressive (*akrê*) and have no fear of hunting. Fire, smoke, and *kangàrà-kanê* (see following section) used to extract honey and wax. Honey pots are placed over banana leaves and mashed to release honey. Larvae and pupae are crushed and rubbed on hunting dogs to make them strong (*tytx*).

Scaptotrigona nigrohirta (*imrê-ṇhy-kamrek,* "red imrê"—a Kayapó proper name)

a) no information
b) várzea forest (*imô*) and light-penetrating forest
c) hollows of medium to large trees
d) distinctive smell
e) tube of yellow cerumen when new; turns dark when old

f) yellow body, white wings
g) very aggressive (attacks and bites); attacks other bees by biting their wings

Observations: Honey good all year; combs with larvae are utilized for food and said to taste like "cookies;" pollen also eaten, but only if yellow, which indicates it is sweet; it is believed that this bee has more than one principal chief (*benadjwyrà-ratx*); cerumen is used to make the ceremonial hat, *mẽ-kutôm*. Method of bee's aggressiveness, attacking others by breaking their wings, may be related to Kayapó idea of *aben-tak* (traditional ceremonial sword fight aimed at breaking long bones of arm); only descendants of chiefs said to receive the proper name of *imrê*.

Scaptotrigona polystica (*imrê-ti*, "big *imrê*"—a family of bees and Kayapó ceremonial name)

a) no information
b) várzea forest (*imô*)
c) hollows of medium to large trees
d) characteristic smell
e) long, tough black entrance tube, pointed downward next to the trunk
f) black body, clear wings
g) not aggressive (*wajabôre*)

Observations: Large amounts of honey taken in dry season; lesser amounts of honey taken in wet season; cerumen used to attach feathers and coat cotton thread, as well as to make *mẽ-kutôm*; for other qualities, see *imrê-nhy-kamrek*.

Melipona melanoventer (*menire-udjà*, "vagina")

a) no information
b) várzea forest (*imô*)
c) hollows of medium to large trees
d) no information
e) shaped like a vagina; made of earth and clay; opening for one bee only
f) thorax (*ibum*) yellow
g) not aggressive

Observations: Produce a very distinctive noise at night that helps to locate and identify the bee; both honey and pollen are eaten; one of the "semi-domesticated" species.

Melipona rufiventris flavolineata (*ngài-kumrenx*, "true *ngài*," a family of bees)

a) direct flight when entering
b) light-penetrating forest (*bà-ràràrà/bà-kamrek*)
c) tree hollows close to the ground (always less than one meter), frequently in dead tree trunks
d) strong smell; easily detectable when colony is swarming (*abem-o-watõ*); odor trail of swarm followed by Indians to locate new bee colony
e) mud (*ngỳ*) and bark fibers (*piã-õm*); hidden inside tree hollow
f) yellow body
g) not aggressive

Observations: Honey very sweet and taken all year; "semi-domesticated" in village and old gardens (*puru-tum*, *ibê-tum*); distinctive sound at night used to locate hive; bees followed from sides of rivers and igrapés when collecting water, mud, and other materials.

Tetragona dorsalis (*tôtn mỳre*, "penis of armadillo")

a) circular, smooth flight before backing off to enter in a direct flight
b) high forest (*bà-tyk*)
c) hollows of trees
d) distinct smell from resins carried by bees
e) small entrance tube of resin; strong smell from resin; shaped like penis of armadillo
f) yellow body, white wings
g) not aggressive

Observations: Honey good all year; bees produce distinct noise when swarming; odor trails of swarm followed by Indians to locate new nest; when new nest is located, Indians wait five to ten years before opening to take honey; division of nest by bees occurs only in wet season; smoke from strong-smelling resins (collected by bees) used to purify houses and body to expel spirits and sickness; resins burned as incense; cerumen and batumen also burned and smoke inhaled to cure "dizziness" or "craziness" (*eijbam*). Nest located in forest by listening for call of a bird (*tô-wa-pê-tê*, *Hypocnemis* cf. *candator*) known to prey upon adult bees near nests.

