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Chapter 4

Harvesting and commercialisation of *kroto* (*Oecophylla smaragdina*) in the Malingping area, West Java, Indonesia

Nicolas Césard[1]

Common names	Part of the resource used	Management	Degree of transformation	Scale of trade	Geographic range
Semut rangrang, Weaver ant, Sireum sirarangge	Larvae	Wild	Low	National	Medium

OVERVIEW

The Asian weaver ant (*Oecophylla smaragdina*) larvae and pupae are collected in the wild from trees and commercialised as songbird food and fishing bait in Java, Indonesia. The produce called *kroto* brings substantial income to numerous rural households throughout the year. The resource's durability is until now ensured by the species' distribution (various ecosystems and polycalic structure of nests), the constraints for collection (inaccessibility of small nests and ants' aggressive behaviour) and the limited number of collectors. However, constraints related to storage and transportation of the resource, retailer's margins and a policy on animal trade (i.e., birds) are limiting the benefits of commercialisation for collectors.

INTRODUCTION

Kroto is the Javanese name given to a mixture of Asian weaver ant (*Oecophylla smaragdina*) larvae and pupae, which is sold in animal markets and small shops as food for songbirds or fishing bait. By extension, the term *kroto* also refers to a range of dried preparations made of small quantities of ants, chicken eggs and honey used as birdfeed. Ant larvae and pupae are not always included in this mixture, which is sold in the markets. Indeed processing companies keep the well-known name of the resource for commercial reasons.

Studies on insects as forest products are limited, but insects and their by-products are popular forest resources in Southeast Asia. Most of these insect products are eaten, some are commercialised (De Beer and McDermott 1996), but few are traditionally managed (De Jong 2001). Honey (*Apis* spp. mainly) is collected mostly from the wild and sold in marketplaces, as are beeswax, pollen and venom (Chuntanaparb *et al.* 1985; Giesen 1987; Marsh and Gait 1988). The resinous secretion of several species of tiny louse (*Laccifer lacca*) is a source of lac with a wide variety of uses (Gupta and Guleria 1980).

This study focuses on the Malingping area of Banten Province, one of the main *kroto* production areas, as well as locations where the resource is commercialised, such as Jakarta and to a lesser extent, Bogor. Asian weaver ants can be found almost anywhere in Indonesia. Thus, many poor people in rural parts of the country harvest *kroto* in order to earn extra money or as a regular source of income. Collection is locally based and is an organised activity led by a collector/trader or by small groups of individuals. But *kroto* production is not confined to organised groups: numerous collectors, songbird owners and amateur fishermen prefer to collect the fresh larvae rather than buy it.

Context and uses

Kroto is an animal product well known all over Java and on other Indonesian islands. Although the name is familiar in other parts of the archipelago, local communities have used ant larvae as bird food for a long time but not called it *kroto* In Java especially, the resource is strongly related to the population's enthusiasm for captive songbirds such as *murai* (varieties of blackbirds and thrushes), *kutilang* (*Pycnonotus aurigaster*) and *perkutut* (*merbock* or zebra dove, *Geopelia striata striata*). The call of each of these birds is distinct, with its own melody, structure, pitch, base and treble. Songbirds have been a part of the Javanese way of life for a long time and have provided their owners with a symbol of their social status.

According to bird lovers, most songbirds can be fed *kroto* with the exception of granivorous birds. People buy the old *kroto* (*kroto tua*), i.e., two- or three-day old larvae, regarded as the lowest quality *kroto* (*kroto kasar*), for feeding chickens since it is believed to accelerate both feather growth and flesh production. Lacking freshness, this *kroto* is also called *kroto busuk* (rotten *kroto*) by songbird owners, as well as *kroto hitam* (black *kroto*) for its poor quality.

A diet of ant larvae is known to provide vitamins, proteins and other mysterious, but essential nutrients, which are believed to improve a bird's performance. Songbird owners nourish their most beautiful and skillful birds with ant larvae in order to prepare them for singing contests, but also for the sole satisfaction of listening to the warbling of their favorite birds at home. Some bird owners occasionally collect the larvae, but most buy the resource from their local shopkeeper or pet shop.

Freshwater anglers also use the fresh *kroto* as bait. In some locations, depending on the fishing season, the ant larvae are used fresh in a home-made mixture of chicken eggs, honey, maize and beans. Most of the *kroto* sales in Bogor are for this purpose.

