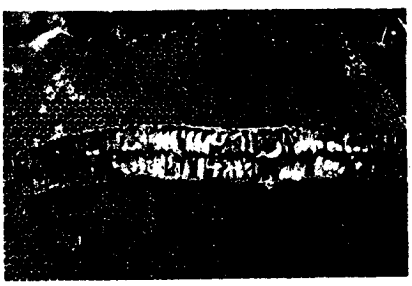
In Thailand, consuming insects as food excites almost none of the squeamishness so prevalent in America. Similar in nutritional content to "standard" fare such as chicken, shrimp, and pork, insects in general and honey bees in particular form an important part of the diets of much of the Thai population. Though consumption of insects differs according to income level and geographical location, insects and insect-related items appear widely in the country, showing up from rural markets to four-star restaurants.

Honey Bees and Other Edible Insects Used as Human Food in Thailand



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THAI PEOPLE, ESPECIALLY THOSE FROM NORTHern and northeastern Thailand, have a long cultural history of eating insects. Though human consumption of insects is common throughout the world, the northern and northeastern ethnic groups in Thailand are remarkable for their large-scale consumption of brood of honey bees (*Apis* spp., Apidae) (Sangpradub 1982, Gullan and Cranston 1994) and the variety of insects they include in their diet. Honey bees are extremely popular; so are *Patanga succincta* L. (Acrididae), called Bombay locusts in Thailand; scarab beetles (Scarabaeidae); and giant water bugs (*Lethocerus indicus* Lepeletier and Serville, Belostomatidae). Other insects, such as mole crickets (*Gryllotalpa africana* Palisot de Beauvois, Gryllotalpidae) and mantises (*Sinensisa* sp., Mantidae), are eaten less often (Vraasvapatib et al. 1975, Leksawasdi and Jirada 1983). Vraasvapatib et al. (1975) listed 50 insect spe-

cies eaten by the northeastern Thai people. Leksawasdi and Jiŕada (1983) identified 96 insect species that are eaten, at least occasionally, in northern Thailand. However, they confirmed that bees and wasps are the most important of the insect foods of northern Thailand. Insects generally comprise 80% of the edible invertebrates in northeastern Thailand (Sangpradub 1982); other edible invertebrates include snails, crabs, shrimp, centipedes, and millipedes.

We conducted a general survey of the insect-eating habits of the Thai people, especially inhabitants of northern and northeastern Thailand. Through interviews and observations, we attempted to determine the current status of the nutrition, sociology, marketing, and gastronomy of eating insects.

Nutrition

Most likely, the largest volume of animal protein consumed by all carnivores in the world's terrestrial ecosystems is from insects. Many insects have high nutritional value, including those found in the diets of Thai people (Niijima et al. 1986, Defoliart 1989, 1995). Where data are available, the nutritional value of insects compares favorably with other animals (Table 1). Honey bee larvae are a richer source of protein than pork and are similar in vitamin and mineral content to chicken and shrimp. The high nutritional values of insects compared to common animal protein sources may stem in part from the use of most of the animal as food (Gullan & Cranston 1994). Values for pork, shrimp, and other common animal protein sources are derived from an analysis of meat only rather than from the whole animal.

Table 1. Recommended dietary allowances (RDA) for average males 25 yr and older and the nutritional analyses for 100 g of three insects and three common sources of dietary protein

	RDA[a]	Honey bee[b]	Cavorting emperor moth[c]	African palm weevil[d]	Pork[e]	Chicken[f]	Shrimp[g]
Energy, kcal	2,900	—	370.50	561.00	318.85	138.46	92.38
Protein, g	63	15.21	28.23	6.69	12.09	15.24	7.99
Lipid, g	—	19.80	—	—	21.84	4.14	0.62
Calcium, mg	800	0.50	0.35	0.19	7.02	8.88	39.56
Sodium, mg	—	4.40	—	—	45.24	61.05	62.78
Potassium, mg	—	83.10	—	—	202.80	265.66	114.38
Phosphorus, mg	800	—	0.70	0.31	137.28	148.00	96.32
Magnesium, mg	350	26.80	54.00	30.00	—	27.38	28.81
Iron, mg	10	1.89	35.50	13.10	1.79	1.33	0.76
Copper, mg	—	0.04	2.40	1.40	—	0.22	0.10
Zinc, mg	15	1.05	22.99	23.70	—	0.63	0.99
Thiamine, mg	1.5	0.02	3.67	3.02	0.51	0.06	0.02
Riboflavin, mg	1.7	0.20	1.91	2.24	0.62	0.37	0.36
Niacin, mg	19	—	5.20	7.78	2.89	5.03	1.04

