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THE FOOD INSECTS NEWSLETTER

MARCH 1991 VOLUME IV, NO. 1

Insect Fatty Acids: Similar to Those of Poultry and Fish in Their Degree of Unsaturation, but Higher in the Polyunsaturates

(Note and acknowledgements: The editor was unable to find a lipids specialist who would have the time either now or in the immediate future to prepare a short article comparing insects and vertebrate domestic animals as sources of dietary fatty acids. The next best option was to prepare a draft which could be quickly scanned by experts. I wish to thank the following University of Wisconsin colleagues for reading the original draft and suggesting improvements: Dr. Denise Ney, lipids specialist in the Department of Nutritional Sciences; Dr. Joanne Csete, specialist in Third World nutrition, Dept. of Nutritional Sciences; Dr. Robert Lindsay, lipids specialist in the Department of Food Science; and Dr. Karla Ritter, insect lipids specialist presently located in the Clinical Science Center.)

Most of the attention on insects as a food source has focused on their high protein content. The malnutrition problem in much of the developing world is the result, however, not principally of a deficiency in protein or protein quality, but rather of a deficiency in total calories. While most North Americans are not looking for more calories, we are looking for animal sources with a lower proportion of saturated fatty acids and a higher proportion of monounsaturated and polyunsaturated fatty acids. It is of interest, then, that insects range from low to high in fat, from less than 10% to more than 30% on a fresh weight basis, and are relatively high in the C18 fatty acids, oleic acid (18: 1), linoleic acid (18:2) and linolenic acid (18:3).

Calvert *et al* (1969), while conducting studies on the protein quality of house fly pupae *(Musca domestica* L.) fed to broiler chicks, also analyzed the fatty acids of the pupae and noted that the fatty acid pattern resembled those of some fish oils. The fatty acid composition of house fly pupae and of the edible stages of several species of insects used as human food are shown in Table 1 (page 2). Although diet and development exert strong influences on fatty acid profiles (Stanley-Samuelson *et al* 1988), the many analyses that have been conducted show a relationship between fatty acid composition and the taxonomic grouping of insects (Thompson 1973). Fast (1970) summarized the results of fatty acid analyses on insects up to that time, and it is apparent from his tabulation, for example, that the Coleoptera (beetles and weevils) in general are particularly high in C 18:2 while the Lepidoptera (butterflies and moths) are particularly high in C 18:3. Linoleic acid comprised 25 % or more of the total fatty acid composition in nearly 40% of the Coleoptera species analyzed, while linolenic acid comprised 25% or more in nearly 50% of the Lepidoptera species.

The essential fatty acids, which include linoleic acid (18:2w6) and a-linolenic acid (18:3w3). serve several physiological functions in vertebrates. As components of specific phospholipids, they are important to the integrity of cellular lipid membranes and their associated enzyme activities. They provide the C20 fatty acid precursors for the hormone-like eicosanoid compounds needed for localized metabolic regulation in many tissues (Dadd 1983). The essential fatty acids also regulate cellular lipid metabolism and are required for growth. Biochemically, fatty acid deficiency in warmblooded vertebrates is characterized by reduced levels of the tetraene, arachidonic acid (C20:4w6) and increased levels of the triene, eicosatrienoic acid (C20:3w9) (Dadd 1983). Linoleic acid, the root member of the w6 (or n6) family, can be metabolized by carbon-chain elongation and further desaturation to arachidonic acid through the following steps (w6 family): 18:2w6 (linoleic) to 18:3w6 to 20:3w6 to 20:4w6 (arachidonic). As with linoleic acid, *a*-linolenic acid (Cl 8:3 or 18:3w3), which is the root member of the w3

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(or n3) family can be elongated and further desaturated through a series of intermediates up to docosahexaenoic acid (22:6w3): 18:3w3 to 18:4w3 to 20:4w3 to 20:5w3 to 22:6w3 (docosahexaenoic). It was thought until recently that all EFA deficiency symptoms in mammals and birds were remitted by dietary fatty acids of the w6 family, but Dr. Ney notes that this is not true in infants and rapidly growing vertebrates. Recent research indicates that both 18:2w-6 and 18:3w3 have essential functions in warm-blooded animals. The w9 family of which oleic acid (18:1w9). is the root member is not essential.

