Chapter 15

CENTRAL AND EASTERN AFRICA: OVERVIEW

The region as treated here is comprised mainly of Angola, Cameroon, Central African Republic, Congo (Brazzaville), Congo (Kinshasa) (formerly Zaire), Kenya, Malawi, Tanzania, Uganda, and Zambia. The wide variety of insects eaten includes at least 163 species, 121 genera, 34 families and 10 orders. Of this group the specific identity is known for 128 species, only the generic identity for another 21, only the family identity of another 12 and only the order identity of one. Gomez et al (1961) estimated that insects furnished 10% of the animal proteins produced annually in Congo (Kinshasa). Yet, in this region, as in others, insect use has been greatly under-reported and under-studied. Until recently, for example, the specific identity was known for fewer than twenty species of insects used in Congo (Kinshasa), but, in a careful study confined only to caterpillars and only to the southern part of the country, Malaisse and Parent (1980) distinguished 35 species of caterpillars used as food. The extent of insect use throughout the region is probably similar to that in Congo (Kinshasa) and Zambia, the best-studied countries. Research is needed.

Caterpillars and termites are the most widely marketed insects in the region, but many others are also important from the food standpoint, nutritionally, economically or ecologically. As stated by this author (DeFoliart 1989): "One can't help but wonder what the ecological and nutritional maps of Africa might look like today if more effort had been directed toward developing some of these caterpillar, termite, and other food insect resources." The inclusion of food insects in the Africa-wide Exhibition on Indigenous Food Technologies held in Nairobi, Kenya, in 1995 is indicative of the resurgence of interest in this resource by the scientific community of the continent.

Regional Taxonomic Inventory

Taxa and stages consumed	Countries
Coleoptera	
Beetles/beetle grubs	Pan-regional
Bostrichidae (branch and twig borers)	
Bostrichid larvae	Congo (Brazzaville)
Buprestidae (metallic woodborers)	
Chrysobothris fatalis Harold, larva	Angola
Psiloptera wellmani Kerremans, larva	Angola
Steraspis amplipennis Fabr., larva	Angola
Sternocera feldspathica White, larva	Angola
Cerambycidae (long-horned beetles)	
Acanthophorus capensis (author?), larva	Zambia
Acanthophorus confinis Laporte, larva	Zambia
Acanthophorus maculatus (author?), larva	Zambia
Ancylonotus tribulus Fabr., larva	Gabon
Macrotoma edulis Karsch, larva	Sao Tome & Principe
Zographus ferox Har.	Angola
Cermbycid larvae	Congo (Brazzaville)
Curculionidae (weevils, snout beetles)	
Rhynchophorus phoenicis Fabr., larva	Pan-regional
Sipalinus aloysii (author?), larva	Tanzania
Elateridae (click beetles)	
Tetralobus flabellicornis Linn., larva	Central African Republic
Passalidae (bess beetles)	
Passalids	Congo (Brazzaville)

Scarabaeidae (scarab beetles)

Augosoma centaurus Fabr., larva	Cameroon, Congo (Brazzaville)
Camenta sp., larva	Angola
Gnathocera sp., larva	Congo (Kinshasa)
Goliathus sp., larva	Congo (Kinshasa)
Oryctes boas (Fabr.), larva	Congo (Brazzaville), Congo (Kinshasa)
Oryctes owariensis Beauv., larva	Congo (Brazzaville), Congo (Kinshasa)
Pachylomera fermoralis	Zambia
Platygenia barbata Afzelius, larva	Congo (Kinshasa)
Platygenia spp., larvae	Tropical Africa
Popillia femoralis Klug, adult	Cameroon
Popillia spp., adults	Cameroon

Diptera

Chaoboridae (phantom midges)

Chaoborus edulis (Edwards), adult	Malawi, Tanzania, Uganda
Lake flies	Kenya

Ephemeroptera

Caenidae

Caenis kungu (author?), adult	Malawi

Hemiptera

Belostomatidae (giant water bugs)

Belostoma spp.	Congo (Brazzaville)

Nepidae (waterscorpions)

A nepid	Congo (Kinshasa)

Family uncertain

Nezara robusta (author?), adult	Malawi
Sphaerocoris sp., adult	Malawi

Homoptera

Cercopidae (spittlebugs)

A cercopid	Congo (Kinshasa)

Cicadidae (cicadas)

Afzeliada sp., adult	Congo (Brazzaville)
Ioba leopardina (author?), adult	Zambia
Loba sp., adult	Malawi
Monomotapa sp., adult	Malawi
Orapa sp., adult	Malawi
Platypleura adouma Distant, adult	Congo (Brazzaville)
Platypleura sp., adult	Malawi
Platypleura stridula (author?), adult	Zambia
Pyona sp., adult	Malawi
Ugada giovannina Fabr., adult	Congo (Brazzaville)
Ugada limbalis Karsch, adult	Zambia
Ugada limbata Fabr., adult	Congo (Brazzaville)
Ugada limbimaculata Fabr., adult	Congo (Brazzaville)