Box 1. Weaver ants as food and medicine

In Thailand and the Philippines, the larvae and pupae of Asian weaver ants are commonly eaten. The taste has been described as creamy. The adults are also eaten; their taste has been described as lemony or creamy and sour. In Malingping, another species of small ant is eaten. *Oecophylla smaragdina* is used as medicine in India. In the Bastiar region (Chhattisgarh), the adult ants are directly used in the treatment of rheumatism, as oil to cure stomach infections and as an aphrodisiac (Oudhia 1998).

Two other uses have been reported in Malingping and in Pelabuhanratu. The excrement of weaver ants is harvested to make a multipurpose varnish (in addition to turpentine), locally used to protect wooden furniture. In Malingping, a few shops (*toko besi*) sell from time to time a home-made varnish made of dry adult ants, called *malam serim,* in small packages for US$0.05[2] per package.

Collection sites

In West Java and Banten Province, the larvae of weaver ants are collected from locations such as Cianjur, Purwakarta, Banjar, Cirebon, Indramayu and Lebak. The collecting grounds in the Malingping area are Cihara, Cimadur, Cisiih, Bayah, Cibaliung, Muara Binuangeun, Bagendur and even the Ujung Kulon National Park area (Figure 1). The *kroto* production area studied is located in the subdistrict of Malingping (Lebak District) in Banten Province. The Malingping subdistrict measures 166.76 km^2 and includes coastal areas, extensive agricultural lands (mostly rice fields) and, in addition to Ujung Kulon National Park, secondary and divided forests.

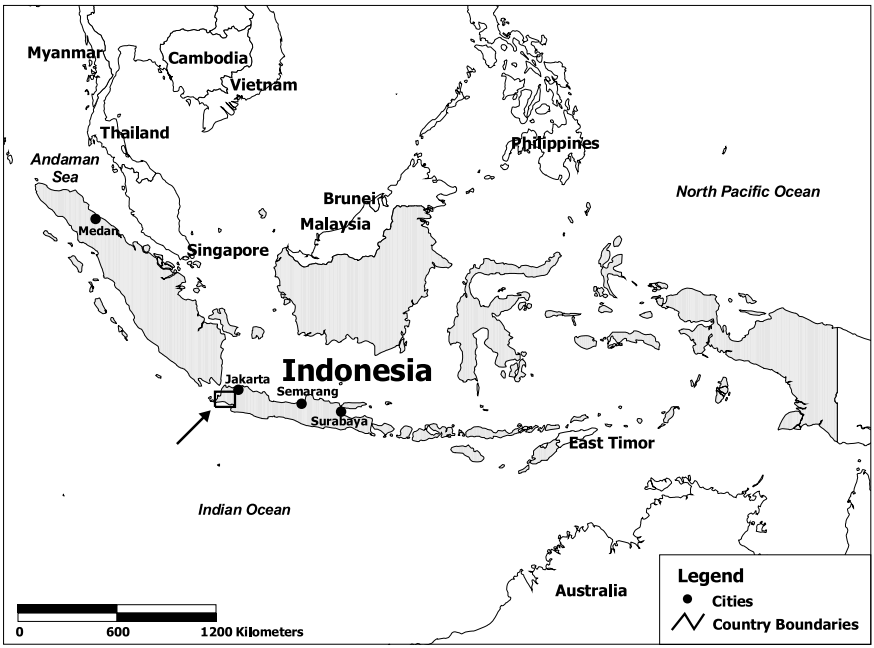
Most collectors have a good knowledge of the different production areas, which is especially important for frequent harvesting. They make the decision about their next harvest based on the season, abundance of the resource, accessibility of the area, climate and length of time since last harvest. If an area is harvested only during a certain time of the year, regular collectors may know more than 15 places in that area from which to harvest, but every year they try new places or, sometimes, they just go further in their explorations in the same areas.

