# Chapter 22

## SOUTH-CENTRAL ASIA

### Overview

In this region, the use of edible insects has been reported in India, Nepal, Pakistan and Sri Lanka. The use of at least 52 species has been reported, belonging to at least 45 genera, 26 families and 10 orders. The complete taxonomic identity (genus and species) is known for 47 of the species. Gope and Prasad (1983), who conducted nutrient analyses on eight of some 20 species used in the state of Manipur, India, encourage insect consumption, especially in view of the fact that many people cannot afford fish or other animal meat.

In *Samia ricini*, the eri silkworm, the region provides one of the best examples of how environmental benefits can be reaped from the use of "multiple product" edible insects. The species feeds on the castor plant which grows well on poor soils, thus helping to prevent soil erosion; castor bean oil is sold for industrial and medicinal uses; excess leaves are fed to the caterpillars which produce silk used in commerce and a pupa that is a high-protein food (India) or animal feedstuff (Nepal); and the caterpillar frass and other rearing residue can be used for pond fish production.

### Regional Taxonomic Inventory

| Taxa and stages consumed | Countries |
|---|---|
| **Coleoptera** | |
| **Cerambycidae (long-horned beetles)** | |
| *Batocera rubus* (Linn.), adult? | India, Sri Lanka |
| *Coelosterma scabrata* (author?) | India |
| *Coelosterma* sp. | India |
| *Neocerambyx paris* (author?) | India |
| *Xysterocera globosa* (author?) | India |
| *Xysterocera* sp. | India |
| **Curculionidae (weevils, snout beetles)** | |
| *Rhynchophorus chinensis* (author?) | Sri Lanka |
| *Rhynchophorus ferrugineus* Oliv., larva | Sri Lanka |
| **Dytiscidae (predaceous diving beetles)** | |
| *Eretes stictus* Linn. (= *sticticus*), larva, adult | India |
| **Hydrophilidae (water scavenger beetles)** | |
| *Hydrophilus olivaceus* Fabr., adult | India |
| **Passalidae (bess beetles)** | |
| *Passalus interruptus* (author?), larva | India |
| **Scarabaeidae (scarab beetles)** | |
| *Oryctes rhinoceros* (Linn.), larva | India |
| *Xylotrupes gideon* Linn., larva | India |
| **Hemiptera** | |
| **Belostomatidae (giant water bugs)** | |
| *Lethocerus indicus* Lep. & Serv., adult | India |
| **Gerridae (water striders)** | |
| *Gerris* sp. | India |
| *Gerris spinole* (author?) | India |
| **Pentatomidae (stink bugs)** | |

| | |
|---|---|
| *Bagrada picta* Fabr. | India |
| *Coridius chinensis* Dallas, adult | India |
| *Coridius nepalensis* (Westwood), adult | India |
| *Cyclopelta subhimalayensis* Strickland, adult | India |
| *Erthesina fullo* Thunb., adult | India |

## Homoptera

**Cicadidae (cicadas)**

| | |
|---|---|
| *Cicada* sp. | India |
| *Cicada verides* (author?) | India |

## Hymenoptera

**Anthophoridae (carpenter bees)**

| | |
|---|---|
| *Xylocopa* sp., adult? | Sri Lanka |

**Apidae (honey bees)**

| | |
|---|---|
| *Apis dorsata* Fabr., larva, pupa | India |
| *Apis laboriosa* (author?) larva | Nepal |
| Bee brood | India, Nepal, Sri Lanka |

**Formicidae (ants)**

| | |
|---|---|
| *Oecophylla smaragdina* (Fabr.), larva, adult | India |
| Red ant | India |

## Isoptera

| | |
|---|---|
| Winged termites | India |
| Termite queens | India |

**Odontotermitidae**

| | |
|---|---|
| *Odontotermes feae* Linn. | India |

**Termitidae**

| | |
|---|---|
| *Termes* sp. | India |

## Lepidoptera

**Arctiidae (tiger moths)**

| | |
|---|---|
| *Diacrisia obliguae* (author?) | India |

**Bombycidae (silkworm moths)**

| | |
|---|---|
| *Bombyx mori* (Linn.), pupa | India |
| *Bombyx* sp. | India |

**Lasiocampidae (tent caterpillars, lappet moths)**

| | |
|---|---|
| *Malacosoma* sp. | India |

**Saturniidae (giant silkworm moths)**

| | |
|---|---|
| *Antheraea assamensis* (Westwood), pupa | India |
| *Antheraea paphia* (Linn.), pupa | India |
| *Antheraea roylei* Moore, pupa | India |
| *Samia cynthia* (Drury) | India |
| *Samia ricini* (Boisduval), pupa | India |

## Mantodea

**Family uncertain**

| | |
|---|---|
| *Hierodula coarctata* (author?) | India |
| *Hierodula westwoodi* Kirby | India |

## Odonata

**Aeschnidae (darners)**

| | |
|---|---|
| *Acisoma parnorpaides* (author?) | India |
| *Aeschna* spp., nymphs | India |

## Orthoptera

**Acrididae (short-horned grasshoppers)**

| | |
|---|---|
| *Acrida gigantea* (author?) | India |
| *Acridium melanocorne* Linn. | India |
| *Acridium peregrinum* (author?) | India |
| *Locusta mahrattarum* Hope | India |
| *Mecapoda elongata* (author?) | India |
| *Schistocerca gregaria* (Forskal) | India |
| Locusts/qrasshoppers | India, Nepal, Pakistan |

**Gryllidae (crickets)**

| | |
|---|---|
| *Acheta bimaculatus* De Geer | India |
| *Brachytrupes achetinus* (author?) | India |
| *Gryllodes melanocephalus* (author?) | India |
| *Liogryllus bimaculatus* (author?) | India |

**Gryllotalpidae (mole crickets)**

| | |
|---|---|
| *Gryllotalpa africana* Beauv. | India |

**Tettigoniidae (long-horned grasshoppers, katydids)**

| | |
|---|---|
| *Holochlora albida* (author?) | India |
| *Holochlora indica* Kirby | India |
| *Lima cordid* (author?) | India |

