

Chapter 26

EASTERN ASIA: CHINA, JAPAN, OTHER COUNTRIES

Overview

This region includes China, Japan, Korea, Macau and Taiwan. The specific identity is known for 46 species used as food, but as indicated in the Regional Inventory, the use of at least 66 species belonging to at least 47 genera, 38 families and 13 orders has been reported. As in other regions, the total number used is much greater than indicated in the Inventory. To cite only one example, the Inventory lists only "cicadid spp." as eaten in China (which counts as one in the above total), but Bodenheimer (1951) states that any available species of cicada is eaten, adults as well as nymphs. Similarly in Japan, Remington (1946) reported that among the very popular insects eaten are all species of Cicadidae, but the Inventory lists only one species by scientific name. A similar lack of published information on specific identities in various other groups results in an Inventory list that is far from complete.

Regional Taxonomic Inventory

Taxa and stages consumed	Countries
Coleoptera	
Beetle grubs	China
Aquatic larvae and adults	Japan
Cerambycidae (long-horned beetles)	
Cerambycid larvae/pupae	China, Japan
Curculionidae (weevils, snout beetles)	
<i>Cyrtotrachelus longimanus</i> (author?), larva	China
<i>Rhynchophorus chinensis</i> (author?)	China
Dytiscidae (predaceous diving beetles)	
<i>Cybister bengalensis</i> Aube, adult	China
<i>Cybister guerini</i> Aube, adult	China
<i>Cybister japonicus</i> Sharp, adult	China, Japan
<i>Cybister limbatus</i> Fabr., adult	China
<i>Cybister</i> spp., adults	China
<i>Cybister sugillatus</i> Er., adult	China
<i>Cybister tripunctatus</i> Ol., adult	China
<i>Dytiscus marginalis</i> (author?)	China
<i>Dytiscus</i> spp., adults	Japan
Dytiscid water beetles	China, Japan, Macau, Taiwan
Hydrophilidae (water scavenger beetles)	
<i>Hydrous bilineatus</i> MacLeay, adult	China
<i>Hydrous cavisternum</i> Bedel, adult	China
<i>Hydrous hastatus</i> Herbst, adult	China
<i>Hydrous pallidipalpis</i> MacLeay, adult	China
Hydrophilid water beetles	Japan, Macau
Elateridae (click beetles)	
Elaterid larvae, pupae	Japan
Scarabaeidae (scarab beetles)	
<i>Scarabaeus molossus</i> Linn., larva	China
Scarab beetle adults	China

Family uncertain

<i>Melanaster chinensis</i> Forster, larva	China
<i>Psacotha hilaris</i> Pascoe, larva	China
Diptera	
Calliphoridae (blow flies)	
<i>Chrysomya megacephala</i> (Fabr.), larva	China
Calliphorid larvae	China
Muscidae (filth flies)	
<i>Musca domestica vicina</i> Macq., larva	China
Sarcophagidae (flesh flies)	
Sarcophagid larvae	China
Ephemeroptera	
Mayfly nymphs/adults	China, Japan
Hemiptera	
Aquatic Hemiptera	Japan
Belostomatidae (giant water bugs)	
<i>Lethocerus indicus</i> Lep. & Serv., adult	China
Belostomatid sp.	China, Japan
Pentatomidae (stink bugs)	
<i>Tessaratoma papillosa</i> Drury, adult	China
Homoptera	
Cicadidae (cicadas)	
<i>Graptopsaltria nigrofasciata</i> Motschulsky, adult	Japan
Cicadid spp., nymphs/adults	China, Japan
Hymenoptera	
Apidae (honey bees)	
<i>Apis mellifera</i> Linn., drone pupa	Japan
Bee larvae/pupae/adults	China, Japan
Formicidae (ants)	
<i>Polyrhachis vicina</i> Roger	China
Ant larvae/pupae	China
Scoliidae (scoliids)	
Scoliid larva, pupa	China
Vespidae {wasps, hornets}	
<i>Polistes</i> spp., pupae	Japan
<i>Vespa japonica</i> (author?)	Japan
<i>Vespa</i> spp., larvae	China, Japan
<i>Vespula lewisi</i> (author?), larva, pupa, adult	Japan
<i>Vespula</i> sp., larva, pupa	Japan
Wasp larvae, pupae	China

Isoptera

Rhinotermitidae*Coptotermes formosanus* (author?)

China

Termitidae*Macrotermes barnyi* (author?)

China

Lepidoptera

Lepidoptera pupae not found in soil

Japan

Bombycidae (silkworm moths)*Bombyx mori* (Linn.), pupa

China, Japan, Korea

Cossidae (carpenter moths, leopard moths)

Cossid spp., larvae

Japan

Gelechiidae*Pectinophora gossypiella* Saunders, larva

China

Hepialidae (ghost moths and swifts)*Hepialus armoricanus* Oberthur, larva with *Cordyceps* fungus

China

Hepialus oblifurcus Chu and Wang, larva with *Cordyceps* fungus

China

Limacodidae (slug caterpillars)

"Eucleid" sp. (hag moth), pupa

Japan

Noctuidae (noctuids)*Hydrillodes morosa* (author?), larval excreta

China

Pyralidae (snout and grass moths)*Aglossa dimidiata* (author?), larval excreta

China

Saturniidae (giant silkworm moths)*Antheraea pernyi* (Guérin-Méneville), pupa

China

Saturnia pyretorum (Westw.), larva

China

Sphingidae (sphinx or hawk-moths)*Clanis bilineata* Walker, larva, pupa

China

Sphinx moth larvae

China

Mantodea

Mantid spp.

Japan

Odonata

Dragonfly nymphs, adults

China, Japan, Taiwan

Orthoptera**Acrididae (short-horned grasshoppers)***Acrida lata* Motschulsky, adult

Korea

Locusta migratoria Linn.

China

Locusta migratoria manilensis Megeen

China

Oxya chinensis Thunberg

China

Oxya japonica japonica Willemse, adult

Japan

Oxya sinuosa Mistshenko, adult

Korea

Oxya velox Fabr.

Japan, Korea

<i>Oxya yezoensis</i> Shiracki Locusts/grasshoppers	Japan China, Japan
Blattidae (roaches) <i>Periplaneta americana</i> (Linn.) <i>Periplaneta australasiae</i> (Fabr.)	China China
Gryllidae (crickets) Crickets	China, Japan
Superfamily Tettigonioidae Tettigonioid sp.	Japan
Gryllotalpidae (mole crickets) Mole crickets	China
Plecoptera	
Stonefly spp., nymphs	Japan
Trichoptera	
Family uncertain <i>Stenopsyche griseipennis</i> MacLachan, larva	Japan

A main characteristic of Chinese medicine is described in an old saying that drugs and food are homologous in their function for human health (Shen et al 1997). In keeping with this, in China there is no clear distinction between use of insects as food and their use as medicine or tonic. Hoffmann, for example, reports that dytiscid water beetles are used both as medicine (as an anti-diuretic) and to a lesser extent as a confection, and hepialid caterpillars infected with *Cordyceps* fungus are considered both a delicacy and as tonic food. Shen (1993) mentions a restaurant in Beijing that is well-known for its use of insects and other arthropods as "medical food." In this double context, there has been much publicity in Chinese newspapers and other mass-media in recent years relative to ants, termites and fly larvae.

According to Hoffmann, Bodenheimer and others, the Cantonese are the most entomophagous of the Chinese, but many insects such as locusts, water beetles, silkworm pupae and others are marketed widely in the country. Not all are considered necessarily as health foods. Of the giant water bug, *Lethocerus indicus*, Hoffmann says, "They are considered a delicacy and are eaten because they are relished; no medicinal value is ascribed to them." In general, according to Bodenheimer, "the insects are taken as accessory food and used as a dish which sometimes is considered as a delicacy." The pupae of the silkworm, *Antheraea pernyi*, are one such luxury. Farmers who have them may give them to their friends or relatives as "a special gift."

In both historical and modern Japan, the most popular and widely eaten edible insect has been the rice-field grasshopper, *Oxya japonica*, which, fried and slightly seasoned with soy sauce, is known as *inago*. After near depletion, populations of this grasshopper have increased in recent years as the result of reduced pesticide use, and *inago* is reappearing on dinner tables, and in supermarkets and restaurants, although still sold as a luxury item (Mitsuhashi 1984). Kantha (1988) notes the two-fold benefit of renewed use of *inago*, lauding its value as a source of animal protein and removal as an agricultural pest. Similarly, Mitsuhashi suggests that, with rice in over-production, why not let *inago* feed on the excess rice, thus increasing the population of a good source of animal protein.

The second most widely eaten insect food in modern Japan is *hachinoko*, bee or wasp larvae which may be eaten raw, boiled down in soy sauce, or served over boiled rice (Mitsuhashi 1984). Bee and wasp brood (and even wasp adults) are among the many canned insects available in Japan, and Mitsuhashi (1988) reports that a wasp-rice dish was a favorite of the late Emperor Hirohito. The canned wasps are expensive, a can (about 65 g) selling for yen 1,000 (about US \$8.00 in 1988). Pemberton and Yamasaki (1995) report that canned "child hornets" were being sold for about US \$20 per 100 g can in the prestigious Mitsukoshi Department Store in Tokyo in 1990. Another widely available product in Japan, both canned and in restaurants, is *zazamushi*, the name for aquatic insects inhabiting gravel beds in rivers and usually consisting mainly of larval Trichoptera. According to Pemberton and Yamasaki, all three of the above foods, *inago*, *hachinoko* and *zazamushi* are found on the menu of restaurants in Tokyo that specialize in foods of the

Japanese Alps.

