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RODENTS AS A FOOD SOURCE

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ABSTRACT: Rodents, one of several kinds of vertebrates included in the human diet, are very suitable as human food. More than 71 genera and 89 species of rodents, mostly hystricomorphs, have been consumed by man. Some have even been domesticated for private or commercial production of food for human consumption. Rodents in the temperate world serve only as a supplement to the regular diet of humans; but in the tropical world, they are widely accepted and a popular source of protein. Although harvesting field rats for human food is beneficial, it is not an effective pest control strategy. Consuming rodents in pesticide-treated areas and handling rodents with potential zoonoses are two possible risks.

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INTRODUCTION

Rodents comprise a substantial portion of wild game consumed by man throughout the world. Rabbits and hares, part of the diet for many human cultures, are lagomorphs, an order of mammals closely related to rodents. This paper will address only rodents and will follow taxonomic nomenclature of Honacki et al. (1982). For several years, the U.S. National Academy of Sciences has gathered information on the use of rodents and other potential microlivestock for food. It will be publishing a report later this year that will bring together the scattered literature on this subject (National Research Council, in press).

Advantages in Utilizing Rodents for Food

Although human food habits are extremely diverse, man has been mostly opportunistic as well as preferential in the selection of food items. Many foods available to humans are not physiologically acceptable; however, rodents are very suitable as human food. Besides providing protein, rodent meat contains essential amino acids necessary in the human diet.

Rodents are one of several kinds of vertebrates that are included in the human diet. Wild birds (which are not used as a food source to any great extent, Eltringham 1984), reptiles, and amphibians do not offer as many eating advantages for human food as those provided by rodents. Rodents generally are not encompassed by game laws and are usually abundant and easy to catch. Some rodents are even numerous near dense human populations where larger animals are scarce (den Hartog and de Vos 1973, de Vos 1977). Although one species of rodent eaten by man weighs more than 50 kg, most are small enough to be consumed in one meal, thereby eliminating the need for refrigeration or other food-storage methods such as salting and drying. Relatively high reproductive rates in rodent populations allow for continuous harvesting without depletion. Among invertebrates, insects offer most of the eating advantages for human food as rodents; insects contain about 35 to 50% protein (DeFoliart 1975)–a much higher percentage than rodents. However, insect food sources are generally very seasonal.

Many rodent species that are eaten are agricultural pests. In fact, the majority of rodent pest species in West Africa are frequently consumed (Funmilayo 1979). Despite decades or even centuries of human predation, most of these rodents continue to be pests and cause significant crop losses. Capturing rodents for food is not a very effective method for reducing crop losses; however, it is one way of recovering some of the food value destroyed by these pests.

Being a pest does not necessarily mean a rodent will be eaten by man. For example, along the Trans-Amazon Highway, where rats and mice are serious pests, they are not eaten by Brazilian colonists (Smith 1976). Among the noncolonists, it is only when larger mammal species become scarce that Amazonians eat rodents regularly. In one area where the habitat was degraded and hunting was common, pacas (Agouti paca) and agoutis (Dasyprocta spp.) accounted for 39% of the annual game take by weight; but in forested areas where larger mammal species were still abundant, these rodents comprised only about 3% of the take.

Rodents are occasionally consumed or used for special circumstances. The guinea pig (Cavia porcellus) in South America and the house rat (Rattus sp.) in Ghana have been used for medicinal purposes (de Vos 1977, Müller-Haye 1984). Rodents are also used for feasts, religious ceremonies, and exchanges for certain initiations (Sale 1983, Müller-Haye 1984). At the University of Arizona, pack rats (Neotoma sp.) are consumed by a social club (Secret Order of the Neotoma Eater) that insists these rodents are a delicacy (Anon. 1987).

History of Rodent Eating

Peruvians have been consuming guinea pigs for centuries. The guinea pig, domesticated since at least 2500 B.C. (Lanning 1967), was the first rodent raised for food. By the 15th century A.D. (during the Incaic Empire), it was the principal meat consumed. Capybara (Hydrochaeris hydrochaeris)may have been domesticated in Brazil as early as A.D. 1565 (Gonzalez-Jimenez 1984).