Tetragonisca angustula angustula (*my-krwàt*, "ridged long penis")

a) slow flight, circles, then retreats before entering in direct flight pattern
b) wide-spread, prefers light-penetrating forest
c) hollows of dead trees lying on ground
d) no information
e) thin tube of yellow cerumen

f) small, yellow
g) not aggressive (*wajabore*)

Observations: Honey highly appreciated and taken all year; larvae and pollen eaten; sound of colony at night not loud, but distinctive; bees caught in rain hide under leaves for protection; if they cannot return to hive at night they die; worker bees fly in straight lines from resources to nest and can be followed to find nest; "semi-domesticated" near houses and old gardens; resin used to attach arrow points.

Trigona fulviventris (*djô,* significance of name unknown)

a) no information
b) margin of forest (*bà-kôt*) and savanna (*kapôt*)
c) subterranean, often in termite nests (*rorot*)
d) no information
e) black tube with pieces of bark fiber
f) black
g) not aggressive

Observations: Honey taken all year, but of small amount; wax used for artifacts and to produce medicinal smoke.

Collection, Exploitation, and Social Significance of Meliponinae

Honey, cerumen, and other products associated with Meliponinae are important economic elements in Kayapó society (Posey, 1983*e*, 1983*f*). One of the principal reasons men give for going to hunt is to procure honey.

Bee specialists in Gorotire are all shamans (*wayanga*), which is not surprising because it was the ancient shamans who conceived of the "natural model" for Kayapó social organization based upon social Hymenoptera studies (Posey, 1981, 1983*d*). One of the shamans' secrets of finding bees is to walk at night listening for the distinctive sounds of colonies ventilating their nests. Most Indians are afraid to leave the village at night for fear of spirits (*karon*); shamans, however, do not fear *karon.* They mentally mark, spacially and temporally, the nests heard at night, then return in the day to observe the colonies. Of the colonies described in this paper (see preceding section), seven were located during night hunting trips. Indians also locate nests by observing flight patterns of bees returning from collection visits at river and stream margins. Indians have been observed (by Posey) running quickly behind a bee to locate its colony. Trails of odor (*mehn-nhy-pry*) of bee swarms are followed as though they were trails of game, such as wild pig or tapir. Bees are believed to always fly upwind toward their nest

when leaving a food or water source. An Indian may observe for hours the flight patterns and activities of bees near flowers or margins of water.

Presence of a bee's nest, once found by a Kayapó individual, is generally announced in some public place (the men's house, *ngà,* or river landing, *ngô kà*) so as to advise others of its discovery and intent by the finder to exploit the colony at some future time. This is done by describing the nest's habitat and geographical location, as well as identifying the bee itself. The finder then has usufruct rights to the colony. If another person raids the claimed colony, misunderstanding and anger can result. Tirades against poachers are sometimes heard in the men's house. Usufruct claims are strongest when bee colonies are located in the old gardens (*puru-tum* and *ibê-tum*) of the finder.

A variety of technologies is used to exploit colonies depending on the nest site, habitat, and aggressiveness of the species. Nests of non-aggressive species (*wajabôre*) are simply opened with axes when the tree is not too large nor the nest too high. With large trees or extremely high nests, the Indians build a special platform with ladders to get to the colony. This platform can be quite elaborate, with several stages, all carefully constructed from poles tied together with vines. In large trees or trees of very hard wood, holes are opened only large enough to insert the hand and arm to pull out the brood and honey pots. Nests high in trees of less than one meter circumference are taken by cutting down the tree. The opening in the forest produced by the fallen tree (*bà-krê-ti*) is later utilized for planting medicinal and food plants (see Posey, 1983*a*, 1983*b*, 1984*b*). These forest openings also attract game and birds for hunting. Thus exploitation of bees figures prominently into the overall system of forest management practiced by the Kayapó and leads to the diversification of floral and faunal species that occur in the forest (Posey, 1984*b*).

Aggressive bees (*akrê,* such as *T. amazonensis, Oxytrigona tataira,* and *Apis mellifera,* are taken with fire and smoke. Dry leaves of palms and wild banana are attached to long limbs and are set on fire. The burning, smoking mass is held near the entrance of the nest to expel the bees. Sometimes trees are then felled and fires built near the opening of the nest.