As happened in Japan, Pemberton (1994) has documented for South Korea the increased marketing of the rice-field grasshopper (known as *metdugi*) following reduced use of pesticides. Canned silkworm (*Bombyx mori*) pupae are also popular (as they are elsewhere in East Asia) and are found in the markets in Seoul. They are also exported. They can be bought in Asian foodshops in the United States, including in Madison, Wisconsin, where, according to a shopkeeper they are a popular item in the local Korean community.

CHINA

Donovan (1798, p.6) quotes an earlier undisclosed author saying, "Under the roots of the canes is found a large white grub, which being fried in oil is eaten as a dainty by the Chinese," and that "the aurelias [pupae] of the silk worm which is cultivated in China, after the silk is wound off, furnish an article for the table." Donovan states that *Scarabaeus molossus* Linn. and *S. bucephalus* are both very common in China, and of the grub found in cane roots, he states, "Perhaps this is the larva of *Scarabaeus molossus*, which, like many other of the Scarabaei, may live sedentary in the ground, and subsist on the roots of plants: the general description and abundance of this insect in China favours such opinion." **Darwin (1800, p. 364)**, possibly drawing on the same early author, mentions that "the aurelia of the silk-worm, after the silk is wound off, and the white earth-grub, and the larva of the sphinx moth, furnish articles at the table, and are said to be delicious."

Williams (1853, II, P. 50), as quoted by Bodenheimer (1951, p. 273) states: "The insect food (of the Chinese) is confined to locusts and grasshoppers, groundgrubs and silkworms; the latter are fried crisp when cooked." According to **Bargagli (1877, p. 7; vide Bodenheimer 1951, p. 274)** locusts are sold in the markets of Tientsin and Peking. Bargagli (p. 9) also mentions the methods of preparing silkworm pupae as food, and says that they are eaten by both the rich and the poor. On page 10, he notes that bee and wasp larvae are eaten, and that the mountaineers of China and Japan dig up the nests of certain ants, the pupae from which are used as food. Chinese boys eagerly seek from bamboo-stems certain larvae which are dark and thick as a finger. Finally Bargagli (p. 11) notes that mayflies are collected when swarming and pounded and mixed with honey to make an acid preserve.

Simmonds (1885, p. 349) mentions that silkworm pupae are hawked about the streets in China and sold to the lower classes for about 5d. per pound as an article of diet. He mentions a price of thirty-four dollars per picul of 133 1/3 lbs at Chinkiang. The Chinese also raise the larvae of calliphorid flies in heaps of rotting fish near the sea-coast, which they apparently put to use as food. The larvae of ants are considered "a great dainty" in China, according to Simmonds (p. 369).

Esaki (1942) states that *Cybister* beetles and giant waterbugs are sold in the markets of Shanghai.

Hoffmann's (1947) paper is a major source of information on the consumption of insects in China. The insects discussed by Hoffmann are included below under the appropriate orders and families.

Bodenheimer (1951, pp. 273, 275-278) reported much original information obtained through correspondence with Chinese residents. Information from Mr. A. Ludin is summarized by Bodenheimer (p. 273) as follows:

Mr. A. Ludin, one of our students who was born in Manchuria and later lived at Peking, informed us that locusts and grasshoppers are widely used there as food. The wings and the legs are pulled off and the remainder boiled in a special oil. Then the oil is drained off and the crisp insect, seasoned by the flavour of the oil, is eaten. Some restaurants prepared fried pupae of bees and roast beetles, but these are dainties which require complicated preparation. Honey is also much used in Manchuria. Many other insects, usually pounded or boiled in water, are in use as popular medicines.

Bodenheimer (pp. 275-278) summarized information on several insects (quoted below under the appropriate orders and families) from correspondence with a Dr. Fen of Peking, some of whose observations were made by himself, others by entomologist friends: "Chinese people eat several kinds of insects; the eating of some of the insects is common throughout the country, while the use of others is limited to certain localities. In most cases the insects are taken as accessory food and used as a dish which sometimes is considered as a delicacy."

Anonymous (date?) lists in a table the identity, method of preparation, localities where eaten, and habitat where collected, for 23 species used as food, 20 of which are used in China (translation). They are included below under the appropriate orders and families.

Kantha (1990) reviews dietary sources of the Chinese population and the incidence, increase and decline of important diet-related health disorders in China during the past four decades. The consensus among researchers is that since 1949 the public health situation in China has improved tremendously. Kantha provides tabular information on insect 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.

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 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 kinds of insects are rich sources of riboflavin and/or iron.

Chen Xiaoming (1990) (The Research Institute of Insect Resources) noted that there are many edible insects in Yunnan Province and that many minority nationalities use them as food and for medicinal purposes. Among the insects often eaten are a species of ant; locusts of the genera *Oxya* and *Locusta*; pupae of the silkworm, *Bombyx mori*; the termite, *Coptotermes formosanus* (Rhinotermitidae); larvae and pupae of five species of bees and wasps among the Apidae, Vespidae and Scoliididae; the moth larva, *Hepialus armoricanus* (Hepialidae); the bug *Tessaratomia papillosa* (Pentatomidae); and the weevil larva, *Cyrtotrachelus longimanus* (Curculionidae).

In addition to studies on the folk edible insects of Yunnan, there is a study of *Macrotermes barnyi* as a health food. The queen termites are steeped in alcohol as a beverage rich in vitamins A and C among other micronutrients of benefit to health. A study that will not sound too appealing to many Westerners is on the presumed health benefits of Chongcha, a special tea made from the feces of *Hydrillodes morosa* (a noctuid moth larva) and *Aglossa dimidiata* (a pyralid moth larva). The former eats mainly the leaves of *Platycarya stobilacea*, the latter the leaves of *Malus seiboldii*. Chongcha is black in color, freshly fragrant, and has been used for a long time in the mountain areas of Guangxi, Funan and Guixhou by the Zhuan, Tong and Miao nationalities. It is taken to prevent heat stroke, counteract various poisons, and to aid digestion, as well as being considered helpful in alleviating cases of diarrhea, nosebleed and bleeding hemorrhoids. Whatever the extent of its preventive or curative benefits, Chongcha apparently serves as a good "cooling beverage" having a higher nutritive value than regular tea.

Prevost (1993), of Lakeland University in Ontario, Canada, stated that during travels in China,

Most Chinese looked at me very puzzled and asked me why I would want to eat insects, when they could offer me eyeballs, stomachs, 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.

Prevost was part of a group that looked for edible insects in Beijing restaurants; they found no insects but did find juvenile scorpions about 4 cm long. The scorpions were placed on a bed of noodles and cost about US \$1.00 each. According to Prevost, they looked ferocious, but tasted fine, probably like a potato chip.

Partly contrasting and partly confirming Prevost's observations, Professor **Zuo R. Shen (1993)** of Beijing Agricultural University states that:

In Beijing a restaurant is known well for the use of insects and other arthropods such as scorpion as medical food. Scorpion often appears now in the dishes of many restaurants including our university restaurant. In Shanghai there has opened a restaurant of food insects, which is sponsored by the Shanghai Institute of Entomology and Jinjiang Restaurant. [Also], two kinds of drugs have appeared in the market recently, which are made of extract from moths and able to improve the sex of man, according to the report by the producers, Jilin Research Institute of Plant Protection and Shenyang Agricultural University.

Chen Yi and Akre (1994) state that the main thrust or characteristic of Chinese medicine is that it combines food and medicine, and the essence of this medicine is based on the Yingyang Theory or white and dark equilibrium theory. They cite old Chinese writings dating to 100-200 A.D. recording 21 species of insects as having medicinal value, a list that was extended to 73 species with the publication of Ben Cao Kang Mu (Compendium Materia Medica) in 1578, and to 84 species with publication of the Supplement to the Compendium in 1756. See these authors under the Formicidae section for an extended discussion of the use of ants as food and medicine in China.

Similarly to the above statement by Chen and Akre, **Shen et al (1997)** cite a Chinese saying that drugs and food are homologous in function for human health, and they discuss a number of pharmacological products and uses based on insects and other invertebrates.

Coleoptera

Cerambycidae (long-horned beetles)

Larvae of the longicorn beetle (Cerambycidae): Fried or eaten raw; Sichuan, northeastern China, Hunan; In trunks of trees (**Anon.**).

Curculionidae (weevils, snout beetles)

Cyrtotrachelus longimanus (author?), larva

Rhynchophorus (= *Calandra*) *chinensis* (author?)

Ghesquière (1947) stated that *Rhynchophorus* (= *Calandra*) *chinensis* is consumed by the people of a large part of Asia from Ceylon to China.

Adults and larvae of weevils in bamboo: After removing head, legs, wings and intestines, adults are soaked in sauces and baked on hot ashes; larvae are fried with sauces; Guangxi, Sichuan; In bamboo fields (**Anon.**).

See also Chen X. (1990) in the Introduction.

