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TRADITIONAL MANAGEMENT SYSTEM FOR *APIS DORSATA* IN SUBMERGED FORESTS IN SOUTHERN VIETNAM AND CENTRAL KALIMANTAN

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Introduction

This paper describes a management system for *Apis dorsata*, reported in 1902 by Fougères[11] and others from the southern Mekong delta in Vietnam, and in 1933 by de Mol[18] from the central lake region of the upper Kapuas, Kalimantan, Indonesia (fig. 12). We found it still practised in the Mekong delta in 1989.

A. dorsata lives in the Asian tropics; a colony produces much honey and wax in a single comb several square metres in area, suspended from a strong lateral support in the open. Many colonies migrate seasonally, living in two or more rich forage areas in the course of each year.

In the southernmost provinces in Vietnam, Minh Hai, Kien Giang and Hau Giang, which are west of the Mekong river, *A. dorsata* is known to migrate between mangrove forests on the coast and the swamp forests of *Melaleuca leucadendron* farther inland, which seasonally produce much pollen and nectar; see figure 1. In the

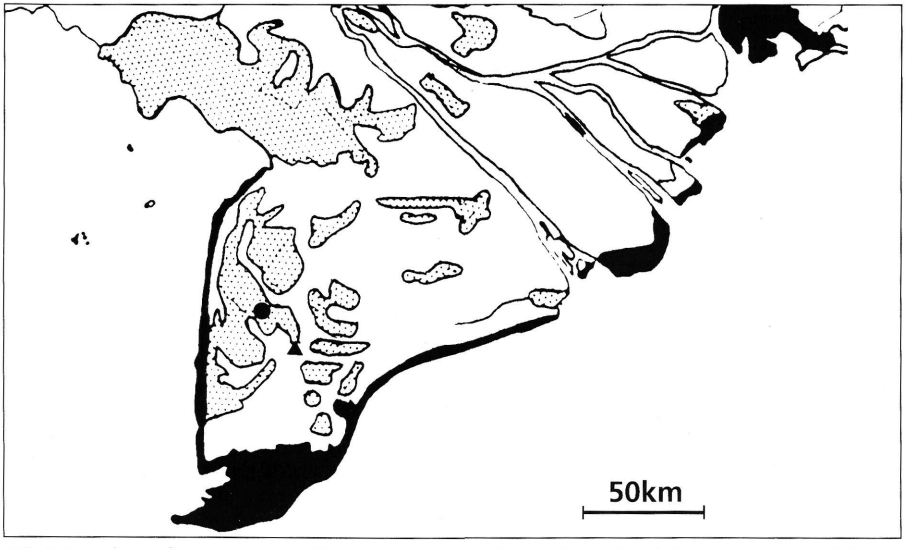

FIG. 1. Locations of mangrove and *Melaleuca* forests in the southern tip of Vietnam, and the Mekong delta[25]. Black: mangrove; stippled: *Melaleuca*. ● Song Trem; ▲ Ca Mau.

FIG. 2. Submerged *Melaleuca* forest in U Minh.

U Minh region in Minh Hai, village collectives (*phong ngan*) obtain part of their income by selling honey and wax from managed *A. dorsata* colonies, and the Song Trem state farm we visited has such collectives among its workers. During the previous two years they harvested 40 tonnes of honey and about 1.3 tonnes of wax. Recent production is said to be low compared with that some 50 years ago, due partly to the felling of *Melaleuca* for timber and firewood and land clearance for crops. In addition, during the Vietnam–USA war chemical agents destroyed large areas of forest: 45 000 ha in the U Minh region were sprayed with arboricides[23].

The management system for *A. dorsata* in the Mekong delta was mentioned by a few authors early in the century[2, 5, 11, 13]. A rather similar system was reported in 1933[18] in seasonally submerged sweet-water mangrove areas of the upper Kapuas lake region of Kalimantan in the island of Borneo, where it was practised mainly by Malay fishermen. There are other submerged — mainly coastal — vegetation areas in south and south-east Asia, where large numbers of *A. dorsata* colonies nest and where honey production is important, but there is no management of colonies; the best known is the Sundarbans in the Ganges delta.

A. dorsata will not live in an enclosure such as a hive. Other types of colony housing and management have been tried, the most successful on a large scale being Mahindre's in India[15, 16]. He used a movable 'attraction plank', which may be placed just under a lateral tree branch where a migrating swarm is likely to settle. The colony builds its comb from the plank instead of the branch, and later the plank, with the colony, is transferred to a more convenient site nearer the ground. This and other methods — including for instance a cage or a partially enclosed box — are described by Crane[9].

Characteristics of the U Minh region and its vegetation

This region, north and west of the town Ca Mau (9°N) in Minh Hai province, is referred to as a 'desert marshland'[29]. It covers 163 000 ha, of which 35% is still seasonally flooded *Melaleuca* swamp forest (fig. 2). The water is fresh, with a pH 4.5–5.0, but the high acid sulphate content of the soils reduces their value for agriculture. *M. leucadendron* is one of the few species that advances the process of deacidification[4].