Early Chinese ate "household deer" [common rat (probably Rattus norvegicus or R. flavipectus) and bamboo rat (Rhizomys spp.)] and during the Tang dynasty (A.D. 618-907) ate newborn rats stuffed with honey, conveniently snatching them with chopsticks (Hendrickson 1983). Romans popularized the edible dormouse [Myoxus (=Glis) glis] by the 2nd century. It was caught from the wild in autumn when it was fattest and either roasted and dipped into honey or baked while stuffed with a mixture of pork, pine nuts, and other flavorings. Romans also raised dormice in special pots called "gliraria" and in large outdoor enclosures where they were fed walnuts, chestnuts, and acorns for fattening (Brothwell and Brothwell 1969). Southeastern Europeans still enjoy dormice.

The Maoris of New Zealand used snares and pit traps in family hunting territories to trap the kiore or Polynesian rat

(R. exulans, Best 1942). In the 16th century, they introduced this rat to Polynesia as a food item by carrying it in their ships. Elsewhere the Irula, a tribal group in India, has traditionally included rats in its diet and today is hired by Indian farmers to capture rodent pests.

More recently a United States Army Quartermaster Corps survey identified 42 different societies in which people eat rats (Harris 1985). Traditionally we think of "rat eaters" (rodentiophagists?) as belonging to primitive societies--small groups living in remote areas with large, undisturbed land areas available for hunting and trapping small mammals. However, squirrel hunters today could be considered just as traditional. The squirrel, a rodent in the Sciuromorpha suborder, is one of the most important game animals in the United States. About 40 million gray squirrels (Sciurus carolinensis) and a lesser number of fox squirrels (S. niger) are harvested annually (Flyger and Gates 1982).

Taboos on rat eating are not as common as one would expect. Leviticus 11:29 prohibits eating "the mouse." The Hebrew word used means rat or mouse. Judaism apparently is the only religion to specifically ban rats, since Christians are not bound by food restrictions written in the Old Testament. Although Moslems avoid scavengers, the Holy Koran (2, 168) only forbids "the flesh of swine," and Buddhists are only prohibited from killing or witnessing the killing of animals (Harris 1985). Thus in Burma, where most people are Buddhists, the rat hunters described by Drummond and Crowe (1985) are either tribal or Christian.

There are several taboos, including supernatural beliefs, that prevent many Nigerians from eating giant rats (Cricetomys spp., Ajayi 1974). Although commensal rodents are generally not eaten by man, because they are associated with urban filth or disease, the siege of Paris in 1871 and food shortages in World War II forced many people to eat city rats. In Malawi, only rats caught in the bush [Praomys (=Mastomys) natalensis], not in homes (R. rattus), were eaten because the latter sometimes ate fingers and toes of humans--and eating them, according to Malawians, would be the same as eating humans (Drummond 1982). In several parts of the world, tribal women during menstruation, pregnancy, or postpartum, and occasionally children, are prohibited from eating rats. However, in many cultures, women and children routinely gather and consume small rodents.

GEOGRAPHICAL INCIDENCE

Temperate climates occur in mostly developed countries where wild game, including rodents, serves only as a supplement to the regular diet. In the United States, mostly squirrels, but also muskrat (Ondatra zibethicus, particularly in the midwest), porcupine (Erethizon dorsatum), and ground hog (Marmota monax) are eaten by humans. Native American Navajo ate prairie dog (Cynomys sp.) baked in mud while the Paiute ate gophers, squirrels, and rats (den Hartog and de Vos 1973).

Muskrat is also eaten in the Netherlands and Belgium, where the meat is "white, tender, and excellent" but still not as popular as restaurateurs had hoped (Kyle 1987). Elsewhere in Europe, squirrels, beaver (Castor fiber), marmot (Marmota sp.), and dormice have been eaten.

Tropical climates include mostly lesser developed countries where rural, tribal, or nomadic people commonly use rodents as a food source. Exceptions occur in West Africa where some urban dwellers eat expensive grasscutters (Thryonomys spp.) with a market price two to four times as much as local beef, mutton, or pork (Asibey 1974a, Baptist and Mensah 1986). Also, in Manaus, Brazil, the top ten wild animal species served in 23 urban restaurants included three rodents-paca, agouti, and capybara (Wetterberg et al. 1976 cited in de Vos 1977).