Another effective method of expelling aggressive bees is to put the shaving of a highly toxic vine called *kangàrà-kanê* (*Tanaecium nocturnum*) into the nest opening (Kerr and Posey, 1985). In a short time (1 to 4 min) the volatile components of the vine stun or kill enough bees so that the nest can be safely opened. Leaves of the same plant are chewed and the saliva–plant mixture passed over the body to prevent stings or bites from the bees. Although we were unable to confirm this, the Indians state that the use of *kangàrà-kanê* is only to stun the bees, not to kill the colony; thus it is left in the colony for only a short time.

We had the opportunity to observe the use of *kangàrà-kanê* by *Kwyrà-kà* with *M. rufiventris flavolineata.* After a small ball (10 cm diameter) of the shaving was put into the opened nest, bees began to die in only 1½ min. Within 4 min the entire colony was dispersed or dead.

Nests of some species, including *M. seminigra pernigra, M. melanoventer, M. rufiventris flavolineata, Scaptotrigona nigrohirta,* and *S. polysticta,* are exploited year after year in the fields and forests. This is possible because after opening the colonies and taking a portion of its contents, parts of the brood comb, honey, pollen, and cerumen are returned to the nest. The Kayapó say this is to keep *Bepkôrôrôti* happy. *Bepkôrôrôti* is the spirit of an ancient shaman who becomes angry if food is not shared (he has a particular penchant for honey) and will send lightning and thunder to destroy those who are greedy (see Posey, 1983*f*:65). Thus, *Bepkôrôrôti* not only functions to encourage sharing in the tribe, but he also becomes the protector of bees and insures the preservation of bee colonies.

Nests of other species, for example, *T. angustula, T. dallatorreana,* and *T. cilipes,* are taken to the village in their natural substrates or put into special baskets called *kangri* (made of banana and wild banana leaves). We observed one colony of *T. angustula* being carried to the house of *Kwyrà-kà* in a *kangri* to be "kept" (*õ-krit*) in a cool, dark place in his house in Gorotire. "Semi-domesticated" bees that form the list of *õ-krit* species are found in Table 2.

General Observations and Notes

The Indians recognize many ecological relationships between bees and other ecosystem components. Plants that produce flowers that attract bees are left to grow, or are even planted, in gardens and alongside forest trails. The Kayapó say that when there are many bees, there are abundant crops. The relationship between bees and crop production, as well as the folk concept of pollination, is yet to be studied in detail.

Relationships of bees with other animals are also recognized. For example, *T. chanchamayonensis* is known to frequently nest with an ant called *mrum-gogo* (still unidentified); *T. cilipes* likes to nest with another ant called *mrum-kudjà* (*Azteca* sp.). Certain bees are also frequently found cohabiting in the same tree or nest site, including *S. polystica, T. clavipes, S. nigrohirta, S. favisetis,* and *T. truncata.* Other bee species are always found alone, such as *M. compressipes fasciculata, M. rufiventris flavolineata*; *T. angustula, M. seminigra pernigra,* and

Table 2.—*Bee species semi-domesticated by the Kayapó Indians.*

Kayapó name	Scientific name
imrê-ti	*Scaptotrigona polystica* (Moure)
imrê-ñy-kamrek	*Scaptotrigona nigrohirta* Moure Ms.
ku-krãi-re	*Trigona dallatorreana* (Friese)
mehnô-rã-kamrek	*Trigona cilipes pellucida* (Ckll.)
mehnô-rã-tyk	*Scaura longula* (Lep.)
menhire-ujdà	*Melipona melanoventer* Schwarz
*my-krwàt	*Tetragonisca angustula angustula* Latreille
ngài-kumrenx	*Melipona rufiventris flavolineata* Friese
ngài-pêrê'ỳ	*Apis mellifera* Linn.
ngài re	*Melipona compressipes* cf. *fasciculata* (Smith)
*udjy	*Melipona seminigra pernigra* Moure and Kerr

* These names represent revision (corrections) in names used in previous publications (that is, Posey, 1983*e*: Table 3; and Posey, 1983*f*: Table 2).