Alpha-linolenic acid or higher members of the w3 family are the primary essential fatty acids for many fish (Dadd 1983). Fish acquire them from ingestion of plankton and other plants. The evidence from vertebrate metabolic studies is that conversions between members of the w3, w6, and w9 families do not occur. Cats are an exception to the general rule that vertebrates can convert 'the C18 polyunsaturates of food into the physiologically necessary C20 and C22 polyunsaturates. Also, some w3-requiring fish are unable to metabolize linolentic acid to longer chain polyunsaturates, thus these animals must acquire them preformed in their food.

It has only recently become recognized that the C20 and C22 fatty acids occur generally in insects and are probably physiologically important to most, or all, species. Although a few pre-

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Table 1: Fatty acids of edible insects (whole body) expressed as percentage of total fatty acids.[1]

Species	Life Stage[2]	Saturated				Unsaturated					Ref[6]
		<16:0	16:0	17:0	18:0	<18	18:1	18:2	18:3	>18[4]	
COLEOPTERA (beetles, weevils)											
Family Curculionidae											
Rhynchophorus phoenicis[5]	L	2.6	36.0	1.4	0.3	1.1	30.0	26.0	2.0	0.6	(14)
Family Tenebrionidae											
Tenebrio molitor	L	1.5	23.6		1.4	4.5	44.7	24.1	1.5		(6)
DIPTERA (true flies)											
Family Muscidae											
Musca domestica	P	3.8	27.6		2.2	20.6	18.3	14.9	2.1		(4)
HOMOPTERA (leafhoppers, cicadas, etc)											
Family Cicadidae											
Unidentified sp.	A	2.0	5.0		4.0	1.0	25.0	63.0			(3)
ISOPTERA (termites)											
Family Termitidae											
Macrotermes subhyalinus	A	1.6	33.0	2.6	1.4	1.6	9.5	43.1	3.0	4.2	(14)
LEPIDOPTERA (butterflies, moths)											
Family Bombycidae											
Bombyx mori	P						29.8	48.9	21.3		(17)
	mP		30.0		7.5		25.6	10.9	26.0		(10)
	fP		17.8		3.5		28.0	15.1	35.6		(10)
	mP[6]	0.2	27.4		3.1	2.2	23.9	6.4	36.7		(13)
	fP[6]	0.3	23.4		5.8	1.9	18.6	9.0	41.1		(13)
Family Megathymidae											
Aegiale hesperiaris	L		30.0		3.6		60.1	4.3			(2)
Family Noctuidae											
Heliothis zea	L	0.3	25.4		2.8	1.6	26.0	12.0	31.8		(16)
Family Pyralidae											
Galleria mellonella	L	t	39.6		3.1	2.9	47.2	6.5			(19)
	L	t	36.0		4.0	3.0	48.0	9.0			(18)
Family Saturniidae											
Antheraea pernyi	mP						33.1	17.3	29.8		(5)
	fP						31.6	11.2	37.8		(5)
Imbrasia ertli	L	1.5	22.0	0.9	0.4	3.9	2.0	20.0	11.0	38.3	(14)
Usta terpsichore	L	2.5	27.4	29.7	0.1	0.6	1.7	27.2	2.8	7.7	(14)
ORTHOPTERA (grasshoppers, crickets, etc)											
Family Acrididae											
Locusta migratoria migratorioides	A	0.9	25.5		5.8		47.6	13.1	6.9	0.2	(7)
Melanoplus atlantis[7]	A		6.7		9.1	4.4	31.5			46.2	(15)
sanguinipes	A	2.0	11.0		4.0	1.0	19.0	20.0	43.0		(3)
	mA	5.8	26.8		6.2	2.7	30.3	7.3	17.8	0.7	(15)
	fA	5.7	26.0		7.6	3.1	31.9	6.8	16.3	0.2	(15)
Oxya japonica	A		+		+		+	+	37.4		(17)
Schistocerca gregaria	A	5.5	20.0		72.0		2.5				(1)
	mA	6.6	40.3		6.7	2.8	31.7	7.5	3.6		(15)
	fA	3.0	34.6		5.8	2.6	37.6	10.2	6.2		(15)
Sphenarium purpurescens	A	2.9	14.8		11.4	9.6	35.5			25.8	(8)
Family Gryllidae											
Acheta domesticus	A	0.6	27.9		5.8	2.6	29.0	2.1			(19)
	N	1.0	27.0		8.0	3.0	23.0	35.0	1.0		(11)
	mA	1.1	29.7		5.2	3.0	32.3	28.8	t		(12)
	fA	0.7	24.7		5.2	1.7	35.9	31.1	0.8		(12)
	fA	1.1	22.9	0.2	6.3	2.6	23.7	41.3	1.0	1.1	(9)
	fA	1.3	25.9	0.2	5.9	1.7	22.9	39.5	1.4	1.4	(9)
	N	1.1	25.0	0.1	4.9	2.3	27.4	37.4	1.0	0.7	(9)