About 75% of the African population below the Sahara depend on traditional sources of protein such as wildlife (mainly fish) and insects (Asibey 1974b). In West Africa, as much as 73% of meat comes from wild animals (Eltringham 1984) of which the grasscutter is the most popular rodent eaten. Meat from the giant rat is widely accepted, but in some areas it is not popular and difficult to market (Baptist and Mensah 1986). In eastern Africa, Ethiopians along the western border eat mice and giant rats (de Vos 1977), and some Sudanese eat Nile rats (Arvicanthis niloticus) and field mice.

In southern Africa, rodents are consumed in Zimbabwe (Gelfand 1971), Zaire, Zambia, Botswana, and South Africa. Species eaten include cane rats (Thryonomys swinderianus), porcupines (Hystrix africaeaustralis), yellow-footed squirrels (Paraxerus cepapi), and springhares (Pedetes capensis). Wild animals, including substantial numbers of readily available springhares (Butynski 1973, Butynski and von Richter 1974), provided 90.7 kg of meat/person/year and about 40% of the diet in some areas of Botswana (Child 1970). Von Richter (1969) conservatively estimated that 60% of the protein consumed in Botswana came from wild animals.

Consumption of rodents is popular in Asia. In southern Asia, primarily rats and squirrels are hunted. Hunts in Thailand may yield 20,000 rice rats at a time (Hauck et al. 1959). Filipinos commonly skin, eviscerate, and sun dry Philippine ricefield rats (R. r. mindanensis) and Asian ricefield rats (R. argentiventer), which are then deep-fried and served in coconut oil. In a taste test at the University of the Philippines at Los Baños, rat meat sausage was ranked as acceptable as pork sausage (Rodent Research Center 1974). Barbecued rat is frequently available at barrio markets in the Philippines. In northern Asia, marmots (M. bobak) provide tarbagan (bobac or bobak) meat for some Chinese and Tibetans (Simoons 1961).

Latin America has many edible rodents, including the largest rodent in the world (weighing about 50 kg), the capybara, and the most familiar, the guinea pig. Several cavies (Cavia spp., Dolichotis spp., Microcavia sp.), spiny rats (Proechimys spp.), agoutis, and pacas have been consumed for centuries. Viscacha (Lagostomus maximus) meat has been commercially sold in cans in Argentina (den Hartog and de Vos 1973). This rodent is not plentiful now, but its meat and hide are still popular.

Australian aborigines do not generally consume rodents (Bourne 1953); however, Jones (1980) and Calaby (1980) mention one rodent [Rattus colletti (=sordidus)] being eaten by one aboriginal group. In Melanesia, rats are not uncommonly trapped for food. For example, New Guineans eat giant naked- or mosaic-tailed rats (Uromys sp., Luyken et al. 1964).

RODENT SPECIES EATEN

Table 1 lists 71 rodent genera, representing more than 89 species that are consumed by man. Families and genera from all three rodent suborders are well represented; however, more families (14 of 25) and species (more than 35) are hystricomorphs. The hystricomorphs are usually larger, tastier (they are vegetarians), and easier to catch when available.

Both the Myomorpha and Hystricomorpha suborders contain 26 rodent genera eaten by humans. Five of seven possible Sciuromorpha families appear in Table 1 and include 19 genera and more than 22 species. Africa has more than 36 rodent species used for food by man, while Latin America and the Caribbean contain more than 24 species, almost all of which are hystricomorphs.

Table 1. Some rodent species used as a food source by man.[a]