**Family uncertain**

| | |
|---|---|
| *Thylotropides ditymus* (author?) | India |

## Trichoptera

| | |
|---|---|
| Caddicefly larvae | India |

Other silkworm species also have great multiple-product potential in the region. The pupae of *Bombyx mori* are used not only as human food in India, but have been experimentally evaluated there and in Sri Lanka as a high-protein replacement for various levels of fishmeal in poultry and egg production. Chopra et al (1970) analyzed 33 samples of feed ingredients from various parts of India and found that de-oiled silkworm pupae meal from Mysore (the only insect product tested) was the highest in crude protein (76.0% with free amino acids removed) and highest in the amino acids lysine, histidine and arginine. In chick feeding trials, Ichhponani and Malik (1971) found that half of the fishmeal and half of the groundnut cake in the ration can be replaced by de-oiled silkworm pupae and corn-steep liquor (a byproduct of the corn starch industry), with no reduction in final weight or feed/gain ratios. The authors point out that the annual production of silkworm pupae meal was 20,000 tons and of corn-steep fluid 8,000 tons, making them significant sources of protein. Saikia et al (1971) tested the effect on egg production of several agricultural and industrial waste products in Assam as substitutes for yellow maize and fishmeal which are costly. The experimental layer mash containing silkworm pupae cost the least, gave the lowest feed-to-egg conversion ratio, and the lowest cost per dozen eggs produced. The pupae-fed pullets also suffered the lowest mortality (nil), produced the largest eggs, thickest shells, light yellow yolks and were graded AA. In feeding trials in Sri Lanka, Wijayasinghe and Rajaguru (1977) also found that silkworm pupae could successfully replace the local fishmeal in poultry rations, both for growth and egg production. Pupae of the saturniid, *Antheraea assamensis*, have also been tested with promising results in chick-feeding trials as a substitute for the irregular and costly supply of fishmeal in Assam.

## INDIA

In a recent study, **Gope and Prasad (1983)** obtained proximate analyses on eight of the nearly 20 species of insects found in a preliminary survey to be commonly used as food among the various tribes in the State of Manipur in northeastern India (India Table 1; authors' Table 1). The experimental insects were starved for 24 hr to allow the gut contents to clear before analyses were conducted. The indentity of specimens was determined by specialists at the British Museum (Natural History). Samples analyzed included representatives of the following species: *Hydrophilus olivaceous* Fabr. (Coleoptera: Hydrophilidae); *Oryctes rhinoceros* Linn. (Coleoptera: Scarabaeidae); *Belostoma indicus* Lep. & Serve. (Hemiptera: Belostomatidae); *Odontotermes feae* Linn. (Isoptera: Odontotermitidae); and from among the Orthoptera, *Acridium melanocorne* Linn. (Acrididae), *Gryllotalpa africana* Beauv. (Gryllotalpidae), *Hierodula westwoodi* Kirby (Mantidae), and *Holochlora indica* Kirby (Tettigoniidae). The authors found, on a fresh weight basis, crude protein values ranging from 4.4% in *B. indicus* to 28.4% in *A. melanocorne*, and calorific values (kcal/100g) ranging from 63.2 in *B. indicus* to 486.0 in *O. feae*. They note that although *B. indicus* was the lowest in protein and calorie value of the insects analyzed, it is a popular dish in Manipur.

Gope and Prasad concluded that insects represent the cheapest source of animal protein in Manipur and their consumption should be encouraged because many of the people cannot afford fish or animal flesh.

**Roy and Rao (1957)** conducted a dietary investigation of the Muria in the Bastar district in southeastern Madhya Pradesh in central India. Muria is a term under which all of the primitive tribes of the district are grouped. Agriculture is the main source of income, which varies between Rs. 70 to Rs. 150 per year. One-third of families are landless and work mainly as laborers, many on road-building. The main dietary staples are rice (primarily) and millets. Pulses and leafy vegetables are grown, with surplusses sold in the local markets. Adult goats, pigs and poultry average 2.6, 1.2 and 3.5 head per family. Family units average 6.6 members. Some foods, including fruits, vegetables and tubers are collected from the forest. The authors summarized the diet as monotonous and nutritionally very unsatisfactory, lacking in animal protein, calories, calcium and certain vitamins. They emphasize that the Muria do not get enough animal meat: "They cannot afford to kill their domestic animals very often. These are generally sacrificed on festive occasions. Not a single family was found to consume meat regularly." Eggs are not eaten, but are hatched to get the chickens.

Roy and Rao state that:

> The people are very fond of some kinds of insect larva known as `chind kira.' The date-palm is known as "chind." These yellowish white larvae, each weighing about 50.0 gm., are collected from young date-palms. Larvae of bees are also eaten. Eggs of ants are collected from the leafy nests and considered as a delicacy. `Gurmuri kira' which is collected from its nests by holding a lighted torch, is also eaten by many of the tribal people.

As to preparation, the authors say:

> Insect larvae (chind kira or gurmari kira) are mostly fried. 'Chind kira' is said to be very tasty. The tribal people put the fatty larvae (chind kira) simply on a hot pan the larvae are fried in their own fat....There are interesting ways of eating ants. Ants captured from the nests in the trees are covered and tied up in cups made of leaves and roasted while covered up in the leaf cups. After the ants have been roasted, these are squeezed into a paste and baked with salt and chillies to make a 'chutney.' Sometimes these are killed and dried in the sun. Sun dried ants are powdered and stored for future use. The powder, which is very sour to taste is used for the preparation of vegetable and meat curry.