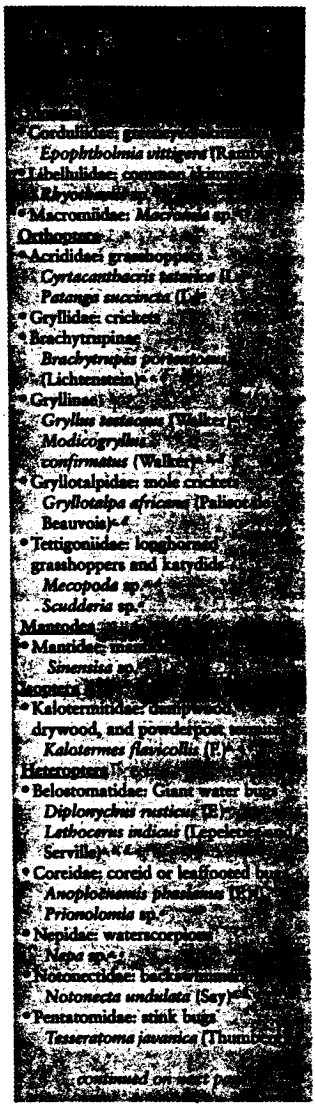
[a] National Research Council (1989).
[b] *Apis mellifera* L. larvae, Hymenoptera (Niijima et al. 1986).
[c] *Usta terpsichore* Massen & Weymer, Lepidoptera (Gullan and Cranston 1994, DeFoliart 1989).
[d] *Rhynchophorus phoenicis* F., Coleoptera (Gullan and Cranston 1994, DeFoliart 1989).
[e] *Sus domesticus* L. (Anonymous 1981).
[f] *Gallus domesticus* L. (Anonymous 1981).
[g] *Crangon crangon* L. (Anonymous 1981).

Sociology

Thais generally eat more kinds of insects and more insects per capita than do peoples of other countries (Sangpradub 1982). Within Thailand, individuals living in the north and northeast consume more insects than those in the south (Sangpradub 1982) (see sidebar). Historically, insects generally were eaten only by poor people; in fact, insects still serve as food for the poor today (Sangpradub 1982). Also, eating insects was more common among people living in rural areas than among those in urban areas and still is common in rural areas today (Vraasvapatib et al. 1975).

Within the past 40 years, Thailand has shifted from an almost exclusively agricultural economy to a mixed economy with a strong industrial sector supported by large urban populations and a large, well-educated work force. Urban and educated people are less likely to eat insects. In our experience, even entomologists—although many agree in taste tests that bees and other insects are delicious—are reluctant to eat them. This reluctance probably stems from historical notions that insects are a food of the poor and from exposure to cosmopolitan culture that includes a learned bias against eating insects.

There are some indications that this cultural trend is changing. Recently, the Oriental Hotel in Bangkok, one of the world's finest and most expensive hotels and home to an internationally highly regarded culinary academy, held a "Festival of Honey Food Day." For that festival, the hotel featured the menu item "Larvae of Honey Bee Queens." We learned that some of these dishes now are offered in many of the finer restaurants in Bangkok and Chiang Mai in northern Thailand. Honey bees often are featured in restaurants serving the affluent residents of these urban areas. In response to this trend, some beekeeping companies [•(e.g., Queen Living Products, Bee King (Thailand), and Thai Lanna Apiculture] now are making a



product of dried bee larvae powder just as they make dried royal jelly.