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chromatographic analyses indicated substantial proportions of arachidonic acid or a similar tetraene, subsequent gas chromatographic analyses have rarely recorded polyunsaturates of carbon chain length greaterthan 18 (Fast 1970; Dadd 1983). In crude lipid extracts of whole insects the long-chain polyunsaturates generally constitute no more than 2% of the fatty acid total, although they may be present in 5-10 times this proportion in extracts Erom certain tissues (Dadd 1983, Stanley-Samuelson and Dadd 1983).

The functions of fatty acids that are essential to vertebrates apply also to insects. The major sources of fatty acids in edible insects are the phospholipids in the cell membranes and the glycerides (especially the triglycerides in the fat body). Dr. Ritter notes that, since insects are poikilotherins the degree of unsaturation of the fatty acids associated with the phospholipids is very important for helping to regulate the fluidity of the membranes. In contrast, the structure of triglycerides is less important, physiologically, and so may be more variable and influenced by diet. Fatty acids also have several other functions that are more-or-less unique to insects such as precursors in biosynthesis of waxes, pheromones, and eicosanoids, and as components of defensive secretions (Stanley-Samuelson *et al* 1988).

Table 2: The proportions of saturated/unsaturated fatty acids in beef, pork, poultry and fish (adapted from National Research Council 1988)

	Percent of total fatty acids		
Animal[a]	SFA [b]	MFA[c]	PFA[d]
Beef	52.0 (28.1)	44.2	(3.8)
Pork	44.1 (24.3)	44.3	(11.6)
Chicken	35.5 (20.2)	40.8	(23.7)
Fish	29.6 (22.6)	39.6	(30.8)

[a] For beef, the averages of 27 combinations of cut and grade; for pork, the averages of 16 cuts; for chicken, the averages of 8 parts; for fish, the averages of two products each of haddock, halibut and tuna.

[b] Saturated fatty acids; stearic acid, C 1 8:0, is shown in parentheses as a percentage of total saturated fatty acids (see text).

[c] Monounsaturated fatty acids.

[d] Polyunsaturated fatty acids.

It appears that the elongation/desaturation pathways described above for vertebrates apply to most, although not all, insects. Of particular interest is the presence of long-chain polyunsaturates in phytophagous insects such as lepidopterous larvae (Dadd 1983), many species of which are used as food. Such insects presumably biosynthesize the longer-chain polyunsaturates from the C18 polyunsaturates in their food. Among insects used as food, arachidonic acid has been detected in the locust, Legend: Table 1 (Fatty Acids of Edible Insects)

1 Saturated acids: 16:0 = palmitic acid; 17:0 = margaric; 18:0-stearic; unsaturated acids: <18:1 = mostly palmitoleic acid 16:1); 18:1 = oleic; 18:2 = linoleic; 18:3 = linolenic.