PRODUCTION-TO-CONSUMPTION SYSTEM

Distribution and species habitat

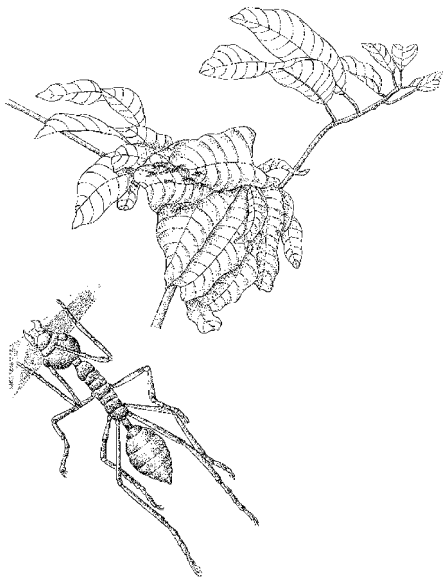
The *kroto* sold in West Java comes from various ecosystems: from coastal areas and gardens to secondary forests and agroforests. Larvae at different stages of development as well as pupae (*telur semut;* 'ant eggs' being the direct

Figure 1. Collection sites around Malingping



Source: ESRI Data and Maps 2002.

translation) are taken from the high nests of weaver ants (Hingston 1923). The distribution of the most common species, *Oecophylla smaragdina* (Fabricius) (Hymenoptera: Formicidae) is wide, throughout the Indonesian archipelago. The Asian species is known as *semut rangrang* in Indonesian, while in the central and western part of Java it is known as *sireum sirarangge* (in the Sundanese language).



(*Oecophylla smaragdina*)

Box 2. Other ant species consumed as *kroto*

Informants reported two other species besides the Asian weaver ant that are occasionally consumed as *kroto*. Their larvae are difficult to find and harvest, however, and therefore seldom collected. Those species are humpback ants (*semut bongkok*), which live in bamboo culms and crevices of dead trees, and ground ants (*semut telas*), which live in soft soil layers. Most of these ants' larvae are not sold, but used by individual collectors to feed their birds; this product should be distinguished from the traded *kroto*.

The distribution of the most common species, *Oecophylla smaragdina*, ranges from India to Australia and extends to most of the rainforests in Asia (Wheeler 1922; Hölldobler 1983). This weaver ant is well known as an unusually aggressive predator, as well as for the construction of complex arboreal nests (or calies). The ant colony may occupy various nests in a single tree (polycalic

structure) or even occupy several trees. Way (1954) mentions having observed a colony that had 151 nests spread over 12 trees.

The queen is located in one nest and her eggs and larvae are distributed to other nests. The ants feed on nearly all insects that attack the host tree, mainly Dipteran, Coleopteran and Hymenopteran (Dejean 1991). Weaver ant nests are among the most complex of social insect nests. *Oecophylla* species use the extremely well developed silk glands of their larvae for connecting living leaves to form their nests. Workers carrying larvae between their mandibles pull leaf edges and weave them together with the silk the larvae produce when pressured lightly. Gradually more and more leaves are connected to the nest.

Weaver ants have delimited territories with a mosaic distribution (Majer 1972; Leston 1973) in a wide range of habitats, both natural as well as plantation areas, and are the dominant species in their habitat. They occupy a great variety of trees from large bananas to small *petai* (*Parkia speciosa*). Collectors harvest the *kroto* in fruiting trees, such as *jengkol* (*Archidendron pauciflorum*, syn. *Pithecellobium jiringa)*, jackfruit (*Artocarpus* spp.), mango (including *Mangifera indica*), *duku* (*Lansium domesticum*), *rambutan* (*Nephelium* spp.), *jambu air* (*Syzygium aqueum*) and other trees such as rubber (*Hevea brasiliensis*), teak (*Tectona grandis*), *buni* (*Antidesma bunius*), *kedondong* (*Spondias* spp.) or cacao (*Theobroma cacao*). According to collectors, some of the best places for harvesting *kroto* are in coconut and oil palm plantations (see Way and Khoo 1991; Way and Bolton 1997), in which the *kroto* is described as abundant and of good quality.

Harvesting

The ants are active during the day, their activity peaking about noon. The best time for collection is during early morning, from six to ten o'clock, and then in the afternoon from two to five o'clock if the morning harvest was insufficient. During the wet season, the best time to harvest is between two rainfalls, allowing the sun time to dry the nests.

In Malingping, as in other locations, collectors go together to the field since travelling together is often easier. The harvesting site is chosen the day before or on the morning of departure. Once they arrive at the collection site, they split into groups of two to three and may divide again at another point, since collectors often look individually for trees with nests, but will try to stay within earshot of fellow collectors. A collector who finds an ant nest will search the host tree and its vicinity for further nests.