Dytiscidae (predaceous diving beetles)

Cybister bengalensis Aube, adult

Cybister guerini Aube, adult

Cybister japonicus Sharp, adult

Cybister limbatus Fabr., adult

Cybister spp., adult

Cybister sugillatus Er., adult

Cybister tripunctatus Ol., adult

Dytiscus marginalis (author?), adult

Hoffmann (1947) states that dytiscid and hydrophilid beetles are commonly eaten in Kwangtung Province and in other places where Cantonese dwell. Hydrophilids are less-liked and cheaper than the dytiscids and both are cheaper than the giant waterbugs. The beetles are used both as medicine (considered an anti-diuretic) and to a lesser extent as a confection. They are prepared by dropping them into hot brine, apparently hastening the appearance of oil on the surface, as they are very greasy as offered for sale. The odor of some of these beetles is offensive, according to Hoffmann. Elytra, legs, and certain other chitinous parts are removed prior to eating. Species of dytiscids used include at least the following: *Cybister bengalensis* Aube; *C. guerini* Aube; *C. japonicus* Sharp; *C. limbatus* Fabr.; *C. sugillatus* Er.; and *C. tripunctatus* Ol.

Bodenheimer (1951, pp. 276-277) states:

Certain species of aquatic beetles known locally in Canton as '*Lung Shih*' literally meaning 'dragon lice', are used for food by the Cantonese. Two species, namely, *Cybister japonicus* Sharp (*Dytiscidae*) and *Hydrous hastatus* Herbst (*Hydrophilidae*), are commonly consumed. These beetles are boiled with salt water and sold in the market. The above mentioned two species can be purchased in any grocery in Canton, they are eaten just as watermelon seeds and peanuts are eaten by the local people. They can be purchased also in Cantonese food shops in other large cities like Peking, Shanghai and Tientsin. They may also be eaten as one of the dishes on the table. Sometimes they are fried.

In addition, Bodenheimer (p. 278) quotes correspondence from Miss N.G. Sproston, of the Institute of Hydrobiology in Shanghai, to Dr. J. Theodorides:

Beetles are a very common article of diet in some provinces. They are for sale in Shanghai, but are rather expensive because of the special preparation they require. They are fried very crisp and are eaten with other rich foods along with wine at the beginning of the feast....The rice does not appear till it (all the best dishes except the soups and pork) is nearly over. The beetles are *Dytiscidae*: *Dytiscus marginalis* is used extensively here, and in Japan and China the equally big *Cybister japonicus* is also eaten. On the whole, the Cantonese are more entomophagous than the other Chinese; next come the Szechuanese from Western China around Chungking. There it is thought, that other water-beetles are eaten. My assistant remembers eating them at his father's table when quite young, but they were small species.

True water beetle (*Dytiscidae*): Removal of internal waste with warm water, then soaked in salt, dried. Wings and legs are removed before eating. Crisp and tasty; Guangdong, Guangxi; In rice fields, pools (**Anon.**). See also Esaki (1942) in the Introduction.

Hydrophilidae (water scavenger beetles)

Hydrous bilineatus MacLeay, adult

Hydrous cavisternum Bedel, adult

Hydrous hastatus Herbst, adult

Hydrous pallidipalpis MacLeay (= *acuminatus* Mots.), adult

Hydrophilids reported by **Hoffmann**: *Hydrous pallidipalpis* MacLeay (= *acuminatus* Mots.) of North China and Tibet; *H. bilineatus* MacLeay of South China (and southward); *H. cavisternum* Bedel of Hainan Island; *H. hastatus* Herbst of Kwangtung and "Indo-China". See also Hoffmann and Bodenheimer under the *Dytiscidae*.

Scarabaeidae (scarab beetles)

Scarabaeus molossus Linn., larva

Scarab or chafer beetle (*Scarabaeidae*): Adults baked until dry, then ground to flour; Jiangsu; Forests, orchards (**Anon.**). See also Donovan (1798), Darwin (1800) and Williams (1853) in the Introduction.

Family uncertain

Melanaster chinensis Forster, larva

Psacotha hilaris Pascoe, larva

Bodenheimer (1951, p. 277) mentioned the above two species as being eaten in certain localities. According to **Anon.**: Grubs: After removing head, legs, and intestine, they are fried with salt and oil; China, Japan; Soil, or dunghills and manure piles associated with fowl or livestock.

Diptera

Calliphoridae (blow flies, bottle flies)

Chrysomya megacephala (Fabr.), larva

According to **Hoffmann**, some people in the Canton area rear and dry the larvae of the green-bottle fly, *Chrysomya megacephala* (Fabr.), as medicine and food. The medicine shops in Canton were apparently large buyers. Pieces of fish and meat were exposed to attract oviposition, but no information is given

concerning the rearing medium. Hoffmann notes that the flowers of privet, an ornamental hedge in Canton, attract green-bottle flies by the thousands. Hoffmann raises questions as to the health implications of these flies, and why they are reared at all, particularly as they may be "obtained by the quarts from the numerous night-soil *kangs* in any village."

Bodenheimer (1951, p. 278) mentions that in some localities maggots from meat (Calliphoridae and Sarcophagidae) are eaten and are called locally 'meat sprouts' in analogy to bean sprouts grown from beans).

Maggot of fly: Cleaned, then mixed with glutinous rice powder, making cake; Southern China (**Anon.**). See also Simmonds (1885) in the Introduction.

Muscidae (filth flies)

Musca domestica vicina Macq., larva

In a report that appeared widely in U.S. newspapers (e.g., *San Francisco Chronicle/Examiner* Jan. 23, 1994; newspaper reports summarized in *Food Insects Newsl.* 7(2): 11, 1994), the official Xinhua News Agency reported that Chinese scientists have developed nutrition-rich extracts from maggots of the common fly [presumably *Musca domestica*], and are negotiating with food and pharmaceutical firms to mass-produce the products. It quoted one scientist as saying the maggot extracts are "surprisingly appealing" but did not describe how they taste. The maggot amino acids can be used as a nutritional supplement for children's food, and the low-fat oil is effective in preventing heart disease, the report said. It noted that the maggots are kept in large bottles and fed distiller's grain, wheat bran and other farm waste.

In studies on mass-rearing of the house fly (*Musca domestica vicina*) for protein production, **Lu and Zhong (1993, 1994, 1995)** developed models and theoretical optimal schemes for fly oviposition during the first 20 days, fly oviposition, average eggs per fly and larval biomass.

Sarcophagidae (flesh flies)

See Bodenheimer under Calliphoridae.

Ephemeroptera

Adults and larvae of mayflies (Ephemeridae): The larvae, which are rich in fat, are fried; China, Japan; In streams or pools (**Anon.**). **Bodenheimer** mentions that larvae of May flies are eaten in certain localities. See also Bargagli (1877) in the Introduction.

Hemiptera

Belostomatidae (giant water bugs)

Lethocerus indicus Lep. & Serv., adult

The giant waterbug, *Lethocerus indicus*, is called *Kwai Fa Shim* or henna flower cicada because it has a pleasant odor not unlike the flowers of henna or *Lawsonia*. **Hoffmann** says of this species:

In Canton these bugs are prepared for eating by dropping into boiling water to which has been added a little salt. More rarely they are placed briefly into deep fat to which some spices have been added....They are considered a delicacy and are eaten because they are relished; no medicinal value is ascribed to them. These bugs, like the hydrophilid and dytiscid beetles, are displayed by the gallons in numerous shops and food stalls in cities like Canton, Hong Kong, and Shanghai. These insects are offered for sale in Shanghai because of the large number of Cantonese living there and are exported abroad for the same reason. The Cantonese seem to be the chief insect eaters among the Chinese although I am informed that the people in the Peiping area are fond of grasshoppers cooked in sesame oil.

The collection of aquatic bugs and beetles is conducted as a business by "professionals," according to Hoffmann. He states:

I have often come across them in the country carrying their catch and their paraphernalia but only once observed a collector at work and he promptly discontinued once becoming aware of my presence. I have not been able to determine if these collectors are the ones who collect frogs for the market, but it seems certain that the professional grasshopper collectors have

nothing to do with the lowly aquatic professions. The grasshoppers are caught and sold, alive, as bird feed.

Hoffmann notes that the use of the giant waterbugs as human food saves the pond-fish culturists of Kwangtung Province several hundreds of thousands of dollars annually because the bugs are destroyers of young fish in the breeding ponds. They also occasionally are troublesome in the outdoor rearing of goldfish and other aquarium fishes.

Bodenheimer (1951, p. 277) states: "*Kwei-hua-ch'an*, a member of Hemiptera, *Lethocerus indicus* Lepeletier and Serville (Belostomatidae), is a large aquatic insect also used by Cantonese as food in a similar manner as the water beetles. They can also be purchased in food shops in Canton."

Adult giant water bug, or fish killer: Prepared similarly to the water beetle: Guangdong; Rice fields, pools (**Anon.**). See also Esaki (1942) and Prevost (1993) in the Introduction.

Pentatomidae (stink bugs)

Tessarotoma papillosa Drury, adult

Lichi stink-bug, *Tessarotoma papillosa* Drury: Head, legs, wings and intestines removed, then salted, covered with cabbage leaves, and quick-boiled on hot ashes; very tasty, no bad odor; Southern China; On lichi trees (**Anon.**). See also Chen (1990) in the Introduction.

Homoptera

Cicadidae (cicadas)

Bodenheimer (1951, p.277) states:

Cicada. Any species available, adults as well as nymphs, are eaten, especially the nymphal forms. The latter are either collected on the tree during evening time or dug out from the ground. They are usually eaten after frying....Boys are always lashing at the street trees with long bamboos to bring down the cicadas, etc. Sometimes children eat various insects and pupae they catch. The nearly emergent cicada nymph is eaten raw as a great delicacy, particularly in Shantung.

Luo Ke (1990) reports that several insects such as cicada are canned for sale in the markets.