Hymenoptera

Apidae (honey bees)

Apis mellifera adansonii Latr., larva	Tanzania, Congo (Kinshasa), Zambia
Apis mellifera capensis (author?), larva	Zambia
Meliponula bocandei Spin., larva	Congo (Kinshasa)
Trigona braunsi Kohl, larva	Congo (Kinshasa)
Trigona erythra interposita Darchen, larva	Congo (Kinshasa)
Trigona lendliana Fr., larva	Congo (Kinshasa)
Trigona occidentalis Darchen, larva	Congo (Kinshasa)
Trigona richardsi Darchen, larva	Congo (Knshasa)
Bee larvae	Angola, Kenya, Malawi, Uganda

Formicidae (ants)

Carebara vidua F. Smith, flying sexual	Malawi, Congo (Kinshasa), Zambia
Oecophylla smaragdina longinoda (author?), larva, adult	Congo (Kinshasa)
Oecophylla sp.	Congo (Brazzaville)
Sternotornis sp., winged adult	Congo (Kinshasa)
Ants	Gabon

Sphecidae (sphecoid wasps)

Sceliphron sp., "fly nests"	Congo (Kinshasa)

Vespidae (wasps, hornets)

Synagris sp., "fly nests"	Congo (Kinshasa)
Wasp brood	Congo (Kinshasa)

Isoptera

Termites, flying ants, white ants, etc.	Pan-regional

Termitidae

Bellicositermes spp., winged adults, soldiers	Congo (Kinshasa)
Cubitermes spp., all stages	Congo (Brazzaville)
Macrotermes bellicosus Smeathman, all stages	Congo (Brazzaville)
Macrotermes falciger Gerstacker, winged adult	Zambia
Macrotermes natalensis Haviland, winged adult, soldier	Congo (Kinshasa)
Macrotermes spp., winged adults, soldiers	Malawi, Tanzania, Congo (Kinshasa)
Macrotermes subhyalinus Rambur, winged adult	Angola, Zambia
Macrotermes vitrialatus (Sjostedt), winged adult	Zambia
Odontotermes badius (Haviland), winged adult	Zambia
Odontotermes sp.	Kenya
Pseudacanthotermes spiniger Sjostedt, winged adult	Congo (Kinshasa), Zambia
Pseudacanthotermes spp., winged adults	Tanzania
Termes gabonensis (author?), winged adult, soldier	Congo (Kinshasa)
Termes spp., winged adults, queens	Tanzania

Lepidoptera

Caterpillars	Pan-regional

Ceratocampidae

Ceratocampid larvae (2 spp.)	Congo (Kinshasa)

Hesperiidae (skippers)

Caeliades libeon Druce, larva	Congo (Brazzaville), Congo (Kinshasa)

Lasiocampidae (eggar moths, lappets)

Catalebeda jamesoni B.-Bak, pupa	Zambia
Pachypasa bilinea Walk., pupa	Zambia

Limacodidae (slug caterpillars)

Limacodid caterpillars	Congo (Kinshasa), Zambia

Noctuidae (noctuids)

Busseola fusca Hmps., larva	Zambia
Heliothis obsoleta Fabr., larva	Zambia
Nyodes prasinodes Prout, larva	Congo (Kinshasa)
Sphingomorpha chlorea Cr., larva	Zambia
Spodoptera exempta Walker, larva	Zambia
Spodoptera exigua Hubner, larva	Zambia
Noctuid larvae	Congo (Brazzaville)

Notodontidae (prominants)

Anaphe infracta Walsingham, larva	Congo (Brazzaville), Zambia
Anaphe panda (Boisd.), larva	Tanzania, Congo (Kinshasa)
Anaphe sp., larva	Cameroon, Congo (Brazzaville), Congo (Kinshasa)
Antheua insignata Gaede, larva	Congo (Kinshasa)
Desmeocraera sp., larva	Zambia
Drapetides uniformis Swinhoe, larva	Congo (Kinshasa)
Elaphrodes lactea Gaede, larva	Congo (Kinshasa)
Rhenea mediata Walker, larva	Congo (Kinshasa)
Notodontid larvae (3 additional species)	Congo (Kinshasa)

Nymphalidae (brush-footed butterflies)

Nymphalid larvae	Congo (Kinshasa)

Psychidae (bagworm moths)

Clania moddermanni (author?), larva	Congo (Kinshasa)
Eumeta cervina Druce, larva	Congo (Kinshasa)
Eumeta rougeoti Bourgogne, larva	Congo (Kinshasa)

Saturniidae (giant silkworm moths)