2 A = adult; L = Larva; P = pupa; N = nymph; m = male; f = female.

3 References: 1 = Albrecht 1961; 2 = Bachstez & Aragon 1942; 3= Barlow 1964; 4 = Calvert et al. 1969; 5 = Demainovsky & Zubova 1956; 6 =Fast 1966; 7 = Fauzi et al. 1961; 8 = Giral et al 1946; 9= Grapes et al. 1989; 10 = Herodek & Farkas 1960; 11 = Hutchins & Martin 1968; 12 = McFarlane et al. 1984; 13 = Nakosone & Ito 1967; 14 = Oliveira et al. 1976; 15 = Saha et al 1966; 16 = Shaeffer 1968; 17= Scoggin & Tauber 1950; 18 = Thompson & Barlow 1972; 19 = Young 1967. References listed here but not in the References Cited can be found in Fast (1970).

4 Most insects probably contain long-chain polyunsaturates, but they generally constitute no more than 2% of the total fatty acids.

5 In Oliveira *et all* (1976), the same values are tabularized for palmitic (C16:0) and palmitoleic (C16: 1) acids; we have assumed that the values listed by Oliveira are correct for palmitic acid and incorrect for palmitoleic acid. The values listed above for the latter represent the difference between the totals of fatty acid percentages listed by Oliveira and 100%.

6 The data are for 2-day-old pupae.

7 *M. atlantis* is considered a synonym of *M. sanguinipes.*

Locusta migratoria and the cricket *Acheta domesticus* (Stanley-Sainuelson and Dadd 1983). Various prostaglandins have been detected in insects and Stanley-Samuelson *et al* (1988) review what is known about their biosynthesis. In addition to functions probably similar to those in vertebrates they are known to have a role in the reproductive biology of some species (Stanley-Samuelson and Dadd 1983; Stanley-Samuelson et al 1988),e.g., among specific food insects the crickets *Acheta domesticus and Teleogryllus commodus*, the silkmoth *Bombyx mori*, and the African termite *Macrotermes subhyalinus.*

Unlike vertebrates, some insects can synthesize linoleic acid *de novo* (there is good evidence for at least 15 species in four orders) (Stanley-Samuelson *et al* 1988). At least one food insect, the"' mealworm *Tenebrio molitor,* can biosynthesize linoleic and linolenic acids (Dadd 1983).

Table 2 above shows the proportions of saturated/unsaturated fatty acids in various vertebrate animal species, as averaged from market available cuts and grades (see Table 2 footnotes). The averages are derived from data tabulated by the National Research Council (1988) and are intended as fairly representative values although there is considerable variation in individual cuts, grades and parts. As shown in Table 1, the saturated/unsaturated ratio of most edible insects is less than 40% saturated, grouping them with poultry and fish. The other most notable feature of insect fatty acids is the very high ratio of the polyunsaturates, linoleic and linolenic acids, higher

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in general than found in poultry and fish. Less favorable for insects, but of relatively minor importance, is that they are generally lower than the vertebrates in stearic acid, C18:0, as a proportion of the saturated fatty acids. Stearic acid, unlike other saturated fatty acids, does not raise the plasma cholesterol level (NRC 1988).

