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THE FOOD INSECTS NEWSLETTER

NOVEMBER 1991 VOLUME IV, NO. 3

Toward a Recipe File and Manuals on "How to Collect" Edible Wild Insects in North America

Our mail, especially during the past year, suggests that there is a sizeable number of people out there, non-entomologists, who want to know which insects are edible, where you go to find them, and how you collect them when you get there. And, finally, where can recipes be found? Answering the last question first, if the book itself can be found (its out of print), *Entertaining with Insects; The Original Guide to Insect Cookery,* by Ronald Taylor and Barbara Carter is an excellent source of recipes (see review in the March *1989 Newsletter).* Although the recipes are based primarily on mealworms, crickets, and honey bee brood, some of them can undoubtedly be successfully applied to a variety of wild insects. Recipes based on a wider variety of insects would be welcomed, however, and this is an invitation to wilderness survivalists and others among our readers who have had first-hand experience with wild insects to send their most tried-and-true recipes for publication in the *Newsletter.*

A more difficult problem is the lack of information available to the non-entomologist on how to find, recognize and collect edible insects in the wild. This presents an opportunity and a challenge to U.S. and Canadian entomologists. The first question of course is which insects are considered edible. To help get the ball rolling, Table I (pp. 3-4) lists more than 60 species that were used as foods by North American Indian tribes, based on ethnographic or archaeological evidence, or probably used based on ecological evidence. Many of these have been mentioned before in *The Newsletter* (see "The Identity of Grasshoppers Used as Food by Native American Tribes," November 1989, and the review of Mark Sutton's monograph, "Insects as food: aboriginal entomophagy in the Great Basin," March 1990), but we list them here in one concise table to make their identity more easily accessible. It is hoped that this list will spawn a bevy of circulars and booklets with titles such as "Edible Insects in California: Where, When and How to Collect Them," "Edible Insects in Montana..., " etc.

As part of an effort to provide background information for use in preparing such booklets, we plan to include in the next issue or two of the *Newsletter* an article on potential hazards posed by insects collected for human consumption, and how to avoid them. Potential problems can be lumped under three headings; 1) Insects as hosts and/or disseminators of vertebrate-pathogenic entities such as bacteria, protozoans, viruses and helminths; 2) Insects as a source of toxins, either secreted or sequestered from their food plants, and 3) Insects as a source of allergens, including ingestant, contactant and inhalant. In passing, and fortunately, it can be said that these hazards are of little concern relative to insects that would be intentionally collected as food in North America. Nevertheless, it is well to stick to the insects, at least congeneric, that have a history of consumption by humans.

Newsletter faces uncertain future; one or more issues may be missed during 1992. See Editor's Corner, p. 2.

In the meantime, the *Newsletter* editor would welcome short "how to collect" notes or articles from individuals who have first-hand experience in harvesting from the wild any of the edible insect groups. For an example, see the article "Collecting Ant Pupae for Food," by Dr. Gregg Henderson, which appeared in the November *1990 Newsletter.* A good subject for one such article might be on how to go out for a Sunday afternoon and collect a few grasshoppers, while exercising more dignity and less maximum exertion. Use a light, medium-sized sweep-net, maybe? Or, in a given geographical area which species of trees and/or logs should be searched for cerambycid beetle larvae, and what is the most efficient procedure for extracting them? How does one distinguish with certainty cerambycid larvae from other creatures that might be found in taking apart a recently felled tree? What is the safest and most efficient way to dig out yellowjacket larvae/pupae? When is the peak season for harvesting specific edible groups in a given geographical locality? Etc., etc. In the one wilderness survival book that we have seen, the information of this type was much too general to be of much value. What is needed next is for entomologists acquainted with the biology of one or more of the various edible groups to make their knowledge available for use within this new context. We hope to hear from some of you. A few thousand actual and potential entomophages will be grateful.

Gene DeFoliart, Editor

Insect Cuisine will make it to the Waldorf Astoria during the New York Entomological Society's 100th Anniversary celebration

The New York Entomological Society will soon begin celebrating its 100th anniversary, and what a celebration! The focal event during the year will be the First Annual Bug Banquet, to be held May 19, 1992 at the Waldorf Astoria in New York City. Culinary schools in the area are being invited to compete in a bake-off to determine who prepares the best insect dishes; winners will participate in the banquet. The goal of the festive occasion, according to society president Dr. Durland Fish, is to emphasize that most insects are not destructive but of great benefit to humanity. Your *Newsletter* editor will be the after-dinner speaker. Needless to say, all of this is expected to be a high-profile media event.

SEE REFERENCES, p. 9.

Notes on Entomophagy in the Philippines

Chris Starr, Ph.D.
Department of Zoology
The University of the West Indies

St. Augustine, Trinidad, W.I.

During a 6-year stay in the Philippines I made occasional observations on insect-eating practices. Some of these were part of developing an undergraduate course in Industrial

bananas and maize. Sarah and her family resisted eating the locusts but were finally persuaded by her grandmother. The grandmother was a Seventh Day Adventist, abstaining from pork, and her argument resembled that of Vincent Holt in the classic *Why Not Eat Insects?:* It is preposterous that you people eat pigs which feed on all manner of filthy trash, and yet turn up your noses at these locusts which eat only clean vegetation. They boiled the locusts, dried them, and then cooked them with lemon and other flavoring.

2. Andres Duatin lived in the Cotabato region of southern Mindanao at the time of an outbreak in 1958. He told me that

Entomology, while others arose by accident as I rambled about the archipelago. Among the Christianized lowlanders who dominate most of the country, I have not found any insect to be a substantial regular part of the diet, and I have rarely seen them in the market. Nonetheless, several species are at least episodically treated as serious food.

As in many parts of the world, locusts (Acrididae: Crytacanthacridinae) seem to be the most common insect food of humans throughout the Philippines. With widespread use of pesticides, large outbreaks of locusts are apparently much less common and regular than they once were, but they are still not rare. At such times they become an important diet supplement for people who would not normally regard themselves as entomophagous. This is illustrated in anecdotes from two friends of mine:

1. Sarah Ancheta is a native of the island of Leyte. In 1941 a locust outbreak in the hill country devastated such important crops as rice, in Cotabato there was no generalized prejudice against eating locusts, and he collected two big sacks of them, which he boiled and dried. They lasted him for about two weeks.