**Maxwell-Lefroy** (**1971**) asks why insects are not more widely eaten by the "civilized" portion of mankind, then states:

> It is pure caprice and we know that many insects are excellent and nourishing food. . . the subject rests in darkness precisely because the people who practice this habit are not those of whom much is known or whom civilisation reaches: we fear that the spread of civilisation will lead to the total abolition of these interesting practices before we know about them, to the detriment of a later generation which will have to rediscover by experiment which are and which are not, good to eat . . . Mankind eats many curious things, including oysters, shrimps, whelks and cockles, dried sea slugs (Holothurians), and birds' nests; the most civilised nation is addicted to eating snails, even uncooked; and yet there is an absurd prejudice against insects, not universal, but

> certainly covering the more civilised portions of mankind. We may doubt if the deterioration in natural instincts that civilisation brings is not revealed in the races that eat so nauseous, deadly and unappetising a thing as an oyster and refuse to consider a nice clean white termite queen or a dish of locusts.

Insects discussed by Maxwell-Lefroy are included under the appropriate taxa below.

As part of a government-sponsored research project (not yet completed), **Bhattacharjee** (**1990**) surveyed a number of areas covering three tribes, Bodo, Demasa and Sonowal Kachuri in different parts of Assam and was surprised at the number of insects which they eat on a mass scale and which they use for medicinal purposes.

As the result of a brief (two-week) field survey, **Meyer-Rochow and Changkija** (**1997**) reported 42 species of insects used as food by the Ao-Nagas in northeastern India. The scientific names (some provided by the Zoological Survey of India and not verified by the authors), English common names and local vernacular names are listed below under the appropriate taxonomic categories. The investigators also observed two species of edible spiders for sale in a local market in Kohima.

## Coleoptera

**Cerambycidae (long-horned beetles)**
*Batocera rubra* (author?)
*Coelosterma scabrata* (author?)
*Coelosterma* sp.
*Neocerambyx paris* (author?)
*Xysterocera globosa* (author?)
*Xysterocera* sp.

The English name of *Xysterocera* sp. is pink wood borer, the others are simply wood borers. Vernacular names used by the Ao-Naga for the species listed above are, in order, *arulangtang, tsükha, khuro tsükha, tsükha, arulangtang tasula* and *angami tsükha* (**Meyer-Rochow and Changkija 1997**). Plant associations are *Alnus nepalensis* and *Calicarpa* spp. for *C. scabrata; Morus* spp. for *C.* sp.; *Albizia* sp. for *N. paris*; and *Butea minor* for *X.* sp.

**Curculionidae (weevils, snout beetles)**
*Balaninus album* (author?)
*Rhynchophorus signaticollis* (author?)

*B. album*, the banana weevil, is known by the Ao-Naga as *merong*, *R. signaticollis*, the palm weevil, as *morong* (**Meyer-Rochow and Changkija 1997**). The "chind kira" mentioned by **Roy and Rao** may refer to a palm weevil larva (see Introduction).

**Dytiscidae (predaceous diving beetles)**
*Eretes stictus* Linn. (= *E. sticticus*), larva, adult

Both larvae and adults of the dytiscid, *Eretes sticticus*, are consumed (**Essig 1942,** p. 539). It breeds in brackish ponds. Larvae are gathered as they leave the water to pupate in the soil, the newly emerged adults as they attempt to return to water.

**Hydrophilidae (water scavenger beetles)**
*Hydrophilus olivaceous* Fabr., adult

See Gope and Prasad (1983) in the introduction and India Table 1 (proximate analysis).

**Passalidae (bess beetles)**
*Passalus interruptus* (author?), larva

The larvae of the passalid, *Passalus interruptus*, a pest of potatoes, are consumed in Bengal (Brygoo 1946, cited by **Bodenheimer 1951**, p. 209).

**Scarabaeidae (scarab beetles)**
*Oryctes rhinoceros* (Linn.), larva

*Xylotrupes gideon* Linn.

The large fat grubs of *Oryctes* are eaten, and probably many other similar insects (**Maxwell-Lefroy 1971**). See also under Gope and Prasad (1983) in the Introduction and India Table 1 (proximate analysis of *O. rhinoceros*). *X. gideon*, the Hercules beetle, is called *lessepo* by the Ao-Naga (**Meyer-Rochow and Changkija 1997**).

## Hemiptera

**Belostomatidae (giant water bugs)**
*Lethocerus* (= *Belostoma*) *indicus* Lep. & Serv., adult

See Gope and Prasad (1983) in the Introduction and India Table 1 (proximate analysis). The Ao-Naga vernacular name of the giant water bug is *atsü leplo* (**Meyer-Rochow and Changkija**).

**Gerridae (water striders)**
*Gerris* sp.
*Gerris spinole* (author?)

In the Ao-Naga vernacular, water striders are called *tsümeroki* (**Meyer-Rochow and Changkija**).

**Pentatomidae (stink bugs)**
*Bagrada picta* Fabr.
*Coridius* (= *Aspongopus*) *chinensis* Dallas, adult
*Coridius* (= *Aspongopus*) *nepalensis* (Westwood), adult
*Cyclopelta subhimalayensis* Strickland, adult
*Erthesina fullo* Thunb., adult

**Distant** (**1902**, p. 283) reported that *Aspongopus nepalensis* Westwood, which is found under stones in the dry river beds of Assam, is much sought after for use as food, pounded up and mixed with rice.

In addition to *Aspongopus nepalensis* which was reported earlier by Distant to be edible, **Strickland (1932)** adds *A. chinensis* Dallas and a new species, *Cyclopelta subhimalayensis* Strickland to the list of edible pentatomids in India. Tribes reported to make use of them include the Miris, Mishmas, Abors, and some Nagas. Strickland puts forth evidence tending to discredit beliefs and superstitions that these bugs are paralytic if eaten without first removing the red bi-lobed stink gland lying between the abdomen and metathorax. The sac contains a highly volatile oil. **Hoffmann (1947)**, in addition to *Coridius* (= *Aspongopus*) *nepalensis*, *Coridius chinensis* and *Cyclopelta subhimalayensis*, lists *Erthesina fullo* Thunb. as eaten by the Nagas in Assam. Hoffmann suggests that probably additional species of pentatomids are used. **Maxwell-Lefroy** (**1971**) mentions that in Assam the large bugs of the genus *Aspongopus* are eaten with rice. The painted bug, *B. picta*, is eaten by the Ao-Naga, and its vernacular name is *tsüngi* (**Meyer-Rochow and Changkija 1997**). Plant associations of *B. picta* are *Osbickia* spp. and *Schima wallichii*.

