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THE FOOD INSECTS NEWSLETTER

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Food Conversion Efficiencies of Insect Herbivores

Richard L. Lindroth
University of Wisconsin
Madison, Wisconsin

In his classic children's book, *The Very Hungry Caterpillar, Eric* Carle describes the development of an increasingly voracious caterpillar, from egg hatch to metamorphosis into a beautiful butterfly. In addition to the character appeal of the larva and aesthetic quality of the illustrations, the book teaches some valuable lessons about the nutritional ecology of insect herbivores. The caterpillar hatched on Sunday; on Monday he ate through one apple, on Tuesday two pears ... and on Saturday "he ate through one piece of chocolate cake, one ice cream cone, one pickle, one slice of Swiss cheese, one slice of salami, one lollipop, one piece of cherry pie, one sausage, one cupcake, and one slice of watermelon. That night he had a stomachache!"

What are the lessons we can learn? First, the older (and bigger) the insect is, the faster it eats. Indeed, consumption and growth rates increase exponentially with insect age. For example, leaf consumption by the forest tent caterpillar *(Malacosoma disstria)* is approximately 0.05, 0.2, 0.8, 2.9 and 18.0 square inches for instars 1-5, respectively. Second, the older an insect is, the more diversified its diet may become. Most herbivorous insects are specialists, feeding on only one or a few related species for their entire lifespan. But some insects are generalists; notable among these is the gypsy moth *(Lymantria dispar)*, which feeds on over 300 species of woody plants. For these generalist feeders, diets typically become increasingly diversified as maturity -affords both greater mobility and increased capacity to detoxify the chemical defenses of plants. Third, for caterpillars, as for humans, some foods or combinations thereof may bring considerable discomfort.

These are basic principles of the discipline of nutritional ecology, which, in short, addresses what insects eat, why they eat what they do, and how efficient they are in doing it. The latter theme will be introduced in this paper. Several excellent reviews have been published on the topic and can be consulted for additional information (see References).

Insects, like all living organisms, require energy and nutrients to survive, grow and reproduce. The nutritional components (e.g., protein, carbohydrates, fats, vitamins, minerals) of ingested food may or may not be digested and absorbed. The proportion of ingested food that is actually digested is denoted by AD, the assimilation efficiency (also called "approximate digestibility"). Of the nutrients absorbed, portions are expended in the processes of respiration and work. The proportion of digested food that is actually transformed into net insect biomass is denoted by ECD, the efficiency of conversion of digested food. A parallel parameter, ECI, indicates the efficiency of conversion of ingested food (ECI = AD x ECD). In short, AD indicates how digestible a food is, whereas ECD and ECI indicate how efficient a herbivore is in converting that food into biomass. These efficiency values may b calculated for specific dietary nutrients as well as for the bulk die, For instance, nitrogen use efficiencies are informative because levels of plant nitrogen (an index of protein) are often times limiting to insect performance.

Food conversion efficiencies may vary considerably within species. One cause of such variation involves homeostatic adjustment of consumption rates and efficiency parameters such that an insect can approach its "ideal" growth rate even with foods of different quality in various environments. For example, insects that experience reduced ECDs due to increased respiratory costs may be able to compensate by increasing consumption rates of digestion efficiencies (ADs). Not all changes are homeostatic however. For instance, many insects increase food consumption rates in response to low concentrations of critical nutrients such as protein. Increased consumption will accelerate passage of food through the gut and thereby reduce ADs. In our work with the gypsy moth we found that larvae reared on a protein deficient diet increased consumption rates by 3-4 fold, but overall ADs declined by nearly as much. Other nonhomeostatic changes in efficiency values may occur in response to plant allelochemicals. For example, compensatory feeding to increase intake of a limiting nutrient may simultaneously increase exposure to plant toxins, which in turn may reduce ECDs. In practice, however, it can be quite difficult to ascertain "cause" and "effect" responses with efficiency parameters. Does the insect eat more because digestibility is low, or is digestibility low because the insect is eating more? Efficiency parameters are so closely physiologically related that determination of "cause" and "effect" is not a trivial matter.

Intraspecific variation in food conversion efficiencies may also be related to insect development. ADs generally decrease, whereas ECDs increase, from early to late instars. In other words older larvae digest their food less completely, but that which they do digest is more efficiently utilized for growth. One study showed that values for AD and ECD change from 46% to 27% and 38% to 60%, respectively, for early and late instars of the desert locust *(Schislocerca gregaria)*. Factors contributing to such changes are still largely unknown, but may include shifts in food selection, digestive physiology, metabolic rates, and body composition.

Food conversion efficiencies also vary greatly among species, and this variation is more closely related to feeding guilds than to taxonomic affinity. Insects that feed on nitrogen-rich foliage generally have higher consumption rates and assimilation efficiencies than do insects that feed on nitrogen-,poor foliage, and

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Recent Technical Paper

Neupane, F.P., R.B. Thapa, and M.N. Parajulee. 1990. Life and seasonal histories of the eri silkworm, *Samia cynthia ricini* Hutt. (Lepidoptera: Saturniidae), in Chitwan, Nepal. *J. Inst. Agric. Anim. Sci.* 11:113-120. Institute of Agriculture and Animal Science, Chitwan, Nepal.

Authors' Abstract. The eri silkworm, *Samia cynthia ricini Hutt. (=Philosamia ricini)* produced six generations a year when reared on castor *(Ricitius communis* L.) in Chitwan, Nepal. The egg, larval feeding, and spinning + prepual + pupal periods from March through September lasted 6-1 1, 15-21 and 14-20 days; from September through November lasted 6-11, 16-21 and 26-31 days; and from November through April lasted 25-27, 58-64 and 31-33 days, respectively. It took 38-50 days during March-September, 49-61 days during September-November and 114-126 days during November-April to complete a generation. The mean weights various benefits of ericulture and report the results of a two-year study on the production biology of the insect. Quality leaves of both castor and cassava are available throughout the year, farmers can use their extra time for silkworm rearing and very little investment is required, and even low-skilled children and older folks in a family can participate in the rearing, thus enhancing employment and economic status of poor and subsistence farmers. There are additional advantages: castor bean oil has medicinal and industrial value, while cassava roots are used as human food and animal feed and the old plants as fuelwood. Planting the trees in marginal lands helps prevent soil erosion.