There are signs that the west is also experimenting with the idea of using insects as food. A restaurant in Washington, DC, The Insect Club, features many dishes predominantly composed of insects (Anon. 1993). Its source of insects is a company that raises them for consumption. Perhaps such experiments will lead one day to more widespread consumption of insects in the west.

Other insect products are found that may be classified as luxury food items. Stands selling Bombay locusts and mole crickets fried in tempura batter are found on the streets of Bangkok and are a common sight in cities in northern and northeastern Thailand. Tourist restaurants often feature salads made mostly of the eggs of giant water bugs or ants (*Oecophylla smaragdina* F., Formicidae) and "tom yam" soups (hot and sour) containing silk worm pupae (*Bombyx mori* L., Bombycidae) or bamboo borers (*Omphisa* sp., Pyralidae).

In smaller cities, the price of edible insects is not as high as in the five-star hotels of the big cities. A girl from a poor family in the Phitsanulok area of north central Thailand, whom we interviewed, regarded edible insects as a delicious and inexpensive element of her diet. She did not consider eating insects to be unusual or special. To her, insects were only a common class of foods such as seafood or poultry. Judging by the variety of insects available in the food markets of smaller cities, many others hold her views.

Traditionally, the Buddhist monks of Thailand begin their day early in the morning by begging daily food from local people. Aside from the ten kinds of animals they are prohibited from eating (elephants, tigers, panthers, lions, bears, monkeys, dogs, cats, snakes, and humans), they accept what they are offered. Often, this offering is comprised of bees, royal jelly, and honey, which many monks report to be delicious (Wongsiri et al. 1995). An interview we conducted with three monks in a temple in Khon Kaen, in northeastern Thailand, revealed that offerings also include grasshoppers, mole crickets, and other insects.

Eating insects has economic advantages in addition to the benefits associated with nutrition. Between 1960 and 1970, the Bombay locust became a major pest of corn and sorghum crops in Thailand (Wongsiri 1983). Farmers now collect them for personal consumption and as a market commodity. Because of this, the Bombay locust is no longer a serious pest. Many farmers and bee hunters regularly collect gastronomically desirable species of insects for market, including the brood-containing nests of *Apis* spp. and *Vespa* spp. (Vespidae). Farmers should be encouraged to collect and market pest insects as luxury foods. Because eating insects is part of the culture already, such activities would serve biological control goals and at the same time enhance the economic prospects of farmers with small holdings (Wongsiri 1983).

Marketing

Marketing of honey bee nests is the most obvious use of insects as food in the food markets of Thailand. The custom is found in all provinces (Wongsiri and Chen 1995); however, the biggest bee market is in the north central province of Nakhonsawan. About 40 to 50 stands specializing in bee nests line both sides of the Phitsanulok-Nakhonsawan highway about 20 km from downtown (see Fig. 1 in Dietz 1992). The stands sell an average of 10 nests of *Apis florea* F./stand/day, each nest costing $2.00 to $4.00 (U.S.), depending upon the size of the nest. We estimate that bee hunters collect 15,000 to 20,000 nests of *A. florea* per year to sell only in this one market and 40,000 to 50,000 nests throughout the country. About 10% of the sales of bee nests in the Nakhonsawan market (and probably throughout the country) are of pieces of *Apis dorsata* F. brood nests, which sell for the equivalent of about $6.00 (U.S.)/kg. *A. florea* nests are generally sold as an entire nest. *A. dorsata* nests, due at least in part to their large size, are sold as pieces of brood nest. Honey typically is squeezed from the *A. dorsata* comb, sold separately, and identified as being from *A. dorsata*.