**Pyrrhocoridae (red bugs, fire bugs, etc.)**
*Lohita grandis* Gray

This species, with the common name of giant red bug, is called *alu tsüngi* in the Ao-Naga vernacular (**Meyer-Rochow and Changkija**). It is a large species, more than 50 mm in length, and feeds on cotton in India (**Essig 1942**, p. 276).

**Family unknown**
*Dolycoris indicus* (author?)

The above is known as the bamboo bug, and in the Ao-Naga vernacular as *pollo* (**Meyer-Rochow and Changkija**). It is associated with the plant, *Dendrocalamus hamiltoni*.

## Homoptera

**Cicadidae (cicadas)**
*Cicada* sp.

*Cicada verides* (author?)

In the Ao-Naga vernacular, these two cicadas are known as *loyang* and *chang changkok*, respectively (**Meyer-Rochow and Changkija).**

## Hymenoptera

**Apidae (honey bees)**
*Apis dorsata* Fabr., larva, pupa
*Apis mellifera* Linn.?, egg, larva, pupa

**Hutton** (**1921**, p.72) reported that the Sema Nagas, who occupy part of the watershed that divides Assam from Burma, collect both the honey and grubs of wild rock bees. The nests are considered the private property of the finder.

**Irvine** (**1957**, pp. 124-125) states that bee brood is commonly eaten in the comb in India: "The larvae, pupae and eggs of the honeybee (presumably *Apis mellifera*) boiled in the honey comb are made into a relished soup in India where the larvae and pupae of the giant bee *Apis dorsata* are also eaten." **Maxwell-Lefroy** (**1971**) mentions that larvae and pupae of *A. dorsata* are eaten by tribes "in the wilder parts of India."

Also see Roy and Rao (1957) in the Introduction.

**Formicidae (ants)**
*Oecophylla smaragdina* (Fabr.), larva, adult

**Long** (**1901,** p. 536) reports the use of the red ant, *O. smaragdina* as a regular item of food by the Murries of Bastar in the south of the Central Provinces. The nests are collected throughout the year, but especially during the dry season, torn open and the contents shaken into a cloth. The insects, both mature and immature, are beaten into a pulpy mass and enclosed in a packet about the size of a goose egg and made of *sal*-leaves. The packets are taken to the bazaar and sold. To prepare the crushed ants for eating, they are mixed with salt, tumeric and chillies, ground between stones, then eaten raw with boiled rice. They are also sometimes cooked with rice flour, salt, chillies, etc. into a thick paste, which is said to give great powers of resistance to fatigue and the sun's heat. According to **Bingham** (**1903**, p. 311), *Oecophylla smaragdina* Fabr. "is the notorious and vicious 'Red Ant' of India." It inhabits trees and its larvae spin the silk from which its nest of leaves is constructed. In Kanara and some other parts of India, as well as throughout Myanmar (Burma) and Thailand, the ants are pounded into a paste which is eaten as a condiment with curry.

Also see Roy and Rao (1957) in the Introduction.

## Isoptera

**Odontotermitidae**
*Odontotermes feae* Linn.

See Gope and Prasad (1983) in the Introduction and India Table 1 (proximate analysis).

**Termitidae**
*Termes* sp.

**Buchanan** (**1807**, I, p. 7) states that the white ant, or *Termes*, is a common article of food used by a people known as the Chensu Carir.

**Family uncertain**

**König** (**1779**, pp. 1-28; vide Bodenheimer 1951, p. 232) (awaiting re-translation) states that in some parts of the "East Indies," live termite queens are given to the old to strengthen their backs, and winged sexuals are collected before they swarm. As summarized by Bodenheimer:

> They dig two holes into the termite nest, one to windward, the other to leeward. At the leeward opening they place the entrance of a pot which has previously been rubbed inside with an aromatic herb, the *bergera*, which is more esteemed than laurel leaves in Europe. On the windward side they make a fire of stinking materials which not only drives the insects into the

pots, but frequently also the hooded snakes, on which account the natives are obliged to be cautious when removing their pots. By this method they catch great quantities of termites, and with these, together with flour, they make a variety of pastry, which they can afford to sell very cheaply to the poor classes. He adds that in seasons when this kind of food is very plentiful, termites eaten in too great quantities may bring about an epidemic colic and dysentery which may cause death in two or three hours.

**Broughton** (**1813**; vide Bodenheimer 1951, p. 232), writing from a Mahratta camp, says that the prime minister, Surgee-Rao, during a severe illness, was nourished at great cost mainly with termite queens. **Forbes** (**1813**, I, p. 305; vide Bodenheimer 1951, p. 233) confirms that termites are eaten by the low castes in Mysore and the Carnatic. **Kirby and Spence** (**1822** I, p. 305) describe how, in the ceded districts of India, winged termites are collected by using smoke.

**Fletcher** (**1914**, p. 212) described termite collecting as follows:

Not content with the capture of these insects at their normal time of emergence from the nest, in many parts of Madras members of certain castes anticipate their flight and build a small domed hut of twigs and branches over the nest, the top of which is sliced off, and a chatty of water is sunk in this or a hole dug and filled with water. A lighted lamp is now placed in the hut and the emergence hastened by blowing into the nest a mixture of certain powdered roots and seeds, whereupon the termites fly out and fall into the water whence they are collected and sold in the bazaars for food amongst the lower castes.

**Maxwell-Lefroy** (**1971**) states that termite queens are eaten in some places in India, and adds:

. . . we can imagine no more dainty or tempting morsel than such an insect, which is most carefully fed and tended and which presents a most pleasing appearance. In some parts of South India, every boy of an age of 12 to 14 is said to be given a termite queen to eat, after which he runs a distance of two or more miles; having once done this he will be able thereafter to endure fatigue and run well.