M. melanoventer. Two wasps are known to be predators of bees; these are *amuh-kamrô-tyk* and *kukryt-anhoroti* (identifications not yet made). Certain bees of the *imrê* family (*Lestrimelitta limão* Prov.) are known by the Indians to rob honey, pollen, and other nest materials from other colonies. Some species of *Scaptotrigona* are likewise known to pillage nests of other bees. A bumblebee, *kungont* (*Bombus transversalis*), is famous as a robber of pollen (Weaver, 1978). The mammal called *krok-krok-ti* (*irará, Eira barbara*) is despised because it destroys the nests of the semi-domesticated species when searching for its favorite food, honey. The small bird *tõ-wa-pêtê* (*Hypocmenis* cf. *cantator*) helps the Indians locate bee hives because it sings when successful in its attack on adult bees.

Another interesting phenomenon observed by the Indians is the coexistence of commensal acarines inside the bee colonies. These acarines are called *nhure* and are believed to be the property of the bees—each bee has its own *nhure* that it raises (*õ-krit*) just as Indians raise dogs. The *nhure* are said to eat the trash left by the bees (*mehnõ-ja'um*) just as village dogs clean up after the Indians.

In relation to the Africanized honey bee (*Apis mellifera,* generally known as the "Brazilian bee"), the Kayapó are keenly aware of its presence and effect in the region. They say that this bee (*ngài-pêrê'y*) arrived during the full moon in February 1966. The Indians report that this bee began to attack and pillage (*ỳr-wai-djà*) the nests of Meliponinae. Likewise, the *ngài-pêrê-y* are so aggressive as to attack other bees at flowers, particularly the flowers of *inajá* (*Maximiliana regia*), as well as at water sources near the margins of rivers and streams. Bees that are particularly vulnerable to *Apis mellifera* are *imrê-ti* (*S. polys-*

tica), *imrê-nhy-kamrek* (*S. nigrohirta*), *udjy* (*M. seminigra pernigra*), *tôtn-my* (*T. dorsalis*), *my-krwàt* (*T. angustula*), among others. Currently the aggressiveness of the *ngài-pêrê-y* is said to have diminished, thereby allowing the native bees to peacefully gather pollen and nectar and therefore to produce more honey. The Kayapó do not like the *Apis* honey as well as that of the Meliponinae. *Apis* honey is usually traded or sold, whereas meliponine honey is kept for local consumption.

Discussion

The purpose of this study is not to compare indigenous knowledge of Meliponinae with that of Western science, but to report indigenous knowledge to aid our search for new ideas about stingless bees and bee behavior. To this end, we feel our work, although only in its beginning phases in relationship to the complexity and sophistication of Kayapó knowledge, has helped to define some important and interesting areas for further biological research.

Characteristics used in Kayapó meliponine taxonomy are indeed similar to that of Western science, although the reliance upon chemical qualities (odors) of species needs to be further investigated. Likewise, bee behavioral groups recognized by the Indians (*mehn-akrê, mehn-ôkabin-djwynh, mehn-ô-petx-djwynh*) could represent actual divisions of labor in addition to those currently accounted for by age variations (see Kerr and Neto, 1953; Hebling et al., 1964; Bassindale, 1955; Sakagami, 1982; Wille, 1983).

Research to date documents communication by odor trails only for Trigonini, whereas in *Melipona* sound is thought to be the principal means of communication (Lindauer and Kerr, 1960; Lindauer, 1967; Esch et al., 1965; Kerr and Fales, 1981; Kerr, 1960; Kerr et al., 1963). The Kayapó, however, insist that other bees have trails of odor as well, including *M. rufiventris flavolineata*, which has an especially distinctive odor during swarming. Is there a chemical component in communication and orientation of *Melipona*?

Acarine mites that live with Meliponinae are little studied until now (Flechtmann and Camargo, 1974; Rosa and Flechtmann, 1983; Delfinado-Baker et al., 1983) and are considered commensal. The Indians, however, believe the species to be symbiotic. Can Indian knowledge give insights into this little-known subject?

Ecological zones and microzones preferred by specific species of Meliponinae is one of the specialities of the Kayapó, but these have not been systematically studied. However, factors affecting the tendency of certain species to share or not share habitats, as observed by the Indians, is of significance to ecological research (Roubik, 1979*a*, 1979*b*, 1983).