The genus *Melaleuca* (Myrtaceae) is native to south-east Asia and Australia, and has been introduced to saline marshes in Africa, South and Central America, and islands of the Caribbean and Pacific. *M. leucadendron* establishes well under seasonally submerged conditions, is tolerant to salinity and acidity (pH even below 4), and under such conditions is a predominant species, growing in almost pure stands not taller than 10 m. The trees are fire-tolerant, partly due to their protective bark. On higher ground beyond U Minh, where the tree can grow up to 25 m, it is exposed to more competition from other tree species.

M. leucadendron is cultivated for various purposes. The wood is used for charcoal production, foundation poles, fencing posts, paper pulpwood, timber and firewood. Its whitish bark easily loosens and is used as insulating material and as a decorative veneer for furniture; some beekeepers in Australia burn it in their smokers. Fresh leaves contain 'cajeput oil' used as an insect repellent and counter-irritant, and in soap manufacture[4]. In addition to shrimps and fish, honey is a major product of the *Melaleuca* forest ecosystem. Figure 3 shows *Melaleuca* flowers, which are important for beekeeping. They provide a fairly consistent nectar flow and also pollen, and few other plants have been mentioned as honey sources in the region. In Australia, the honey is dark, has a strong flavour, and granulates rapidly.

The *Melaleuca* forests are transitional between submerged saline mangrove and continental forest vegetation[22, 23]. Mangrove forests are mainly to the south of U Minh, but also to the west in a coastal strip 2–30 km wide (fig. 1). Under the natural process of maritime sedimentation, there is a natural sequence of mangrove species; *Avicennia alba* is the first to establish on newly formed coastal land, followed by *Rhizophora apiculata* on higher ground, then *Bruguiera parviflora* and *Ceriops* spp.

Most mangrove species now present are reported elsewhere as nectar and pollen sources. For instance along the coast of northern Vietnam (20°–21°N), beekeepers migrate colonies of *A. mellifera* and *A. cerana* to mangroves in July, mainly low bushes of *Bruguiera gymnorrhiza*. Species in the U Minh coastal region reported to be visited for nectar by *A. dorsata* in India, or by *A. mellifera* in Australia, are *Sonneratia alba*; *Avicennia officinalis*, *A. alba*; *Ceriops tagal*, *C. decandra*; *Bruguiera gymnorrhiza*; *Rhizophora mucronata*; *Acanthus ilicifolius*; *Aegiceras corniculatum*; *Excoecaria agallocha*[3, 7, 8, 20].

FIG. 3. *Melaleuca leucadendron* flowers and leaves.

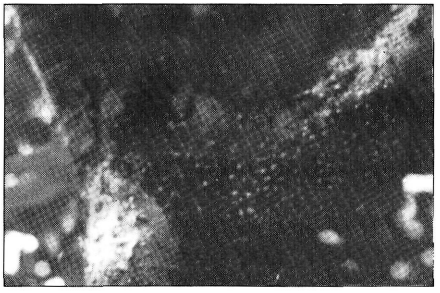

FIG. 4. Vacated clustering site of *A. dorsata* on a branch of *Euphoria longan*, Cat Ba.
Deposits of wax were left where the bees had clustered.

During the 1980s, replanting schemes were operated in heavily deforested parts of both *Melaleuca* and mangrove forests in the U Minh region, as these forests are essential for the process of land reclamation and coast protection, and most trees that grow there are sources of valuable wood and tannins. However, as a result of a policy shift to increase private land use, many settlers in the area practise further forest clearance for crop growing — mainly rice — although yields are low where soil acidity is high. Therefore at present *Melaleuca* forests are mainly in state forest farms, where the total area under occupation is less than 100 000 ha. Another hindrance to reforestation is the frequency of forest fires; see Mulder 1992 [19a].

Behaviour of *Apis dorsata* colonies in the U Minh region

In U Minh, nests of *A. dorsata* are found every year in the inland *Melaleuca* forest, and colonies migrate from there to coastal mangrove forests; we were told that colonies cluster there under tree branches without building a comb or rearing brood, and forage on mangrove species especially *Excoecaria agallocha*. Combs are only rarely found in mangrove forests. Fishermen have reported that migrating swarms fly low over the Gulf of Thailand west of U Minh, and colonies clustering without comb on rocks or trees are found seasonally on islands 20–50 km offshore. Such clustering behaviour also occurs in the north of Vietnam; figure 4 shows a site 2.5 m above ground level, after a colony had clustered on it for at least a month. White wax spots (*c* 5 mm) in an irregular pattern were left on the underside of the branch. Such a site is referred to locally as a 'transit cluster location'. Underwood[26] described combless clustering in winter by *A. dorsata laboriosa* in sheltered parts of rock faces in the Himalayas, below 1 700 m.

In most parts of Vietnam, *A. dorsata* nests on smooth lateral branches of tall trees (up to 20 m) and also — even in forest areas where tall trees are available — in small trees 2–3 m from the ground. On Cat Ba in the north (fig. 12), such lower nest sites are sheltered by neighbouring vegetation: it is said that winter nest sites are low and sheltered, and summer ones high and so more easily seen. In flooded areas where there are no tall trees, any nests are usually built from a branch of a small tree a few metres above the water. This has also been reported in other submerged areas, e.g. the Sundarbans in the Ganges delta[7] and the Kapuas lake region of central Kalimantan[18].