**Rajan** (**1987**) reports that after the first showers of the rainy season, the winged adult sexual forms of termites fly into houses in swarms, attracted by the lights - oil lamps, electric lamps or tube lights. After hovering around the lights, they lose their wings, drop to the floor, crawl for a bit and die. In South India, in some houses, the next morning they are swept up, cleaned, fried and eaten. In the North Arcot district of Tamilnadu, the winged termites are known as *Eesal* in Tamil. Rajan reports that, at the first hint of rain in the district, a forest tribe known as *Irumbars* sets three or four lighted lamps around each termite mound. The next morning the dead termites are swept up, cleaned, brought to the nearest big town and sold to merchants who fry part of the catch and put it up for sale. Part of it is mixed with fried ground nut. Bengal gram, puffed rice, salt and spices which are added during frying, and then this portion is put up for sale. The fried pulses, spices and salt enhance the taste. In Karnataka, the winged termite is known as *Eechalu hula*. Again lights are used to collect it. Rajan notes that in some villages, the queen termite is collected and fed raw to weak children. Although queens are very nourishing, only occasional feeding of under-nourished children with a queen does not help much.

## Lepidoptera

**Arctiidae (tiger moths)**
*Diacrisia obliguae* (author?)

The larvae are known as wooly bear caterpillars and in the Ao-Naga vernacular as *wakak* (**Meyer-Rochow and Changkija**).

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

The common names of the above are silkworm and banana leaf-roller, respectively; the Ao-Naga vernacular names are, respectively, *mugamesen* and *mango longpen* (**Meyer-Rochow and Changkija**).

**Sridhara and Bhat (1965)** studied the lipid composition of silkworm (*Bombyx mori* Linn., Mysore strain) mature (spinning) larvae, pupae and adults. Pupae and adults were higher in total fat, as a percentage of dry weight, than were larvae (India Table 2; authors' Table 1). The iodine value tends to increase from larva to pupa, while the phospholipid content decreases. The total lipid, iodine value and phospholipid content are each similar in male and female pupae and remain unchanged in the adult. It was found that the amount of free fatty acids in the lipid of spinning larvae progressively increased in the transformation to pupae and adults. The fat body contained the highest concentration of fat and the haemolymph the least. The percentage of unsaturated fatty acids increases from the larval to pupal stage (India Table 3; authors' Table 3), from 64% in the former to 73% in the latter. Total sterol, apparently cholesterol, was found to be 1.2% of total fat, with most of it in the free form.

See also the section on "Insects as Animal Feed in India."

**Lasiocampidae (tent caterpillars, lappet moths)**
*Malacosoma* sp.

Tent caterpillars are known as *mesang-long* in Ao-Naga vernacular (**Meyer-Rochow and Changkija**). The host plant is *Schima wallichii*.

**Saturniidae (giant silkworm moths)**
*Antheraea assamensis* (Westwood) (= *assamica*)
*Antheraea (= Antheroea) paphia* (Linn.), pupa
*Antheraea roylei* Moore
*Samia (= Atticus) cynthia* (Drury)
*Samia (= Atticus) ricini* (Boisduval), pupa

**Maxwell-Lefroy** (**1971**) states that "rearers of wild silk such as tassar (*Antheroea paphia*) are known to regard the pupae in the cocoon as a delicacy and to eat it when the silk has been reeled off." According to **Peigler** (**1993**), the tropical tasar industry (as opposed to temperate tasar) is based on *A. paphia*, and India's foreign exchange earnings for exporting tasar to foreign countries, particularly the U.S., Germany and Japan, total hundreds of thousands of dollars annually.

About 40,000 families in northeastern India are involved in ericulture (**Chowdhury 1982**, p. 1). It is practiced as a cottage industry, and carried out traditionally by village women during leisure hours; the women also do the spinning and weaving. The eri silkworm, *Samia ricini*, feeds on castor. The cocoon does not yield a continuous thread and must therefore be spun like cotton. Its value is thus much less than that of the reeled cocoons of mulberry and muga, but eri cocoons are nevertheless traded in sizable quantities in the weekly markets. For the tribals in northeastern India, according to Chowdhury, the "eri chrysalid [pupa] is a delicacy and the cocoon is more or less a byproduct." 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. According to Peigler, the government of India is currently "attempting to expand ericulture to the states west of Assam where the castor can be grown in stressed ecosystems, providing leaves to feed the eri silkworms and beans to yield castor oil."

There appears to be some error in the application of names to edible saturniids by **Meyer-Rochow and Changkija**, who apply the names as follows (scientific name, common name, vernacular name): *Antheraea assamica*, muga silkworm (emperor), *mugamesen*; *Antheraea roylei*, tusar oakworm (emperor), *sarang mesen*; *Attacus cynthia*, tusar oakworm, *mugamesen; Attacus ricinis*, erriworm, *allishi mesen*; *Phyllosomia* [sic] *ricinae*, erriworm, *errimesen*. According to **Peigler** (**1993**), *Antheraea assamensis* is indeed the producer of muga silk; the tropical tasar silk industry is based on *Antheraea paphia*, of which "there are more than 25 `eco-races' in cultivation in various districts and on various host plants; the temperate tasar silk is reared on oak and is the product of a hybrid produced by crossing the native Himalayan *Antheraea roylei* with the Chinese *A. pernyi*, known as the Chinese oak silk moth or tussah (or tusser) silk moth (the word `tussah' obviously being derived from tasar. Finally, *Samia ricini* is the eri silk moth (the reader interested in distinguishing between the wild silk producers should consult Peigler 1993).

## Mantodea

*Hierodula coarctata* (author?)
*Hierodula westwoodi* Kirby

The Ao-Naga vernacular name for *H. coarctata* is *aei changkok* (**Meyer-Rochow and Changkija**). See Gope and Prasad (1983) in the Introduction and India Table 1 (proximate analysis of *H. westwoodi*).