Mean temperatures in the region are highest from April to September (above 30'C) and lowest from December to February (below 20'C). Although fresh leaves are available throughout the year, rearing is not advised during the cold months, November to April, because three months is required to complete a cycle. Pebrine disease (caused by *Nosema* sp.) constitutes a

of a matured larva, a cocoon, a pupa and a shell (silk) were 5.24-+0.86, 3.75±0.56, 3.09±0.51 and 0.61±0.19g respectively, during July-August. Cassava *(Manihot esculenta* L.), which is a substitute food plant of the eri silkworm, also gave similar results. But the mean weights of larvae, cocoons, pupae and shells (silk) were slightly lower when reared on cassava compared to castor.

Ericulture, after nearly disappearing for two decades in the eastern Tarai of Nepal, is slowly regaining popularity. The authors discuss problem during rearing, but is controlled by treating the silkworm eggs and all rearing equipment with 2% formalin. The mean number of eggs per female moth ranged from 149.9 to 398.3 from May through November, with maximum numbers being laid during October and November.

The authors don't mention it in this paper but in Nepal the pupae are fed to chickens rather than being consumed by humans as they are in India. (See elsewhere in this issue for an item on eri silk production in India.)

EDITOR'S CORNER

The National Research Council is talking about "microlivestock," rush of research dollars yet for edible insects

John Rennie's article on entomophagy in the August issue of *Scientific American* (page 20) wasn't included in our November roundup of meritorious magazine articles because it was shorter and of earlier vintage than the articles we mentioned. But Rennie made an important point about the importance of the American attitude that is too seldom made in the popular press. The point was derived actually from a conversation that Rennie and I had in New York. After noting the nutritional attributes of insects, and that people in other cultures don't eat them just out of necessity but because they enjoy them, Rennie's article states:

"'Chacun a son gout' [roughly 'Each to his own taste or preference'], some cvnics might shrug, but DeFoliart argues that such narrowmindedness is harmful. Because Americans and Europeans do not consider insects a food source, few funds are available for research on the food uses of insects. Such research could help identify particularly nourishing insects and improve methods for raising and harvesting them."

The old saying quoted above by Rennie expresses an admirable degree of tolerance, but it needs to be lengthened somewhat to accurately reflect what has long been the prevailing Western attitude toward insects as food: "Each to his own taste, but don't expect us to provide research support that would help you compound the error of yourways." But things may be heading in the right direction. In 199 1, The National Research Council/National Academy of Sciences released a report titled, "Microlivestock: Little-known Animals with a Promising Economic Future." I haven't seen the original report, but it was summarized by Gibbons (199 1) *in Science.* The title sounded exciting. But, lo and behold, the report wasn't talking about "micro" at all. They were talking about "miniature," as in miniature pigs, cows, sheep and goats. The report states that large animals "such as cattle are too large for the world's poorest people, they require too much space and expense." The NRC panel annointed 40 down-sized animals, citing as their advantages that they are less expensive to buy and feed, they take up less space, reproduce quickly, and can be moved around easily.

Conventional livestock will certainly continue to have a place in animal agriculture, but the move toward smallness appears to be a step in the right direction for many situations. A second step in the right direction is toward greater diversity. Several large rodents were among the 40 species which the panel selected from a list of 150 proposed by 300 animal scientists in 80 countries. Relative to rodents specifically, as summarized by Gibbons, they "are among the world's most adaptable mammals -- and they breed like crazy." In all likelihood, the inclusion of rodents required some painful cultural adjustment on the part of some of the NRC panelists, despite the stated adaptability of rodents and the fact that they are

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Letters

Grasshopper consumption by humans and free-range chickens reduces pesticide use in The Philippines

Edward Litton of Manila writes, in part: "Grasshopper is a favorite food in many parts of the Philippines and therefore it is not destroyed with chemical insecticides. It is also fed to chicken raised on pasture. Pastured chickens in the Philippines are not fed commercial feed and therefore have a delicious taste and are sold at a much higher price than chickens fed with commercial feed.

Insect condiments for North Americans

Tree Willis of Venice, California was looking for sources of additional information or confirmation when she wrote, in part:

"I've become interested in utilizing insect [secretions] as a condiment for foods after reading a passage in a book called *Flowering Plants of the Santa Monica Mountains* by Nancy Dale. She writes, 'Indians in Placer County are reported to have put the leaves near the entrance of red ant holes. After the ants had swarmed on the leaves, they were shaken off leaving a vinegary taste which was much relished.' The leaves mentioned are of a plant in the Portulacaceae, called *Claytonia perfoliala.* I'm eager to try it."

Ed.: Are there readers who can cite personal experience? The following comment by Dr. Roger Akre is quoted from the March *1992 Newsletter* (Letters section, p. 5): "Army (and Air Force) survival schools in Washington also advocate the use of *Formica obscuripes and F. exsectoides* [two species of ants] as sources of formic acid as 'salad dressing' for any greens such as pig weed, dandelion, or lambsquarter that can be collected and eaten. The formic acid gives the greens a better flavor, not quite so flat."

A **first record of edible insects used in Macau?**

Emmett R. Easton, Convenor of Math and Science (but who also has a

The San Francisco Insect Zoo's 14th Annual Open House will be May 23, 1993 .

January 25th from Ms. Leslie Saul, director of the Insect Zoo:

"Enclosed please find a check...to help defray publication costs for *The Food Insects Newsletter* which is a truly wonderful resource.

"The San Francisco Insect Zoo will be having our 14th Annual Insect Zoo Open House (alias "What's Bugging You? Day") on May 23rd, 1993. As has become a tradition, we will be serving up some specially created insect recipes and in addition will be having an insect recipe contest (bake off) with one of San Francisco's famous gourmet chefs as judge. That day will also feature a new exhibit on sustainable insect management for conversation (the working title is "Can a butterfly save the rainforest?"). If you have any information on sustainable insect management projects involving insects for use as human/animal food, particularly if there is a conservation benefit from it, I would be terribly grateful to get any reprints/information. (I did read the articles on seasonal caterpillar harvesting on Africa in one of the earlier issues.)

"There will be many other aspects of entomology also highlighted that day as usual: butterfly/insect gardening, "Appreciating Arachnids", insect-plant interactions (insectivorous plants, worm composting, garden clinics), insects in amber, oh-mys from the California Academy of Sciences. This year, a representative from Food & Drug here in SF has asked to participate and Peter Menzel has offered to do a photographic presentation.

"It would be most appreciated if you could put a notice of our upcoming bake-off in the new *Newsletter* issue if it's timely. Also, would it be possible to get reprints of nutritional information on domestic crickets and mealworms if you have it. We are getting more and more requests for detailed information. Thanks very much. Best regards."