Some of the study area consists of former agricultural lands on rolling hills, some of which are fallow lands covered in a mixture of large herbaceous vegetation, dotted with a variety of trees and bushes. This open, seemingly discarded landscape abounds in *kroto* host trees. The openness of the area makes collection much easier than in the woods. (Perhaps this is the reason why weaver ants are more likely to be found in agroforestry systems, orchards and sometimes gardens in the vicinity of houses.) Although an abundant harvest is possible from plantations and untapped forest areas, even if the host trees

are rather scattered, collectors are a bit reluctant to harvest *kroto* in areas that are less familiar to them. The parts of primary forests not dedicated to cultivation are located on hillsides (often difficult to access) and in a protected area (where collectors are not allowed to gather forest resources, although, discreetly, they do enter). Thus, the harvest in unknown areas is expected to be exhausting and less bountiful. Another criterion apparently decisive to collectors is the remoteness of forested areas from the village. The difficulty of access even by road leads to high transportation costs and lost time.

Kroto harvesting is marked by two climatic seasons, which partly intersect the biological cycle of the ants: the dry season with final-stage larvae and the wet season, when the pupae of the future queens, males and worker larvae are smaller. During the dry season the resource is less abundant and consequently more difficult to find, according to collectors, and the *kroto* consists of big larvae, pupae and sexual forms (future queens and males) that collectors call 'capsule' (*kapsul* in Indonesian) for their similarity to capsules used to hold medicines. Big larvae are considered as of poor quality since they are too big for use as birdfeed, and the dry season is known as low quality season for that reason. *Kroto* harvested at that time of year is also described as black (*hitam*), because the pupae are almost adults, and moist (*basah*), because of the weight of the mixture.

Songbird owners prefer the 'rice' type of *kroto,* which is the most valuable and marketable product of its kind. Rice *kroto,* or *kering* (dry) because of its appearance, is made up of small larvae and pupae that are common during the rainy season. Paradoxically, *kroto* harvesting decreases during this season, as collectors are busy with other subsistence or economic activities. The peak season for harvesting *kroto* is in the transition period between two monsoons (the *pancaroba* season), in particular during parts of July and August.

For the harvesting of *kroto* collectors require stamina, patience and a lot of dexterity. The collector bursts the nest and then shakes it with the tip of his 5 m or longer bamboo stick, to which a conical paddy bag is attached. Most of the larvae, as well as many ants, fall into the bag. The collector repeats the procedure multiple times until almost all the biggest nests of a tree are collected. Some collectors will add an extension of 2 m or 3 m (added to the 5 m bamboo stick) to get to the top of the tallest trees. Nevertheless, the highest nests often remain out of reach and are sometimes hidden by the vegetation. The collector will memorise the location of a bountiful tree for a future trip, waiting a couple of weeks for the ants to move to more accessible nests or to build new nests.

The harvest often turns into a painful ordeal for collectors. During the harvesting many larvae and ants fall from the nest to the ground. Trying to defend their nests and save their larvae, the thousands of aggressive ants bite anything under the tree, the collector included, making the harvest a dangerous operation. After the collector's departure, the ants climb back up the host tree with the remaining larvae and pupae to rebuild the ripped open nests or to start new ones.

Up to 60% of the harvested produce may be lost before arriving at the trader's house. About 40% of the *kroto* of harvested nests is lost at the site

Photo 1. *Kroto* is collected with a long bamboo stick to reach the nest in the trees (Photo by N. Césard)

and during the rest of the day while the collector is working other sites. Adult ants, larvae and various organic fragments fall from the bag during the harvest and during the trip from the one site to another. The insects in particular will continue to escape from the bag during the trip, leaving behind most of their larvae. At the end of the day the collector will remove another 20% of the initial weight in the form or debris. After having quickly removed the undesirable debris, collectors transfer the contents of their bags to a container or appropriate box, eventually cleaning the bag of the last ants using a synthetic feather duster (*kemoceng*). Twigs and small leaves, but also dead insects or their remains, are graded and separated from the larvae.

Many fruit tree owners welcome collection in their orchards and plantations[3] as they see weaver ants as a nuisance, especially during fruit harvesting, which can become a painful operation. Collectors and fruit tree owners are unaware of the positive role these ants play in the eradication of insect defoliators (caterpillars, larvae and adult coleoptera) and Heteroptera (Majer 1972; Leston 1973; Room 1975; Dejean 1991).