Hymenoptera

Apidae (honey bees)

Bee larvae and pupae. See Bargagli (1877), Bodenheimer (1951) and Chen (1990) in the Introduction.

Formicidae (ants)

Polyrhachis vicina (Roger)

Brygoo (1946, p. 51; vide Bodenheimer 1951, p. 233) states that the Chinese regard ant larvae as a delicacy.

In a report carried in U.S. newspapers (e.g., *The Capital Times* [Madison, Wisconsin] Oct. 22, 1992; summarized in *Food Insects Newsletter* 5(3): 4, 1992), the Chinese News Agency, Xinhua, reported a recent meeting in Nanking by ant experts and medical workers to discuss the health benefits of eating *Polyrhachis vicina* - the country's most common ant - as "crunchy morsels," or taking a sip of essence of ant. "In some regions of southwestern China, local people regularly eat ants," Xinhua reported. "As a result, the locals enjoy good health." Ants were especially effective against rheumatism, said Zhang Zhilin, the vice chairman of the Chinese entomological society. The formic acid and other mineral traces in the insects were also effective in the treatment of hepatitis-B and other immunity disorders, the agency reported.

In another report carried in U.S. newspapers (e.g., *San Francisco Chronicle* Jan. 28, 1994; newspaper account summarized in *Food Insects Newsl.* 7(2): 11, 1994), Xinhua, China's official news agency, urged people to add ants to their diet: Wu Zicheng, "an expert on ant diet" based in the central city of Nanjing, has worked out dozens of recipes for ant-based cakes, teas and wines to promote ant eating, the news agency

said. "Ants are a miniature nutritious treasury," Xinhua quoted Wu as saying, adding that ants contain more zinc than either soybeans or pig liver. Xinhua said Chinese have been eating ants for more than 3000 years and "the longevity of many old people who are now over 100 years old has been found to be connected with an ant diet."

According to an article in the *Asahi Evening News*, entitled "Ant foods make big bucks in China," annual sales of ant foods in the country amount to approximately US \$100 million (**Kantha 1994**).

Chen Yi and Akre (1994) discuss the food and, especially, the medicinal uses of ants, primarily the weaver ant, *Polyrhachis vicina*. In ancient China ants were used as food for the nobles as well as for the common people, and the Book of Etiquette mentions that ant eggs (pupae) were prepared as a special paste to serve the nobles. In the southern provinces, large quantities of pupae were collected to make a caviarlike dressing. "This delicacy was served at dinner to welcome honored guests." It was believed that eating ants would rejuvenate old people, and in the Supplement of the Compendium Materia Medica it is stated that eating 6-10 g of ants per day could make one healthy and increase milk production in women. The authors cite (and tabularize) data on amino acids and minerals from earlier nutrient analyses of *P. vicina* by Chen, and they remark specifically on the high concentration of zinc in these ants. The reported protein content is 42-67%.

The ants are believed to have many medical functions including improving blood circulation and metabolism, bolstering the immune system, reducing inflammations, reducing pain, treating asthma and rheumatoid arthritis, and slowing aging, among others. For cancer patients, ant medicines are reported to increase appetite, relieve pain, improve digestion and increase the number of white blood cells. Ant medicines currently sold without prescription include an ant wine, a syrup, a paste and a powder. To improve palatability, they are sometimes mixed with tea or selected medicinal herbs. Chen and Akre cite research relevant to some of these conditions, but there is little or no clinical confirmation for most of the presumed medical benefits. The authors mention that USDA chemists are currently testing ant powder to determine whether it contains prostaglandin inhibitors, chemicals that mimic aspirin, and which, if found, might lend some scientific foundation to the use of ants in treating arthritis and some other ailments.

According to Chen and Akre, the Chinese people are enthusiastic about ants used as medicine, and their popularity is increasing. The medical uses are widely reported in newspapers and magazines and on television and radio. Scientists are concerned that there is danger the ants are being over-harvested to the point of extinction, and efforts are now underway to develop mass-rearing methods. An ant breeding farm, the first, was established in Yuyao, Zhejiang province in 1991.

See also Bargagli (1877), Simmonds (1885) and Chen (1990) in the Introduction.

Scoliidae (scoliids)

See Chen (1990) in the Introduction.

Vespidae (wasps, hornets)

Vespa sp., larva, pupa

Among insects eaten in certain localities, **Bodenheimer (1951, p. 277)** mentions the larvae of *Vespa* sp.

Pupae and larvae of wasps and hornets: Fried in oil, also canned; Eaten in many areas of China; Combs hanging on trees, under eaves, holes in trees, in the soil (**Anon.**). See also Bargagli (1877) and Chen (1990) in the Introduction.

Isoptera

According to the official New China News Agency, as reported in U.S. newspapers (e.g., *San Francisco Examiner* March 15, 1992; newspapers summarized in *Food Insects Newsl.* 6(1): 5, 1993), Yang Siqi, director of the Yingtan Termite Research Institute, believes termites can cure a variety of ills. He developed the 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 produce termite-based medicines for the international market.

Rhinotermitidae

Coptotermes formosanus (author?)

See Chen (1990) in the Introduction.

Termitidae

Macrotermes barnyi (author?), queens

Termites (Termitidae): Fried; Southern China; Nests in soil and in wood (**Anon.**). See also Chen (1990) in Introduction.

Lepidoptera

Bombycidae (silkworm moths)

Bombyx mori (Linn.), pupa

Silkworm pupae are eaten, mixed with egg yellows and fried in butter (**Verrill 1938**, p. 162; vide Bodenheimer 1951, p. 274).

Hoffmann mentions that the pupae of the silkworm, *Bombyx mori* Linn., are used extensively as food in the silk districts of Kwangtung Province in South China. He describes as follows:

In reeling, the cocoons are dropped into very hot water and the reeling girls have a plentiful supply of freshly cooked food before them all day long. They seem to eat off and on all day long since they work rapidly for long hours at a stretch and the cooked morsels are ever before them. One gets a pleasant odor of food being cooked as he passes through a reeling laboratory. I understand that the pupae are also roasted and have seen pupae in the food stalls which had the appearance of having been roasted. The pupae are offered for sale throughout the silk district in the south and to some extent in other areas. I am told that there are other ways of preparation employed in the silk districts in central China. The pupae, along with waste material from the reeling factories, are used as fish food in pondfish culture. Even more extensively used as fish food is the waste from silkworm rearing (feces, dead worms, and mulberry leaves).

Bodenheimer (1951, p. 275) states:

Silkworm cultivation is an important industry in many provinces, e.g. Shantung, Kiangsu and Chekiang and in some parts of Szechuan. In these places country people raise silkworms and make silk themselves. Spring is a busy season in the field. The cocoons of silkworms cropped in the spring are preserved by baking or by pickling them with common salt. Silk is made at leisure during the summer rainy season. Consequently large amounts of silkworm pupae are produced during the season. The pupae either from the baked cocoons or from the salted cocoons are then dried in the sun and preserved as food for the rest of the year. Pupae from the baked cocoons are more delicious and are liked most. For eating the pupae are first softened in water and then fried either with chicken eggs in the form of omlette or simply fried with onion and sauce. It is used as a dish in the ordinary meal or on occasions when guests are invited. In all three provinces silkworm pupae are eaten in a similar way. The commonest species is *Bombyx mori* L.

Merle (1958) credits a Chinese doctor with the information that (translation), "in certain remote areas of China [silkworm] chrysalides, scalded and gathered together at the moment the cocoon's silk is unwound, are placed in containers where, upon fermenting, they produce a liquid which serves as a condiment (a little like the Vietnamese 'nuoc-man')." "

Hyde (1984, p. 15) noted that stir-fried silkworm pupae at a Chinese commune added a protein-rich supplement to a predominantly vegetarian diet, and mentions also that silkworm frass is collected by the Chinese for fish food and fertilizer.

Pupae of the silkworm, *Bombyx mori* Linn.: Cooked with Chinese chives, or fried in oil; Zhejiang, Jangsu; From silk reeling mills (**Anon.**). See also Donovan (1798), Darwin (1800), Williams (1853), Bargagli (1877), Simmonds (1885), Chen (1990) and Prevost (1993) in the Introduction.

Gelechiidae

Pectinophora gossypiella Saunders, larva

Overwintering larvae of the pink bollworm, *Pectinophora gossypiella* Saunders: Fried in oil; Jiangsu, Shandong; Cotton storehouses (**Anon.**).

Hepialidae (ghost moths and swifts)

Hepialus armoricanus Oberthur, larva

Hepialus oblifurcus Chu and Wang, larva

According to **Hoffmann**, hepialid caterpillars infected with fungus of the genus *Cordyceps* are sent from Szechwan Province to other provinces in China as well as abroad. About a dozen of the infected caterpillars, each with a long strand of fungal growth, are tied into neat bundles of uniform size. They are made into a broth, with both the larvae and the broth being consumed. They are considered both a delicacy and as tonic food, and are expensive, only the middle classes and the well-to-do being able to afford them. Hoffmann states that, "I have sampled this material myself and found it quite tasty, but since I felt fine both before and after doing so, I cannot testify as to its efficacy." Hoffmann observed an instance in which hospitalization was necessary for three individuals who ate a large quantity of cicada nymphs infected with *Cordyceps*.

Chinese caterpillar fungus, *Cordyceps sinensis*: Cooked with chick; Yunnan, Sichuan, and Tibet; High mountains (**Anon.**).