Ed.: Leslie, "Amen" to your last paragraph. We also hear from more and more people wanting more and more detailed information. The phone number for more information on the Open House is (415) 753-7053. Mitchell Clark of San Francisco sent in some recent press coverage of the Zoo's Open House, an article called " Putting the Bite on Bugs," by Tara

background in entomology) at the University of Macau, wrote recently to tell us that beetles of the aquatic families Dytiscidae and Hydrophilidae are commonly eaten in Macau. We wanted to get this in the newsletter before 1999 because Macau, a Portuguese outpost since 1557, will then revert to China and it would no 1011911 represent a new geographic record. Actually, to find that these aquatic beetles are used in Macau was not surprising because they are commonly eaten wherever cantonese dwell and Canton is only a short distance from Macau. But life gets harder even for old geography freaks like your editor. We were only vaguely aware that Macau is somewhere along the South China coast, so Emmett's report sent us to the bookshelf to pull out the 1990 Atlas and check things out. Right off, had trouble locating the city of Canton, which is now called Guangzhou. It is located in Guangdong Province (isn't this what used to be called Kwangtung Province?). Maybe the best way to pinpoint it is to simply say that Macau (formerly spelled Macao) is located across the mouth of the Zhu (also known as the Pearl) River from Hong Kong.

Aronson, in the *San* Francisco *Chronicle* of December 9, 1992. According to the article, between 1000 and 3000peoplecrowd up to sample the edible insect delights each year.

Reader suggests that palm weevil culture has economic potential in Indonesia

Ideas for commercial development of palm weevil culture in Indonesia were discussed in two long letters from Edgar Dresner of Vernon, Connecticut. The following is extracted from the first letter, dated November 3, 1992:

"In the now distant past when I worked in Indonesia under U.S. Foreign Aid, I was given the opportunity to eat cooked Curculio larvae; my reaction was enthusiasm, but as you can imagine, I found

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Letters (from page three)

no support by my U.S. or local associates for a program to make these a world food crop. At that time there were many technical difficulties in addition to the cultural antipathy.

"My introduction was palm weevil larvae, fairly large, tasty morsels. Varying with species, these larvae attain up to 90 mm length, diameter about 1/6 length. During my introduction no adult beetles were presented, so I do not know the species. There are at least four large species in East Indonesia and possibly other nearby areas (K.W. Dammerman, 1929, in *The Agricultural Zoology of the Malay Archipelago* (pp. 99- 10 1) listed three Indonesia area palm *weevils: Rhynchophorus ferrugeneus* Fabr., *R. papuanus* Kirsch and *Protocerius praetor* Faust).

"In the copra production areas of East Indonesia back yard culture of the palm weevil larvae is common. A two- meter length of a fallen trunk is retained in a horizontal position and in about two months the trunk is opened and the larvae and pulp are removed. The larvae are separated by washing, then cooked and feasted upon. The trunk piece I saw included the growing tip but I believe the beetles also oviposit in wound areas anywhere on the trunk.

"Though these larvae are locally esteemed, they did not usually enter commercial marketing even within the country because at that time there was no rapid transit from the field to the market; certainly there was no refrigeration to preserve the crop for a later trip. Perhaps equally important, the urban market consisted primarily of people who would not consider eating insect larvae. This fare is forbidden by the Moslem code as well as disapproved culturally by those who have embraced our Western culture.

"In spite of those negatives, I believe there is now a very large potential market for these larvae both in urban Indonesia and in foreign markets. In Indonesia the potential consumers include the more than four million of Chinese background and the even larger number of Moslem Indonesians who now eat in Chinese restaurants and now consume pork and shrimp dishes. However, the most important potential market is foreign sales to Singapore, Hong Kong, and Japan, areas of wide ranging food acceptance. It will take many years for production to satisfy the potential of these markets before merchandising in the U.S. and Europe will be required. I think demand in these Western markets may come before the supply is ready.

"In contrast to the 50's when I worked in Indonesia, many of the rural areas now have generators or even established electric power which could sustain refrigerators; both sea and air transport has been greatly improved. Commercial production of these larvae would be done in small or larger town labs and the trunks could be transported the relatively short distances to the labs.

"Developing techniques for commercial production will require entomological skills similar to those now used to mass produce I 00 million fruit flies (Trypetidae) per week in a single lab; once the technique has been established, relatively unskilled personnel could maintain the operation. I anticipate that oviposition could be concentrated through discs cut out of the green growing tips of the palms. Eggs from a few days' oviposition would be held until hatching, then placed in the culture medium, and after a calculated time, harvest of the mature larvae. I expect, but don't know for sure, the entire trunk could be used as a culture medium. With most of the coconut plantations in Indonesia now overage, 80 years plus, this program would provide an incentive to cut down the old, less productive trees and replace them with genetically selected high yielding plants. In addition to coconut palms, these weevils infest sago, betel, royal, and other palms."

Ed-: The July 1990 *Newsletter* contains an article on palm weevils. Mr. Dresner mentioned that, although now retired, he would welcome any opportunity to investigate the potential for commercial palm weevil culture in Indonesia.

The medicinal ant, *Polyrhachis*, facing extinction in China?

Under date of 20 January 1993, Dr. Roger Akre of Washington State University writes, in part:

"On page 4 of the most recent *Food Insects Newsletter* is a reference to the Chinese eating ants. I have a new student from China, Yi Chen (Charlie) who persuaded his mother to send me a copy of the video "Value of Ants" which is perhaps better titled the medicinal uses of ants .... Perhaps the most interesting information on the video is that so many *Polyrhachis* are eaten that there is a concern that the species may become extinct. They have established formicaries to prevent this possibility.

"I enclosed a packet of powdered ants. These were packaged by the hospital in Beijing. The package is to be taken in three separate doses in water, hot water, tea, coffee, or wine. It tastes a bit like pungent sand, but isn't too bad if you add honey or sugar to your drink. Enjoy!"

A Canadian reports difficulty in finding insect delicacies in China

Dr. Yves Prevost, professor at Lakeland University in Thunder Bay, Ontario, wrote (November 11, 1992) in part:

"I heard quite a bit about the successes of the New York Entomological Society Banquet. As well, I heard one interview with Vickie Gabereau of the Canadian Broadcasting Corporation (CBC). That was successful as well. We are planning something similar, but not as elaborate for the icebreaker of our upcoming annual meeting of the entomological Society of Canada in Sault St. Marie, Ontario in October 1993.

"This past summer I was in China for the Entomology Congress among other things. I was looking forward to eating many different insect preparations, buying insects from street markets and whatever else I could imagine. I would be visiting remote areas where they probably never have seen a foreigner. I did not know what to expect, but I did think this would be fertile ground for feasting on insects, based on what I knew of Chinese food. This was obviously my first time in China.