## Odonata

**Aeschnidae (darners)**
*Acisoma parnorpaides* (author?)
*Aeschna* spp., nymphs

The Ao-Naga vernacular names are *atsü-kumbo* and *anga-mechep*, respectively (**Meyer-Rochow and Changkija**).

## Orthoptera

**Acrididae (short-horned grasshoppers)**
*Acrida gigantea* (author)
*Acridium (= Agridium) malanocorne* Linn.
*Acridium (= Agridium) peregrinum* (author?)
*Locusta mahrattarum* Hope
*Mecapoda elongata* (author?)
*Schistocerca gregaria* Forskal

**Hope** (**1842**, p. 138) mentions that locusts are salted and eaten in the Mahratta country and suggested the name *Locusta mahrattarum* Hope. C. Horne (1863), cited by **Bodenheimer** (**1951**, p. 232), also reported that locusts are eaten in India, and according to **Bargagli** (**1877**, p. 8; vide Bodenheimer 1951, p. 232) Indian sepoys made a famous curry with locusts as ingredients. **Fletcher** (**1914**) quotes Kirby and Spence that when a "cloud of locusts ... visited the Mahratta country, the common people salted and ate them."

**Das** (**1945**) analyzed the locust, *Schistocerca gregaria*, for use both as food and as fertilizer (India Table 4; Das text table, p. 412). The locusts (adults) were high in crude protein (61.75%, air-dried) and fat (16.95%). Das suggests that dried locusts could be tinned in quantity to ensure their keeping indefinitely. He also takes a cue from Dr. A. Gunther (1893) of the British Museum (Natural History) who observed that dried locusts might be utilized for insectivorous cage and game birds "which are now reared on ants' eggs at great expense." Das suggests that "tons of dried locusts might be profitably exported from India to the United Kingdom for this purpose." As fertilizer, Das found the locusts to be fairly high in nitrogen, phosphate and potash, and notes that, while a menace to crops it does contribute as fertilizer after death.

According to **Maxwell-Lefroy** (**1971**), "Locusts are appreciated in many parts of India and it is said that dried locusts form an ingredient of curries even in Calcutta, where a locust swarm is looked on as a providential occurrence."

**Meyer-Rochow and Changkija** provide the following common and vernacular names: *Acrida gigantea* (grasshopper, *chupong*), *Agridium* [sic] *melanocorne* (brown locust, *koropong changkok*), *Agridium peregrinum* (migratory locust, *wara serapong*), *Mecopoda elongata* (green locust, *serapong changkok*). See Gope and Prasad in the Introduction and Table 1 (proximate analysis of *A. melanocorne*).

**Gryllidae (crickets)**
*Acheta bimaculatus* De Geer
*Brachytrupes achetinus* (author?)
*Gryllodes melanocephalus* (author?)
*Liogryllus bimaculatus* (author?)

Again, there may be some confusion in the names listed. **Meyer-Rochow and Changkija** list the following English common names and vernacular names for the above, in order: field cricket (*chokokza*), common cricket (*shati-chokok*), blackhead cricket (*chokok*), and spotted cricket (*metsü-chokok*).

**Gryllotalpidae (mole crickets)**
*Gryllotalpa africana* Beauv.

The Ao-Naga vernacular name for *G. africana* is *chokok* (**Meyer-Rochow and Changkija**). See Gope and Prasad (1983) in the Introduction and India Table 1 (proximate analysis).

**Tettigoniidae (long-horned grasshoppers)**
*Holochlora albida* (author?)
*Holochlora indica* Kirby

*Lima cordid* (author?)

The Ao-Naga vernacular name for *H. albida* is *aya changkok* (**Meyer-Rochow and Changkija**), and the name for *L. cordid* is *alu changkok*. See Gope and Prasad (1983) in the Introduction and India Table 1 (proximate analysis of *H. indica*).

**Family uncertain**
*Thylotropides ditymus* (author?)

The English common name is nocturnal grasshopper and the Ao-Naga vernacular name is *aya changkok*, according to **Meyer-Rochow and Changkija**.

### Trichoptera

The Ao-Naga vernacular name for edible caddicefly larvae is *tsü-longben* (**Meyer-Rochow and Changkija**)

## Insects as Animal Feed in India

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

Relative to poultry production, **Chopra et al (1970)** analyzed 33 samples of feed ingredients from various parts of India for proximate chemical composition, energy value, and the basic amino acids (lysine, histidine and arginine). Samples included cereals (4 samples), cereal byproducts of milling (5), cereal byproducts of processing (9), oilseed cake (7), animal products (7), and legumes (soybean). Deoiled silkworm pupae meal from Mysore (the only insect product included) was the highest of all of the samples tested in crude protein (76.0%, with free amino acids removed), lysine (5.36%), histidine (1.94%), and arginine (4.13%). Lysine is not present in high levels in proteins of plant origin and, therefore, according to the authors, particularly likely to be deficient in rations. Deoiled pupae were low in calcium and phosphorus compared to fish meals and some other products. Soybean was highest of the materials tested in gross energy with 5006 KCal/kg, with maize gluten meal second (4542 to 4784 KCal/kg in 3 of 4 samples tested); the silkworm pupae contained 4331 KCal/kg.

In chick feeding trials (white leghorn) to 8 weeks of age, **Ichhponani and Malik (1971)** found that half of the fish meal (5%) and half of the groundnut cake (10%) in the ration can be replaced by de-oiled silkworm pupae and corn-steep fluid, respectively, with no reduction in final weight or feed/gain ratio. When pupal meal replaced all of the fish meal, growth was significantly reduced. The authors note that the fish meal used in the experiment was of very fine quality containing about 62% protein. The annual production of silkworm pupae meal in India is 20,000 metric tons, while that of corn-steep fluid (a byproduct of the corn starch industry) is 8,000 metric tons, thus making them significant sources of protein.