Other Hymenoptera commonly are sold as food in the markets. We found one woman in the morning market of Ubon Ratchathani in northeastern Thailand selling vegetables while eating a breakfast of living bee brood. In a nearby market, a woman was selling living ants, including adults, larvae, and pupae. These

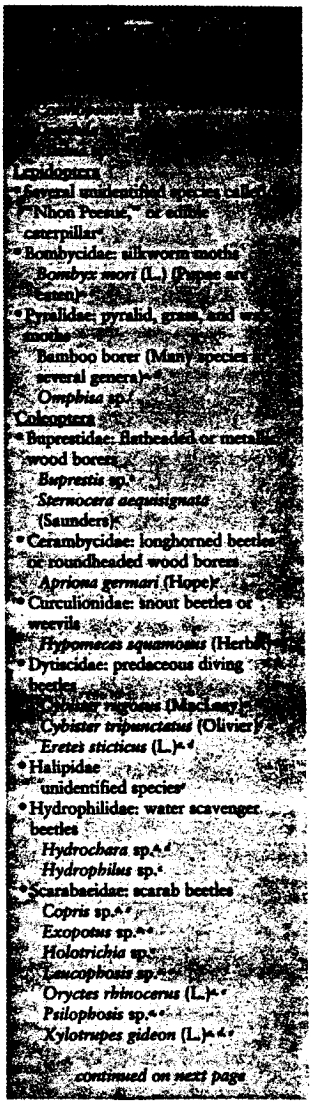
were of a red and yellow species (perhaps *Oecophylla*) that makes its nest of growing leaves in trees, especially mango trees (Wongwiggarn & Leksawasdi 1987). She said that collectors sell entire nests for $0.16 (U.S.)/kg. She then sells them in the market for $2.40 (U.S.)/kg. She reported that many pregnant women buy them, believing their consumption is healthful for the baby. A vendor in the morning market on the road from Chiang Mai to Chiang Rai specialized in large wasps and hornets. She reported that she sold a single adult to a Japanese tourist for $0.25 (U.S.), a price she considered amazingly high. She also reported that Japanese tour groups now are coming to the market specifically to buy and eat bees and wasps. In addition, we discovered there is a developing export trade in fresh insects for consumption in Japan.

Collection of insects for food is strongly entrenched in Thai culture. As the society becomes urbanized, more industrialized, and larger, the pressure on wild edible insect populations will grow. This consumer pressure will be especially intense on nests of *Apis florea* F. and *A. dorsata* F. because they are regarded highly as food. Both the opportunity and the need exist for beekeepers to produce nests of *A. cerana* F. and *A. mellifera* L. specifically for sale as food. To the degree that they are successful, such endeavors will reduce the hunting pressure on wild honey bee nests and help preserve the biodiversity of the ecosystems of Thailand by maintaining the populations of these important pollinators (Wongsiri *et al.* 1992).

Gastronomy

Insects generally are involved in two ways in food preparation. First, the specific flavors of insects are used as an important ingredient in a product made primarily from something else. For example, sex pheromone glands from male giant water bugs are added as a flavoring to shrimp paste to form a product called Nam Prik Mangda, a product that is packaged for wide distribution and might be found in Asian markets in the United States (Pemberton 1988). Thai farmers collect them by light traps in rainy seasons. Fresh ants, because of their rich formic acid content, are used as ingredients in salad dressing and contribute flavor in much the same way as the acetic acid of vinegar. We found that ant nests were collected easily from mango trees.

More often, insects are a major portion of the protein in various dishes. They are prepared as "fresh" or as roasted, fried, or steamed and used in curries and salads. Although a visit to Thailand is the best way to experience Thai insect cuisine, it is possible to prepare some of the dishes using ingredients found in the United States. For readers interested in doing so, we provide the following selected recipes. We chose them because they use honey bee brood and have other ingredients that can be bought in the United States. Except for colonies being treated with acaracides for the control of parasitic mites, honey bee brood is unlikely to be contaminated with toxic chemicals.



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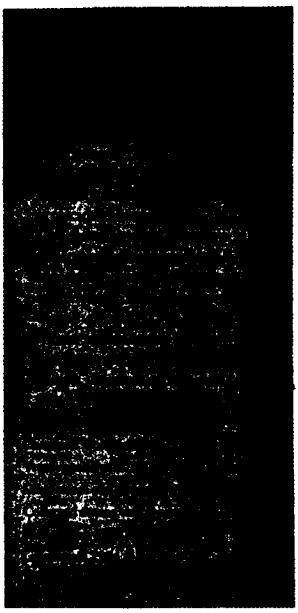

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Stir-fried Queen Bee Larvae *with* Fresh Green Peppercorns

from the Oriental Hotel, Bangkok, Thailand

Thailand and other tropical places have fresh green peppercorns; canned green peppercorns are available in most places.