Anthocera monippe (author?), larva	Gabon
Anthocera spp., larvae	Gabon
Anthocera teffraria (author?), larva	Gabon
Athletes gigas Sonthonnax, larva	Congo (Kinshasa)
Athletes semialba Sonthonnax, larva	Congo (Kinshasa)
Bunaea alcinoe Stoll, larva	Tanzania, Congo (Kinshasa), Zambia
Bunaeopsis aurantiaca Rothschild, larva	Congo (Brazzaville), Congo (Kinshasa)
Bunaeopsis sp., larva, pupa	Zambia
Cinabra hyperbius Westwood, larva	Congo (Kinshasa), Zambia
Cirina forda Westwood, larva	Congo (Brazzaville), Congo (Kinshasa), Zambia
Gonimbrasia belina Westwood, larva	Malawi, Zambia
Gonimbrasia hecate Rougeot, larva	Congo (Kinshasa)
Gonimbrasia richelmanni Weymer, larva	Congo (Kinshasa)
Gonimbrasia zambesina Walker, larva	Congo (Kinshasa)
Goodia kuntzei Dewitz, larva	Congo (Kinshasa)
Gynanisa maia ata Strand, larva	Malawi, Congo (Kinshasa), Zambia
Holocerina agomensis Karsch, larva	Zambia
Imbrasia dione Fabr., larva	Congo (Kinshasa)
Imbrasia epimethea Drury, larva	Congo (Kinshasa), Zambia
Imbrasia ertli Rebel, larva	Angola
Imbrasia macrothyris Rothschild, larva	Congo (Kinshasa)
Imbrasia obscura (author?), larva	Congo (Brazzaville)
Imbrasia rubra Bouvier, larva	Congo (Kinshasa)
Imbrasia spp., larvae	Congo (Brazzaville), Congo (Kinshasa)
Imbrasia truncata (author?), larva	Congo (Brazzaville), Congo (Kinshasa)
Lobobunaea christyi Sharpe, larva	Zambia
Lobobunaea saturnus Fabr., larva	Congo (Kinshasa), Zambia
Melanocera parva Rothschild, larva	Congo (Kinshasa)
Micragone ansorgei Rothschild, larva	Zambia
Micragone cana Aurivillius, larva	Congo (Kinshasa)

Micragone herilla Westw., larva	Congo (Kinshasa)
Nudaurelia oyemensis (author?), larva	Congo (Brazzaville), Congo (Kinshasa)
Nudaurelia spp., larvae	Congo (Kinshasa)
Pseudantheraea discrepens Butler, larva	Congo (Brazzaville)
Tagaropsis flavinata Walker, larva	Congo (Kinshasa)
Saturnia marchi (author?), larva	Gabon
Urota sinope Westw., larva	Gabon, Congo (Kinshasa)
Usta terpsichore M.& W., larva	Angola

Sphingidae (sphinx or hawk-moths)

Herse convolvuli (Linn.), larva	Zambia
Nephele comma Hoppfer, pupa	Zambia
Sphingid larvae	Congo (Brazzaville), Congo (Kinshasa)

Odonata

Family uncertain

Dragonfly nymphs	Cameroon, Congo (Brazzaville)

Orthoptera

Acrididae (short-horned grasshoppers)

Acanthacris ruficornis Fabr., adult	Congo (Brazzaville), Malawi, Zambia
Acorypha nigrovariegata (author?), adult	Zambia
Acrida sulphuripennis Gerstacker, adult	Zambia
Affroxyrrhepes procera Burmeister, adult	Congo (Brazzaville)
Affroxyrrhepes sp., adult	Zambia
Amblyptymus sp., adult	Zambia
Ampe sp., adult	Congo (Brazzaville)
Cantatops ornatus (author?), adult	Zambia
Cantatops sp., adult	Zambia
Cantatops spissus Walker, adult	Congo (Brazzaville)
Cardeniopsis guttatus (author?), adult	Zambia
Chirista compta Walker, adult	Congo (Brazzaville)
Cyathosternum sp., adult	Zambia
Cyrtacanthacris aeruginosa (author?), adult	Malawi, Zambia
Cyrtacanthacris septemfasciata Serville, adult	Malawi, Tanzania, Uganda, Congo (Kinshasa), Zambia
Cyrtacanthacris tartaria (author?), adult	Zambia
Gastrimargus africanus Saussure, adult	Congo (Brazzaville)
Heteracris guineensis Krauss, adult	Congo (Brazzaville)
Homoxyrrhepes punctipennis Walker, nymph, adult	Congo (Kinshasa)
Locusta m. migratoria Linn., adult	Congo (Brazzaville), Tanzania, Uganda, Zambia
Locusta migratoria migratorioides R.& F., adult	Congo (Kinshasa), Zambia
Locustana pardalina (Walker), adult	Zambia
Oedaleus nigrofasciatus (author?), adult	Zambia
Ornithacris spp., adults	Zambia
Ornithacris turbida (author?), adult	Congo (Brazzaville)
Oxycantatops congoensis Sjostedt, adult	Congo (Brazzaville)
Poecilocerastis sp., adult	Zambia
Schistocerca gregaria Forskal, adult	Tanzania, Uganda, Zambia
Schistocerca peregrinatoria Linn.	Angola
Grasshoppers/ locusts	Pan-regional