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From a basketful of newspaper articles sent in by readers

But please keep sending them. They are helpful in ascertaining the amount and quality of media coverage of the subject, and the popular press offers up-to-the-minute sociological slants not as frequently found in technical papers.

In Mexico -- Insect-fortified tortillas

A United Press International article by Eda Chavez, datelined Mexico City. Actual title: "Bug s May Be Added to Mexico's Tortillas." Thanks to Ronald Sommers of San Leandro, California, for sending it:

> Mexicans could find themselves munching on tortillas made with ground flies [Ed.: meaning larvae or pupae?] or tacos filled with ants if scientists succeed in their plans to raise the nutritional level of Mexican staples.

Nutrition specialists are investigating enriching basic foodstuffs with high-protein substances from insects such as crickets, flies, worms, or termites. "The tortilla is one of the basic dietary elements among Mexican families because of its low cost, but it also has a low protein content," said Pedro Valle, dietary researcher at the National Autonomous University of Mexico. "By adding animalderived protein, we could effectively lower the incidence of malnutrition in the country," he said.

> Dr. Julieta Ramos-Elorduy, an entomologist at the university, noted that 40% of Mexicans suffer from malnutrition. "And this will continue as the buying power of the average Mexican decreases daily." Many peasants, especially among Indian communities, exist on tortillas, black beans and hot chile peppers. They almost never eat meat or vegetables. "Insects ensure a reliable alternative protein source and would reduce the possibility of Mexico being a hungry nation in the future," Elorduy said. [Ed.: Dr. Ramos-Elofduy's books and research papers are cited frequently in the *Newsletter.]*
>
> Javier Cordoba, researcher at the Institute of Agronomic Research, noting that dietary customs may make whole insects repulsive, says, "But just by using insect flour, we can convert any type of snack into a product with high protein value."
>
> Dr. Hector Burges, at the Institute of Nutrition, mentioned a wide range of insect flavors resembling almonds, pine nuts, apples, a hot highly seasoned flavor, and fried pork- rinds.

In Colombia -- For Tukanoans, it's yes to insects, no to chicken!

> This short Associated Press article (titled "Where Little Bugs Are Great Grub") was also sent in by Ron Sommers, and is reprinted in its entirety.

"Termites taste like fish**,** palm grubs resemble pork sausages, and ants can remind one of goose-liver pate," says anthropologist Darna Dufour. Sound tasty? Well, Dufour says "in the jungle, insects are good to eat."

That was the theme of her lecture on insect cuisine last week at the University of Colorado Museum in Boulder. Dufour dined on such delicacies as ants, termites, beetles and caterpillars during a 16month study of the eating habits of the Tukanoan Indians of eastern Colombia. In her research along the Colombian-Brazilian border, Dufour found the Tukanoans consumed insects as a food supplement and sometimes as a sole source of nourishment when fish weren't available.

Natives preferred to harvest some of the insects, particularly termites and ants, in larvae stages, "when they're highest in fat and protein content," she said. Sometimes, insects like ants are used as a spread for bread and the ants resembled "bacon-bit sort of things," she said. Although some caterpillars are saved, most of the insects collected are eaten rapidly. "It's a hand-to-mouth situation with insects," she said.

Dufour said that after overcoming some initial queasiness, she learned to like some insects. While Westerners are repulsed about consuming caterpillars, she added, the Tukanoans don't particularly like some foods, either. Eggs and chickens are out, because chickens are seen as scavengers. And milk, she said, "makes them want to vomit."

Ed.: The technical report describing the excellent research conducted by Dr. Dufour in Colombia is: Dufour, D.L. 1987. Insects as food: A case study from the northwest Amazon. *American Anthropologist* 89(2):383-397. One of the conclusions in her study was that, "the role of insect fauna in the diet needs to be included in any evaluation of the adequacy of protein resources in Amazonia."

China -- An investment opportunity in the health Field?

A Reuter dispatch, datelined Beijing. Thomas Slone of Berkeley was the first to send it, as it appeared in *The San Francisco Examiner* of March 15, 1992 under the title "Eating termites like taking medicine." We offer only a brief summary as there are no experimental results as yet:

Yang Siqi, director of the Yingtan Termite Research Institute, believes termites can cure a variety of ills, according to the official New China News Agency. He developed his theory after orthodox treatments failed to cure his fever and gastritis. After three months of eating termites, "a miracle happened," and doctors were amazed at how quickly his ailments had disappeared, according to the report. Yang has set up three companies to chutn out termite-based medicines for the international mark-et.

Zambia -- Where armyworms are appreciated; maybe Kenya could export theirs

Dateline Rome. This article by Francis Mwanza, titled, "Fancy a meal? -- catch a bug," as it appeared in *The Herald* (Harare, Zimbabwe), October 19,1988, was sent along several years ago by Dr. John Phelps (some items simply get caught in the *Newsletter.*

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Newspapers (from page five)

backlog). We've extracted the latter part of the article, which pertains primarily to Zambia:

When a plague invaded parts of Zambia, street vendors appeared with dried locusts for sale. A spokesman for the Zambian Ministry of Agriculture and Water Development issued a warning that the locusts being sold were sprayed with chemicals.

But the buying and selling went on briskly. Zambian nutritionists have long acknowledged that army worms, known as *ifishimu,* and butterfly larvae are rich sources of protein. Mothers are advised not to overlook the food value of *ifishimu.* Nutritional posters in schools also show the insects as good sources of protein.

A Zambian newspaper reader asked why Kenya, which is often badly affected by army worm invasions, does not export them to Zambia. Termites, caught at the beginning of the rainy season, are also eaten with gusto in Zambia and fetch a high price.

> as the June beetle, grasshopper, ant, mole cricket, water beetle, katydid, locust and larvae of the dragonfly. She said laboratory examinations show that such insects are "loaded" with protein, fats, and calcium, thus providing nutrient needs of those who eat them.

The insects are made palatable through various ways of cooking. Some are fried in fat, broiled, sauteed with vegetables, turned into "adobo" and "paksiw," Ms. Colting explained. Size of the insects ranges from 0.25 millimeters to a few centimeters and thus lots of them are needed to provide a person with the required daily nutrients, she said. Colting added that the Cordillera mountains abound with insects and there is not going to be any shortage even if the entire upland population avail of them as daily food.

Eating insects is an old custom among the various minority tribes in the highlands of North Luzon. The habit is due to food needs and a way of reducing pests which attack food crops, according to entomologists. The MSAC study, which is still going on, also discovered that a growing market for edible insects has sprang up in a number of towns in the Cordillera provinces of Benguet, Mt. Province, Ifugao and Kalinga-Apayao.