In 1993, stunning world record track performances by Chinese women runners rocked the track world and received considerable press coverage in the U.S. and elsewhere (summarized in the *Food Insects Newslet.* 6(3): 3, 1993). The Chinese coach attributed his athletes' success to hard work and drinking large portions of an expensive potion made from the rare *dong chong xia chao* worm found on China's western high plateau. **Steinkraus and Whitfield (1994)** cited a source in the sports world in saying, "Although recent statements from the Chinese attribute the athletes' success to their intense training schedules rather than to their dietary supplements, the possible stress-relieving properties of the caterpillar fungus continue to intrigue Western athletes and scientists." The authors cite a 1992 study (Gao et al, *Acta Entomol. Sin.* 35: 317-321) that the caterpillar fungus consists of larvae of *Hepialus oblifurcus* Chu and Wang (Lepidoptera: Hepialidae) infected with the obligate entomopathogenic fungus *Cordyceps sinensis* (Berkeley)(Clavicipitales, Ascomycotina). The authors briefly summarize biology of both hepialid moths and the fungal genus *Cordyceps* and the methods of packaging and preparing the fungus for ingestion.

The fungus has always been expensive, affordable only by the well-to-do, and remains so today. Steinkraus and Whitfield ordered it from an American-Chinese apothecary in 1993 at a price of US \$18/oz which is very close to the wholesale price quoted in China (US \$700/kg). The pharmacologic properties of the caterpillar fungus are said to resemble those of ginseng (*Panax quinguefolius*), strengthening and rejuvenating a system harmed by overexertion or long illness. Many other medical benefits are also attributed to the fungus. Although the incredible performances of the Chinese women's track team cannot yet be attributed to the fungal potions, the authors conclude that, "Clearly, *Cordyceps* spp. deserve more [research] attention from pharmacologists, chemists, and entomologists." Unfortunately, *Cordyceps* has its greatest diversity in rainforests and becomes much less abundant as the rainforests are disturbed and destroyed. "The loss of these fascinating insect pathogens will be especially tragic because of their potential as a source of pharmacologically active compounds."

Espelie (1994) and X. Chen (1990)(see Introduction) give the identity of the caterpillar as *Hepialus armoricanus*, which raises a question as to whether there is taxonomic synonymy involved or whether more than one species serves as host for the fungus. *Cordyceps* species appear to be host-specific, according to Steinkraus and Whitfield, but they note that this may only be apparent because more than half of the described species are known only from the original collection.

Noctuidae (noctuids)

Hydrillodes morosa (author), larval excreta

See Chen (1990) in the Introduction.

Pyralidae (snout and grass moths)

Aglossa dimidiata (author?), larval excreta

See Chen (1990) in the Introduction.

Saturniidae (giant silkmoths)

Antheraea (= *Antherea*) *pernyi* (Guérin-Méneville), pupa

Saturnia (= *Eriogyna*) *pyretorum* (Westw.), larva

Bodenheimer (1951, p. 275) states:

In Shantung, people of certain hilly districts cultivate *Antherea pernyi* on oak trees. On account of the large size and thick cuticle, the pupae are generally prepared by frying with onion and sauce, and not with eggs as is done for ordinary silkworm pupae. Since the pupae of this species are rather rare, but of large size, they are especially valued. Farmers who have these pupae may give them to their friends or relatives as a special gift.

Peigler (1993) describes a rather bizarre deviation from the normal exploitation of silk from cocoons. For centuries in southern China, particularly on the island of Hainan, mature larvae of *Saturnia* (= *Eriogyna*) *pyretorum* (Westwood)(Saturniidae) "were collected just before pupation and the silk glands were extracted, soaked in vinegar, washed, stretched more than 2 m, and made into what was hailed as very strong leaders for fishing lines. The caterpillars were sometimes fried and eaten after the silk glands were extracted."

Sphingidae (hawk moths, sphinx moths)

Clanis bilineata Walker, larva, pupa

Pupae and larvae of *Clanis bilineata* Walker (Sphingidae): Salt-soaked, then fried; Shandong, Henan, Hebei, Anhui, Jiangsu; In soybean fields and the wood of the Chinese scholartree (**Anon.**). See also Darwin (1800) in the Introduction.

Odonata

Bodenheimer (1951: 277-278) mentions that the larvae of dragonflies are eaten in certain localities.

Orthoptera

Acrididae (short-horned grasshoppers)

Locusta migratoria Linn.

Locusta migratoria manilensis Megeen

Oxya chinensis Thunberg

In Tientsin, **Oliphant (1861, p. 273)** saw boys in the street hawking bushels of fried locusts. Locust hunting is a favorite occupation of the children, and Oliphant compared the taste of the locusts to that of periwinkles. **Cowan (1865, p. 126)** cites the Chinese Repository to the effect that the Chinese consider the locust, when deprived of its abdomen and properly cooked, as passable eating, but do not appear to hold the dish in much esteem.

Bodenheimer (1951, pp. 275-276) states:

The eating of grasshopper is common in various parts of China. Many species are eaten and the species concerned depends on what is available. In Shantung at least 4 species are eaten. The female of the large form is about 3 inches long. The time these insects are collected to be used as food is the late autumn. At that time the female insect contains a large number of eggs and on account of the chilly mornings they are more easily caught. During this time children as well as adults usually collect them while working in the fields. The catch forms one of the dishes of the evening meal. The wings are taken off, the heads together with the intestine are pulled out and the whole insect is fried with the addition of salt and sauce.

In Tientsin and Peking even city people eat grasshoppers. The farmer in the autumn collects and brings them to the market to be sold alive. The grasshoppers of a market value are only the locust, *Locusta migratoria*, as this is the only species that can be collected in large numbers in some years. Also regarding this species, those collected in the late autumn containing eggs are especially appreciated. This species is so commonly eaten that during autumn and winter months it can be obtained from any groceries in both Peking and Tientsin. Some are already fried ready to be eaten, while dried ones (they are killed by boiling in water or by steam and dried) can be purchased and fried at home.

While grasshoppers are ordinarily used as accessory food, they, especially the locusts, when the crop has been destroyed by them and the farmers can collect them in large numbers, are used as ordinary food. Families are known who passed the famines due to destruction of crop by locusts by eating the locusts collected in the field with the limited amount of cereal they had on hand. In such cases the collected locusts are either killed by boiling them in water or by steam, then dried in the sun and fried for eating when needed.

Locust (Acrididae): Cooked with salt, then dried under the sun. Mixed with rice to make porridge or cake, or cooked with vegetable as a dish. Or, fried in oil after removing the intestine, head and legs; very crisp and tasty; Eaten in many areas of China and Japan; Found on grasses in uncultivated fields (**Anon.**).

Luo (1990) reported that *L. migratoria manilensis* Megeen and *O. chinensis* Thunberg are widely used as food in China. The latter has been canned for sale in some town markets in recent years.

See also Williams (1853), Bargagli (1877), Bodenheimer (1951) and Chen (1990) in the Introduction and Hoffmann under Bombycidae.

Blattidae (cockroaches)

Periplaneta americana (Linn.)

Periplaneta australasiae (Fabr.)

Bodenheimer (1951) states that cockroaches (*Periplaneta americana* and *P. australasiae*) are eaten in certain localities, as does **Anon.**: Cockroach (Blattidae): Cooked; Guangdong; Wardrobes.

Gryllidae (crickets)

Adult crickets: Cooked with soysauce and sugar; China, Japan; Small ridged holes in vegetable fields (**Anon.**).

Gryllotalpidae (mole crickets)

Adult mole crickets (Gryllotalpidae): After the legs, wings and intestines are removed, they are eaten with sauce; Guangdong, Guangxi; In the soil, especially in gullies and ravines; Collected during spring ploughing, or when attracted to baits (**Anon.**).

Insects as Animal Feed in China

According to **Clausen (1963, pp. 137-138)**, the small scale insect, *Ericerus pala* (Coccidae), which produces the wax known as "peh-la" in China, forms a byproduct that is fed to swine. See also Hoffmann (1947) and Hyde (1984) under Bombycidae.

Luo (1989) summarized the results reported in numerous research papers published in China since 1980 on the nutritive value of insects, primarily three species, as feed for poultry, fish, pigs and farm-grown mink. The three species are *Musca domestica* (larvae and pupae), the silk worm, *Bombyx mori* (pupae), and the yellow meal worm, *Tenebrio molitor* (larvae). Data on proximate analyses, calcium and phosphorus content of the three insects are presented in China Table 1 and compared to earthworm meal and two conventional high-protein feeds, fish meal and bean cake (see Luo's Table 1 and his text).

In at least the majority of the feeding trials reported, experimental diets involved substitution of insect meal for equivalent weights of fish meal, either all or part of it. There is no mention of whether diets were kept isonitrogenous and isocaloric within experiments.

In all of eight reports on laying hens, hens fed fly meal-containing diets fared as well or better than those fed fish meal diets as measured by egg production, egg quality, and feed costs. In one test on pigs fed fly larval diet, the pigs showed increased growth and reduced cost per pound of meat produced. In two reports on first-year grass carp, fish fed fly meal showed increased weight gains and protein efficiency and reduced cost per pound of fish produced.

In one report on silkworm pupal meal fed to chicks, weight gains of chicks fed the pupal meal were slightly lower than those fed fish meal, but the cost per pound of meat produced was reduced because the price of pupae is only half that of an equivalent amount of fish meal. In two reports, silkworm pupae were an excellent protein source for commercially reared mink, resulting in improved lustre and quality of fur. Silkworm pupae produced increased weight gains in pigs but also resulted in an odor problem in the meat. The

problem was eliminated by removing pupae from the diet one month before slaughter. Chemical methods also show progress in eliminating the offending odor from silkworm pupae.