The main objective here has been to bring together the available data on fatty acid composition of the edible insect groups. Their dietary value compared to other animal sources in specific situations concerning human or aminal nutrition remains to be determined. Dr. Ney notes that essential fatty acid deficiency is rare in human populations in the developed countries, and the current trend in human nutrition is not to more polyunsaturated fat intake but to less saturated fat. According to Dr. Csete, the degree of saturation of fatty acids is probably not much of an issue in developing countries, at least not in places where undernutrition is most severe. Meeting essential fatty acid requirements in the diet and also attaining enough calorie density in general, particularly in certain seasons and for children whose stomachs can take only so much bulk, are much more important. Because so much of the insect body would be indigestible but would fill the infants stomach, she raises a question as to whether insect fatty acids can meet the need for calorie-dense foods that young children, in particular, can ingest in adequate quantities to make a difference.

Research is needed. Relative to marginally nourished children's diets, for example, the more "thin-skinned" insects among those traditionally used may play a valuable role. And processed insects that have undergone dechitinization may have a place (the chemical methodology is simple and cheap). Some robust young children have been observed in indigenous populations that rely heavily on insects as part of the diet, suggesting an ample protein/calorie intake for both mothers and children. Mountford (1946:98), who studied the Pitjendadjara aborigines in central Australia, provided an interesting photograph of a native baby, age unstated but sitting upright, 'fat and saucy," who "thrives on a diet of mother's milk, white grubs, and honey ants." Mountford drove home the point that the child's home was in the Mann Range "where previous travelers' reports indicated that the country was too bad to support even aborigines." Tindale (1953) similarly states that, "Aborigines with access to witjuti grubs [leopard moth larvae,

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genus *Xyleutes*] usually are healthy and properly nourished... Women and children spend much time digging for them and a healthy baby seems often to have one dangling from its mouth in much the same way that one of our children would be satisfied with a baby comforter. "And the older literature from Africa is full of accounts of how indigenous populations grew noticeably fatter and in better condition when termites or grasshoppers were available. Relative to animal nutrition, Dr. Lindsay notes that there is currently a particularly active search for new sources of the w3 fatty acid precursors of long chain w3 polyunsaturated fatty acids and for the latter preformed for use in pond fish production. Yes, research is needed.

Gene R. DeFoliart, Editor.

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LETTERS

The Food Insects Newsletter was listed by Peace Corps Washington in its recently updated (September 1990) edition of "Free and Reduced Rate Periodicals for Peace Corps Volunteers."

From the Peace Corps in Kenya

The first letter resulting from this listing was received from June Plecan, Training Coordinator, Naivasha Peace Corps Training Center in Kenya: I am writing on behalf of the U.S. Peace Corps Training Center in Kenya to request a subscription to your publication "The Food Insects Newsletter." We train approximately 100 Peace Corps extensionists and teachers each year and I believe that your publication could be a valuable resource for their work in rural Kenya and back in the states.

With a Peace Corps Volunteer in Zaire

Amy Roda, a PCV from Metamora, Michigan, who is serving as a fish culture specialist in Zaire, wrote an interesting letter from which we excerpt the following:

Thank you for sending "The Food Insects Newsletter" and your paper ""The Human Use of Insects as Food and as Animal Feed." They have reaffirmed my direction in entomology. Even before coming to Zaire I was interested in the nutritional role that insects have in developing countries. Now, I am a volunteer in a country where I have personally experienced their culinary benefits.

The extent that insects are used in the Zairian diet varies between the different regions and even within the same region. I am posted in Bas Zaire in an area known as the Mayombe. Insects such as caterpillars and palm grubs have been served to me but on rare occasions.

The Mayombe is still forested with a few tracts of virgin jungle. But they are being made smaller by international logging companies. The forest supports a large population composed mostly of subsistence farmers. Along with casava, taro, rice, plantains, beans and peanuts, the villagers plant cash crops of coffee, cacao, palm nuts, and rubber. Animal protein is supplied by domestic animals (cows, pigs, sheep, goats, chickens), forest beasts, and salted fish brought in from the coast.

It was not until this last October that I was served *Biphatu*, a type of caterpillar which during the dry season congregate inside orange silk packets. The caterpillars are roasted, then cooked in a tomato/ palm oil soup seasoned with hot pepper. It tastes really quite good.