Blattidae (roaches)

Cockroaches	Congo (Kinshasa)

Gryllidae (crickets)

Acheta spp., adults	Zambia

Brachytrupes membranaceus Drury, adult	Pan-regional
Gryllus bimaculatus De Geer, adult	Zambia

Gryllotalpidae (mole crickets)

Gryllotalpa africana Palisot	Uganda

Tettigoniidae (long-horned grasshoppers)

Ruspolia differens Audinet-Serville, adult	Uganda, Congo (Kinshasa), Zambia
Ruspolia vicinus Walker, adult	Malawi, Tanzania
Tettigonia sp.	Congo (Brazzaville)

Much information is available on the insect foods in this region, and highlights are briefly summarized below under each country, with countries treated in alphabetical order (except that Congo (Kinshasa) which was still known as Zaire when this chapter was written is still located between Uganda and Zambia). Nutrient analyses have been conducted in several countries, with especially valuable studies in Angola and Congo (Kinshasa). Partly because of their remarkable abundance caterpillars and termites are not only of great nutritional importance but also of great ecological importance. In studies in Malawi, Congo (Kinshasa) and Zambia, the food importance of caterpillars has been shown to be a factor that can result in better forest management and protection. Throughout the region, generally, insects are a favored food and widely marketed.

In Angola, Oliveira et al provide nutrient analyses of four commonly eaten species, a termite, two species of saturniid caterpillars and the palm weevil larva (see Angola Table 1). The insects are shown to be high in crude protein, calories and many of the important vitamins and minerals. The termite, *Macrotermes subhyalinus*, and the palm weevil larva, *Rhynchophorus phoenicis*, are especially high in energy value, 613 and 561 kcal/100 g, respectively, and the weevil larva and the saturniid caterpillar, *Usta terpsichore*, are high in zinc, thiamine and riboflavin. The caterpillar is also a rich source of iron. Of other insects, Wellman mentions that the people are very fond of roasted locusts and that the cricket *Brachytrupes membranaceus* is esteemed a great delicacy. The cricket is collected mainly by the women, often in great numbers, and by children.

Among the insects marketed in Cameroon are *Anaphe* and saturniid larvae, *Rhynchophorus* weevil larvae and *Popillia* beetles. Grimaldi and Bikia provide a recipe for the weevil larva, which they describe as a favorite dish offered only to "good friends." Merle (1958) suggests that Africa would do well "not to brutally reject its whole past," and that the rearing of edible caterpillars should be considered by appropriate agencies. The abundance of the wild caterpillars is hard to believe, according to Merle, who states that even when not seen, their presence can be detected by the sound of their chewing or the sound of frass hitting the ground. Tessmann reported that 21 species of caterpillars are eaten by the Pangwe; the scientific identity has not been reported for any of them, thus showing the need for taxonomic studies in Cameroon.

Little information is available concerning insect consumption in the Central African Republic, but termites and caterpillars are widely sold, and Noyes compares the welcome given the termite season with that given the advent of the oyster season by British gourmets. Junker reports that he soon overcame his repugnance to locusts, finding them in fact to be "very palatable."

In Congo (Brazzaville), Nkouka states that many of the nutritional deficiencies observed in hospitals are found among people who have lost contact with traditional foods and whose income is inadequate for suitable replacement. In earlier years, consumption of caterpillars around Brazzaville was estimated at 30 g/person/day, and Nkouka believes that promoting the use of edible insects merits more attention. Bani, as did Nkouka earlier, decries the attitude that insects are "uncivilized" food or a vestige of a time long past, and similarly urges greater promotion and popularizing of insects for improving both nutrition and local economies. Some species command a higher price in the market than imported meat.

The palm weevil larva, *Rhynchophorus phoenicis*, according to Bani, is the "most appreciated" edible insect in Congo (Brazzaville), and Nkouka notes that its rarity in the markets and its taste make it a high-priced food. Termites, similarly to caterpillars of many species, are popular and widely sold. Grasshoppers and other Orthoptera are also sold in the markets, allowing people from rural areas to use these insects as a "cash crop" (Bani 1995). Two former U.S. Peace Corps Volunteers (Bissmeyer and Dury 1992) asked, after sampling palm grubs and other Congo (Brazzaville) edible insects, "Why are insects so taboo in America?; they make quite tasty snacks." Nutritional analyses of cooked caterpillars of *Anaphe infracta* by Le Clerc et al showed them to contain 51.5% protein and a calory value of 3198/kg. Fatty acids were 64% unsaturated. Nkouka compiled data useful in comparing nutritive value of edible insects and other local foods (see Congo-Brazzaville Table 1).