Miscellaneous

See Hoffmann under Belostomatidae.

JAPAN

Esaki (1942; vide Bodenheimer 1951, pp. 278-279) mentioned that certain insects are said to be eaten in some localities of Japan. **Remington (1946)** reported information provided by Professor T. Inukai of the Hokkaido Imperial University in Sapporo, Nagano Prefecture, which is in north-central Honshu. Nagano is one of the few wholly inland provinces. The people "are unable to get enough fish and meat to fill their protein needs, and they extensively tap the insect population." According to Remington, "all pupae (other than wasps) taken in the soil are carefully avoided. Apparently some are very poisonous. On the other hand, all insects found in fresh water are edible and delicious. Larvae and aquatic adults of Coleoptera, Hemiptera, Ephemera, Plecoptera, Trichoptera, Odonata, and others are eaten, unsorted. Aquatic insects are frequently gathered by nets and screens which are held in swift water while the stream bottom above them is agitated, stones moved, and trash stirred." Insects mentioned by Remington are discussed below under the appropriate orders and families.

Mitsuhashi (1984), in his book, "Edible Insects of the World," includes a section on insects as traditional foods in Japan (DeFoliart [1988] provides a sketchy outline of the contents of the book, which is in Japanese). Concerning the varieties of insects eaten in Japan, Mitsuhashi cites data gathered in 1919 by Dr. Tsunegata(?) Miyake of the Agricultural Experiment Station, Ministry of Agriculture and Commerce. This report contains the results of a survey carried out in each prefecture, and includes not only edible insects but also medicinal insects. The survey identified 55 varieties of edible insects and 123 varieties of medicinal insects that were known in Japan at that time.

In the ranking by prefecture, Nagano Pref. is found to be at the top, as might be expected. This is probably due to the fact that Nagano is a mountainous region, where the supply of animal protein from sources such as fish is not sufficient. In Nagano hachinoko (bee or wasp larvae) and zazamushi (aquatic insects) are particularly renowned, and these items are sold packed into cans. These foods are still eaten today, and the canned items are even exported to foreign countries. The traditions of eating insects in the other prefectures were substantially the same, without any particularly unusual items. Only Miyazaki Pref. failed to respond to this survey; replies from Toyama Pref., Osaka Pref., and Kagawa Pref. indicated that there was no tradition of eating insects in those areas, but Mitsuhashi wonders whether this is so. Maybe the respondents, thinking that the idea of eating insects was somewhat embarrassing, may not have answered truthfully.

Three important insect foods discussed by Mitsuhashi are inago (see under Acrididae), hachinoko (see under Apidae) and zazamushi. Zazamushi, rather than being unique to Japan, may properly be called a food item that is unique to Nagano Prefecture. Zazamushi is not a single variety of insect, but is a catch-all name applied to the larvae of insects that live at the bottom of rivers. About 1955 Dr. Y. Torii studied the zazamushi taken along the Tenryugawa River near Ina in Nagano Pref. and found the great majority (93%) were larvae of tobikera (Trichoptera). The larvae of hebitonbo (Protohermes) accounted for 6%, while larvae of kawagera (Plecoptera) made up 0.2% and larvae of nabebutamushi(?) 0.3%. This species composition is not constant; kawagera larvae are said to have been the principal component in the past. In general, insects that live in water are not poisonous and are delicious. Thus, zazamushi were surely popular as a food item. The name "zazamushi" means insects (mushi) that live in a place where the river makes the sound "zaazaa" as it flows. At one time it was possible to catch as much as several tens of kilograms of zazamushi, but these days only a small quantity can be taken. Even today, however, it is still possible to enjoy canned zazamushi.

Ichinose (1989) mentions eating, as a child in the Nanshin district of Nagano prefecture, various species of insects, and that many people still consume insects of the following groups: Ephemeroptera, Odonata (Libellulidae), Orthoptera (Tettigonioidea and Acridioidea), Plecoptera, Hemiptera (Cicadidae), Neuroptera, Trichoptera, Lepidoptera (silk worm pupae and adults), Coleoptera (true water beetle and water-scavenger beetle adults, and longicorn beetle larvae, pupae and adults) and Hymenoptera (all species of *Vespa* and *Polistes*). One can buy canned aquatic insects, canned *Vespa* spp., rice hoppers, and cooked pupae and adult silk worm in Nanshin supermarkets. Most insects are cooked before being eaten, but some people eat raw wasp larvae and pupae.

Ichinose suggests that insects may have been an important source of salt and minerals in Nanshin, which, because of terrain and climate, was sometimes hard to reach with deliveries from coastal districts.

Until about 100 years ago, when humid weather reduced salt production, "the people of Nanshin frequently either ate more insects to increase their salt intake or extracted salt by boiling *tatami*."

Kiuchi and Tamaki (1990) note that, at present, only a few insects are consumed as food in Japan and only four are found on the market: "inago" (see under Acrididae), the silkworm (see under Bombycidae), "hachinoko" (see under Vespidae) and "zazamushi." Zazamushi is a general term for edible insects living in the gravel of river fords. Those eaten are mainly the larvae of may flies (Ephemeroptera) and caddis flies (Trichoptera), but their production is minimal. According to the authors, "most people who have eaten insects say that insects are good if they are properly cooked." They discuss psychological and cultural barriers and believe that people's evaluation of insects as food can be changed. Finally, they state the necessity of developing mass production methods if we are to realize edible insect production as a modern industry.

Pemberton and Yamasaki (1995) reported that, in Japan, there is a type of restaurant, traditional but not common, that specializes in foods of the Japanese Alps. These restaurants serve many kinds of gathered foods, including insects. In 1985, the authors visited one of these restaurants called the Sinshu-Sakagura, located in the Sinjuku district of Tokyo. The menu included:

- 1) *hachi-no-ko*, boiled wasp larvae (*Vespula lewisi* Cameron), 500 Yen (US \$3.15);
- 2) *zaza-mushi*, larvae of aquatic insects, mainly Trichoptera (*Stenopsyche griseipennis* MacLachan in this case) boiled in soy sauce, 350 Yen (\$2.20);
- 3) *inago*, fried rice-field grasshoppers (*Oxya japonica japonica* Willemsse) slightly seasoned with soy, 300 Yen (\$1.90);
- 4) *semi*, a fried cicada (*Graptopsaltria nigrofasciata* Motschulsky).

They were also served *sangi*, fried pupae of the silk moth (*Bombyx mori* L.) which did not appear on the menu.

In 1992, the authors looked again for insect foods and found the Kisoji in Ikebukuro, part of the Jamasa chain of Japanese Alps style restaurants which at that time had eleven branches in Tokyo. Three of the same kinds of insects they had tried in 1985 were on the menu: wasp larvae and pupae, rice-field grasshoppers and caddicefly (Trichoptera) larvae. The restaurant manager told them that most customers order insect dishes.

The authors found canned insects sold in the large food centers usually found on the basement levels of department stores and also in small stores. These included silk moth pupae, honeybee larvae, rice-field grasshoppers, and "child hornets." The latter were being sold for about \$20 per 100 g can in the prestigious Mitsukoshi Department Store in Tokyo in 1990. Some people enjoy catching rice-field grasshoppers while on picnics or holidays, and some mountain inns and hotels will prepare the grasshoppers that their guests catch.

The textures of the insects were more pronounced than their flavors, probably because they were not fresh (even the restaurant insects seemed to be from cans) and because of the use of soy sauce and sugar in the preparations.

All of the insects except the silk moth pupae, which are a by-product of the silk industry, are wild-caught. Rice-field grasshoppers were traditionally caught by hand by farmers' wives, but today, some are caught by net-bearing motor scooter riders. The Trichoptera are captured by placing large nets across mountain streams, then disturbing rocks upstream to dislodge them. The large underground nests of *Vespula lewisi* are found by catching a wasp, tying a long silk thread to it, then following it back to its nest. Sometimes, a small piece of paper is tied to the thread to slow the flight of the wasp and make it even more visible. The nest is dug up after driving the adult wasps from it with smoke.

There are several reasons for the appeal of edible insects in modern Japan: simple enjoyment of the tastes, or the novelty, or the nostalgia of the old foods, even in Tokyo "amongst the glass and steel towers and the fast food restaurants." Foraging for wild foods like grasshoppers and edible plants is a popular pastime for some hikers, and wasp larvae and pupae are consumed by some to promote good health and a long life. Among several factors mentioned by the authors, in historical times the traditional Japanese Buddhist prohibition against eating four-legged beasts probably helped maintain insect usage.

Coleoptera

Cerambycidae (long-horned beetles)

Larvae and pupae of Cerambycidae and certain other wood-boring beetles are dug out of dead wood and are valued as food (**Remington 1946**). See also Ichinose (1989) in the Introduction.

Dytiscidae (predaceous diving beetles)

Cybister japonicus Sharp, adult
Dytiscus spp., adults

Dytiscus adults are among the aquatic insects commonly eaten (**Remington 1946**). The large dytiscid beetle, *Cybister japonicus*, is eaten (**Bodenheimer 1951**, p. 278). See also Ichinose (1989) in the Introduction.

Elateridae (click beetles)

Larvae and pupae of Elateridae are dug out of dead wood and valued as food (**Remington 1946**).

Hydrophilidae (water scavenger beetles)

See Ichinose (1989) in the Introduction.