Raw material producers and socio-economic context

In Indonesia, numerous rural families earn part of their living from the collection and commercialisation of *kroto*. Most collection takes place by individual, self-employed collectors who sell directly to merchants, bird owners or fishermen. Small producers sometimes also play the role of middlemen, buying *kroto* from other collectors, and selling it on to other middlemen or merchants.

Box 3. The use of weaver ants in agriculture

In other parts of their range *Oecophylla* have frequently been used as a natural control agent in the prevention of insect pests for many tropical crops: cashew (Peng *et al.* 1995), citrus (Way 1954, Huang and Yang 1987), mango (Way 1954), coconut (Vanderplank 1960; Way and Khoo 1992), cocoa (Room 1975) and coffee (Leela 1961). In the Mekong Delta in Vietnam, citrus farmers also appreciate the benefits of ant husbandry in terms of the improvement of fruit quality—a direct response to the fertilising properties of the excretions deposited by weaver ants patrolling the fruit (Stapley 1980). In Sri Lanka, however, the weaver ants' utilisation as a biological control agent has been given up because of their aggressive behaviour during the coffee harvest (Leela 1961).

Kroto is harvested and sold throughout the year, although there are periods of the year during which the harvest is more productive and of better quality than others. Some collectors harvest only the larvae from December to May, when the quality of larvae ranges from fair to good. Others will collect the larvae from August to October. Farmers in Malingping usually collect *kroto* between the two rice harvests (each rice-harvesting season lasts for two to three months). Several collectors harvest the larvae daily all year round and have no other source of revenue. Others harvest *kroto* maybe two or three days a week and engage in other activities the rest of the week.

Nowadays in Malingping only eight collectors are involved full-time, six days per week throughout the year. The collection takes place outside Malingping subdistrict in places such as Karang Taraje (Bayah subdistrict) and villages near Ujung Kulon (Labuhan). Collectors sell their production to a local trader, who has been in business for 15 years. They leave their harvest at the trader's house at the end of each day. During the month of Ramadan, collectors limit their harvesting to only a few hours a day.

Over the last few years production has been low compared with 8 or 10 years ago. Formerly, there were more than 15 collectors from Malingping and surrounding villages who harvested the nests every day. The trader used to hire several collectors. Relatives, neighbours, and friends were also welcome, on the single condition that they sold their collection to the trader. At that time, a group of collectors could harvest 30 kg to 50 kg in one day, an average of 2 kg to 5 kg per collector.

Today, harvesters still collect the *kroto* in the same way, choosing large nests made of fresh leaves and avoiding old nests known to be poor in larvae. One of these fresh nests can contain 1 oz. to 2 oz. (28 g to 56 g) of *kroto*. A collector may harvest from 6 to 10 trees per hectare. During the rainy season (the high season) collectors are able to collect up to 2 kg per person (an average of 1.5 kg per day) and the price may be US$1.2 per kg depending on demand. It often gets harder for collectors at the end of the high season,

when the *kroto* is a bit moist and less plentiful, but on the other hand the price is better and can reach on average US$1.4 per kg.

The collection of *kroto* offers not only additional but also substantial income to numerous families. Generally speaking, farming is the main activity in Malingping. Collectors and their families use the money they earn from *kroto* for daily subsistence, not luxuries. They buy meat, fish, rice and sometimes clothes for everyone in the family. Among those higher up in the trading chain, however, there are cases where the income is used to acquire luxury goods, such as one of the main traders who bought a television set a few years ago after saving for a long time. He is the one who organises the market chain to Jakarta, and therefore earns more than the collectors.

During the months of July and August collectors obtain higher income from *kroto* and might save the money for harder times. Additional money is especially welcome during the month of Ramadan (fasting month) in order to buy food and presents for relatives at *Idul Fitri* (end of Ramadan). Exhausted by the fasting, collectors' harvesting activities are considerably reduced during Ramadan.

There is the belief that *kroto* is *haram* (unclean, almost immoral, according to Muslim law), even if it is not consumed directly by humans. Therefore, many people think that the money earned from selling *kroto* is also *haram*. A collector told the author there was no benefit from *kroto* in terms of prosperity as long as collectors considered the resource immoral. For many people, collectors or not, the money from the sale of *kroto* is deemed dirty money that must be quickly spent and not saved. In view of this, it is relevant to ask why people would still harvest *kroto*. The answer is simple. The product is regarded as a chance to earn cash, and according to a collector, poor households will always try to make a living from a free resource.