Some enterprising folk- have taken to trapping the insects and selling them

Insects are becoming more useful even in livestock feeds. Researchers at the University of the Philippines have developed a chicken feedmeal from maggots of the common housefly to replace fishmeal. The maggots, which are dried, are reported to contain 53 percent crude protein and 18 percent crude fat. And a change of diet to include bugs, bees and beetles could mean that insects are harvested rather than attacked by expensive insecticides.

Ed.: What is the scientific identity of the army worm(s) known as *ifishimu?* Richards (1939) mentions *ifishimu* as one of seven main kinds of edible caterpillars in Zambia. I have not seen it mentioned elsewhere in the technical literature, including Silow (1976), but have not seen the papers by Thompson (1954) or White (1959).

The Philippines -- Hard times in the Cordilleras: Back to insect-eating.

The above is the title of an article by Robert Domoguen, datelined La Trinidad, Benquet. Like the previous article, it has been caught for some time in the *Newsletter* backlog. It was sent (along with a letter dated September 9, 1990) by Dr. Chris Starr who mentioned that it appeared in a Manila daily "a few years back." The Cordillera is the highlands of northern Luzon, according to Chris:

La Trinidad, Benguet. Certain edible insects are helping a growing number of folk in the Cordillera uplands come by simple but protein-laden meals during these harsh economic times. Mountain rice spiked, laced or mixed with insect viands is becoming more common everyday fare for highland families whose poverty prevents them from even thinking of buying exorbitantly priced meat and fish. A survey conducted by entomologists at the Mountain State Agriculture College (MSAC) in this town found that the insect-eating provides the upland folk with their daily protein and other nutrient needs.

Lolita Colting, chairman of MSAC's plant protection department who is an entomologist, identified the more popular edible insects in the markets. The common measure is by the tin can-full, with costs ranging from PI to P2 per can (25 pisos = US $ 1 J. The insects come out in full force during the middle of the dry season and early weeks of the rainy months to feed on newly planted food crops. Those who trap them usually build fires in open spaces at onset of evening. Basins full of water are placed around the fires. Other trappers use nets, woven baskets or simply pick the insects off the ground.

Colting said interviews with the insect-eaters elicited the information that the latter have been introduced to such "eating delights" by their parents and grandparents. Such answers confirm that the uplanders have long been availing of insects as protein sources, the MSAC entomologist said. However, some respondents born and bred in the citified ways of nearby Baguio City confessed that they have never eaten insects. Colting said a few admitted that they did not know insects can serve as human food. The majority of respondents who said they eat insects come from the rural areas.

A related development is the finding of staffers at the Sericulture Research Training Center, located in the MSAC campus, that fried caterpillars are "delicious."

From Thailand --

Everything you want to know about the giant water bug

In the November 29, 1992 edition of *The Nation* (Bangkok newspaper), Martin Clutterbuck reviews a 63-page booklet by Chaiya Yusoongnem which is apparently entirely devoted to the giant water bug, *Lethocerus indicus.* The title is Malaeng Daa Naa *(Of Edible Insects).* It was published by the Centre for Agricultural Texts, price Bt35 [25 baht = US $ 1]. Among his early paragraphs, Clutterbuck says, "Blissfully unaware of the revulsion experienced by those from other cultures, Chaiya Uisoongnem uses this book to

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For eri silk producers in India, unlike mulberry silk producers, the edible pupa is the prize and the silk is the by-product.

Dr. Richard Peigler of the Denver Museum of Natural History recently sent extracts from the 1982 book, *Eri Silk Industry,* by S.N. Chowdhury, a publication of the Directorate of Sericulture & Weaving published by the Government of Assam at Gauhati, Assam. From it we learn (page i, Introduction) that for the tribals in northeastern India, the "eri chrysalid [pupa] is a delicacy and the cocoon is more or less a by-product." It is the pre-pupa, actually, that is removed after the cocoon has been completely formed (p. 64). The production of eri cut cocoons in Assam and six other states in northeastern India was estimated at about 183 metric tons in 1979.

About 40,000 families are involved in ericulture. It is practiced as a cottage industry and will probably remain as such because culture is too risky and uncertain to be attractive to investors. It is carried out traditionally by village women during leisure hours; the women also do the spinning and weaving. The eri silkworm *[Samia cynthia ricini* Hutt.] feeds on castor. The cocoon, being open-mouthed, does not yield a continuous thread and must therefore be spun like cotton. Its value thus is much less than that of the reeled cocoons of mulberry and muga. The eri cocoons are nevertheless traded in sizeable quantities in the weekly markets.

See Neupane *et al* under Recent Technical Paper, page 2 of this *Newsletter,* for massrearing biology of the eri silkworm.)

Request for Information

The BBC Natural History Unit in Bristol, UK has recently embarked on a major new 6 x 30 minute series about insects. The series will take a "science fiction" style look at the alien world of insects. Visually stunning computer effects mixed with live action are one strength of the series. The other is provided by the insects themselves - extraordinary creatures carrying on extraordinary lives, most of which have never been previously filmed.

Our aim is to seek out the most exciting and bizarre insect stories to include in six programmes with the following themes: insect design, reproduction, feeding, migration and dispersal, social insects and man versus insects. If you have any insect stories that you would like to bring to our attention please contact:

Wendy Darke (Tel: 44 272 742164) or
Ian Gray (Tel: 44 272 742428)
Fax No: 44 272 237708
BBC Natural History Unit
Broadcasting House
Whiteladies Road
Bristol, BS8 2LR, UK.

Insect snacks part of ESA's Insect Expo in Baltimore

Following its annual meeting held early in December, the ESA (Entomological Society of America) sponsored Insect Expo, a day of hands-on education designed to introduce children to entomology. Held in the host city's Convention Center for an expected 3600 students from 43 Maryland schools, attendance was held to about 900 because of an early morning snow storm. As described, in part, in the ESA Newsletter (January 1993): "A six-foot, plush costumed ladybug greeted students as they roamed through more than 30 hands-on display booths, attended puppet shows, participated in the human caterpillar race, and stopped by the entomological eatery for a handful of pan-fried mealworms ... [or] sampled caterpillar crunch, a mixture of nuts and fried waxworm larvae."

Tom Turpin, immediate past-president of the ESA and the expo's founder, commented that he "was impressed by the members willingness to participate and the childrens' genuine interest in not only the fun stuff but also the science." The Society plans to continue the Insect Expo in Indianapolis next year.