Scientific name	Common or local name	Geographic Area	Suborder
Agouti (=Cuniculus or Stictomys) paca	Paca, tepezcuinte, give nut or gibnut, conejo pintado, lapa, laba, guagua	Central and South America	H
Anomalurus spp.	Scaly-tailed flying squirrels squirrels	Africa	S
Arvicanthis niloticus	Unstripped grass rat, Nile rat, kusu rat	Africa	M
Atherurus africanus	African brush-tailed porcupine	Africa	H
Atlantoxerus getulus	Barbary ground squirrel	Africa	S
Bandicota bengalensis	Lesser bandicoot rat	Asia	M
B. indica	Greater bandicoot rat	Asia	M
Bathyergus suillus	Dune mole rat	Africa	H
Callosciurus prevosti	Prevost's squirrel	Asia	S
Cannomys badius	Lesser bamboo rat	Asia	M
Capromys pilorides	Cuban hutia, hutia conga	Cuba	H
Castor canadensis	Beaver	North America	S
C. fiber	Beaver	Europe	S
Cavia aperea	Cavy, aperea	South America	H
C. fulgida	Cavy	South America	H
C. porcellus	Guinea pig, cuy, curi, sucuy, jaca, conejillo	South America	H
C. tschudii	Cavy	South America	H
Coendou bicolor	Prehensile-tailed porcupine	South America	H
Crateromys schadenbergi	Busy-tailed cloud rat	Philippines	M
Cricetomys emini and	African giant rats, giant rats, pouched rats,	Africa	M
C. gambianus	"agouti," "rabbits"	Africa	M
Cryptomys spp.	Common mole rats	Africa	H
Cynomys sp.	Prairie dogs	North America	S
Dasyprocta spp.	Agouti, cotia	South America	H
D. punctata	Agouti	Central America	H
Dinomys branickii	Pacarana, false paca	South America	H
Dolichotis patagonum	Mara, patagonian cavy, pampas hare	South America	H
D. salinicola	Salt-desert cavy	South America	H
Epixerus ebii	Ebiana palm squirrel	Africa	S
Erethizon dorsatum	North American porcupine	North America	H
Funisciurus spp.	African striped squirrels, rope squirrels	Africa	S
Geocapromys brownii	Jamaican hutia	Caribbean	H
Gerbillus spp.	Northern pygmy gerbils	Africa	M
Graphiurus hueti	Huet's dormouse	Africa	M
Heliophobius argenteocinereus	Silvery mole rat, sand rat	Africa	H
Heliosciurus spp.	Sun squirrels	Africa	S
Hydrochaeris hydrochaeris	Bocaburro, cabiari, capiba, capibara, capigua, capigua, capiguara, capincho, capybara, carpincho, chiguire, chiguiro, chindo, chindoco, culopando, dia-baj, jesus, julo, kiato, pataseca, ponche, poncho, ronsoco, samanai, sancho, tanacoa	South America	H
Hylomyscus alleni	Allen's wood mouse	Africa	M
Hystrix africaeaustralis	South African porcupine	Africa	H
H. brachyura	Common porcupine	Asia	H
H. cristata	Crested porcupine	Africa	H
Idiurus spp.	Pygmy scaly-tailed flying squirrels	Africa	S
Jaculus orientalis	Greater Egyptian jerboa	Africa	M
Kerodon rupestris	Rock cavy, moco, capibari	South America	H
Lagidium viscacia	Mountain viscacha	South America	H

Table 1. (continued)