It is evident that further research is needed on the use of edible insects in the Congo (Brazzaville) and their taxonomic identity. Nkouka states that more than 20 species of caterpillars are used in Baya country but provides the taxonomic identity for none of them, and Bani mentions that many species of caterpillars and grasshoppers are used in addition to those now known.

Information on Kenya is limited and pertains mostly to termites and lake flies (Chaoboridae), both of

which are found in markets. According to Massam, winged termites and honey are distinctly luxury foods and are "especially esteemed" when eaten together. Grasshoppers, both short-horned (Acrididae) and long-horned (Tettigoniidae) are also eaten. In research on the red locust (presumably *Cyrtacanthacris septemfasciata*) as a protein source for pigs, the insects (sundried) were found to have a crude protein content of 58.4%.

A wide variety of insects are consumed in Malawi. Shaxson et al (1985) provide recipes for many of them and state that, "It is not generally known in the Western world that insects are a very good and cheap source of protein." These authors state, relative to the lake fly, *Chaoborus edulis*, that it is "extremely nutritious," high in protein and calcium and contains six times as much iron as ox liver. A study by Munthali and Mughogho (1992) shows the potential of edible caterpillars in efforts to preserve biodiversity. Beginning in 1990, Malawi's Department of National Parks and Wildlife allowed some of the families living around Kasungu National Park to harvest caterpillars in the Park, and simultaneously initiated modern bee-keeping in the Park in order to diversify the rural communities' income base and to win their support for wildlife conservation programs. The study demonstrates the advantages of introducing economic incentives that integrate biological conservation with economic development for the rural people, and shows that opening national parks and other wildlife preserves to controlled sustainable use by local populations can reduce the problems of poaching in protected areas.

In Tanzania, many insects are included as a regular part of the diet (Harris 1940), but relatively little information is available about them. According to Harris, the lake fly, *Chaoborus edulis* is important in the limited areas where it occurs, as are termites in the western part of the country where they are sold in the local markets. Locusts of several species are widely eaten, and, fried in butter, their flavor is reminiscent of shrimps, according to Harris. According to Mors (1958), the long-horned grasshopper, *Ruspolia*, known as *nsenene*, is "the greatest delicacy of the Bahaya." They occur in vast swarms and are collected mainly by the women and children. All land is communal when it comes to *nsenene*, and owners cannot exclude trespassers who come to collect them.

Owen (1973) notes that in Uganda, as elsewhere in tropical Africa, the insect species used as food are those that are locally or seasonally abundant, and people who are no longer dependent on wild foods still collect insects. Relative to the European aversion, Owen states that "insects are indeed good to eat and some taste as good as the best lobster or crab." As with some other foods, ritual ceremonies and discriminatory taboos govern the use of some important species; "some insects are held in high esteem and are therefore reserved by custom for the more important and senior members of the community." Widely eaten insects include termites, lake flies, caterpillars, crickets, locusts and the tettigoniid grasshopper known as *nsenene* (*Ruspolia*).

Termites are widely marketed and sometimes transported long distances to markets. Termite mounds are individually owned (Owen). Osmaston (1951) regarded raw termites as "one of Uganda's cheapest luxuries," describing the flavor as delicate and excellent, "somewhere between fried whitebait and hazelnuts." Osmaston predicted the future development of "vast termitaria" under government promotion. Although caterpillars are widely marketed, according to Owen, he gives no clue to their identity. Relative to other insects, Owen reported that the cricket, *Brachytrupes membranaceus*, is regarded as a particular delicacy, and that the streets of Kampala may become completely blocked to traffic by people who come in from the countryside to collect *nsenene*, which are attracted in vast numbers by the city lights.

In Congo (Kinshasa) (formerly Zaire), Malaisse and Parent (1980) analyzed caterpillars of 23 species (including 17 Saturniidae), with samples prepared in a manner identical to that which precedes their culinary preparation and then dehydrated. Crude protein content averaged 63.5%, kcal/100 g averaged 457 (ranging up to 543), and most species proved an excellent source of iron, 100 g averaging 335% of the daily requirement. Kondondi et al (1987) analyzed three species of saturniids for vitamins and conducted rat-feeding trials showing that vitamins supplied by the caterpillars are sufficient to allow proper growth of young rats, except for vitamins B1 and B6. According to Chinn (1945), caterpillars are eaten very frequently when in season, and a native eats 400 g of fresh caterpillars per meal. Analysis of a *Nudaurelia* species yielded a dry weight protein content of 62.1% and fat content of 16.1%, but digestibility was only 50%, thus reducing their dietary value. For some people in the province of Coquilhatville, caterpillars are the main source of animal protein for five months of the year, for three months as fresh caterpillars and for two additional months as smoked caterpillars. Among the Yansi, caterpillars are harvested mainly by women and children, according to Muyay, although men are beginning to harvest them more for sale in the cities. Several species are reserved for the children. Miracle (1967) describes a system of caterpillar farming practiced by the Holo, and states that these caterpillars (species not known) are "the delicacies of connoisseurs, the equal of caviar, snails, or truffles among the European gourmets."