Pork	500 g (1 lb.)
Queen bee larvae	105 ml (6 T)
Chopped garlic	10 g (1/3 oz.)
Vegetable oil	120 ml (½ C)
Chicken stock	120 ml (½ C)
Green peppercorns	100 g (13.5 oz.)
Sliced red chili	80 g (3 oz.)
Chopped basil leaves	150 g (5–5 ½ oz.)
Fish sauce	60 –75 ml (4–5 T)
Honey	45 ml (3 T)
Black pepper powder	2 ½ g (½ t)
Whole basil leaves	100 g (3–4 oz.)
Steamed rice	

Cut pork into 1 cm (½ in.) cubes and mix with queen bee larvae. Refrigerate this meat mixture for 3 hours. Deep fry basil leaves in oil until crisp and set aside. Caution: because of basil's high moisture content, the oil will spatter intensely when the basil is placed in it. Sauté the garlic in the vegetable oil until golden brown. Add the pork with larvae and stir fry until done. Remove meat and deglaze the wok with the chicken stock. Add remaining ingredients (except whole basil leaves—see above), heat, return meat to sauce, and heat. Garnish with deep-fried basil leaves. Serve accompanied by steamed rice. For five persons.

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Queen Bee Larvae Omelette

from the Oriental Hotel, Bangkok, Thailand

Eggs	4 (4)
Water	15 ml (3 T)
Fish sauce	15 ml (1 T)
Honey	5 ml (1 t)
Black pepper	to taste
Vegetable oil	30 ml (2 T)
Unsalted butter	15 ml (1 T)
Queen bee larvae	60 ml (4 T)

Whisk eggs, water, fish sauce, honey, and pepper until blended. Heat vegetable oil and butter. When butter melts and bubbles in oil, add the egg mixture. Scatter larvae into egg mixture. Fry by lifting cooked edges and allowing uncooked egg to flow under the cooked egg. When all of the egg mixture is cooked, arrange the omelette on a plate, garnish, and serve immediately. For 5 persons.

Steamed Bee Brood *with* Chili Sauce

from T. E. Rinderer

In traditional Asian steaming, food is wrapped in banana leaves, but, because the banana does not impart flavor, aluminum foil can be substituted.

Bee Preparation:
Cut three in. square (six cm square) pieces of sealed brood comb from freshly drawn comb. The brood should be the first generation of brood raised in the comb and recently sealed brood (prepupae or early white colored pupae are preferable). The comb itself should be new to avoid the presence of pollens with off tastes and cocoons from previous generations of brood. Wrap the comb sections in banana leaves or aluminum foil and steam for 7 to 10 minutes. The brood will cook and the wax will melt and mix with the brood. The entire mixture is eaten with the sauce. As an alternative, large unsealed larvae can be extracted and steamed. This produces a product not mingled with wax.

Chili Sauce:
(Serves as a dipping sauce for steamed brood)

Lime juice and zest	2 limes (2 limes)
Fish sauce	45 ml (3 T)
Seeded & chopped Thai or Serrano chilies	10 chilies
Red chili paste	5 ml (1 t)
Chopped fresh ginger	5 ml (1 t)
Chopped garlic	5 ml (1 t)
Chopped lemon grass	5 ml (1 t)
Chopped coriander leaves (cilantro)	15 ml (3 t)

Mix above ingredients and serve.

●●●

Scrambled Brood

from T. E. Rinderer

Squeeze freshly sealed brood comb through a colander to obtain "puree" of larvae and pupae. This product is similar to uncooked scrambled eggs and congeals when cooked in much the same way. However, the cooked product is white rather than yellow. Prepare it as you would prepare scrambled eggs, adding salt (or fish sauce), black pepper, fresh herbs (e.g., tarragon, chives, chervil), fresh chili, cream cheese, etc. The "squeezed brood" also can be used as an egg substitute whenever scrambled egg is used as a binder in recipes because it is high in protein and will congeal and bind other ingredients.