Scientific name	Common or local name	Geographic Area	Suborder
Lagostomus maximus	Vizcacha, viscacha, plains viscacha	South America	H
Lemniscomys griselda	Striped grass mouse, zebra mouse	Africa	M
Marmota bobak	Bobac, bobak, tarbagan	Asia	S
M. monax	Woodchuck, ground hog, marmot	North America	S
Microcavia australis	Mountain cavy	South America	H
Myocastor coypus	Coypu, nutria, coipo	South America and Europe	H
Myoprocta acouchy	Green acouchy(i), agouti	South America	H
M. exilis	Red acouchy(i), agouti	South America	H
Myoxus (=Glis) glis	Fat or edible dormouse	Africa	M
Neotoma spp.	Pack rats, wood rats	North America	M
Nesokia indica	Short-tailed bandicoot rat, short-tailed mole rat rat, pest rat	Asia	M
Oenomys hypoxanthus	Rufous-nosed rat	Africa	M
Ondatra zibethicus	Muskrat, marsh rabbit	North America and Europe	M
Orthogeomys spp.	Taltuzas	Central America	S
Otomys angoniensis	Angoni vlei rat	Africa	M
Paraxerus cepapi	Yellow-footed squirrel	Africa	S
Pedetes capensis	Springhare	Africa	S
Pelomys fallax	Groove-toothed creek rat	Africa	M
Petaurista petaurista	Giant flying squirrel	Asia	S
Petromus typicus	Dassie rat	Africa	H
Phloeomys spp.	Slender-tailed cloud rats	Philippines	M
Plagiodontia aedium	Hispaniolan hutia, zagouti, hutia	Caribbean	H
Praomys (=Mastomys) natalensis	Multimammate rat	Africa	M
Proechimys spp.	Spiny rats, casiragua	South America	H
Protoxerus spp.	Oil palm squirrels	Africa	S
Rattus argentiventer	Asian ricefield rat	Asia	M
R. exulans	Polynesian rat, bush rat, kiore	Asia and New Zealand	M
R. r. mindanensis	Philippine ricefield rat	Philippines	M
R. sordidus (=colletti)	Djingombula, small fat rat	Australia and New Guinea	M
Ratufa affinis	Giant squirrel	Asia	S
Rhabdomys pumilio	Four-stripped grass mouse	Africa	M
Rheithrosciurus macrotis	Tufted ground squirrel, Groove-toothed squirrel	Asia	S
Rhizomys spp.	Bamboo rats	Asia	M
Saccostomus campestris	African pouched rat	Africa	M
Sciurus carolinensis	Gray squirrel	North America	S
S. niger	Fox squirrel	North America	S
Solomys spp.	Naked-tailed rats	Melanesia	M
Steatomys caurinus	Northwestern fat mouse	Africa	M
S. pratensis	Fat mouse	Africa	M
Thryonomys gregorianus	Savanna cane rat	Africa	H
T. swinderianus	Marsh cane rat, cutting grass rat, grasscutter	Africa	H
Trichys fasciculata	Long-tailed porcupine	Asia	H
Uromys anak	Giant naked-tailed rat	Melanesia	M
Xerus spp.	African ground squirrels	Africa	S

[a]Sources primarily were Booth (1960), de Graaff (1981), den Hartog and de Vos (1973), Jardin (1970), Nowak and Paradiso (1983). Geographic area denotes continent, except where distribution of species is limited to a much smaller area. Suborder initials: S = Sciuromorpha; M = Myomorpha; H = Hystricomorpha.

DOMESTICATION

Domestication of several rodent species has evolved in areas where rodents have been eaten for a long time and where the supply no longer meets demand. Research for improving domestication of the capybara has occurred in Brazil, Columbia, and Venezuela. Both relatively sophisticated as well as simple domestication methods are widely used in Latin America and West Africa. The simple methods are used by the landless poor, who can raise easily kept rodents, such as the guinea pig in Peru or the grasscutter and giant rat in Nigeria.

Not all rodents are good candidates for domestication. Mason (1984) outlines four characteristics that a domestic animal in its most developed form should exhibit: the animal must (1) breed under human management, (2) provide a product or service useful to man, (3) be tame (or be induced to become tractable), and (4) be selected away from the wild type. The guinea pig, described below, has all four of these favorable characteristics.

Latin America

The guinea pig, domesticated for centuries in the Andes, is found in most rural homes and fed a diet of household food scraps. In Peru there are 20 million domestic guinea pigs which annually produce 64 million edible carcasses (Kyle 1987). This animal is an excellent food source since the flesh is 19% protein.

Capybara domestication is a serious venture in Venezuela, where licensed ranches harvest about 85,000 animals each year. The partially web-footed capybaras graze near water and do not compete with cattle, even in the wild (Gonzalez-Jimenez 1977). Animals are captured in the dry season and the meat, then leaner than at other times of the year, is deboned, salted, and dried. Harvest rates of 40% can occur without population depletion, and the net cash return per hectare is nearly three times higher for capybara than for cattle ($11 versus $4; Escobar 1973 cited in Gonzalez-Jimenez 1977). Meat production efficiency of capybaras is more than three times greater than cattle; and compared with sheep and rabbits, capybaras need less food per unit weight. In 1977, dried meat sold at $2/kg in Venezuela (Gonzalez-Jimenez 1977). Taste varies, probably due to the oil content in the fat. All recipes call for the removal of fat, usually by boiling three times and throwing away the fat and water. For other rodent species consumed, fat is very desirable and nutritionally beneficial.

Capybara pelts (carpincho leather) bring high prices in European markets (Gonzalez-Jimenez and Parra 1975). In fact, in Brazil, Uruguay, and Argentina, capybaras are hunted mostly for their pelts, which stretch in one direction only, making them excellent for high quality gloves (Gonzalez-Jimenez 1977). In parts of South America, the animal is considered a pest when it damages rice, sugarcane, and other crops.