Analysis of *Elaphrodes lactea* by Malaisse et al (1969) revealed that lipid content of this notodontid caterpillar (29.6%) is more than twice the values reported for most other caterpillar species. It is also a significant addition to the protein supply of the rural people. The investigators urge that its food importance be considered in determining forest protection policies against this species which is an important forest defoliator (see below for quantitative data).

Relative to the Kwango, LeLeup and Daems (1969) state that: "Large game having become very scarce,

it is fish, and especially caterpillars, of which certain species abound, that constitute the most important sources of protein for local consumption." They are also a source of income. Of more than 30 species consumed in the Kwango and Kwilu districts, only three (the widely eaten *Cirina forda* and two other saturniid larvae) account for most of the exports. From 1954 to 1958, the dried caterpillar production in the district was estimated at 280-300 tons per year. Because of reduced annual tonnage after that period, LeLeup and Daems were commissioned by the territorial administration to determine whether fluctuations and reduced tonnage might be caused by badly-timed burning. The three exported species all pupate underground, but the adult moths emerge and lay their eggs at different times. Although other complicating factors were involved, the investigators were able to determine the optimum dates for burning that minimize caterpillar destruction (see Congo (Kinshasa) Figure 1); other recommendations were: 1) enforce the ban on felling trees to harvest caterpillars, 2) forbid the increasing practice of harvesting pupae, 3) encourage resowing attempts on a massive scale by collection of eggs prior to burning, and 4) create "reserves" of some small wooded savannahs in which all harvest for purposes of consumption would be forbidden.

Proximate analysis of winged *Macrotermes natalensis*, conducted by Chinn, revealed a dry matter content of 33.06% protein and 54.68% fat, while *Termes gabonensis* soldiers were 37.05% protein and 3.00% fat. Chinn mentions that the natives are "wild" about winged termites, and he compared the taste of the winged forms to that of hazelnuts. Tihon says of lightly grilled termites sold in the market at Kinshasa that they are a food that "the majority of natives consume voraciously." In some areas, termite hills are considered village property. Reporting that analysis of termites revealed a calorific value of 561 kcal/100 g, Tihon suggested that the use of termites, along with caterpillars and larval and adult beetles, should be encouraged in meeting the dietary needs of the inhabitants. According to Muyay, the delicious taste and protein content of termites make them a good meal for children, and Hegh (1922) notes that roasted termites are suitable to the European palate. Bequaert (1921) observed dried soldier termites for sale; he also mentions that termite hills are considered private property in the Uele district.

Chinn found a dry matter content of 52.4% protein in larvae of the palm weevil, *Rhynchophorus phoenicis*, and a dry matter content of 48.3% in analysis of a mixture of adult and larval weaver ants, *Oecophylla smaragdina longinoda*. He says of palm weevil larvae that they are always eaten alone, as a delicacy, and have a taste like light wine. The Bakela may eat 250 g of the larvae at a time, and the harvest and selling of the larvae was, in times past, their principal source of revenue. Concerning orthopterans, Bouvier (1945) mentions that older people remembered locust invasions as a period of food abundance. The locusts did relatively little damage to corn plantings and manioc (the staple food) and were very much appreciated. Among the Yansi (Muyay), some kinds of grasshoppers are eaten mainly by children, and crickets are harvested mainly by women and children. A woman may collect 400 or more crickets in a night, and when many are caught, some are smoke-dried and bought by traders who sell them in the large towns.

Insects are widely marketed in Congo (Kinshasa). Adriaens (1951), for example, reported that a single store in the commercial center of Kwenge had stocked 50 bags of caterpillars, 50 kg per bag with caterpillars priced at 12 francs per kilo, making them slightly more expensive than dried salted fish and much more expensive than hulled rice, peanuts, maize and manioc. The large *mafundi* (larvae of the beetle, *Platygenia barbata*) were much cheaper at a native market in Feshi, one lot of 15 selling for 1 fr 50. The larvae are harvested by the women. At a public market in Lubumbashi, Heymans and Evrard (1970) purchased soldier termites, winged termites, caterpillars of two kinds and grasshoppers. All of these insects are prized by the local populations; they are low-priced and make not a negligible contribution to nutrition, according to Heymans and Evrard. Katya Kitsa (1989) conducted a survey on household expenditures for edible insects in the city of Kananga, and estimated that the average consumption was 663 g insects/person/month or 12,000 tons for the city as a whole. Relative quantities consumed (weight basis) were termites (35%), caterpillars (30%), other larvae (23%) and grasshoppers (12%). On a weight basis, the price of smoked caterpillars was only 26% of the price of beef. Katya Kitsa recommended that health workers should be paying more attention to edible insects as a protein source. Former Peace Corps Volunteers reported encountering a variety of edible insects for sale in markets in different parts of Congo (Kinshasa), including palm grubs and other beetle grubs, caterpillars, termites and grasshoppers. Some species were collected mainly by women and/or children.