As far as I know, mole crickets (Gryllidae: Gryllotalpinae) are most commonly eaten in northern Luzon, where they are sometimes gathered in rice fields in an organized hunt. There has been some attention to the possibility of developing the culture of mole crickets in that region as a regular food.

June beetles (Scarabaeidae: Melolonthinae) seem to be the second most commonly eaten group of insects. My host in the city of Laoag, at the northern end of Luzon, had them cooked for me in vinegar and soya sauce after the appendages, head and prothorax were removed.

SEE PHILIPPINES, p. 12.

EDITOR'S CORNER

The Food Insects Newsletter is in danger of becoming a victim of its own success. About a year ago, with impending retirement to emeritus status and impending cessation of the research program, I renamed whatever it is we are trying to do around here as the "Educational Outreach Program on Insects as a Food Resource," and staked out four primary objectives: 1) Continue publication of the *Newsletter*, 2) Continue work toward completion of a global bibliography (with abstracts) entitled "The Human Use of Insects as a Food Resource," plus a related "working file" on the biology of edible insect groups, 3) Continue teaching a 1-credit course here at the University on insects as food, and 4) Develop a traveling school exhibit aimed at upper elementary and lower middle school ages and called "Insects as Food in Different Cultures." I consider Number 2 the objective of basic importance because it would be a valuable resource for researchers, educators and others when published, and because it provides the information base that undergirds the *Newsletter*, the school exhibit, and the 1 -credit university course.

Rather strenuous efforts earlier this year to obtain outside funding for this program at a level of about $25,000 per year for two years were not successful. The proposed budget was for such things as a part-time staff person to conduct the literature searches and arrange the interlibrary loans which are essential under Objective 2 and to maintain the cricket colonies which are a part of the school exhibit (Objective 4), payment for foreign-language translations, purchase of exhibit materials, and partial reimbursement to the Department of Entomology for clerical assistance and postage in handling well over 100 pieces of correspondence per month. The actual count (letters received) during the four weeks immediately preceding was 153; postage is significant because of numerous bulky packets, some of which are sent to overseas destinations. *Newsletter* costs *per se* have not been included in budget proposals. Income from reader contributions and sale of back issues totalled approximately $2,000 the past year, enough to cover the cost of printing and postage for the three issues. Also, Catherine Howley continues to put the *Newsletter* together for the printer on a donated-time basis (even though she commutes from Milwaukee), thus holding down production costs.

The current problem with the *Newsletter* is simply its prodigious growth in circulation--for a desktop operation--from fewer than 80°C in March 1991 to more than 1,500 as this November issue was going to the printer. Theoretically, and actually, this is cause for great happiness, but this growth spurt has come at a time when the availability of paid personnel and residual funding from formerly funded projects has dwindled to zero. The result is that your editor strongly suspects that he has become the most-do-it-yourself, xeroxing, envelope-licking professor, active or emeritus, in North America today. Progress on other objectives has come to a virtual standstill. Thus I wanted to let you know in advance that it could become necessary to skip an issue of the *Newsletter* during the coming year in order to resume satisfactory progress on some of those other objectives.

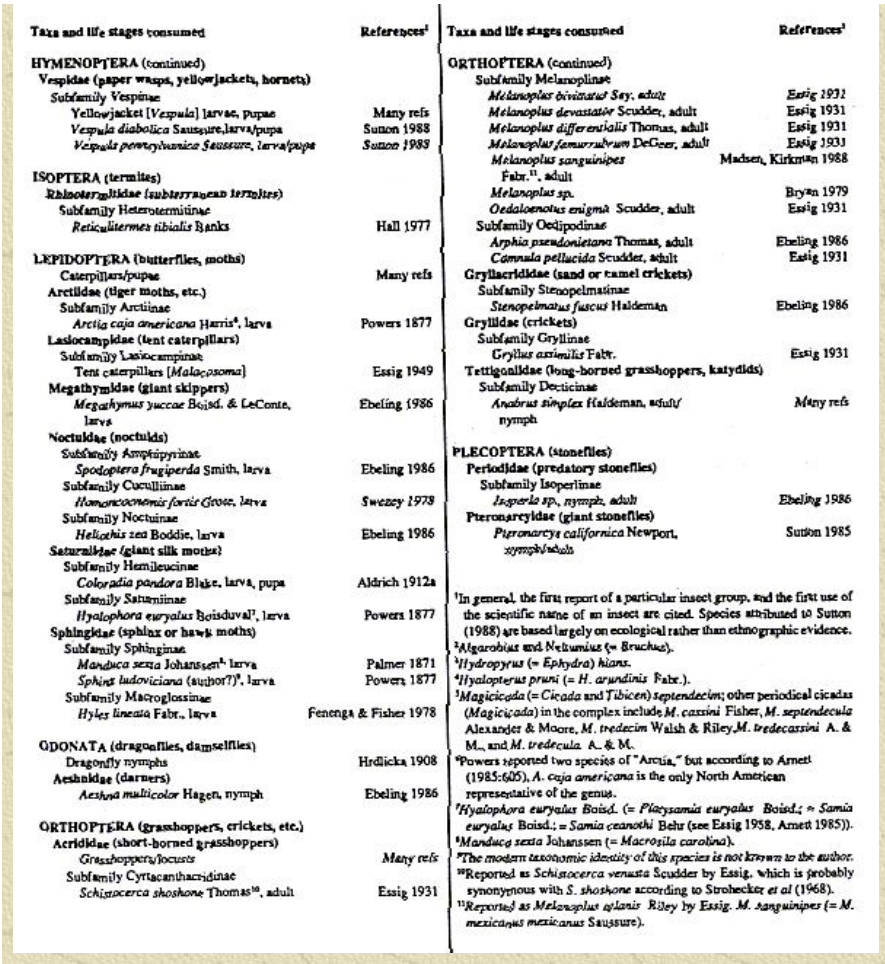
GRD

Table 1. Taxonomic Inventory of Insects Used as Food by Indigenous Groups in North America North of Mexico