Attempts to breed paca (Agouti paca) and agoutis (Dasyprocta mexicana and D. punctata) in captivity have occurred in Latin America. Cattle, sheep, goats, and pigs do not do well in lowland, humid environments, generating a need to domesticate a more suitable species (Smythe 1987). Some early successes in breeding and taming the paca have already been achieved at the Tropical Research Institute in Panama. Compared to the agouti, the paca produces more meat and is more desirable for domestication (being nocturnal, less active, and more hygienic; Smythe 1987). Paca meat is also better tasting, sells at a higher price, and contains more fat.

Africa

Two rodent species in West Africa, the giant African rat (Cricetomys gambianus) and the grasscutter or cane rat (Thryonomys swinderianus), are now being domesticated. Due primarily to reduced habitat and more people, these two rodent species are no longer present in West Africa in sufficient numbers to satisfy human demand. Both the giant rat and grasscutter are considered delicacies by poor and rich Africans alike. In southern Nigeria, 71% of those who returned survey forms indicated acceptance of the giant rat as food. Acceptance was more pronounced among poorer and younger groups (Ajayi and Olawoye 1974).

Large commercial rearing facilities are being established in Nigeria for the 1-1.5 kg giant African rat (Tewe et al. 1984). Breeding programs gradually reduced agnostic behavior and produced docile animals from the fifth generation (Ajayi et al. 1978). Domestication costs were initially about $0.45/animal from weaning to adult (Ajayi 1974). Although they can be fed household scraps, such a diet alone will not sustain growth (Tewe and Ajayi 1982).

Grasscutter breeding programs for selecting docility, favorable growth and reproductive characteristics have been started in Benin (Baptist and Mensah 1986) and Nigeria (Ajayi 1983). Trials in Nigeria showed that 25 females and 5 males could produce 200 young/year, yielding 400 kg of high protein carcass meat (Kyle 1987). This 5.5 kg herbivore prefers elephant grass and sweet potato, and is kept in some Nigerian homes for food.

DISCUSSION

Human food habits may appear to be irrational; but in most cases, they have a practical origin (Harris 1985). Rat meat is perfectly suitable nutritionally and poses no risk to human health when it is properly prepared, yet some cultures do not use it for food. According to Harris (1985), when there is no practical benefit for a culture to eat a particular food (such as rodent meat) the practice is spurned. In that situation, other food sources are usually more available, are less expensive, require less effort, and provide sufficient nutrition.

When larger wild mammals or livestock production no longer provide sufficient protein, rodents often fill the gap. Domestication of rodents, however, is not an easy as task, and simply encouraging the use of microlivestock on small farms is not enough. Basic technology, fodder crops, coordination with other crops, disease, climate, and the general well-being of the animal must be considered (Huss 1982). Captive breeding programs may take years of effort before favorable characteristics are genetically expressed in a domesticated wild species.

Despite widespread, unfounded recommendations, harvesting field rats is not an effective pest control strategy. Human predation on rats is subject to the same principles that govern other predator/prey relationships. Rodent pests are usually gathered when they are most plentiful, after harvest when crop damage has already occurred. When rodents are more difficult to capture, other food sources are used. Documentation is lacking to establish that predation on rodents in agricultural areas reduces crop losses. Other effective crop protection strategies, including the proper use of rodenticides, are available for many rodent pest situations.

Collecting rodents for food should be avoided in agricultural areas where rodenticides or other pesticides, including insecticides, are used. Pesticide materials may be retained in meat. If a person consumed enough rodents containing such residues, the potential for health effects would be of concern. If necessary, the potential risks presented by different species and materials could be clarified by further study. Exposure to zoonoses from ectoparasites, blood, and urine while handling rodents to be used for food is another possible risk that deserves attention.

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LITERATURE CITED

AJAYI, S. S. 1974. Giant rats for meat--and some taboos. Oryx 12(3):379-380.

AJAYI, S. S. 1983. Domestication of mammals in Africa. Nigerian Field 47(4):145-156.