Trade and Marketing

In Malingping, *kroto* is widely used for fishing bait, but demand for this purpose is modest—about 5 kg per day. The main outlet for *kroto* in West Java is the capital Jakarta where up to 100 kg of *kroto* are sold every day for both birdfeed and fish bait[4].

At the trader's house, after cleaning the larvae and separating out the last debris, collectors pack the *kroto* in a *besek*, a 1 kg box made from raw bamboo collected in the surrounding area. The trader usually buys the boxes from other families for a few cents. The trader, or occasionally a friend or relative, takes the boxes to Jakarta every day. Sometimes a trader may wait another day to gather more *kroto* from his collectors, but he will go or send it as soon as he can. Freshness assures the quality of the produce and thus appears to be commercialisation's main restriction. Indeed once collected, *kroto* can be kept fresh for only two days, but according to a trader, a freezer may help to maintain the resource longer before transportation.

During the wet season, larvae are very small and the risk of losing the resource during transportation to Jakarta increases as they deteriorate rapidly. Heat and storage change the colour of larvae to pale yellow; because

Photo 2. A *besek* of ant larvae equals 1 kg of 'wet' quality *kroto* (Photo by N. Césard)

of the quick deterioration of *kroto* it is again subjected to grading in Jakarta. More than 10% of the produce may have to be thrown out. From experience collectors know that weaver ants produce fewer larvae during the hottest months of the year, but that the nests contain the biggest larvae (sexed larvae). This *kroto* can be kept longer than the *kroto* composed of smaller larvae.

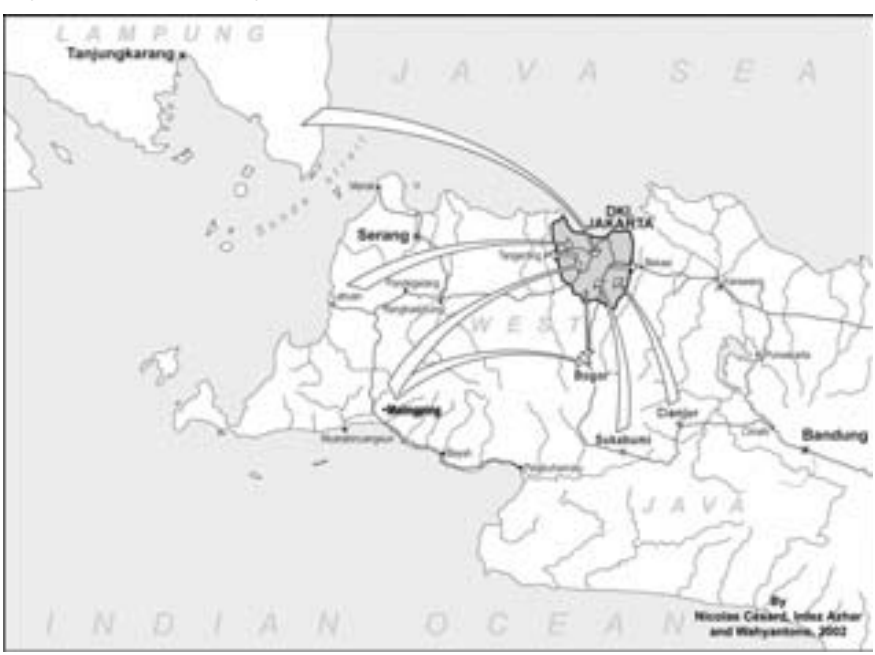
In Pasar Pramuka, Jakarta's main animal market, there is a rule among merchants that during the low season (the season of bad quality *kroto*), the price should be fixed. However, conflicts may arise among middlemen who sell *kroto* to merchants. Indeed, there is competition among middlemen as to who gets better sources (fresh *kroto*) first. Some middlemen are willing to pay collectors more for fresh, good quality larvae. A few individual collectors and some traders enforce their bargaining position by following the classic supply and demand system: they know that a good quality resource is difficult to find and try to increase the margin. Nevertheless, the maximum price set for the low season rarely exceeds US$1.4 per kg at the collector level.