Impact of the invasion of the Africanized *Apis mellifera* into new ecological zones is also little known (Roubik, 1979*b*, 1980, 1981, 1983), yet it has been carefully observed by the Kayapó and deserves further study.

Another important subject that must be considered in future research is to what extent the Kayapó knowledge of biology is reflected in their social and cultural systems. Are their beliefs about social bee behavior (including social division of labor, moving of colonies, aggressiveness and attacks, pillaging, defense, differential food distribution, and other behavior) really only anthropomorphic explications of observed biological phenomena? Or, as the Kayapó insist, were these social and cultural patterns really intentionally developed based upon ideas and knowledge by an ancient shaman of social insect behavior? Was Kayapó society created upon an intentional "natural model" or is it simply explained by a "natural reality?" These are questions rarely raised by anthropologists or biologists, but should no longer be avoided.

Concluding Remarks

This and other published works on Kayapó knowledge of meliponines represent still only superficial treatment of a much larger and more complex body of indigenous information about stingless bees. Further investigation of this knowledge will have to proceed with care and perseverance to "discover" the more intricate aspects of Kayapó folk science. Frequently the most interesting and revealing cognitive structures and their logical constructions lie submerged in the nonverbal realm of indigenous thought. The noted bee expert of the Gorotire-Kayapó, Kwyrà kà, for example, was able to quickly and accurately separate for us numerous closely related *Trigona* species, but was unable to verbalize the reasons for such decisions. This is because his knowledge of nature comes from silently observing, rather than verbally analyzing. Observations are registered in a gestalt manner along with a myriad of information regarding niche, habitat, ecological zone, geographic coordinates, and associated elements of the same ecosystem.

Non-literate societies depend upon symbols transmitted orally for the dissemination of knowledge. Myth, therefore, functions as a compact vehicle for the transmission of ecological concepts (Posey 1983*b*). To understand myth and what it really communicates to the people who understand its symbols, the scientist must understand the symbolic language that generates and interprets the secrets of oral tradition. Until this is done, the ethnobiologist can never evaluate the validity of indigenous ideas about nature. Judgements of ideas as being "absurd," "impossible," "mere superstition," or just "quaint, with no true scientific value," must be purged from the self-proclaimed superiority of ethnocentric western science. In the true spirit of scientific inquiry, however, hypotheses can be generated, stimulated by indigenous ideas, and subsequently tested with proper scientific rigor. In this manner, ethnobiological research offers an unequalled philosophy and methodology for the enrichment and advancement of a world science.

One of the most valuable results of the investigation of Kayapó knowledge of meliponines is the understanding of how stingless bees are seen by the Indians as an integral part of a complex natural system. Clearings produced by trees felled to take honey, for example, serve as garden openings where medicinal and edible plants are planted and transplanted. Fruit trees and leafy vegetation also provide food for wildlife, with some species actually planted by the Indians to attract desirable game animals (Posey 1985). Thus management of bees is part of an overall strategy for the conservation and exploitation of secondary forest.

It is precisely this type of integrated knowledge, based upon intricacies of indigenous science, that offers many new ideas for those persons and institutions interested in long-term, ecologically and socially sound plans for development and conservation in the humid tropics (Parker et al., 1983; Posey et al., 1984). Thus specific studies such as this one on Kayapó knowledge of meliponines represent only initial stages of a truly comprehensive model of ethnobiological research. It is our hope that these notes will help to stimulate other ethnobiological studies that will, in turn, expedite the creation of the larger model, founded upon respect for other scientific systems and the urgency of their systematic study.

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GLOSSARY

English meaning of Kayapó Indian words.

Kayapó	*English*
abem-o-watõ	bee swarm
abu	batumen
abu-krê-kryre	lower batumen (with drainage channels)
akrê	aggressive
ãn-jê	close cell with wax
apynh-kra-djà	cell
ara-abatyx	large wing
ara'i	wing vein
ara-kratx	wing joint
ara ngri-re	small wing
arup-metx	good/ready honey
arup-tytx	already hard (pupae)
a-ũ	pollen
bà-kamrek	open forest
bà-kôt	forest margin
bà-krè ti	forest opening
bà-ràràrà	closed forest
bà-tyk	high forest
benadjwyrà	chief
benadjwyrà-nhõ-kra	chief's child
benadjwyrà-pron	chief's wife
benadjwyrà-ratx	principal chief
eijkwa	mouth/entrance
eijkwa-krê-krê	entrance gallery
hĩ	abdomen
hĩ-ja-krê-ô	antenna
ibê-tum	old field
ibum	thorax
imô	varzca forest
inhot	distal
kà	shell
kaingàrà	segments
kangàrà-kanê	"bee medicine"; medicinal vine
kangri	bee basket
kapôt	savanna
krã	head
kra-arup-ka-toro	pigmented pupae
kra-kuni	brood comb
kra-ku-pu-djà	cocoon