Thanks to Luther Dietrich of Annandale, Virginia, for sending the only press feedback we've seen, coverage by writer Fern Shen in the Washington Post of December 1lth. Shen seemed less than exuberantly enthusiastic about either the snacks or the show in general. Maybe the snacks ruined the rest of the show for her.

Letters (from page four)

"Most Chinese looked at me very puzzled and asked me why I would want to eat insects, when they could offer me eyeballs, stomaches, intestines and heads of chicken, pigeon and turtle. They believed that I was joking when inquiring about insects as food. After a further discussion they finally admitted that some people eat silkworm pupae and giant waterbugs, but it was not common. Silkworm pupae are eaten only in the silkworm areas during harvest of the silken cocoons when the cocoon-bearing pupae are placed in hot water to kill them and to unravel the thread from the cocoon. These pupae can be further processed by roasting in peanut oil.

"During the congress, a group of us decided to forage for edible insects in Beijing restaurants. The only animals that we ate which resembled insects were juvenile scorpions about 4 cm long. They were placed on a bed of rice noodles and cost about $1.00 each. The specimens looked ferocious, but tasted fine, probably like a potato chip. Everyone was content with the experience, I went back for seconds."

Ed.: Yves may have been looking in the wrong places or talking to the wrong people. See communications from Luo Ke and Chen Xiaoming, respectively, in the March and July 1990 *Newsletters*.

Newsletter connects with the world of "rock"

January 13, 1993
Dear Dr. DeFoliart: Enclosed is the December 1992 issue of *VOX* Magazine; I thought you might like to see the review of *The Food Insects Newsletter* ("Run For Your Life, Jiminy Cricket," page 4). VOX is the official program guide of CJSW 91, The University of Calgary radio station. Our content leans toward "rock" interviews and reviews (with book and theatre coverage), but whenever something as nifty *as The Food Insects Newsletter* comes along, we like to pass it on to our readers.

Although I have never (knowingly) eaten an insect (but am open to the possibility), I really enjoy reading the *Newsletter*. Congratulations on putting out such a great publication.

Sincerely, [signed] James Martin, VOX Magazine
Ed.: Thanks, Jim. The review was cool.

For insect cuisine in the Washington DC area -Go to The Insect Club

The first Bourgeois Bug Tasting event at The Insect Club (625 E Street, NW, Washington DC 20004; (202) 347-8884) began at 8:00 pm on February 15th. The flier advertised that "The only bugs you'll find here . . . are in our food!" The fare included mealamari, mealworm chimibugga, mini mix pizza, trailmix, dessert medley, and cricket crunch/cricket cups. The insect basics were mealworms, crickets and, maybe, wax worms. But probably the most concise way to sum up the first gala is to quote a couple of paragraphs in a letter from the executive chef, Mark Nevin:

"Our bug debut didn't get the turnout we were hoping for, however, the weather and the timing was not the most opportune. Your technical and moral support has been most appreciated and helpful. It enabled me to produce some really good food. I was quite surprised by the public's acceptance. The majority of patrons that sampled our vittles were pleasantly surprised with their gastronomic experience. We'll continue to do free tastings for the next month or so.

"I'm sending along some of the invitations, menus and a copy of the article in the *Washinton Times*. It wasn't flattering, but it wasn't a bashing either. I guess insect cuisine will take some getting used to. I'm not sure whether the 1 1/2 star rating is for the insects or for our regular food. Oh well, any press is good press, as they say. We've also done two radio shows and the *Washington Business Journal* will be in in the next few days to do an interview.....

Ed:
More about this later.

Details began arriving only shortly before press time and our space in this issue was already at a premium. It sounds like The Insect Club is loaded with "atmosphere."

Newspaper (from page six)

tell us everything we could possibly want to know about Thailand's favourite edible insect."

Many "for instances" are given by Clutterbuck (only a few of which are included here) concerning biology, harvesting, market prices, recipes and other culinary uses. For those wanting to be in Bangkok at the right time, tne selling season for *malaeng daa* is usually October-March. Male *malaeng daa* can be sold wholesale for Bt35 apiece, while females fetch only 50-75 satang [1 bhat = 100 satangs]. This is because the male has the distinctive odor.

"The eggs can be eaten on their own, raw or grilled, the result 'yet another form of deliciousness.' The rather Tasteless female is best deep fried in batter and dipped in itamjim. Alternately

she can be stuffed in pork and fried, or she can make a nice roast *malaeng daa* curry. The male, after a grilling to increase his flavour and removing his wings, is best crushed in a mortar to make *nam phrik chili* sauce.

"Chaiya recommends adding fish, prawn sauce *(kapi)*, the aubergine relative *makheua* or the fermented *plaa raa* for 'tastiness you shouldn't tell anybody' about *(aroi yaa bork khral)*. This writer [Clutterbuck] can confirm, that as a dip for grilled chicken, *nam phrik malaetig daa* is indeed tasty and distinctive."

Clutterbuck concludes that, "For the adventurous, another world of flavour is waiting, once they discard their conditioning." And one final useful hint: "When buying, the best way to sex a *malaeng daa* (and avoid being tricked by market women) is to look for the female's egg-laying appratus."

Ed.: Thanks to Dr. Hugh Popenoe, Center for Tropical Agriculture, University of

Florida, who noticed the review during a recent trip to Bangkok. This review seems to confirm my impression that you want to have a Thai chef around when you try giant water bug.

Food Conversion (from page one)

as a consequence grow and develop much faster. The classic example here is the difference between forb- and tree-feeders. Forb leaves typically have high levels of nitrogen and water, whereas tree leaves have lower levels of those substituents and higher levels of poorly digestible compounds such as cellulose, lignin and tannins. Accordingly, insects that feed on mature tree leaves exhibit growth rates half or less than those insects that feed on forbs. The relatively poor nutritional quality of tree foliage has had important consequences for insect life histories. In temperate regions forbfeeders often have many more generations per year than do treefeeders. Among tree-feeders, numerous species have adapted to emerge and feed only on the especially nutritious early spring foliage, and thus have only one generation per year.

Other examples that demonstrate how the various efficiencies are strongly influenced by food quality include wood- and seed-feeding insects. Wood is tough and nutritionally poor. Thus wood-chewers have slow rates of consumption and digestion (much of which is accomplished by symbiotic microbes). The combination of these factors precludes all but slow growth rates in wood-feeders. In contrast, seeds are high in readily digestible carbohydrates and protein and low in fibrous material. Thus seed-feeders exhibit high ADs. Growth rates are nonetheless only low to moderate, due to low consumption rates and low ECDS. Low ECDs may result from a requirement of these insects to metabolize digested food in order to produce water.