Taxa and life stages consumed	References[1]
COLEOPTERA (beetles, weevils)	
Bruchidae (seed beetles)	
Subfamily Bruchinae	
Algarobius spp.[2], larvae, pupae	Bell;Castetter 1937
Neltumius spp.[3], larvae, pupae	Bell;Castetter 1937
Cerambycidae (long-horned beetles)	
Grubs in decayed oak trees	Powers 1877
Subfamily Cerambycinae	
Neoclytus conjunctus Leconte, larva	Essig 1931
Xylotrechus nauticus Mann., larva	Essig 1931
Subfamily Lamiinae	
Monochamus maculosus Hald., larva	Essig 1931
Monochamus scutellatus Leconte, larva	Essig 1931
Subfamily Lepturinae	
Rhagium lineatum Olivier, larva	Essig 1931
Subfamily Prioninae	
Ergates spiculatus Leconte, larva	Essig 1931
Prionus californicus Mots., larva, adult	Essig 1931 Roust 1967
Dytiscidae (predacious diving beetles)	
Water beetles	Hrdlicka 1908
Subfamily Cybisterinae	
Cybister explanatus, adult	Roust 1967
Scarabaeidae (scarab beetles)	
"White grubs"	Essig 1931
"Grubworms"	Carr 1951
Subfamily Melolonthinae	
Cyclocephala dimidiata Burmeister, adult	Sutton 1988
Cyclocephala villosa Burm., adult	Sutton 1988
Phyllophaga fusca Froelich, adult	Sutton 1988
Polyphylla crinita LeConte, adult	Essig 1931
DIPTERA (true flies)	
Ephydridae (shore flies)	
Subfamily Ephydrinae	
Hydropyrus hians Say[3], pupa	Williston 1883
Fly larvae or "worms"	Many refs
Rhagionidae (snipe flies)	
Subfamily Rhagioninae	
Atherix sp., egg masses w/adult females	Aldrich 1912b
Tipulidae (crane flies)	
Subfamily Tipulinae	
Holorusia rubiginosa Loew, larva	Essig 1931
Tipula derbyi Doane, larva	Essig 1931
Tipula quaylii Doane, larva	Essig 1931
Tipula simplex Doane, larva	Essig 1931
HEMIPTERA (true bugs)	
Belostomatidae (giant water bugs)	
Subfamily Lethocerinae	
Lethocerus americanus Leidy, adult	Essig 1949

Taxa and life stages consumed	References[1]
HOMOPTERA (aphids, scale insects, etc.)	
Aphididae (aphids)	
Subfamilies not applicable	
Hyalopterus pruni Geoffroy[4], honeydew	Jones 1945
"Honeydew"	Many refs
Cicadidae (cicadas)	
Cicadas	Many refs
Subfamily Tibiceninae	
Diceroprocta apache (auth?), nymph/adult?	Ebeling 1986
Subfamily Tibicininae	
Magicicada septendecim Linn. complex[5], nymphs	Many refs
Okanagana bella Davis, nymph & adult?	Sutton 1988
Okanagana cruentifera Uhler, nymph & adult?	Sutton 1988
Platypedia areolata Uhler, nymph & adult?	Sutton 1988
HYMENOPTERA (bees, ants, wasps)	
Apidae (honey bees, bumble bees)	
"Bee larvae"	Downs 1966
Subfamily Bombinae	
"Bumblebee larvae"	Muir 1911
Bombus appositus Cresson, larva/pupa	Sutton 1988
Bombus nevadensis Cresson, larva/pupa	Sutton 1988
Bombus terricola occidentalis Greene, larva/pupa	Sutton 1988
Bombus vosnesenskii Radoszkowski, larva/pupa	Sutton 1988
Cynipidae (gall wasps, etc.)	
Subfamily Cynipinae	
Oak galls produced by cynipid wasp	Carr 1951
Formicidae (ants)	
Ants, ant "eggs" (larvae, pupae)	Many refs
Subfamily Formicinae	
Camponotus sp., larva, adult	Muir 1911
Formica rufa Linn., larva/pupa/adult?	Sutton 1988
Lasius niger Linn., larva/pupa/adult?	Sutton 1988
Myrmecocystus melliger Forel, honeypots	McCook 1882
Myrmecocystus mexicanus hortideorum McCook, honeypots	Sutton 1988
Subfamily Myrmicinae	
Pogonomyrmex sp., adult	Frison 1971
Pogonomyrmex californicus Buckley, larva/pupa/adult?	Sutton 1988
Pogonomyrmex desertorum Wheeler larva/pupa/adult?	Sutton 1988
Pogonomyrmex occidentalis Cresson larva/pupa/adult?	Sutton 1988
Pogonomyrmex owyheei Cole, larva/ pupa/adult?	Sutton 1988

Table 1 continued on page 4



Taxa and life stages consumed	References[1]
HYMENOPTERA (continued)	
Vespidae (paper wasps, yellowjackets, hornets)	
Subfamily Vespinae	
Yellowjacket [*Vespula*] larvae, pupae	Many refs
Vespula diabolica Saussure, larva/pupa	Sutton 1988
Vespula pennsylvanica Saussure, larva/pupa	Sutton 1988
ISOPTERA (termites)	
Rhinotermitidae (subterranean termites)	
Subfamily Heterotermitinae	
Reticulitermes tibialis Banks	Hall 1977
LEPIDOPTERA (butterflies, moths)	
Caterpillars/pupae	Many refs
Arctiidae (tiger moths, etc.)	
Subfamily Arctiinae	
Arctia caja americana Harris[4], larva	Powers 1877
Lasiocampidae (tent caterpillars)	
Subfamily Lasiocampinae	
Tent caterpillars [*Malacosoma*]	Essig 1949
Megathymidae (giant skippers)	
Megathymus yuccae Boisd. & LeConte, larva	Ebeling 1986
Noctuidae (noctuids)	
Subfamily Amphipyrinae	
Spodoptera frugiperda Smith, larva	Ebeling 1986
Subfamily Cucullinae	
Homorocoenemis fortis Grote, larva	Swezey 1978
Subfamily Noctuinae	
Heliothis zea Boddie, larva	Ebeling 1986
Saturniidae (giant silk moths)	
Subfamily Hemileucinae	
Coloradia pandora Blake, larva, pupa	Aldrich 1912a
Subfamily Saturniinae	
Hyalophora euryalus Boisduval[7], larva	Powers 1877
Sphingidae (sphinx or hawk moths)	
Subfamily Sphinginae	
Manduca sexta Johanssen[8] larva	Palmer 1871
Sphinx ludoviciana (author?)[9], larva	Powers 1877
Subfamily Macroglossinae	
Hyles lineata Fabr., larva	Fenenga & Fisher 1978
ODONATA (dragonflies, damselflies)	
Dragonfly nymphs	Hrdlicka 1908
Aeshnidae (darners)	
Aeshna multicolor Hagen, nymph	Ebeling 1986
ORTHOPTERA (grasshoppers, crickets, etc.)	
Acrididae (short-horned grasshoppers)	
Grasshoppers/locusts	*Many refs*
Subfamily Cyrtacanthacridinae	
Schistocerca shoshone Thomas[10], adult	Essig 1931