Why insects are not eaten regularly probably involves incorporating hundreds of years of Belgian, Portuguese, and missionary habits w ith those indigenous to the population. By many, insects are not considered food for people. When the *Biphatu* were being cooked up, most of the older generation looked away in disgust - a reaction I would expect from a Westerner. It is difficult to say whether insects are being reintroduced because other meat sources are decreasing as the population grows and the forest diminishes, or if the strong western influence will continue to hold sway.

Even though not readily eaten here, *Biphatu* are collected and sold to merchants who transport them to large cities such as Boma and Matadi. There, market women sell them, dry, by the bar glass or tomato can.

When I visited the Cateral, the area between Matadi and Kinshasa, and two other regions of Zaire, Bandundu and Kaisi Occidental, I noticed insects were more frequently included in the diets. In the local market one has a variety of textures and flavors to choose from. Live palm grubs can be had pretty much any time, though I prefer the seasonal grasshoppers and termites. They are best when fried in palm oil with a bit of hot pepper and salt. They are a better complement to a cold beer than any "Frito-Lay" product.

In the Bandundu region insects are eaten raw. When a mound of emerging termites is found, all other planned work is stopped, to the frustration of the Volunteer. I have not tried them myself, but I have been told that a mouthful of live termites tastes much like bacon.

At the Grand Marché in Kinshasa, next to the live lungfish and crocodile steaks is the insect section where the largest selection can be found. Insects are brought in from all the regions, both live and preserved. Also, in Kinshasa's fashionable night hot spot, the Matonge, insects are regularly sold as a bar snack.

Being an aquaculture extension agent, I was particularly interested in your comments on mass harvest strategies for light-attracted insects and controlled mass production of food insects. Currently, plankton serves as the fish's major food source in the pond. A simple and cost-free cultivation of insects would enhance production as well as aid in the collection of fingerlings. Usually, nests of ants are used to attract fingerlings to be 'lift-netted" and transferred to other ponds. Often after a couple of years the ant population is depleted making it difficult to harvest fingerlings.

If you could, please send articles describing low-tech methods currently being used. I am interested in doing some practical field testing.

Palm weevils in Costa Rica

Although palm weevils have been widely consumed in South America, the Caribbean islands, and Mexico, the Editor knows of no published records from anywhere in Central America. Angelo Mitchell wrote from Costa Rica:

I have had the most uncommon but delightful experience of dining on sauteed beetle grubs from an infected coco palm. I collected about

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20 white, thumb-sized grubs from their fiber-encased capsules between the leaf sheaths and trunk; have you any info on these guys? They were killing the palm. Their taste was similar to lean pork. (For info on palm weevils, see the July 1990 *Newsletter.)*

Getting it straight on the difference between mescal and pulque

Botanist Stephen Jones, writes from Cave Creek, Arizona:

I have a special interest in the plant genus Agave, and couldn't help but notice a mistake--albeit a common one--in one of the articles in the *Newsletter.* The article [November 19881 quotes a person named Bates, who refers to, '... mescal, the potent drink that the Mexicans distill from the fermented pulque."

Whoops! Mescal is not distilled from pulque. It's made by an altogether different process. Pulque is indeed a fermented product. It is made by allowing aquamiel to ferment Aquamiel is the sap collected from an agave plant which has had its emergent flowering stalk cut. The cut surface is cupped, and the sap is collected daily from the basin thus formed.

Both aquamiel and pulque are highly nutritious drinks. They might be even more nutritious if the insects which are attracted to and trapped in the aquamiel were not filtered out, as they generally are.

Mescal, and its cousin tequila, are made by the following process: *Agave* plants which are about to flower (the terminal event in the life of the plant) are cut off at the roots, their leaves removed, leaving a globular stem called a 'cabeza' (Span., head). The cabeza is then baked, to convert the starches and polysaccharides (which build up in the stem in anticipation of flowering) into sugars. The cabeza is shredded, and the liquid extracted. This liquid is fermented and then distilled into mescal. Commercial mescal and tequila are generally distilled twice, to 110 proof, then watered back down to 80 proof.