**Saikia et al (1971)** tested the effect on egg production of using several agricultural and industrial waste products which are available in Assam as substitutes for yellow maize and fishmeal which are very costly. The experimental layer mashes, containing 16-17% protein, were fed to White Leghorn pullets beginning at 16 weeks of age for 179 days. The substituted ingredients in the different diets included broken rice, silkworm pupae, meat offal, soybean, distillery waste, and molasses. The mash containing silkworm pupae cost the least (0.35 Rs./kg compared to 0.68 for the control diet), gave the lowest feed to egg conversion ratio, and the lowest cost per dozen eggs produced (India Table 5; authors' Table 3). Relative to other characteristics studied, the pupae-fed pullets suffered the lowest mortality (nil), produced the largest eggs (49.65 g), thickest shells (0.46 mm), light yellow yolks, and graded AA. Of the other experimental groups, two graded AA, three graded A. Saikia et al concluded that the use of silkworm pupae and other waste products as a replacement for fishmeal and yellow maize should be encouraged.

**Noctuidae (noctuids)**
*Spodoptera litura* (author?), larva

**Sharma** (**1990**) reported that larvae of the above species that escaped from a laboratory colony were relished by a cat that had taken up residence in the laboratory. When it was noticed that the larvae no longer littered the floor, as they had formerly during peaks of abundance, the cat was encouraged to maintain permanent residence.

**Saturniidae (giant silkworm moths)**
*Antheraea assamensis* (Westwood), pupa

**Bora and Sharma (1965)** explored the utility of using pupae of the Assam muga silkworm, *Antheraea* (= *Antharaca*) *assamensis* (Westwood), as a high-protein substitute for fishmeal in chick diets. The supply of fishmeal is irregular and costly in Assam, while the silkworm pupae offer an opportunity to utilize a local waste product, thus being of benefit for both the silk industry in Assam and for local poultry production. From proximate analysis, the pupae (undefatted) contained 74.37% crude protein (India Table 6; authors' text table, p. 355). Three experimental diets were tested on chicks to 4 weeks of age: 1) Basal ration + 7% fishmeal (control diet); 2) Basal ration + 4.67% silkworm pupal powder (protein content equivalent to 7% fishmeal) + 2% limestone + 1% bone meal; 3) Basal ration + 4.67% silkworm pupal powder. Weight gains were not significantly different between chicks fed diets 1 and 2, respectively, but gains were significantly reduced in chicks on diet 3. The lower growth rate on diet 3 was attributed to a deficiency in the ration of calcium and phosphorus (see India Table 6). Slightly accelerated growth of chicks on diets 2 and 3 toward the end of the third week indicated the presence of an unidentified growth factor in the silkworm pupae (see also the results of Wijayasinghe and Rajaguru [1977] in Sri Lanka).

## Miscellaneous

**Venkat Rao et al (1960)** note that earlier studies have shown that insect infestation of foodstuffs results in loss of thiamine and possibly other B-vitamins, an increase in fat acidity, and contamination with insect excreta and body fragments. They also cite studies showing that consumption of infested foodstuffs caused digestive disturbances and pulmonary disorders, or diarrhoea. Thus, they investigated the effect of feeding insect-infested jowar (*Sorghum vulare*) and Bengal gram (*Cicer arietinum*), simultaneously in the diet, to albino rats. The jowar was infested (25% damaged kernals) by *Sitophilus oryza* Linn., and the Bengal gram (25% damaged kernals) by *Bruchus chinensis* Linn. In rats fed for eight weeks, weight gains were slightly (but not significantly) greater in the rats fed the uninfested jowar diet. There was no significant difference in the haemoglobin and red blood cell count of rats on the infested and uninfested diets. Average fat content of the livers of rats fed the infested jowar diet was significantly higher than that of the rats on the uninfested diet. Histological examination of the livers of rats fed for six months on the infested jowar diet showed various degrees of centrilobular fatty infiltration, which was not observed in the livers of rats on the control diet. The authors discuss the significance of the fatty livers produced by insect-infested jowar in relation to nutritional studies by others.

For insects (grasshoppers) as fertilizer, see Das (1945) under Orthoptera above.

# NEPAL

## Hymenoptera

### Apidae (honey bees)

*Apis laboriosa* (author?), larva

Bee brood (larvae and pupae) is widely consumed by Nepalese (Dr. **F. Neupane** and others at the Institute of Agriculture and Animal Science, Rampur, and the Ministry of Agriculture, Kathmandu, pers. comm. **1988**).

In their beautiful book of photographs, "Honey Hunters of Nepal," **Valli and Summers (1988)** mention (and illustrate, Fig. 80) that in harvesting the honey and wax from the huge nests of the wild bee, *Apis laboriosa*, the hunters squeeze the white fluid from the larvae into a small pot of heated honey. Rich in protein, the mixture is considered to be a tonic. The larval liquid is also cooked with chilis and salt. The authors mention that:

> The honey, which is valued as a universal remedy and tonic, is sold to villagers or exchanged for grain, yogurt, milk, a chicken, or even a day's work. The price of a pound is ten rupees, the equivalent of fifty cents, a luxury in a country where some 60 percent of the rural population lives on less than two rupees a day. The wax is sold in Kathmandu to the artisans who use it in the lost-wax process of casting statues.

The Nepalese term for the bee brood preparation is *bakuti*, according to **Burgett** (**1990**).

## Orthoptera

### Acrididae (short-horned grasshoppers)

Following grasshopper invasions from India, fried grasshoppers are sold on the streets of Kathmandu and elsewhere (**S. Joshi** and **Mrs. R.B. Pradhan**, Ministry of Agriculture, pers. comm. **1988**).

## Insects as Animal Feed in Nepal

### Saturniidae (giant silkworm moths)

*Samia ricini* (Boisduval), pupa

Ericulture involving this species is a cottage industry in Nepal, as it is in India. The pupae are not used as food for humans in Nepal, however, as they are in India, but there is interest in using them as feed for poultry and pond fish (F.P. Neupane, Inst. of Agriculture and Animal Science, Rampur, pers. comm. 1988). The species offers an almost ideal example of sustainable agriculture: the castor plant grows on poor soils, helping to prevent erosion; castor bean oil is sold for medicinal and industrial uses; excess leaves are fed to the caterpillars which produce silk and a pupa that is a high-protein food or animal feedstuff, and the caterpillar frass and other rearing residue can be used for pond fish culture.