kra-ngri-re	2nd instar larvae
kra-no-ro-djà	brood chamber
kra-nu	1st instar larvae
kra-pôt	unpigmented pupae
kra-pôt ket rã'ã	still pupae
kra-rhyn	pre-defecating larvae
kra-tum	post-defecating larvae
kratx	joint
kra-tytx	prepupae
kra-ỳ-trỳ	comb
kri-metx	village
kukõ	base of antenna
kunõ	resin
kupu-djà	involucrum
kuroro	shell of nest
me-ê-krê	honey pot
mehn-akrê	warrior bees
mehn-ê-krê	honey storage pot
mehn-kangô-kaigo	fermented/spoiled honey
mehn-nhy-pry	bee odor trail
mehnõ-ja'um	bee trash
mehn-ô-kabin-djwynh	scout bee
mehn-ô-petx-djwynh	worker bee
mẽ-kutôm	beeswax hat
mêtê	rotate leg
mêtê kam ami tê o wai ri	put resin on leg to carry pollen
mut	prothorax
ngà	warrior's house
ngrê	egg
ngrê-kango	egg liquid
ngỳ	mud
nhiênh-djà	opening to pot; pot opening
nhum	stored pollen
nhum-ê	pollen pot
nhum-ê-krê	empty pollen pot
nhy (ñy)	social insects
nhy-jaka	newly emerged adult
nhy-ngrire	small adult
nhy-pônu	emerging adult
nhy-rêrêk	young, weak adult
no	eye (compound)
no-kà-i	ocelli (simple eye)
õ-krit	animal being raised
õ-to	tongue
õ-to-pra	tongue cover
pa	arm
pĩ-ã-ari-a-djà	pillar
piã-õm	plant fiber
pidjo-rã-kangô	nectar
[illegible]ĩ-tum	dead trunk
[illegible]y	anchiote, urucu
[illegible]ã-kangô	nectar
[illegible]y	long, thin
[illegible]	foot

tê'a-ma	affix pollen to leg
te'ỹ	end of abdomen
ũrũkwa	house
wa	mandible
wai-krã	labrium (labrum)
wajabore	non-aggressive
wa-nhot	teeth of mandible
wayanga	shaman
ỳr-wai-djà	invasion

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PELVIC MYOLOGY OF THE KINGBIRDS AND THEIR ALLIES (AVES: TYRANNIDAE)

MARY C. MCKITRICK[1,2]

ABSTRACT

The hindlimb muscles were studied in 43 species of tyrant flycatchers (Tyrannidae), of which 26 are in the monophyletic kingbird group. Series of up to 15 individuals of certain species were dissected. The study (1) provides the first comprehensive descriptions of hindlimb myology for New World suboscines; (2) tests Raikow's (1982) hypotheses about several passeriform synapomorphies; (3) examines the assumption that intraspecific variation in hindlimb muscles is sufficiently low as to have no impact on phylogenetic studies, and (4) assesses the value of the hindlimb musculature as a source of data for generating phylogenetic hypotheses for the Tyrannidae, particularly the kingbirds. Raikow's (1982) myological synapomorphies are confirmed for the Tyrannidae, but the assumption that individual variation is low is rejected for this group. The results show remarkable uniformity for most muscles within and among species, but the patterns of variation in several flexors are irregular and suggestive of multiple origin and loss within tyrannids, as well as atavistic reappearance in some cases. This may be atypical among birds, and dissection of even larger series of individuals would help to elucidate this issue.

INTRODUCTION

The present research was undertaken for four reasons. The most general of these was to address the need for comprehensive descriptions

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