Understanding of these basic principles of nutritional ecology can enhance our appreciation of insects as a food resource. Environmentalists and others concerned about nutrition and world food resources have long decried the reliance of some people on large animal protein (e.g., beef) as a dietary staple. The reasoning is that production of such high-quality protein is very inefficient; more food would be available if people ate the grain instead. This debate is complex and beyond the scope of this paper. Suffice it to say, however, that a major reason that large animals are inefficient in transforming plant biomass into animal biomass is that they have very high maintenance costs (i.e., low ECDS). Large amounts of energy and nutrients are used to maintain constant body temperatures. Insects, being "cold-blooded,", are more efficient in transforming plant biomass into animal biomass.

Understanding of basic nutritional ecology may also improve selection of insect and plant species for large-scale insect production. For example, production will be more rapid with forbfeeders than with tree-feeders and with leaf-feeders than with wood-feeders, other environmental factors equal. Want to know what plant/insect characteristics may be limiting production? Some simple input/output and growth measurements will tell whether production is limited by low consumption, poor digestibility, or inefficient conversion of assimilated food into body mass. Different corrective measures may be available for each situation.

Acknowledgement

This article benefited greatly from the content and inspiration of excellent reviews by Frank Slansky and Mark Scriber.

Further Reading

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Slansky, F., and J.M. Scriber. 1985. Food consumption and utilization. Pp. 87-163, in G.A. Kerkut and L.I. Gilbert (eds.), Comprehensive Insect Physiology, Biochemistry and Pharmacology. Vol. 4. *Regulation: Digestion, Nutrition, Excretion*. Pergamon Press, N.Y.

A FOLLOW-UP INTERVIEW WITH DR. LINDROTH

The *Newsletter* has never used this journalistic technique before, but it seems a good way of getting the most out of our invited experts while we have their attention. We'll designate the questioner as The *FIN (The Food Insects Newsletter)*. It's too bad we're not in the fish business because it would make a great acronym.

The FIN: First, thank you Dr. Lindroth for accepting our invitation to set forth some basic principles of insect food conversion efficiency in the *Newsletter* and for taking additional time to respond to some questions. The food conversion efficiency of edible insects has important ecological and environmental implications. First question. Remembering that edible insects furnish not only protein, but fats, vitamins, and minerals, and. as a very high proportion of growth occurs in the last two larval or nymphal instars (about 95 % in lepidopterous larvae as shown with your example, *M. disstria)*, can we assume that the combined ECI for the last two instars is a valid (and the simplest) statistic for comparing food conversion efficiency (let's shorten it to FCE) between or within species in different situations? A second, related question. Do ecologists have any "rule-of-thumb" ECI level that is considered good, or is everything comparative and dependent on the quality of the food source?

Dr. Lindroth: If I had to select only one efficiency measure, ECI would be a good candidate, as it represents efficiencies of both digestion and how well digested food is converted to biomass. Bear in mind though, that insects can compensate for low ECIs to some degree simply by increasing their feeding rates. Thus two insects could have the same growth rate, one achieves it by eating less but being very efficient with what it eats, the other by eating more but being less efficient. Because so much of an insect's feeding and growth occurs. in its last few instars, FCEs from that period are a very useful comparative measure. Another caution here is that dietary characteristics (nutrient deficiencies or toxins) may affect younger instars more than older instars, and if the impact is great enough, you'll never see those insects as older instars.

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Interview (from page nine)

I'm reluctant to suggest what ECI values may be "good" or "bad"; they're really more useful in a comparative sense. What is "good" for one insect feeding on one substrate may or may not be "good" for another insect feeding on another substrate. What is most valuable is to compare different species (or races) feeding on the same food, or individuals of one species feeding on different foods.

TheFIN: You pointed out that forb-feeders show higher FCEs than tree leaf-feeders because forbs are higher in nitrogen and water and lower in such hard-to-digest compounds as cellulose and lignin. I've seen combined ECI data (Scriber's) on only one forb-feeding edible *insect, Spodoptera eridania* (the southern armyworm). When tested on 10 varieties of alfalfa, combined ECIs ranged below 15% on six varieties, from 15.5-20.3% on three others, and showed an incredible 29.8% on Vernal alfalfa. Two questions. Do you know of any vertebrate meat animal that can come anywhere close to 29.8%? And secondly, how do you explain such great ECI differences at the plant varietal level?

Dr. Lindroth: Yes. As you'll see below, poultry can attain this level of efficiency. But their food source is grain, which is even richer than alfalfa.

Considerable variation in ECIs at the plant varietal level has not been well-studied, but may not be as unusual as one might expect For example, in a study with gypsy moth larvae feeding on individual aspen trees from a common habitat, we found ECI values that ranged from 6% to 16%. In our case among tree variation in levels of phenolic toxins greatly influenced ECIs and subsequent larval growth rates. I'm not at all surprised that differences of the magnitude you describe exist among plant varieties. Those differences probably result from differences in chemical or physical attributes of the varieties.

The FIN: In scanning ECI data, one can dream up some wild schemes. For example, Scriberalso tested *S. eridania* on five kinds of clover and trefoil. The highest combined ECI was on *Trifolium agrarium* (yellow blossom sweetclover), 23.6%. Now, commercial pond fish producers are looking for good sources of long-chain w3 polyunsaturated fatty acids, and lepidopterous larvae, in general, would be a rich source if they could be feasibly exploited. Yellow blossom sweet clover must do very well on poor soils, because it's along roadsides all over the country. And *S. eridania* has multiple generations per year. Maybe it would pay the fish growers to hire a young entomologist (or maybe put some research money into your lab) to look into the possibilities. Maybe the armyworms should be harvested at the end of the penultimate (second to last) instar. Scriber's data showed an incredible ECI of 56.9% for that instar on YBSC (it was even higher, 58.3%, on Vernal alfalfa.)

Dr. Lindroth: You're right, the possibilities are great. As you know better than I, a minor shift in one's thinking about insects as food can open up many new avenues of research and application.

The FIN: Unfortunately, many more of the major edible insect groups seem to feed on trees and grasses, or even wood, than feed on forbs. Tests on two species of edible grasshoppers, *Locustana migratoria* and a species of *Melanoplus,* fed on several kinds of grasses showed combined ECIs in the range of 10-15% and 8-11%, respectively. Two questions. How do ECIs in the range of 10-15% compare with other grass-eaters such as cattle? (I believe there is a rule-of-thumb in cattle husbandry that 15 lbs of hay puts on a pound of gain). As grasshoppers are generalists, if they were reared on forbs, should we expect higher ECIs?