Taxa and life stages consumed	References[1]
ORTHOPTERA (continued)	
Subfamily Melanoplinae	
Melanoplus bivittatus Say, adult	Essig 1931
Melanoplus devastator Scudder, adult	Essig 1931
Melanoplus differentialis Thomas, adult	Essig 1931
Melanoplus femurrubrum DeGeer, adult	Essig 1931
Melanoplus sanguinipes Fabr.[11], adult	Madsen, Kirkman 1988
Melanoplus sp.	Bryan 1979
Oedaleonotus enigma Scudder, adult	Essig 1931
Subfamily Oedipodinae	
Arphia pseudonietana Thomas, adult	Ebeling 1986
Camnula pellucida Scudder, adult	Essig 1931
Gryllacrididae (sand or camel crickets)	
Subfamily Stenopelmatinae	
Stenopelmatus fuscus Haldeman	Ebeling 1986
Gryllidae (crickets)	
Subfamily Gryllinae	
Gryllus assimilis Fabr.	Essig 1931
Tettigoniidae (long-horned grasshoppers, katydids)	
Subfamily Decticinae	
Anabrus simplex Haldeman, adult/ nymph	*Many refs*
PLECOPTERA (stoneflies)	
Perlodidae (predatory stoneflies)	
Subfamily Isoperlinae	
Isoperla sp., nymph, adult	Ebeling 1986
Pteronarcyidae (giant stoneflies)	
Pteronarcys californica Newport, nymph/adults	Sutton 1985

[1]In general, the first report of a particular insect group, and the first use of the scientific name of an insect are cited. Species attributed to Sutton (1988) are based largely on ecological rather than ethnographic evidence.
[2]*Agarobius* and *Neltumius* (= *Bruchus*).
[3]*Hydropyrus* (= *Ephydra*) *hians*.
[4]*Hyalopterus pruni* (= *H. arundinis* Fabr.).
[5]*Magicicada* (= *Cicada* and *Tibicen*) *septendecim*; other periodical cicadas (*Magicicada*) in the complex include *M. cassini* Fisher, *M. septendecula* Alexander & Moore, *M. tredecim* Walsh & Riley *M. tredecassini* A. & M., and *M. tredecula* A. & M.
[6]Powers reported two species of "Arctia," but according to Arnett (1985:605), *A. caja americana* is the only North American representative of the genus.
[7]*Hyalophora euryalus* Boisd. (= *Platysamia euryalus* Boisd.; = *Samia euryalus* Boisd.; = *Samia ceanothi* Behr (see Essig 1958, Arnett 1985)).
[8]*Manduca sexta* Johanssen (= *Macrosila carolina*).
[9]*The modern taxonomic identity of this species is not known to the author.*
[10]Reported as *Schistocerca venusta* Scudder by Essig, which is probably synonymous with *S. shoshone* according to Strohecker *et al* (1968).
[11]*Reported as Melanoplus atlanis* Riley by Essig. *M. sanguinipes* (= *M. mexicanus mexicanus* Saussure).

Insects in Chinese Medicine

Thomas H. Slone
1617 Berkeley Way
Berkeley, CA 94703-1273

In Volume 4(l) of *The Food Insects Newsletter,* I wrote a query regarding the alleged practice of eating walking stick excreta. A fellow reader, D. Keith McE. Kevan, kindly answered my query with a reference stating that this indeed was/is a practice among the Chinese of Malaysia:

Their [the walking stick] presence in a Chinese house is a good omen, but more than this they believe in the healing powers of droppings of the stick-insect. For this, more than any other reason, Chinese are known to rear them. They claim that dried excreta mixed with herbs will cure a number of ailments, such as asthma, stomach upsets, muscular pains. A brew is also made from the droppings and drunk like tea. This they claim will cleanse the body (Nadchatram 1963:35-36).

I was intrigued by this practice, as I had not considered that insect excreta would be used for medicinal purposes. Searching the library turned up an excellent monograph on insects in Chinese materia medica by Read (1984) which has not been previously mentioned in *The Food Insects Newsletter.* Read translated the Pen Ts'ao Kang Mu, an encyclopedia of traditional Chinese medicines, and supplemented it with translations of ancient Chinese records. Besides descriptions of uses for bee and silkworm products, the monograph includes uses for hornets, wasps, mantids, flies, stink bugs, caterpillars, beetles, butterflies, cicadas, mole-crickets, silverfish, cockroaches, crickets, dragonflies, locusts, lice, parasitic worms, spiders, scorpions, leeches, and other invertebrates. The monograph also includes uses for unusual invertebrate products such as insect galls, mantid egg cases, cicada fungus, cocoons, spider's webs, earthworm castings, and excreta. Notably, however, there is no mention of retained bloodclots", and as a "galactogogue" (milk inducer).

-Cicada exoskeleton (from *Pellis cicadae)* were very common and cost $.50/ounce. "For skin eruptions and ulcers and urticaria .... For deafness with running pus from ear, eye growths after smallpox, for indigestion and vomiting" (Read 1994:118-119).

-Cicada *(Pellis cicadae)* parasitized by the fungus *Cordyceps soboliferea* were fairly common and cost $.75/ounce. "For infantile convulsions, tetany and tetanus; for night-crying and fear", also same as the exoskeleton (Read 1984: 119-120). An herbalist at one of the shops told me that these were good for the eyes, and were commonly used by his customers.

- Silkworm caterpillar *(Bombyx mori)* was either rare or not commonly understood to be an insect, since it is sold bleached and nondescript at $.50/ounce. Read (1984: 56-57) describes many uses for them.

Notedly the most commonly found insect product at the shops (aside from honey bees), the cicada exoskeleton, consists principally of chitin which is known to have several valuable medical properties (Goodman 1989).