The difference between mescal and tequila is the place in which it is made. Much like the wines of Bordeaux, tequila comes from the Tequila region of the state of Jalisco, Mexico. Only one cultivar, the "azul" (Span., blue) variety of *Agave tequilana*, called blue maguey, is cultivated there.

The distilled product from any other species of *Agave*, or from outside the Tequila region, is generally called mescal. Some are known by local names. A good deal of it is bootlegged.

The larvae which are put in the bottles are natural parasites on the rich stem and root tissues of *Agave* plants. Why is this misnamed "worm" added? It is an indication of the proof of the liquor. If the larva is in good shape, it means that the percentage of alcohol is high enough to keep it preserved. If the booze has been watered down, the larva goes bad, and only the most determined entomophile would drink it. It makes you wonder about those brands with the little plastic larvae, doesn't it?

Thanks, but no more honey bee cookies, please.

Adult honey bees (as opposed to bee brood [larvae and pupae]) are sometimes recommended for inclusion in cookie recipes. A recent newspaper article suggests, for example, "you put them in the oven at low heat for eight hours, then grind or blend the dry husks into flour. Makes great cookies." There can apparently be a problem with this as revealed in the following correspondence from Dr. James K. Ryan, formerly of the University of Alberta and now with Ryan and Hilchie Biological Consultants in Edmonton:

When I first used honey bees I expected that the venom would be unstable and easily denatured by aging, mechanical disruption, and especially cooking. It later began to appear that the venom was much more stable than I had anticipated....

My research with honey bees at the University of Alberta Food Science Department led me to analyse a complaint about 'scratchiness in the throat' after eating honey bee cookies. I determined that this was caused by the venom, not cuticular spines as I initially supposed. I isolated venom sacs and compared the taste of frozen fresh sacs with dry cooked, microwave cooked, papain treated, and papain treated and boiled venom sacs. The peppery scratchy taste remained unchanged. Evidently the melletin (26 amino acid protein) and promelletin (19 a. a.) and perhaps other venom components were not denatured by these treatments. I foresaw possible reactions among bee consumers, from irritation to mouth and throat lesions to allergic and hypersensitive reactions, and consequently discontinued serving honey bees to members of the general public. Heating bees for 8 hours, as described in the news story . . . may overcome this problem, but [this should be demonstrated] before presuming that it is so.

(For more on the edibility, or lack thereof, of adult worker honey bees, see letter from J. Schmidt in the November 1990 *Newsletter.* None of this should sully the reputation of honey bee brood, which "tastes great" and is good for you, high in vitamin D and low in cholesterol.)

Hoping to enlarge on the Tanzania experience

Ames Gilbert of Renaissance, California, writes:

Although I am new to eating American insects, I ate fried flying ants [winged termites] in Tanzania at the beginning of the rainy season each year, with relish, as well as locusts with honey. I look forward to enlarging on my experience.

Pre-Hispanic Foods of Mexico Exhibit at the Smithsonian Institution:

This fascinating exhibit, which opened in June last year at the International Center of the Smithsonian, was sponsored by the Secretariat of Foreign Affairs, Embassy of Mexico, through the Mexican Cultural Institute, and the Smithsonian's Office of Quincentenary Programs. Entomologists of the National Museum of Natural History staff who attended the opening were surprised and delighted at the numbers of insects featured in the exhibit, insects comprising about 20 of the approximately 70 foods featured. We hope to include more details about the exhibit in the next *Newsletter,* space permitting, and thank Dr. Paul Spangler of the NMNH staff, who devoted time, energy and expertise to the exhibit, for sending a "Guide." Dr. Ted Spilman also sent some