In Malingping one middleman has been in business for more than 15 years and is still co-ordinating the harvesting and packaging of fresh *kroto* from Malingping to Jakarta. His production now goes to the Pramuka market whereas it used to be sold in Bogor. The middleman sells the *kroto* at US$1.6 to US$1.7 per kilogram to two merchants in the Pramuka market, one of whom is an old acquaintance. Depending on the season, quality of the produce and amount of supply in the market, the merchant sells the *kroto* at US$0.3 to US$0.6 per ounce. This means there are regular variations for 1 kg ranging from US$3.5 to US$5, which is two to three times as much as the buying

price. According to its aspect and composition, two categories of *kroto* are distinguished in the market by various descriptions: *kroto basah* (wet) differs from *kroto kacang* (literally meaning 'peanut' in Indonesian, i.e., dry) and *kroto kasar* (inferior quality) from *kroto halus* (superior quality). Middlemen pay between US$5 and US$7.5 for transportation to Jakarta per trip, thus profits appear low.

There are three main markets where *kroto* is sold in Jakarta—Pasar Pramuka, Barito and Jatinegara—and many small shops and stalls all over the city sell small quantities. Those retailers buy the resource from individual collectors who deliver directly to their shops or they buy *kroto* from bigger shops or at bus stations in the early morning for resale. Bus stations are attractive places for local men who specialise in various produce (*kroto* included) because of their central locations and good connections to different production areas. Middlemen in Kampung Rambutan Terminal (South Jakarta) buy *kroto* from collectors not only from Malingping but also from other areas in West Java, especially Banten and Lampung provinces in south Sumatra. It also serves as a place for distribution to bird shops in Jakarta, and even to surrounding cities, such as Bogor, Bekasi, and Tangerang (see Figure 2).

Figure 2. Main trading flows of *kroto* in West Java



Merchants have tried to find more reliable sources in South Sukabumi, Cianjur, and Lampung in order to meet demand. This year especially, collectors from Malingping were competing with collectors from Lampung. The province

of Lampung has a few competitive production areas and has an effective transportation system to the capital. Collectors harvest the ant larvae during the day, then their trader leaves for Jakarta in the evening, travelling all night by boat and bus (seven to eight hours altogether) to meet merchants the next day at the market.

Processing the resource

Fresh *kroto* from harvest to the produce being sold in the marketplace requires little to no processing—only cleaning and grading are necessary—but the raw material can also be processed to obtain dried *kroto*, a less perishable produce. Prepared at home, dried *kroto* does not require sophisticated processing by the collectors' families: the larvae are boiled for one hour and dried for two or three days. Five kilogram of fresh *kroto* make 1 kg of the dried variety (20% of the original weight). It is a *kroto* that contains many adult ants and can be kept for at least six months. The price for dried *kroto* is usually half that of the fresh variety.

A few sources report that some small companies have commercialised a mix of dry larvae and ants, chicken eggs, maize, honey and beans as songbird food. This product is often labelled as *kroto* even though it contains only a small quantity of ants. The processing and packaging of this product may need more investment in time and capital. The product is sold in national animal markets and may be exported. No gatherers in Malingping seem to be selling the product for this purpose. According to birdfeed sellers, some of the *kroto* used is produced in the Sukabumi area, south-east of the capital.

Policy environment

Collecting *kroto* is a solitary job, even if collectors go to the forest in groups of two to four people. If they find the same resources in the same areas, conflicts are unlikely to occur, as there is a sort of customary law which states that whoever finds the resource first has all rights to it. This is open access tenure where no land title deed is required. *Kroto* is considered public property that can be collected wherever it is found: even in another collector's garden. However, in the early 1990s, the demand for *kroto* was diminished by a policy that limited the trade in songbirds. There is little government interest in the conditions of *kroto* production. In fact, local officials ignore the whole process.

TRENDS AND ISSUES—DEVELOPMENT AND CONSERVATION LESSONS

Trends

There is high demand for *kroto*, in particular for fresh larvae. Good quality *kroto* is quickly sold from street stalls and market shops. For instance, 5 kg of fresh product is sold within a few hours in Bogor every day. Even old larvae are sold in two or three days in Jakarta. The merchants in Pasar Pramuka

often complain of irregularities and delays in traders' deliveries. Consumers, songbird owners and fishermen often have to wait for the produce to arrive. Demand for first-rate *kroto* has increased. Because more people are getting involved in collecting *kroto*, the competition for the resource has increased in the last few years. Collectors are going back to sites where *kroto* is easy to find more frequently than they used to and thus collect from the same host trees more often. They collect all the nests they can find, even the smallest ones. Collection is often still organised as it was before, with small groups of collectors and middlemen, but in addition many individual collectors are now looking for *kroto* on their own. They know where to look for nests and then sell directly to retailers, who are often willing to pay more for fresh *kroto*. People collecting *kroto* seem to be less regular in their activities than before, seeking other opportunities first, and spend only a few days per week or month harvesting *kroto*.