It is unfortunate that so few insects used in traditional Chinese medicine are available in the United States. One herbalist indicated to me that insects are difficult to import because the customs officials do not like to deal with them (but see Brickey and Gorham [19891). Some of the people I encountered at the herb shops, both customers and herbalists, expressed disbelief, shock, or disdain when they realized what I was asking for; two herbalists actually said that the insects I was showing them in Read (1984) were not used in medicine! The Chinatowns of Oakland and San Francisco are not static, and they constantly receive new immigrants from China, Korea, and Southeast Asia. So it would seem that the sparsity of insects is not due solely to the alleged difficulty of importing them, since the newer immigrants would presumably create sufficient demand for them; consequently it seems that insects, though diversely represented, are generally of marginal importance to Chinese materia medica. It would be interesting to know to what

walkingsticks, so the use of walkingstick excreta may be peculiar to the Chinese of Malaysia. The insect excreta described are from silkworm caterpillar and various grubs.

Spurred on by DeFoliart's query (1988), and my own desire to find insect excreta for sale, I surveyed several Chinese herbal shops in Oakland and San Francisco. Unfortunately, I found very little diversity in these shops. Of course, honey bee products were very common (honey, royal jelly and wax). I found only two non-insect invertebrates: scorpions and leeches; the scorpions, I was told were expensive, but I was not told how much. Here is a summary of the insects that I found (they were all dried):

- Mason bees *(Xylocopa violacea)* were found at only one shop at $.20 each (perhaps overpriced). It was stored in salt, perhaps indicating its age and disuse. Read (1984: 29-30) describes the bee but only gives a use for its honey.

- Cockroaches (various species have been used) were fairly common, and cost $2.00/ounce. According to Read (1984: 134-136) they are used "for internal feverish-chills", "for breaking up degree insects constitute current materia medica in Asian Chinese communities where import restrictions would not be an issue.

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Recent Technical Papers

Kantha, Sachi Sri. 1990. Nutrition and health in China, 1949 to 1989. *Progress in Food and Nutrition Science* 14:93-137. Department of Physiology and Biochemistry, Medical College of Pennsylvania, Philadelphia, PA 19129[1]

Author's Abstract. Since the establishment of a new social order in 1949, China's attempts to feed and nurture its large population has been a topic of serious study in many disciplines. This review focuses on dietary sources of Chinese population and incidence, increase and decline of important diet-related health disorders in China during the last four decades. Literature published since 1949 on goiter, rickets, riboflavin deficiency, beri-beri, vision impairment, favism, cancer, atherosclerosis and coronary heart disease, hypertension, dental and smoking-related diseases, diabetes mellitus, pancreatitis, lactose intolerance, mineral deficiency, Kashin-Beck disease, parasitic diseases and genetic disorders are reviewed. Also presented selectively are reports related to ethnodietetics, health care, maternal health and pediatric care as well as longevity.

In the 1980s, total caloric intake of Chinese population showed a 19% increase on a daily basis from that of late 1940s. In overall terms, plant-derived foods supplied 93% of energy, 87% of protein and 55% of fat to the Chinese. Among the animal foods, pork remains the most common and least expensive form of meat, contributing more than 90% of China's total meat production, excluding poultry and fish. In 1949, the life expectancy in China was only 36 years. In early 1980s, it has increased to 68 years. This increase in life expectancy is attributed mostly to improved nutrition and lowering of mortality due to decrease in infectious diseases. Though population, disease and mortality statistics of modern China are spotty and sometimes questionable, common consensus among the researchers is that since 1949 the public health situation in China has improved tremendously.

Tabular information is provided by the author on animal products used in Chinese traditional medicine and their implicated remedial action (the information is drawn from an NIH translation of "A Barefoot Doctor's Manual").

Bee hive: Relieves flatulence, counteracts toxicity and kills worms.
Cicada exuviae-. Reduces fevers and clears lungs.
Cricket: Promotes diuresis.
Dung beetle: Dissipates clots and bruises.
Locust, flying: Supplements deficiencies and complements the blood.
Mantis: Resolves bruises and clots.
Mantis cocoon (found on mulberry leaves): Strengthens kidneys and relieves convulsions.
Mole cricket: Promotes diuresis and eliminates edema.
Silkworm: Relieves flatulence and loosens congestion.
by mouth. Relative to ethnodietetics, of four regional variations that can be identified in China's food preparation, Kantha mentions insects specifically only in relation to Canton (southern China). The Cantonese style is characterized by a reliance on color, and stir-frying and steaming are the most-used methods of preparation. Significant dietary problems in the country include deficiencies in riboflavin and iron with an estimated 100 million Chinese children probably suffering from nutritional anemia due to iron deficiency. (Although not mentioned in the review, it can be noted in this context that many insects are rich sources of riboflavin and/or iron.)

[1]The author's current address is: Osaka Bioscience Institute, 6-2-4 Furuedae, Suita. Osaka 565, Japan.

Kok, R.; Shivhare, U.S.; Lomaliza, K. 1991. Mass and component balances for insect production. *Canadian Agricultural Engineering* 33:185-192. Department of Agricultural Engineering, Macdonald College of McGill University, 21 1 11 Lakeshore Blvd., Ste. Anne de Bellevue, PQ, Canada H9X 1CO.

Authors' Abstract. Our overall objectives are to create the technology to mass-produce insects and stimulate their industrial use. A process to grow insect larvae for human food was previously described. It consists of two major cycles, conversion and propagation, and contains three unit operations: solids mixing, sifting and air classification. Central to the process is a reactor with four material streams passing through it and having four functions: feed conditioning, feed conversion, dormant stage incubation and propagation. Because the reactor is of the batch-fed plug-flow type, the process was operated semi-continuously with *Tribolium confusum* as the reactant, growing on a feed of flour and yeast extract. At the end of a six-month operating period the system was sampled opportunistically and in this paper the results of that sampling are presented. The samples were analyzed for moisture, ash, protein and fat. Mass balances were then calculated for these components. Carbohydrate was found by difference. Process losses were dominated by losses incurred during the organism propagation cycle; nitrogen was lost in organism wastes such as larval exuvia. The objectives of nutrient incorporation and fat generation were partially met and the results from the study will be used as the basis for the design of a second generation process.