AJAYI, S. S., and O. O. OLAWOYE. 1974. Some indications of the social acceptance of the African giant rat (Cricetomys gambianus Waterhouse) in southern Nigeria. Nigerian J. Forestry 4(1):36-41.

AJAYI, S. S., O. O. TEWE, and E. O. FATUROTL 1978. Behavioural changes in the African giant rat (Cricetomys gambianus Waterhouse) under domestication. East Afr. Wildl. J. 16:137-143.

ANON. 1987. Barbecued pack rat: breakfast of champions. Pest Control Technology 15(10):56.

ASIBEY, E.O.A 1974a. The grasscutter, Thryonomys swinderianus Temminck, in Ghana. Symp. Zool. Soc. Lond. 34:161-170.

ASIBEY, E. O. A. 1974b. Wildlife as a source of protein in Africa south of the Sahara. Biol. Conserv. 6(l):32-39.

BAPTIST, R., and G. A. MENSAH. 1986. Benin and West Africa: the cane rat (Thryonomys swinderianus)--farm animal of the future? World Anim. Rev. (FAO) 60:2-6.

BEST, E. 1942. Forest Lore of the Maori. Dominion Museum Bull. 14, Wellington, New Zealand. 503 pp.

BOOTH, A. H. 1960. Small Mammals of West Africa. Longmans, London. 68 pp.

BOURNE, G. H. 1953. The Food of the Australian Aboriginal. Proc. Nutr. Soc. 12:58-65.

BROTHWELL, D. R. and P. BROTHWELL. 1969. Food in Antiquity. A Survey of the Diet of Early Peoples. Thames & Hudson, London. 248 pp.

BUTYNSKI, T. n.d. [1973?] Life history and economic value of the spring hare (Pedetes capensis Forster) in Botswana. Botswana Notes and Records 5:209-213.

BUTYNSKI, T., and W. von RICHTER. 1974. In Botswana most of the meat is wild. Unasylva 26(106):24-29.

CALABY, J. 1980. Ecology and human use of the Australian savanna environment. Pages 321-337 In: Human Ecology in Savanna Environments (D. R. Harris, ed.). Academic Press, London. 522 pp.

CHILD, G. 1970. Wildlife utilization and management in Botswana. Biol. Conserv. 3(1): 18-22.

DEFOLIART, G. R. 1975. Insects as a source of protein. Bull. Entomol. Soc. Am. 21:161-163.

DRUMMOND, D. C. 1982. Man eats rats. Soc. Biol. Hum. Aff. 47(2):69-75.

DRUMMOND, D. C, and T. J. CROWE. 1985. Rat hunters of Burma. Museum Ethnographers Group Newsletter 18:47-52.

ELTRINGHAM, S. K. 1984. Wildlife Resources and Economic Development. John Wiley & Sons, NY. 325 pp.

ESCOBAR, A. 1973. Diagnostico tecnico economico de la explotacion comercial del chiguire. Informe. 33 pp. CONICIT DF 030. (mimeo)

FLYGER, V., and J. E. GATES. 1982. Fox and gray squirrels. Chapter 11 In: Wild Mammals of North America: Biology, Management and Economics (J. A. Chapman and G. A. Feldhamer eds.). The Johns Hopkins University Press, Baltimore, MD. 1147 pp.

FUNMILAYO, O. 1979. Pests, pest control and human diet in Nigeria. Nigerian Field 44(l):40-41.

GELFAND, M. 1971. Diet and Tradition in an African Culture. Livingstone, London. 248 pp.

GONZALEZ-JIMENEZ, E. 1977. The capybara: an indigenous source of meat in tropical America. World Anim. Rev. (FAO) 21:24-30.

GONZALEZ-JIMENEZ, E. 1984. Capybara. Pages 258-259 In: Evolution of Domesticated Animals (I. L. Mason, ed.). Longman Group Limited, NY. 452 pp.

GONZALEZ-JIMENEZ, E., and R. PARRA. 1975. The capybara, a meat-producing animal for the flooded areas of the Tropics. Pages 81-86 In: Proc. III World Conference on Animal Production (R. L. Reid, ed.). Sydney University Press. 694 pp.

de GRAAFF, G. 1981. The Rodents of Southern Africa. Buttersworth, Pretoria. 281 pp.