In Zambia, nutrient analyses of foods used by the Bemba revealed 65 g protein/100 g of insect for dried caterpillars compared to 32 g for dried fish, 30 g for roast venison and lesser amounts for other foods (Richards 1939). Caterpillars are the single most important source of nutrients during the "hunger months," November to February, when the other most widely available foods are fresh mushrooms and fruits which contain only 2 g and 1 g protein, respectively. Kumar (1990) confirms the importance of insect foods during the hunger season, noting that the nutritional contribution is small on an annual basis, but very significant on a seasonal basis. Insect items are included in the Zambian food composition tables which are widely used by nutritionists in the country. While Kumar says there seems to be a trend toward reduced consumption of insects, Mbata (1995) states that entomophagy is gaining prominence in recent years as the result of drought and poor economic conditions. Large quantities of insects, especially caterpillars, grasshoppers and termites, are brought from rural areas for sale in

town markets. According to Mbata, entomophagy has undoubtedly played an important role in reducing kwashiorkor in young children.

The classic studies of Silow (1976, 1983) have shed much light on the use of caterpillars and termites in Zambia. Silow lists a number of tribes in which it is generally agreed that the meat of winged sexuals of *Macrotermes* spp. is better than the meat of animals, birds or fish; most people consider *Macrotermes* or honey to be "the best existing food." The winged *Macrotermes* are widely marketed. A few people don't eat termites, and some missionaries have condemned termite eating as a heathen custom. Caterpillars of at least three families, Saturniidae, Lasiocampidae and Sphingidae, are marketed, and representatives of several other families are eaten. A few caterpillars are considered comparable, or nearly comparable, to termites in taste, and Silow mentions that even the least-liked caterpillar, a limacodid called *kavambe,* is liked better than fish. Silow decries the European influence that has undermined the traditional attitudes toward caterpillars.

In Zambia, as in Malawi and Congo (Kinshasa), the food importance of caterpillars has been shown to be a factor that can result in ecological benefits, in that the desire by local populations for protection of traditional food resources can be favorable for good forest management. Late burning during the dry season can severely damage regeneration of the *miombo* woodland, killing trees, reducing regrowth and increasing erosion. The best way to prevent this damage is by early burning. In part of the country, there is a saturniid caterpillar known as *mumpa* which is important both as a source of nutrition and source of income. Holden (1991) observed that there were very few late fires in the areas where the *mumpa* caterpillars are found. The people are careful to burn early to protect the caterpillars, thus also enhancing woodland regeneration.

Platt (1962: 24) tabulated the results of proximate, mineral and vitamin analyses of four types of commonly used edible insects in Africa. These tabulations were greatly extended by Wu Leung (1968: 165-176). Data on nutrient content of raw, dried, smoked and fried African termites are shown in Central and Eastern Africa Table 1 (see Wu Leung pp. 175-176, and data on three additional species occurring in this region, *Chaoborus edulis* (lake fly), *Carebara* sp. (winged ant) and *Brachytrupes membranaceus* (cricket) in CEA Table 2 (see Wu Leung pp. 165, 168, 169). As stated by the compilers of these data, "Unless the compositions of local foods [are] known, calculations of the habitual diet and the introduction of complementary foods to combat malnutrition cannot be put into practice satisfactorily."

The ecological importance of edible caterpillars as a tool in preserving biological diversity is readily apparent from studies cited above in Malawi (Munthali and Mughogho), Congo (Kinshasa) (LeLeup and Daems) and Zambia (Holden). Abundance is a factor. Many observors in the region have been impressed by the prodigious numbers of individuals in some edible caterpillar populations, and Malaisse provided quantitative data on one of them, *Elaphrodes lactea*, in Congo (Kinshasa). *E. lactea* is an oligophagous species that feeds only on the Caesalpiniaceae (Malaisse 1978). Malaisse et al (1969) discussed the biology and described the extensive defoliation it causes periodically to its food tree, *Brachystegia boehmii*. Malaisse (1978) states that *E. lactea*, because of the predominance of its host plants in the tree stratum, is capable of "spectacular destruction and total defoliation over large areas." Malaisse lists several parasites and predators and notes that these provide effective population control during the second year of buildups. Rearing experiments showed that, at their peak density, monthly leaf consumption by *E. lactea* was 733 m^2/ha (a dry weight of 98 kg/ha) and the dry weight of their feces was 90 kg/ha. The effect on tree growth is unknown but new leaves appear in May or June.