Nakagaki, B.J.; DeFoliart, G.R. 1991. Comparison of diets for mass-rearing *Acheta domesticus* (Orthoptera: Gryllidae) as a novelty food, and comparison of food conversion efficiency with values reported for livestock. *Journal of Econonic Entomology* 84(3):891-896. Department of Entomology, University of Wisconsin, Madison, WI 53706.

Authors' Abstract. As part of research on mass-rearing the cricket *Acheta domesticus* (L) as a novelty (innovative) food, four cricket diets, two prepared in the laboratory and two

Spanish fly *(Cantharis):* Cauterizes tissues to control toxin spread (esp. used in rabid dog bites).

As medicine, insects such as crickets, flying locusts and mantis are roasted, pulverized and mixed with boiled water before being taken

commercial, were compared on the basis of cost per kilogram (wet weight) of eighth instars produced. Costs were influenced by dietary ingredients,

SEE RECENT TECHNICAL PAPERS, p. 11.

They Ate What? (Catching up on the magazines)

The above is the title of an article published in the Cuisine Section *of American Way,* the official mag of American Airlines. I found it on my desk one day last spring. Dr. Jane Homan, who has flown to just about everywhere in her travels for the UW Office of International Agricultural Programs, had attached a note: 'When this starts showing up in airline magazines it must be getting 'chic'!!

Author Dick Reavis, a contributing editor of *American way,* certainly makes it sound so, with "creepy creatures" now considered by some as the height of *haute cuisine.* According to Reavis; "It's in style: Now that Mexican restaurants are popular from Bangor to San Diego, the cognoscenti of real Mexican food are seeking out restaurants that serve unadulterated, un-Europeanized food from Central America and Mexico. Pre-Hispanic or pre-Columbian food it's called, the kinds of dishes Mexicans ate before the region was subdued by the Spanish. Worms [read insect larvae], cooked or live, are a big part of pre-Hispanic cuisine, and eating them has become a rite of passage for those who would be intimate with the Mexican past."

One restaurant providing this kind of fare is Don Chon's, near the historic La Merced market in Mexico City, "a back-street landmark for rustics and adventurous connoisseurs." It's unpretentious, "but diplomats, ambassadors, and the theater crowd flock there at lunchtimes." The owner of Don Chon's, Leopoldo Ortega, notes that back in the 'fifties, the restaurant was mainly patronized by the vendors who came to La Merced from the countryside. Because pre-Hispanic food has become relatively expensive, tourists and people with bohemian tastes now outnumber the country folk, who, Ortega says, have "become our sellers more than our customers.' A hint of how expensive is given by Reavis who ordered a plate of red agave worms [Larvae of the moth, *Xyleutes redtenbachi];* price, 30,000 pesos or about $11, nearly two times the daily wage of most Mexicans. (Reavis also tried a side dish of live worms and describes the indelicate maneuvers required to remove one when it bit him.)

Reavis concludes his article with the following paragraph: "In my opinion, the finest pre-Hispanic delicacy at Don Chon's (and also sometimes served at the highbrow Prendez restaurant downtown on 16 de Septembre Street, a place not known for pre-Hispanic food; that it even offers such a dish proves the trend) is escamoles in green sauce, sprinkled with diced onion and bits of cilantro. Escamoles are the larvae of black ants. When boiled, they look like cottage cheese. Rank amateurs scoop them up with a spoon, and ordinary Mexicans with a corn tortilla. But the blase know, and the bold quickly see, that a torta de ahuatli - a wafer made of batter and the eggs of a swamp fly [read Mexican caviar, eggs of several species of aquatic Hemiptera, or true bugs] - does the trick in higher style. The season for escamoles is in the spring. By then, Don Chon's will also be serving white worms as big as your fingers. I don't know if they bite, but take my advice: They're tasty when toasted, but I wouldn't eat them alive."

If we are looking for glamour, however, we needn't settle for the airline magazines. How about the 1989 25th Anniversary Swimsuit Issue of *Sports Illustrated'* Now we're talking sun and surf and the Pacific Coast of Mexico. But, according to the author, it is the worst place in the world to be a grasshopper. A recipe is offered (page 260) for a small species sometimes served for lunch in Oaxaca:

Ingredients

About 1000 grasshoppers (the younger the better)
1/2 cup chili sauce
garlic
1 lemon
1 cup guacamole
onion
6 tortillas

Directions: Soak the grasshoppers in clean water for 24 hours. Boil them, then let dry. Fry in a pan with garlic, onion, salt and lemon. Roll up in tortillas with chili sauce and guacamole. According to the author, "Serves six if you can find six."

- If one prefers not glamour but a more sedate and intellectual approach, one can consult *Natural History* magazine, specifically food historian Raymond Sokolov's column, "A Matter of Taste." Three times in the past two years, Sokolov has dipped into things entomophagous. The first was in the August 1989 issue in an article titled, "Before the Conquest" and subtitled 'Thousands of Mexican dishes could not have existed before Cortes.' Sokolov notes that Mexico offers a better opportunity than most cultures do for precisely tracing the evolution of a national cuisine. The evidence comes from many sources; the Aztecs, who wrote about their own civilization; from pre-Columbian and colonial Mexican art; from ethnographic documents produced at the direction of the Spaniards soon after the conquest; and from survival of ancient foodways that are still abundantly practiced in Mexico today.

The single most important work was the monument *General History of the Things of New Spain* (Historia general de las cosas de Nueva Espana), by the Franciscan friar Bernardino de Sahagun. From Sahagun it is known that the Aztec diet was based on corn and tortillas, tamales and plenty of chilies in many varieties. Sokolov describes how this diet was influenced by the importation of European-style foods that began with Cortes, and states that it is a wonder "that so much of what Mexico ate before Cortes is still available today and popularly consumed, from cactus paddles to chilies, from tadpoles to various worms and bugs."

The article concludes with a recipe for Salsa de Jumilies (Mountain chinch sauce) taken from Adela Fernandez's book, *La Tradicional Cocina Mexicana y sus Mejores Recetas,* Panorama Editorial, Mexico, 1989. We have not reprinted this recipe because we doubt that very many Americans are yet ready for it. Jumilies belong to the "stink bug" family, Pentatomidae, Order Hemiptera.