Dr. Lindroth: As I alluded to in the article, FECs are generally higher for insects than for vertebrates. One must be careful in making such comparisons, however. One problem is that insect values are reported on the basis of dry weights, whereas livestock values are reported as "gain" which typically includes 70% water. After adjusting for water weight, ballpark- figures for efficiency of gain are seen below. Clearly, the insects are superior to mammals when fed the same food. FCEs of vertebrates can approach or even surpass those of insects when they are fed especially nutritious and digestible food such as grain.

Chicken	(grain)	30%
Pigs	(grain)	11%
Beef	(grain)	5%
Beef	(grass)	3%

About rearing grasshoppers on forbs: I would expect higher ECIs than when reared on grass.

The FIN: Larvae of the giant silk moths (Family Saturniidae) are a major food insect group, especially in Africa. Most of these are tree-feeders, and as you indicated in general for tree-feeders, most have only one generation per year. I don't know of any ECI data on African species, but data by Scriber and Feeney on nine North American species on 21 host species showed combined ECIs ranging from 7.1 to 15.8 (ECIs above 10 on nine of the 21 larva/host combinations). Doesn't it seem that, even with ECIs at the relatively low range of 10-15%, if the forest was property managed for caterpillar (and termite) preservation (as has been recommended in several instances by researchers **in** Africa), it would be about as productive for animal agriculture as grassland? Is there a short answer for this complex question, or **is** the question not as complex as it seems?

Dr. Lindroth: On the surface the reasoning seems sound. But a number of complicating factors come to mind; the answer really is complex. For example, because grasslands have coevolved with large grazing mammals grasses can recover remarkably well from extensive grazing. Remove the same percentage of green foliage from a forest habitat and you'll not have the forest for long. And then there are the practical matters of harvest, etc. It is probably much easier to harvest 1000 lbs of large animal biomass from a grassland than an equivalent amount of insect biomass from a forest! This is not to say that management of forests for insect production should not be considered, just that the comparison with grassland systems is frought with problems.

The FIN: Several important food insect groups develop in wood, including decaying or rotten logs. As would be expected, most have

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Interview (from page ten)

long life cycles, one or more years, for example in the beetle families, Buprestidae and Cerambycidae. Palm weevils of the genus *Rhynchophorus* (Family Curculionidae), however, complete development in only two or three months in palm logs. Is this an exception to the "feeding guilds" principle that you mentioned (feeding guilds more important than taxonomic affinity in determining food conversion efficiency), or what would explain such relatively fast development on such poor food?

Dr. Lindroth: This is an interesting example. I don't know the answer, but I can hazard a guess. Most trees are dicotyledons and the woody tissue of these species is loaded with lignins, tannins, etc. Palm trees are monocotyledons: they are more closely related to Kentucky bluegrass than to oaks or maples. I know next to nothing about the chemical composition of palm logs, but would suggest that they have higher levels of particular nutrients (e.g., nitrogen, sugars) and/or lower levels of lignins and tannins than occur in the wood of dicots.

Editor's Corner (from page two)

intended for people who have long thought that their native rodents are good food anyway.

What does all of this portend for the future of edible insects? Maybe nothing. But, insects offer in profusion all of the features of smallness deemed desirable in the NRC report (and they lack the disadvantages cited for miniature animals in the report). To elaborate a bit on one of the advantageous features, who knows what might happen when the NRC bears about the reproductive capacity of insects. Female crickets *(Acheta domesticus),* for example, chum out 1500 progeny per female and they are ready for the pot 30-45 days later depending upon temperature. No rodent can come close to that. Nor can rabbits.

Objectivity is supposed to be one of the prime virtues of science, but cultural conditioning can be hard to overcome even for scientists. Having given the okay to rodents, however, it shouldn't take too much additional attitude adjustment for U.S. panels to give the okay to insects. They, too,

The FIN: Thanks again, Rick, and a final question. Are forbs and herbs the same thing?

Dr. Lindroth: Not quite. Herbs are non-woody plants, including both monocots and dicots. In temperate regions they "die back" to ground level at the end of the growing season. Forbs are herbs that are not grasses (dicots).

have long been used as food by indigenous populations, and in at least some regions where both rodents and insects have been used, the people preferred the insects. GRD

Reference cited

Gibbons, Ann. 1991. Small is beautiful: Microlivestock for the Third *World. Science* 253:378.

Entomological Society of Canada looking for outstanding new recipes for its Annual Meeting

Under date of February 1, 1993, Dr. Yvres Prevost wrote:

Enclosed please find a recent article produced by the *Globe and Mail*. M. LeGault did a great job on it. As a consequence of this article I gave another interview to CBC radio Sudbury in northeastern Ontario. The preparations for our insect tasting at the Entomological Society of Canada this September 25 to 29 in Sault Ste. Marie, Ontario are moving along. I have lined up silkworm pupae, house crickets, mealworms and waxworms. I have ideas about how to prepare these and still conserve the insect form, but if someone has some outstanding recipes, I would like to hear from them. I can be reached at School of Forestry, Lakehead University, Thunder Bay, Ontario CANADA P7B 5EI.

Ed.: The *Globe and Mail* is for Canada what *USA Today* is for the U.S., sort of a national newspaper. The article is titled "The case for some grubs in our grub," and subtitled "With billions of mouths to feed around the world, there's one rich source of food we in North America have completely overlooked -- insects. If nothing else, it would certainly cut down on our use of harmful pesticides. Pass the ants, please. " I agree with Yvres. It is one of the best comprehensive newspaper articles I have seen on the subject. To quote just one sentence by LeGault: "To a great extent, it is a case that makes itself."

The Ralph M. Parsons Insect Zoo, a part of the Natural History Museum of Los Angeles County, to present the 7th Annual Insect Fair on May 15 and 16.

The displays are designed to introduce the fascinating world of insects to children of all ages. Both live and preserved insects are included. Exhibit themes include conservation, careers in entomology, insect behavior, photography, specimen preparation, local insects, giant tropical insects, and more. Invited vendors offer collecting equipment, books, t-shirts, arts and crafts, and other insect paraphernalia. Guest speakers will talk- about a variety of insect subjects on May 15th. The Fair is held at Arcadia, California and attracts more than 8000 people each year. For more information, contact: Dr. Arthur V. Evans, Director, Ralph M. Parsons Insect Zoo, Natural History Museum of Los Angeles County, 900 Exposition Boulevard, Los Angeles, CA 90007; (213) 744-3558. Thanks to Kathy Burk-holder, Insect Zoo Technician, for furnishing the above information.

At our press time, it was still uncertain whether insect goodies will be offered at the Fair -- because of a technicality. Regulations prohibit the Zoo staff from entering competition with the regular food vendors.