Termites are also important in preserving biodiversity, and they are also abundant. The high termitaria of some species of the termite genus *Macrotermes* are a spectacular feature of the African landscape. The mounds are not only imposing in size, reaching 8 meters in height and 15 m in width, but the termitaria vegetation is characteristic and quite different from that of the surrounding *miombo* woodland (Malaisse 1974). In southern Congo (Kinshasa) the mounds average 3-5 per hectare and may cover 4.3 to 7.8% of the *miombo*. Malaisse (1978b) states that assuming "only one primary active termite mound per hectare, the biomass of a *Macrotermes falciger* colony represents 35 percent of the total pedofauna biomass in *miombo*."

The characteristic termite hill flora mentioned above is ecologically important in that it creates additional habitat diversity. The termite hill flora numbers more than 200 species in both Zambia and southern Congo (Kinshasa) but differs significantly from one region to another. And of 72 termitaria species listed by Wild in Zimbabwe, only 17 can be found on the high termitaria of Shaba in southern Congo (Kinshasa) (Malaisse 1978b). Malaisse points out that three species of edible saturniid larvae in Congo (Kinshasa) feed only on Shaban termite hill plants, i.e., *Tagaropsis flavinata* on *Allophyllus africanus, Urota sinope* on *Erythrina abyssinica*, and *Gonimbrasia zambesina* on *Piliostigma thonningii, Diospyros mespiliformis* and *Strychnos potatorum*. Three other species that feed on termite hill plants, i.e., *Bunaea alcinoe* on *Balanites aegyptica* and *Piliostigma thonningi, Gonimbrasia hecate (= nictitans)* on *Combretum molle* and *C. mechowianum*, and *G. richelmanni* on *Annona senegalensis*, also feed on other *miombo* plants. *Macrotermes* are only sporadically serious pests, occasionally causing damage locally to such crops as coconut, coffee, cocoa, clove, groundnuts, rice, sugarcane, fruit trees and forest trees (Hill 1983: 172).

Macrotermes not only build large mounds, but the termites themselves are large, the alates of

Macrotermes falciger for example having a wing span of 85 mm or more and the major soldiers a length of more than 15 mm (Ruelle 1970). The termites (Subfamily Macrotermitinae) are fungus growers. They do not have symbiotic intestinal microorganisms, so they utilize the plant cellulose by carrying collected plant material back to the nest for construction, in special chambers, of honeycombed fungus gardens inoculated with the fungus *Termitomyces*. The mycelium spreads over the cellulose "garden" and at intervals along the hyphae are found white, globular swellings known as bromatia, on which the termites feed (Hill 1983: 172).

It is difficult to determine the number of individuals and the biomass of a termite nest population. Malaisse (1978b) cites other workers for an estimate of two million individuals as the average number in the Upper Shaba of Congo (Kinshasa) where *M. falciger* is the main inhabitant of primary active termitaria. In such a colony, winged individuals number only an estimated 59,405 (3%) but comprise 9,800 g (59.9%) of the dry weight biomass. Based on an average of four mounds per hectare, one can calculate that active primary termitaria constitute a regenerative system producing nearly 40 kg/ha (dry weight) per year (winged individuals only) of harvestable high-protein, high-energy food. Productivity is somewhat higher if harvest of soldier termites is included. Also, termites of several other genera including the edible *Odontotermes* and *Pseudacanthotermes* frequently establish their underground nest chambers at the bases of the large mounds, further increasing productivity.

Like *Macrotermes*, *Odontotermes* and *Pseudacanthotermes* belong to the subfamily Macrotermitinae and are fungus growers. They are more serious pests of crops than is *Macrotermes*. In addition, *O. badius* is often found under buildings (and, in S. Africa, is said to cause more damage to buildings than is caused by all of the other subterranean termites combined) (Ruelle 1970).

Unfortunately, the future of the high termitaria is dark. Malaisse (1978b) reports that in suburban regions and towns, although the mounds persist, their flora and fauna have been destroyed. They have become the main supplier of brick-clay and a favorable site for maize crops; they are sometimes converted into flower-beds, and near villages they are frequently opened and used as ovens. Malaisse notes that the decay of the termitaria began a long time ago, following the destruction of vegetation that increasingly resulted in a greater number of abandoned and fossil termitaria.

Manipulation of the African mound-builders for greater food production does not appear possible, but their presence and decline add one more reason why tropical forest destruction is to be lamented and slowed if possible. They seldom do serious damage to trees or crops and represent a food resource that is lost when the forest is destroyed.

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