- In the September 1989 issue *of Natural History,* Sokolov follows up on the previous month with an article titled "Insects, Worms, and

SEE THEY ATE WHAT? P. 8

They Ate What? (cont)

Other Tidbits" and subtitled "The Mexican diet, before Cortes, obtained high-quality protein from lowly sources." He

popular as snacks among Mixtec peasants; ant larvae and pupae (called ant eggs); and in Jungapeo, Michoacan, wasps. Two excellent photographs (one of maguey worms) accompany the article. (Ed.: It can be noted that Dr. Julieta

emphasizes that "authentic" cuisine "virtually everywhere" is not the immobile tradition that traditionalists wish it to be," and furnishes an impressive list of foods contributed by the New World to the Old, including potato, tomato, corn, chocolate, squashes, beans and many others. Some of these New World foods have had great nutritional impact, for example, the sweet potato, peanut and the chili pepper in China, and manioc, corn, peanuts and pumpkins in Africa.

Relative to Mexico when Cortes appeared Sokolov notes that the country 'was a major world civilization with a vigorous culture that continues to challenge imported European culture today. [Enough native Mexicans have survived] to carry on local food traditions in tandem with the new ideas and foods from Spain and the Spanish Empire." Insects of many species are a prominent part of these local food traditions, but Sokolov devotes the most space to the maguey worm, larvae of the giant skipper butterfly, *Aegiale hesperiaris*, which are also called palomillas del maguey (maguey squabs), champolocos, meocuilines and pecahs. Sokolov paraphrases the account of these larvae in Teresa Castello Yterbide's *Presencia de la Comida Prehispanica,(*Banamex, 1986), as follows: "Larvae harvesters poke about among the maguey's lower leaves, looking for the telltale tunnels at the base of the leaves near the outer edges. Working very carefully with a machete, so as not to disembowel the larvae unwittingly, they cut open the leaf. To extract the larvae whole, they use hooks formed by cutting thin strips from the edge of a maguey leaf. Then they remove all its spines except for one at the end of the strip. This they form into the hook they use to catch the larvae by the head. To store the larvae, they make pouches with the skin of a tender new maguey leaf, which is called mixiote (it gives its name, synecdochically, to a dish made of chunks of marinated meat wrapped in mixiote pouches and steamed).

To cook the larvae, people sometimes just put a whole gusano (larvae)-filled mixiote over coals or hot ashes, or they might just put the larvae directly on a bakestone until they swell and stiffen, turning golden brown and crunchy. And this is not some quaint account of a long-forgotten practice. Castello Yturbide nonchalantly mentions that maguey larvae can be obtained in April in the market of San Juan in Mexico City or in Actopan and Ixmiquilpan (two villages of the state of Hidalgo) or in farm hamlets around Mexico City.

Relative to other insects, Sokolov notes that the eggs of water bugs (moscos de pajaro) (Hemiptera) are still harvested in the same manner described by Sahagun. Today, they are toasted, ground up and made into little cakes held together with turkey egg. In the late 18th Century, they were apparently a garnish for the festive dish called revoltijo, served on Christmas Eve and at the vigil of Thursday night of Holy Week. Other insects still eaten include locusts, available year-round at markets in Oaxaco and Atlixco, toasted and eaten with tortillas and a sauce of chili pasilla; mountain chinch bugs, eaten toasted or living; oak-boring beetles which are

Ramos-Elorduy, who has done extensive research on entomophagy in Mexico, has reported that more than 200 species of insects are still eaten in Mexicc [personal communication, 1986]).

Raymond Sokolov's third venture into entomophagous topics occurred in the July 1991 issue of *Natural History* when he drew the difficult assignment of trying to write a food column relevant to the remainder of the July issue, which was devoted entirely to mosquitoes. In this one, he draws some material from past issues of *The Food Insects Newsletter,* particularly on bakuti (made from brood of the giant honey bee in Nepal, as described by Professoi Michael Burgett in the November 1990 issue). In the process, Mr. Sokolov makes some nice comments about the *Newsletter,* which immediately stamped him as my favorite food author. But, if you are wondering about the mosquito connection, even a gifted write, like Mr. Sokolov encounters some difficulty. After flowery dissertation at some length about the joys of fly-tying, the beauty of mountain streams, and other interesting diversions, he finally settles, for the basic fact that trout eat mosquitoes and we eat trout.

- Marge Knorr, a free-lance (primarily travel) writer from Reno. Nevada, had an article called "Food for Thought: Are Mormon crickets pests or protein?" in the May/June 1991 issue of *Nevada* magazine. At the end of the article, Ms. Knorr identifies herself as a loyal subscriber to *The Food Insects Newsletter,"* making her another favorite author. Inspiration for her article was the 1990 banner year for Mormon crickets in Nevada, but she describes, interviews with a number of entomologists and anthropologists on a variety of edible insects. Diverse insights emerged. Catharine Fowler, an anthropology professor at the University of Nevada Reno, described pandora moth *[Coloradia pandora]* caterpillars as very good - like a scrambled egg omelet with mushrooms." About 10 years ago, Fowler mediated a dispute between the Paiute Indians, and the U.S. Forest Service in California as to whether the caterpillars (a traditional food of the Paiute) would be harvested or sprayed. This time the Paiute won. On the other hand, an assistant professor of nutrition at the UNR said, "I'd never eat insects. I'm too deeply immersed in my own culture."

- Finally, to be right up-to-date, there is an article called "Zaire River: Lifeline for a Nation," by Robert Caputo in the current issue (November 1991) of *National Geographic.* It is accompanied by an interesting photograph (page 26) captioned: Caterpillars and palm grubs fresh off the riverboat cover a table in Kinshasa's central market.

- The pre-Hispanic insect foods of Mexico seem to get the lion' share of attention from the popular press in the United States. Don Chon's, in particular, has been featured or at least mentioned in several magazines and newspapers, lately, and by now it must be one

SEE THEY ATE WHAT? P. 11

Japanese Scientists Visit U.S. and Canada on Fact-Finding Mission

(Editor: At the specific request of the two undersigned, the item below is published as received. The session in Madison was interesting, enjoyable and of mutual benefit. It is encouraging for the world that an official agency of a technologically advanced nation is taking a serious look at the potential of insects as food.)