Ephemeroptera

Nymphs of Ephemeroptera are eaten, boiled (**Esaki 1942**). Also see Remington (1946), Ichinose (1989), and Kiuchi and Tamaki (1990) in the Introduction.

Hemiptera

Belostomatidae (giant water bugs)

See Remington (1946) in the Introduction.

Homoptera

Cicadidae (cicadas)

Graptopsaltria nigrofasciata Motschulsky, adult

Among the very popular insects eaten are all species of Cicadidae (adults) (**Remington 1946**). See also Ichinose (1989) and Pemberton and Yamasaki (1995) in the Introduction.

Hymenoptera

Apidae (honey bees)

Apis mellifera Linn., drone pupa

Takaishi (1908) reported that, in Shinano Province, the larvae and young bees of a species of wild bee (Japanese name, jibachi or anabachi) that nests in holes in the ground are used as food. The high price indicates that they are considered a delicacy. The dish is prepared with sugar and shoyu-sauce, and similarly prepared bees and larvae are canned in tin containers and exported to other provinces in Japan, about 1,000 cans annually. One kilo costs yen 2.50. The insects are dug up after first igniting gun-powder at the nest entrance to stupify them; they are killed by placing them briefly in hot water. Analysis of the canned preparation revealed water 28.15%, crude protein 13.69%, crude fat 11.15%, glucose 5.71%, cane sugar 5.81%, NaCl 6.23%, ash 10.92%.

In an article in the Saturday Evening Post, "My Adventures in Eating," Joseph Alsop says of fried bees [brood?] served in a Tokyo restaurant (**Anon. 1957**): "I really rather enjoyed the bees, which are a pleasant dish. The country children make a game of finding the wild hives, imitating the bee birds; their families pick the young bees from the combs, fry them and put them down in crocks..."

According to **Mitsubishi (1984)** hachinoko (bee or wasp larvae) is the most widely eaten insect food in Japan next to inago. Eating hachinoko is not a custom confined merely to Japan. All over the world different varieties of bees or wasps are eaten, but in Japan it is mainly the jibachi(?) and kurosuzumebachi(?) that are eaten. In general, hachinoko are either eaten raw, boiled down in soy sauce, or served over boiled rice. In Nagano Pref. a mixture of larvae, pupae, and adults is boiled down in soy sauce, canned and sold.

[**NAME 1990**] discussed bees and bee larvae as traditional food in Japan [this needs better translation].

See also Mitsuhashi (1988), Kantha (1988), Kiuchi and Tamaki (1990) under Vespidae.

Vespidae (wasps, hornets)

Polistes spp., pupa

Vespa japonica Saussure, larva

Vespa spp., larva

Vespula lewisi (Cameron), larva, pupa, adult

Vespula sp., larva, pupa

Okamura (1912) discussed wasp brood as food [this awaits translation]. According to **Esaki (1942)**, the so-called "bee-larvae" sold on the market are actually wasp grubs, *Vespa* sp., which fits with information that honeybees were rarely kept in Japan.

Remington states: "The favorite insect for food in Nagano is the Yellow-jacket Wasp (subg. *Vespula*), whose larvae and pupae are highly prized. Pupae of all wasps are eaten when found, but *Polistes* seems to rank next to *Vespula* in frequency of occurrence on Japanese menus. In Sapporo the writer saw *Vespula* pupae preserved in cans and apparently sold in grocery stores." **Bodenheimer (1951, p. 278)** reports that larvae of *Vespa japonica* are prepared as canned goods in Japan and have a large annual sales volume.

In the fourth edition of the Standard Tables of Food Composition in Japan (**Anon. 1982**; vide Kantha 1988), the protein content of canned larvae of *Vespa japonica* Saussure is given as 15.7 grams per 100 grams of edible portion.

Mitsuhashi (1988) mentions that Emperor Hirohito, following surgery in 1987, reportedly "finished all of the wasp-rice dish even when he had no appetite and left most of the other dishes." Mitsuhashi describes the dish as follows:

The wasp-rice is a mixture of cooked rice and canned wasps. The canned wasp is a specialty of Nagano Prefecture. It is a cooked wasp (a mixture of larvae, pupae, and adults of *Vespula lewisi*; sometimes male larvae of bees, *Apis mellifera*, are used) with soy sauce and sugar. In my experience, the wasp-rice tasted good. It was somewhat sweet and nutty. The shortcoming is that the shapes of dark adults with wing, pupae, and white maggots are well preserved. If one doesn't care about the appearance, it is really good.

Mitsuhashi describes how the wasps are collected, and states, without citing a source, that they are a protein-rich food which contains 10 times as much B-group vitamins and iron as ordinary food. A can of the cooked wasps (about 65 g) presently sells for yen 1,000 (about U.S. \$8.00).

Kantha (1988) mentions that wasp larvae (*hachinoko*) are eaten in Japan. **Kiuchi and Tamaki (1990)** note that "hachinoko" consists of the larvae of small wasps of the genus *Vespula* which make large nests in the ground. The larvae taste very good and are expensive. Production has been decreasing in recent years, and honey bee larvae are often used as substitutes.

See Pemberton and Yamasaki (1995) in Introduction.

Lepidoptera

Lepidoptera pupae not found in the soil are said to be very tasty (**Remington 1946**).

Bombycidae (silkworm moths)

Bombyx mori (Linn.), pupa, adult

Silkworm pupae and adults are eaten, boiled (**Esaki 1942**). The pupa of the silkworm (*Bombyx mori*) is eaten, not only in Nagano Prefecture, but throughout Japan (**Remington 1946**). "When the silk is reeled from the cocoons the edible and nourishing pupae remain, and are not discarded." They are fried in fat and salted. Remington mentions that, as a dinner guest at Hokkaido Imperial University, he was served *Bombyx* pupae prepared in this manner. He found the pupae "very delicious," and he determined to investigate the taste of several North American Saturniidae, such as *Platysamia cecropia*, *Actius luna* and *Telea polyphemus*.

Kiuchi and Tamaki (1990) note that silkworm pupae are used as food after the silk is taken from the cocoons, and that in some cases adult silkmths are also eaten. "Three pupae of the silkworm are said to have nutrition equal to an egg." The pupae are also fed to fish and chickens in Japan and India.

See also Ichinose (1989) and Pemberton and Yamasaki (1995) in the Introduction.

Cossidae (carpenter moths, leopard moths)

Remington states that larvae of Cossidae (wood-boring moths) are dug out of dead wood and are valued as food.

Limacodidae (slug caterpillars)

Common and easily gathered is the pupa of the Hag moth (Eucleidae), a pest insect whose larvae bear stinging hairs (**Remington 1946**).

Mantodea

All praying mantes (Mantodea) are eaten (**Remington 1946**).

Odonata

Dragonfly nymphs. See Remington (1946) and Ichinose (1989) in the Introduction. **Mitsubishi (1984)** reported the use of dragonflies as food, and **Pemberton (1995)** described a traditional Japanese dragonfly catching technique.

Orthoptera

Acrididae (short-horned grasshoppers)

Oxya japonica japonica Willemse, adult

Oxya velox Fabr.

Oxya yezoensis Shiracki

Grasshoppers are eaten, boiled (**Esaki 1942**). Popular insects include *Oxya velox* (called 'Inago' in Nagano Prefecture) and practically all other grasshoppers (**Remington 1946**). They are killed in a hot pan and preferably cooked by frying. The protein content of *tsukudani* from *Oxya yezoensis* Shiraki was reported as 22.5 grams per 100 grams of edible portion (**Anon. 1982**).

Considering the variety of insects in the 1919 survey (see Introduction), the insects most widely eaten were undeniably the batta (locusts, grasshoppers) (**Mitsubishi 1984**). Typical among these is the inago (*Oxya velox*), so much so that there was hardly a region where inago were not eaten. The inago, which at one time would have been served at the dinner table as a source of animal protein, virtually disappeared as a result of the postwar use of DDT and BHC, and it became difficult to collect enough inago to comprise a meal. However, recently, since strong regulations were enacted regarding the use of insecticides, the number of inago has been increasing slowly, so that inago have now begun to reappear on dinner tables. When late autumn arrives, inago preserved by boiling them down in soy sauce begin to appear in supermarkets, even in Tokyo, and are sold in train stations. At one time inago occupied an important position as a source of animal protein, but these days they are sold as a luxury item. Alternatively, several inago may be served neatly in a small dish as a snack in a country style bar. There are many inago lovers, and there were times when the number of inago had decreased so seriously as a result of the use of insecticides that the owners of restaurants specializing in cooking peculiar to certain localities searched frantically to find inago.

Catching inago is an activity that adds poetic charm to rice paddies in autumn. This event was practically abandoned at one time, but the recovery of the inago population has meant that inago may now be caught even on the outskirts of large cities. A letter in a newspaper in the autumn of 1981 recounted that the research laboratory where the writer worked had held an inago hunt at an elementary school in Tsukuba Science City in Ibaraki Pref. The fathers and mothers who participated in the hunt collected 68 kilograms of inago in 2 hours. Mitsubishi states that this is an age when we face a problem of overproduction of rice. Rather than harvesting this excess rice, why not let inago feed on the rice so that their population will increase, thereby increasing the yield of animal protein?

Kantha (1988) mentions that: "In autumn in the agricultural villages, rice hoppers (*inago*) are collected from the farms and after removal of wings and limbs are cooked with soy sauce and sugar, and served....Processed rice hoppers (mainly from Nagano prefecture) called *tsukudani* are sold in packets in supermarkets and are mainly eaten as a snack with alcoholic beverages." Kantha notes a two-fold benefit, use of a good source of animal protein (in itself notable in a country which, until a century ago, detested killing land mammals), and removal of an agricultural pest.