**Neupane et al** (**1990**) investigated the production biology of *S. ricini* (as *S. cynthia ricini* Hutt.) in Nepal and found that six generations per year are produced when the caterpillars are grown on castor leaves. They do not recommend rearing during the cold months, November-April, however, because the life cycle requires 114-126 days for completion compared to only 38-61 days from March to November. Cassava can also be used as a host plant, but mean weights of the larvae, pupae and cocoons are slightly lower. Among the benefits of ericulture, the authors report that quality leaves of both castor and cassava are available throughout the year; farmers can use their extra time for silkworm rearing and very little monetary investment is required; and even low-skilled children and older folks in a family can participate in the rearing, thus enhancing employment and the economic status of poor and subsistence farmers. If cassava is the host plant, rather than castor, the roots are used as food and animal feed and the old plants as fuelwood.

## Miscellaneous

In the hill country toward the border with Tibet, giant earthworms are collected during the monsoon season, held in water overnight to void ingested soil, then dried and stored as provisions which last for several months (**F. Neupane**, pers. comm. **1988**).

## PAKISTAN

### Orthoptera

**Acrididae (short-horned grasshoppers)**

According to **Das** (**1945**), inhabitants of Makran in Baluchistan and some tribes in Sind reportedly use locusts as food, both in the fresh and the dried state. Makranis call the locusts *Hawaii Jhinga*, meaning aerial crustacean, and find the taste similar to that of crayfish.

## SRI LANKA

### Coleoptera

**Cerambycidae (long-horned beetles)**
*Batocera rubus* Linn. (= *B. albofasciata* Deg.), adult?

**Netolitzky** (**1920**) reported that the longicorn beetles, *Batocera albofasciata* Deg. and *B. rubus* Linn. are eaten in Sri Lanka and Indonesia.

**Curculionidae (weevils, snout beetles)**
*Rhynchophorus ferrugineus* Oliv., larva
*Rhynchophorus* (= *Calandra*) *chinensis* (author?)

**Gourou** (**1948**; vide Bodenheimer 1951; awaiting re-translation) reported consumption of *Rhynchophorus ferrugineus* Oliv., and **Ghesquièré (1947)** mentions that *Calandra chinensis* is a widespread species that is consumed by people from Sri Lanka to China.

### Hymenoptera

**Anthophoridae (carpenter bees)**
*Xylocopa* sp.

According to **Knox** (**1817**, p. 48; vide Bodenheimer 1951, pp. 245-246), *Xylocopa* and other large bees are eaten.

**Apidae (honey bees)**

When a bee swarm is discovered on a tree, a burning torch is held under it to make the bees drop (**Knox 1817**, p. 48). They are carried home, cooked and eaten. Also, when a tree containing a bees' nest is felled, the bees are collected along with the honey. When cooked they are an esteemed dish.

**Spittel (1924)** and others mentioned by Bodenheimer (1951, pp. 245-253) discuss honey-hunting by the Veddas of Sri Lanka, and more briefly, by other Asiatics.

### Insects as Animal Feed in Sri Lanka

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

**Wijayasinghe and Rajaguru (1977)** conducted tests to determine the effects of silkworm pupae (SWP) as a replacement for various levels of the local fishmeal on the performance of broiler starters, broiler finishers, and laying hens. They used a dry, mechanical and manual method for removing the chitinous exoskeleton, in order to avoid the loss of soluble nutrients that can occur with wet methods. The pupal residue was not defatted although the pupal oil contains nearly 75% unsaturated fatty acids, which imparts a peculiar odor, and some previous investigators have reported that the flesh and eggs of animals fed undefatted SWP have an unpleasant odor. Others have not observed this effect and it was not observed in this investigation. The authors note that the pupal oil, with its high unsaturated fatty acid content has a number of valuable industrial uses, and there are a number of patented biological and chemical methods for deodorizing the pupae. They also note that a large quantity of SWP can be expected to be available as a byproduct of the rapidly expanding sericulture industry in Sri Lanka.

The results of proximate and amino acid analyses are shown in Sri Lanka Tables 1 and 2, respectively (authors' Tables 1 and 2 also). Compared to the local Grade I fishmeal, the SWP were high in dry matter, protein and fat content, and relatively low in total ash and in calcium and phosphorus. In the feeding trials, experimental rations were balanced according to 1966 recommendations of the U.S. National Research Council. The investigators summarized their study as follows: "The results indicated that SWP could successfully replace local fish-meal in poultry rations. The presence of an unidentified growth factor in SWP for chicks was also observed. Improvement in reproductive performance in terms of hatchability of eggs and weight of chicks at hatching time were observed when SWP was included in layers rations. A favourable alteration of the sex ratio in chicks towards femininity was observed." The authors note that SWP rations need supplementation with calcium and phosphorus. They also mention that the price of SWP must be more reasonable if farmers are to use it as a high-protein feed supplement.

## Miscellaneous

### Papilionidae (swallowtail butterflies)

**Maitipe (1984)** suggests that one area of promise in trying to meet problems of tropical malnutrition is the exploitation of certain insect larvae. One candidate, Maitipe believes, is the larva of the swallowtail butterfly, *Papilio polytes* (Papilionidae), which feeds on certain alkaloid-rich leaves and completes the fourth instar within 17 days at 28C. The larva accepts different alkaloid-containing leaves, but the growth rate is faster on some than on others, for example, citrus leaves as compared to "woodapple" leaves. Maitipe suggests that high food conversion efficiency, such as is the case with leaf-eating caterpillars, should be an important criterion in looking for future sources of protein. This insect has no history of consumption by humans, insofar as this author is aware.

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## Items Needing Attention

Pp. 10, 22. Konig (1979); need a translation of the pertinent part.

Pp. 19, 21. Gourou (1948); need a translation of the pertinent part.

Pp. 18, 22. Netolitzky (1920); need a translation of the pertinent part.