HARRIS, M. 1985. Good to Eat: Riddles of Food and Culture. Simon and Schuster, NY. 289 pp.

den HARTOG, A. P., and A. de VOS. 1973. The use of rodents as food in tropical Africa. FAO Nutr. Newsl. 11(2):1-14.

HAUCK, H. M., J. R. HANKS, and S. SUDSANEH. 1959. Food habits in a Siamese village. J. Am. Diet. Assoc. 35(11): 1143-1148.

HENDRICKSON, R. 1983. More Cunning Than Man: A Social History of Rats and Man. Dorset Press, NY. 274 pp.

HONACKI, J. H., K. E. KINMAN, and J. W. KOEPPL (Eds.). 1982. Mammal Species of the World: A Taxonomic and Geographic Reference. Allen Press, Inc., and The Association of Systematics Collection, Lawrence, Kansas. 694 pp.

HUSS, D. L. 1982. Small animals for small farms in Latin America. World Anim. Rev. (FAO) 43:24-29.

JARDIN, C. 1970. List of foods used in Africa. Nutrition Information Doc. Series No. 2, 2nd edition. FAO, Rome. 328 pp.

JONES, R. 1980. Hunters in the Australian coastal savanna. Pages 107-146 In: Human Ecology in Savanna Environments (D. R. Harris, ed.). Academic Press, London. 522 pp.

KYLE, R. 1987. Feast in the Wild. Kudu Publishing, Oxford, England. 203 pp.

LANNING, E. 1967. Peru Before the Incas. Prentice Hall, NJ. 216 pp.

LUYKEN, R., F.W.M. LUYKEN-KONING, and N. A. PIKMAR. 1964. Nutrition studies in New Guinea. Am. J. Clin. Nutr. 14:13-27.

MASON, I. L. (ed.). 1984. Evolution of Domesticated Animals. Longman Group Limited, NY. 452 pp.

MÜLLER-HAYE, B. 1984. Guinea-pig or cuy. Pages 252-257 In: Evolution of Domesticated Animals (I. L. Mason, ed.). Longman Group Limited, NY. 452 pp.

NATIONAL RESEARCH COUNCIL. In press. Microlivestock: Small Animals with a Promising Economic Future. National Academy Press, Washington, DC.

NOWAK, R. M., and J. L. PARADISO. 1983. Walker's Mammals of the World, 4th Edition, Vols. 1 and 2. John Hopkins University Press, Baltimore, MD. 1362 pp.

von RICHTER, W. 1969. Report to the Government of Botswana on a survey of the wild animal hide and skin industry. Unpublished report UNDP/FAO No. TA 2636, Rome. 46 pp.

RODENT RESEARCH CENTER. 1974. Unpublished Annual Report. University of the Philippines at Los Baños, College, Laguna. 102 pp. (mimeo)

SALE, J. B. 1983. The Importance and Values of Wild Plants and Animals in Africa. International Union for Conservation of Nature and Natural Resources, Gland, Switzerland. 44 pp.

SIMOONS, F. J. 1961. Eat Not This Flesh: Food Avoidances in the Old World. University of Wisconsin Press, Madison, WI. 241 pp.

SMITH, N.J.H. 1976. Utilization of game along Brazil's transamazon highway. Acta Amazonica 6(4):455-466.

SMYTHE, N. 1987. The paca (Cuniculus paca) as a domestic source of protein for the neotropical, humid lowlands. Appl. Anim. Behav. Sci. 17:155-170.

TEWE, O. O., and S. S. AJAYI. 1982. Performance and nutritional utilization by the African giant rat (Cricetomys gambianus Waterhouse) on household wastes of some local foodstuffs. Afr. J. Ecol. 20:37-41.

TEWE, O. O., S. S. AJAYI, and E. O. FATUROTI. 1984. Giant rat and cane rat. Pages 291-293 In: Evolution of Domesticated Animals (I. L. Mason, ed.). Longman Group Limited, NY. 452 pp.

de VOS, A. 1977. Game as Food. A report on its significance in Africa and Latin America. Unasylva 29(116):2-12.

WETTERBERG, G. B., et al. 1976. Amazon fauna preferred as food. FAO/FO: DP/BRA/71/545. Unpublished Field Doc. 23. FAO, Rome. 17 pp.