Ecological implications

Under normal conditions, weaving ants have a quick population recovery. Regeneration takes between 17 and 24 days (Paimin and Paimin 2001). According to collectors, it takes five days before new nests appear and around 20 days for the ants to produce new larvae. It underlines the collectors' knowledge of the resource: they know that rotations in space and time allow the ants to build new nests with larvae. Nowadays, both old and new collectors less often respect the necessary harvesting rotations, thus harvesting becomes destructive and the resource is becoming scarce in several exploited areas.

When discussing resource regeneration, it should be taken into account that one colony can extend to several trees and that the queen's nest is often unreachable. We assume that if not all larvae are harvested, this will allow the resource to partially regenerate (under specific and nondestructive harvesting conditions of the nests). The medium sized nests of queen ants are located near the tree canopy, being indeed the most inaccessible of nests. The queens apparently stay in one nest from which eggs are distributed to the other nests in the colony. Each tree contains many nests, but only one nest contains queens. There are commonly multiple queens in mature colonies (Peng *et al.* 1998).

Weaver ants prefer fruit trees, and therefore so do *kroto* collectors. The tree owners are only too happy to let the collectors remove the nests from their trees, as discussed earlier. The impact of harvesting nests on tree growth and fruit production in the region may well be worth evaluating.

The importance of *kroto* in livelihoods

Income gained from *kroto* does help collectors, but it hardly brings major economic changes to their lives. Households spend the money earned to cover basic needs. Small amounts of money may be saved so as to start other economic activities or to buy useful equipment or accessories to help the production (i.e., a refrigerator or motorcycle). Transportation from the

production area to the market places proves to be an important limitation. Collectors or traders have to sell the product to shops that are located in large cities far from the production areas. They use public transport, which implies they have to wait for long periods of time and change vehicles several times. This is especially difficult with the fresh larvae: profits are dependent on the rapidity with which collectors can deliver the resource to the sellers. The alternative to fresh *kroto* is dried *kroto*. However, the production of dried *kroto* means more pressure on the resource, since it requires larger quantities of both ants and larvae, and results in a poor quality end product.

As with many other non-timber forest products, *kroto* collectors cannot take advantage of an increase in demand (Dove 1993). Merchants establish the product's price and appear to be the main beneficiaries of the commercialisation of *kroto*. Most middlemen are in the same situation as the collectors (Padoch 1992). Both collectors and middlemen could have more power over selling prices, since the resource is becoming scarce, but they do not negotiate with merchants to increase their profit margin. We may see this attitude as a lack of consensus between collectors and middlemen, and between middlemen and merchants, to the detriment of both collectors and middlemen. Many collectors never meet merchants and ignore the extent to which *kroto* is in demand.

In terms of livelihoods, harvesting *kroto* does not present an alternative to agriculture conversion or logging. For most collectors, harvesting *kroto* complements other economic activities, principally agriculture. Moreover, the agricultural extension does not seem to prejudice the colonisation of weaver ants so long as trees are left to host the nests. One may consider the resource and its collection as adapted to a very modified natural landscape, which is prevailing in Java, and in that sense, one may think of *kroto* as a forest resource as much as a post-forest resource.

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ENDNOTES

1. Institut de Recherche pour le Développement (IRD), Wisma Anugraha, Jalan Taman 32 B, Jakarta 12730, Indonesia. E-mail: ncesard@wanadoo.fr

2. Exchange rate (September 2001): US$1 = Rp10,000.

3. In the 1970s, an informant reported that before insecticides were widely used in orchards and plantations to eradicate weaver ants and other small fruits predators, local villagers used buffalo bones to kill ants. A bone would be hung on a tree branch, where the targeted ants were swarming.

Once gathered, bone and ants were set on fire in order to kill all the ants. This procedure was repeated for three days in a row.

4. According to some bait merchants the trend is changing. Fish caught with *kroto* have bruises in their mouths as *kroto* contains a heating agent, and merchants think about changing to another animal bait if demand for *kroto* decreases.

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