The Japanese Ministry of Agriculture, Forestry and Fishery is planning a research project in which various insect functions are analyzed so that the results will be utilized by industries. In this connection, we, a group of six, including two entomologists, Dr. J. Mitsuhashi (Tokyo University of Agriculture and Technology) and Dr. K. Umeya (Food and Agricultural Research and Development Association) visited the United States and Canada this past August. On the trip, we visited Emeritus Prof. DeFoliart at Wisconsin University, to talk about insects as foods. We confirmed the idea that insects other matters. Through this talking, Prof. DeFoliart gave us deep impression with his gentle personality and enthusiasm on food insects. As he pointed out the realization of insect foods has many difficult problems. In the United States as well as in Japan, it will be a long time before the government takes this problem seriously. However, a world-wide deficiency of protein sources will continue to occur in the future and this will turn the people's eyes to insect foods.

Professor DeFoliart also showed us his collection of food insects. Among them, a lollipop containing an insect. The name was Hot Lix. We obtained this candy later in San Francisco. The insect was found to be a mealworm, a larva of *Tenebrio molitor.* When we visited Prof. DeFoliart we brought cooked Japanese grasshoppers, "Inago," and a can of wasps as gifts for him. He opened the bag of "Inago" on the spot and enjoyed it with us.

We hope that Prof. DeFoliart is in good health for a long time and can continue his activities, including *The Food Insects Newsletter*
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are the most valuable food source which has been left unutilized on the earth. Based on this idea, we discussed selection of species suitable as foods, methods of large scale production of insects at low cost, ways of reforming people's hatred for insects, and

Dr. J. Mitsuhashi
Dr. K. Umeya

Toward a Recipe File (cont.)

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Contents intentionally omitted.

Recent Technical Papers (cont.)

mean cricket wet weight at time of harvest, and feed/gain ratios. For the laboratory-prepared diets, crickets grown on Patton's diet no. 16 or on NRC reference chick diet averaged 0.443 and 0.418 g at time of harvest, with feed/gain ratios of 0.923 and 0.949, respectively. Because of the cost of ingredients, however, the cost per kilogram of live crickets produced was only $0.21 for the NRC chick diet compared with $2.55 for Patton's no. 16; these costs exclude the cost of labor for mixing the diets. Performance of crickets on the laboratory-prepared diets was somewhat better than performance on the commercial diets. The food conversion efficiency of crickets at 30°C or higher was found to be higher than reported for broiler chicks and pigs and much higher than those reported for sheep and cattle.

The authors estimate, after adjusting for dressing percentage and carcass trim in the vertebrate livestock and for removal of legs and the indigestibility of chitin in the cricket, that the dry weight food conversion efficiency of crickets harvested as 8th instar nymphs (no wings) is more than twice as high as those of chickens and pigs, >4 times higher than sheep and nearly 6 times higher than steers. The crickets were fed a high-protein diet similar to those used in bringing meat animals to market weight. The crickets were maintained at temperatures of 33-35°C; cricket food conversion efficiency decreases rapidly as temperature falls below 30°C, thus high food conversion efficiency in crickets requires energy input. On the other hand, the authors note that a tremendous further advantage accrues to the cricket when fecundity is considered. A female cricket produces 1200 to 1500 offspring, while in beef production, four animals exist in the breeding herd for each animal marketed, thus giving the cricket an additional 4X advantage over beef.

They Ate What? (cont.)

of the best known restaurants in Mexico. Makes you wonder if some enterprising restaurateur in the U.S. might reap a million dollars' worth of publicity free by offering some of the grasshoppers, harvester ants, yellowjacket larvae/pupae, etc. that were such an important part of the food of our Indian forebears on this continent.

The foregoing is not by any means a complete inventory. There are no doubt many articles that we have not seen, and only one (of many) in which this editor has been involved as an interviewee is included. It would be hard to believe that the kind of media bombardment that has been occurring isn't increasing public awareness that edible
insects are respectable players on the world stage.
GRD

Phlippines (cont.)

Remarks by people in other areas indicate that this very common form of cooking (known as adobo) is the usual one for June beetles. They are often available in the market in Laoag, and probably in some other areas as well. I am told that adults and larvae of other large scarabaeids and longhorn beetles (cerambycids) are also eaten.

I have not seen indications that any termite is commonly eaten in the Philippines. The most likely candidate would be the sexuals of *Macrotermes gilvus* (Termitidae: Macrotermitinae). This is the largest Philippine termite, and colonies are often so massive that they undoubtedly give off large, harvestable masses of sexuals during the pairing season.

The only ant which I have found as human food is the weaver ant *Oecophylla smaragdina* (Formicinae). Ronald Taylor mentions in *Butterflies* in *my Stomach* that the Dyaks of Borneo sometimes mix worker ants in their rice for flavoring (due to the formic acid). I have not seen this done, but during the season when new queens are produced, farmers in the Philippines sometimes slash the silk nests and catch the falling brood. The ideal time is undoubtedly when prepupae and early pupae of queens predominate. Still, one should never expect to get a pure harvest, and when I was served stir-fried weaver ants in a village on the northern coast of Luzon I found quite a heterogeneous mixture. At that time of year we had ants at every meal in that village, to my delight. I never learned how they harvest weaver ants without getting bitten (and formic acid sprayed directly into the bite) by the masses of aggressive workers, and it may be that harvesting is not worthwhile except during the queen-rearing season.

About the author: since completing his Ph.D. (Georgia 198 1), Chris Starr has worked in Canada, the USA, Taiwan, Trinidad and the Philippines. Depending on how you look at it, this means that a) he has a rich and varied background, or b) he can't hold a job. His research is in systematics and behavioral ecology, especially of social insects.

Letter

... But, the Indians were ahead of the Ohioans

From Janet Stein Carter, formerly of the Cincinnati Zoo:
By the way, the folks in Chicago who were eating cicadas last year (Brood 13) are "copycats." In the spirit of friendly competition, we here in Cincinnati were eating them way back in Brood 10 [Ed. 1987?]. We served batter-dipped and fried cicadas to quite a crowd. Did you see the segment on "Entertainment This Week" of the cicada stir-fry? Although George Ciccarone was "chicken," the Zoo staff made short work of the leftover stir-fry. Actually Gene Kritsky knows of a newspaper article from the Cincinnati paper, 1902 emergence of Brood 10, about some high-society folks who were eating cicada pie.