Another TV Bash: The host scientist was the University of Waikato's Dr. Benno Meyer-Rochow who has written several research papers on entomophagy among indigenous populations in Papua New Guinea and central Australia. The chef was Brian Anderson, owner of the Left Bank Cafe in Hamilton, New Zealand. The guests were the film crew for the popular Japanese TV show, 'Give Us A Break," which is fronted by personality Koji Ishizaka. Crew coordinator Naomi Madea said the Japanese audience would find the meal interesting. 'Japanese are very caring about food shortage. If we have a food shortage maybe insects will be put into our diet." she said. Some tinned insects, like locusts and the aquatic Dobson fly larvae are available in Japan. The aim, said Chef Anderson, is to make the insects appealing to the eye. "You eat with your eyes first" He said he quite likes the taste of bugs, but isn't planning to offer insect dishes in his information.

Position Available

Wanted: A person to develop and demonstrate a practical method to produce insect protein for small organic poultry farms. Stipend of room and board on an organic family farm and shared development rights. Contact:
Jim Leuba
1860 Hilt Road
Yellow Springs, Ohio 45387

restaurant.

Walkingstick Insects -- A Query: Thomas Sloan (1617 Berkeley Way, Berkeley, CA 94703-1237) is trying to determine whether it's fact or fancy that there are (or were) people in Southeast Asia who feed (or fed) guava leaves to walkingsticks (Order Phasmotodea),. and then eat (or ate) the walkingstick excrement. He would appreciate hearing from anyone with pertinent information.

McGrasshoppers in Montana

In her Entomology 102 course, called "Insects in Society," professor Florence Dunkel of Montana State University devotes a class period to raising student consciousness about the use of insects as food, both in other countries and here in the United States. The exercise is called "Gastronomic Entomology." The demonstration includes lunch and the lunch includes Montana grasshoppers.

This past year the class got newspaper and TV coverage. According to staff writer Mac Daniel of the Bozeman Daily Chronicle (April 19, 1990), "With a little soy sauce and a dash of paprika, a fried grasshopper tastes something like a little soy sauce and a dash of paparika." "They taste like a huge sunflower seed," said Andrew Cofer, a senior who ate four of the legless and headless hoppers. "I think McDonalds should pick these up. It could be like McGrasshopper." Said student Tony Martinez, "You just have to bypass what they are, and eat them." [Ed: A good guess is that Cofer got an "A" in the exercise, Martinez probably only a"B' or "C."] According to Dr. Dunkel, there appears to be a genuine increase in interest in making food out of grasshoppers in Montana, not only among students but among Montanans in general. She sent along the recipe she uses.

Preparation of grasshoppers prior to frying:

Obtaining fresh grasshoppers may be difficult Their abundance is seasonal and also varied from year to year in any specific location. Grasshoppers must be gathered and then starved for about 24 hours. Freeze for 1-4 hours. It is possible that the grasshoppers may be stored frozen without any further preparation, but the author has not yet experimented with the maximum storage period for maintaining a fresh frozen taste.

Remove from freezer. Thaw. Wash in several rinses of cold water. Remove grasshopper legs, wings and head. When removing the head, attempt to pull the entire gut out also. If you withhold food from the grasshoppers for 24 hours before freezing, they will have cleared their gut, and gut removal may not be necessary. (Note: the head is only the first ovoid segment in front of the leg area.)

Frying and spicing of grasshoppers:

Place grasshoppers and sliced onions (if desired) in hot oil. Saute, stirring constantly for 5 minutes. Add spices as preferred. Serve immediately, with or without bread, e.g., European-style hard rolls sliced or in chunks. ENJOY!!

Fried Grasshoppers .. a high protein appetizer

Assemble ingredients:

	soy sauce to taste
5-10 grasshoppers per serving	cayene powder to taste
(per guest)	onion powder or sliced onion
vegetable cooking oil (high quality)	garlic powder if desired
2 Tablespoons butter for 6 servings	salt and black pepper if desired