"Inago," a grasshopper that eats rice plants, is the most popular edible insect in Japan (**Kiuchi and Tamaki 1990**). The insects are mainly caught in paddy fields after harvest by old people and children who

want to earn a little money on their own. Some insects on the market are said, however, to be imported from abroad. According to the authors, "the nutrition of 'inago' is known to be equivalent to that of beef with a low fat content."

See also Ichinose (1989) and Pemberton and Yamasaki (1995) in the Introduction. For the results of biochemical studies on *Oxya velox*, see **Ichikawa (1936 a,b, 1938)** in the References Cited.

Gryllidae (crickets)

All crickets are eaten (**Remington 1946**). They are killed in a hot pan and preferably cooked by frying.

Superfamily Tettigonioidea (long-horned grasshoppers, etc.)

See Ichinose (1989) in the Introduction.

Plecoptera

Stoneflies. See Mitsuhashi (1984) and Ichinose (1989) in the Introduction.

Trichoptera

Family uncertain

Stenopsyche griseipennis MacLachan, larva

Nymphs of Trichoptera (caddiceflies) are eaten, boiled (**Esaki 1942**). See also Mitsuhashi, Ichinose, Kiuchi and Tamaki, and Pemberton and Yamasaki in the Introduction.

KOREA

There appear to be few published records of insect consumption in Korea.

Lepidoptera

Bombycidae (silkworm moths)

Bombyx mori (Linn.), pupa

Silk moth pupae (*Bombyx mori*), a by-product of the Korean silk industry, are almost always present in the Seoul markets (**Pemberton 1994**).

Canned silkworm pupae, presumably *Bombyx mori*, with labeling entirely in Korean and imported from Korea, have been found for sale since 1988 in an Asian foodshop in Madison, Wisconsin. According to the shopkeeper, they are a favorite of the Korean community in Madison (and, presumably, elsewhere in the United States.)

Orthoptera

Acrididae (short-horned grasshoppers)

Acrida lata Motschulsky, adult

Oxya sinuosa Mistshenko, adult

Oxya velox (Fabr.), adult

According to **Pemberton (1994)**, rice-field grasshoppers, primarily *Oxya velox* (Fabr.), called *metdugi*, were formerly a common food ingredient in Korea, but their use as food declined as insecticide use increased during the 1960s and 1970s. *Metdugi* ceased being found in the Seoul markets whereas silkworm pupae (*Bombyx mori* L.) are almost always present. In Chahwang Myun (a district in Sanchung County) insecticide spraying began to decline in 1981, allowing *metdugi* populations to begin increasing. In 1982 some *metdugi* began to be collected and sold again in the local market at Sanchon.

Pemberton states: "The decline in insecticide use and the desire of some Koreans to eat pesticide-free rice led to the development of organic rice farming in Chahwang Myun. This was economically viable

because the yields of rice were the same in unsprayed fields as in sprayed fields, and organic rice sold (and still sells) for higher prices." In 1989, the Chahwang Agricultural Cooperative began buying dried *metdugi* from farmer-collectors. In 1990, more than 600 families sold 1744 liters of *metdugi* to the Cooperative at 5000 Won per liter (US \$6.98). The Cooperative sold them for 6500 Won per liter (US \$9.08); much of the 1990 sale went to a supermarket company in Pusan which divided the *metdugi* into 0.2 liter packages and sold these for 3000 Won (US \$4.19). By 1992, the Cooperative was paying US \$9.91 per liter for *metdugi* and selling it at bulk rate for US \$12.03 per liter. In addition to selling to the Cooperative, farmers sell *metdugi* at the local five-day markets (open one day every five days) and on the street.

Metdugi are most commonly collected by older women, and usually from mid-October to early November. The collected *metdugi* are steamed or boiled, then dried in the sun for one day and in a room for two more days. For two women studied by Pemberton, the average collection rate was about 0.25 liter per hour, with a best rate of 1.0 liter per hour. During 1990, the income per hour for these women for collecting *metdugi* ranged from US \$1.75-6.98, excluding the time spent in processing and marketing.

As to food preparation of dried *metdugi*, they are sometimes eaten dried without seasoning, but they are usually pan-fried with or without oil after the wings and legs have been removed. The author describes further preparation as follows: "During or after cooking, they are flavored with sesame oil and salt, or sesame oil and sugar, or soy sauce with or without sugar. I have also seen live ones fried whole. These turn red like shrimp as they cook. Many of these preparations produce a product with good snack food essence. They are bite-sized, crispy, crunchy, and salty and/or slightly sweet. . . ." According to Pemberton, many Koreans consider *metdugi* to be a health food, and, for older Koreans, it brings nostalgia - a taste of the past.

A one liter package of *metdugi* purchased from the Cooperative was found to consist of three species, *Oxya velox* (84.5%), *Oxya sinuosa* Mistshenko (14.8%) and a single *Acrida lata* Motschulsky, a large species not expected to be found in *metdugi* although it is one of the species eaten in Korea.

MACAU

Coleoptera

Beetles of the aquatic families Dytiscidae and Hydrophilidae are commonly eaten in Macau (E.R. Easton, University of Macau, pers. comm. 1993). These beetles are commonly eaten wherever Cantonese dwell and Canton is only a short distance from Macau.

TAIWAN

Coleoptera

Dytiscidae (predaceous diving beetles)

Dytiscid beetles are said to be eaten in Taiwan (**Esaki 1942**; vide Bodenheimer 1951, p. 279).

Odonata

Dragonflies were roasted and eaten in Taiwan at least as recently as the 1950s (**Pemberton, 1995**).

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As the first step in biochemical studies on the locust, *Oxya velox*, a general analysis and an analysis of inorganic components were carried out with the following results: 1. The average weight of a living locust was 0.92 g for a male and 1.33 g for a female. 2. On a water-free basis the body of a locust consisted largely of protein (75%) with 6% fat, 4% carbohydrate and 6% ash. 3. Alkaline phosphates accounted for the greatest portion of the inorganic components of the body of a locust. Phosphoric acid accounted for 32%, potash 25%, soda 20% and silicic acid 13%. 4. The major difference between the inorganic components in the body of a locust, compared to those of other crops, lies in the large quantities of heavy metals such as copper, iron, and manganese present in the locust. 5. In summary, locusts are higher in protein content than the yeast that is currently sold. Further, the high content of copper, iron, manganese and other heavy metals means that locusts should be utilized as a food item, and should be further researched. 6. The presence of copper in the body of a locust is thought to be significant for the locust as an organism.

Ichikawa, C. 1936b. Biochemical studies on the locust (Part 2)[In Japanese]. *Jour. Agric. Chem. Soc. Japan* 12: 412-414.

This paper contains the results from chemical analyses of locusts collected from rice paddies in xxxx Village in Gifu Pref. in July, August and September. The purpose of the research was to determine the changes in the chemical components of locusts during growth. The results of chemical analyses of locusts collected on

July 20, August 25 and September 30, 1935 are shown in the author's Tables 1-4. Based on the data in his Table 4 regarding the changes in inorganic components, the content of Fe_2O_3 was highest in mid- or late August. The content at this time was approximately twice the content in late September. The content of CaO was highest in mid- July. The content at this time was approximately twice the content in mid- or late August. The content of MgO was highest in mid-July. The MgO content decreased as the locusts grew, and by late September had fallen to a value approximately half of the value in mid-July. Both the K_2O content and the Na_2O content were highest in mid- or late August. By late September both had fallen to values lower than the respective values in mid-July. The content of P_2O_5 was lowest in mid- or late August, with the content in late September higher than the content in mid-July. The content of SO_3 was highest in mid- or late August; no significant difference was observed between the value in mid-July and the value in late September. The highest values were observed for MnO , TiO_2 , and CuO in mid- or late August. No significant differences were observed between the values in mid-July and those in late September.

In summary, mid- or late August appears to be the best time to collect locusts to take advantage of their value as food. This is also the time when locusts do the most damage to rice plants. Thus, collection of locusts in mid-August seems to be the best strategy.

Ichikawa, C. 1938. Biochemical studies on the locust (Part 4)[In Japanese]. *Jour. Agric. Chem. Soc. Japan* 14: 43-44.

The purpose of this study was to identify differences between the protein of male and female locusts. The locusts used were collected from rice paddies in xxx Town in Niigata Pref. The male was found to have a higher content of water soluble nitrogen, globulin-type nitrogen, glutelin-type nitrogen and chitin-type nitrogen. The female was higher in albumin-type nitrogen and prolamin-type nitrogen. Alcohol soluble protein, i.e. prolamin-type nitrogen, was detected in the body of the locust.

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Items Needing Attention

Pp. 2, 11. To what family of Coleoptera do the genera *Melanaster* and *Psacothoa* belong?

Pp. 5, 29. To what family of Trichoptera does the genus *Stenopsyche* belong?

Pp. 7, 31. Anonymous (date?, title?). This publication has been misplaced except for one translated page, page 186 with a "Table 4. Lists of Common Food Insects in World." Based on this one page, the work is cited several times in the China text. I would like to hear from anyone who, from the above information, knows the identity of the work.

Pp. 26, 34. Name 1990. The author's name is lacking.

P. 26. Okamura, 1912 (under Vespidae), needs translation.

P. 35. Shen et al, 1997, where published?