Melaleuca forests in U Minh are flooded from the middle of the rainy season (August–September) until the beginning of the dry season (December). Most *A. dorsata* colonies are absent during this period, but they return between December and March, build new nests, and remain until August; *M. leucadendron* blooms during the whole of this period with peaks in March and July.

When a colony is storing much honey, its temperature rises. The bees then regulate the temperature of the brood nest in several ways. They collect much water, and during the hottest part of the day (11.00–14.00 h) many of the bees on a comb leave on a mass defaecation flight, thereby reducing the temperature of the nest. This behaviour, described in detail in Malaysia[17], also occurs in U Minh.

During a dearth of nectar, some colonies in U Minh build a small extra comb parallel to the large one; similar behaviour was reported in the Philippines[19].

Management system for colonies in the U Minh region

Using rafters as artificial nest sites

Preparation for the arrival of colonies in the *Melaleuca* forest during December consists of making and erecting 'rafters', so named because they are like the rafters of a house (fig. 5). Bark is removed from a pole 2.0–2.5 m long and 0.1–0.25 m in diameter, of *M. leucadendron*, *Areca catechu* or another tree with odourless wood impervious to water; then it is split lengthwise to produce two rafters. A rectangular or triangular hole is made near what will be the upper end (see fig. 5), which is slotted over the top of a wooden supporting post about 2 m high (on the left in fig. 6). A shorter pole, or a fork in a suitable tree, is used to support the lower end at 1.0–1.5 m, and the rafter slopes at about 15°–30° to the horizontal. The curved side of the pole faces downwards, and a channel is often made along the flat upper side to drain off rain water. Figure 7 shows a rafter with an unoccupied comb.

FIG. 5. Beekeeper holding prepared rafter, U Minh.

FIG. 6. Two men erecting a rafter, U Minh (*photo*: Apiprodex). On the right, the lower end is positioned in the fork of a tree, and on the left the beekeeper is lifting the upper end to the top of the supporting post.

Rafters are set up in a dense forest of *Melaleuca* trees 5–10 years old, and their sites are selected carefully to conform with what the bees are observed to prefer for a nest site. The upper end of the rafter is usually oriented towards (or within 90° of) south-east, and trees and bushes are cleared round this end to create an open space and to expose it to the morning sun. Beekeepers believe that the flight direction of arriving and departing bees should be borne in mind; the upper end may be placed to face a canal or an open path between two rows of trees. Vegetation surrounding the rafter in other directions protects the comb and the bees from direct sunlight, rain and wind; leafy branches of *Melaleuca* are also tied over the rafter, and replaced when they become rotten. An ownership mark may be cut in the higher end of the pole.

In early December arriving swarms cluster in *Melaleuca* trees, and a few scout bees inspect any rafter nearby — walking up and down as if measuring it. Owners check the occupation of their rafters every 2 or 3 days, to make small changes to those still unoccupied and so that they will know when the first harvest can be taken.

The bees usually build combs 1.5–2.0 m long and 0.6–0.8 m high. They store honey near the upper end, where they may build the comb to a thickness of 11 cm (fig. 8, also fig. 10).

Most colonies migrate away in August, but a few remain during the rainy season every year. After the bees have left, beekeepers clean the rafters, and remove remaining comb except for a thin layer of wax to attract a returning colony next season. Rafters are usually left in place, except that those unsuccessful in attracting swarms may be removed or repositioned.

If the comb near the upper end of the rafter 'bellies out' (has deep storage cells), it should yield 20 litres (28 kg) of honey or more per harvest, but a small nest may yield only 2 litres. Beekeepers also estimate the likely honey yield of a nest by watching the activity of water-collecting bees from a distance. While

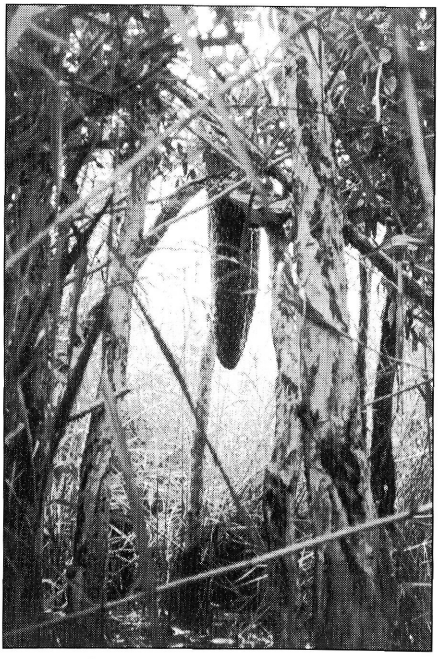

FIG. 7. Rafter and (unoccupied) comb, seen from the lower end, showing the space cleared of vegetation beyond the upper end.

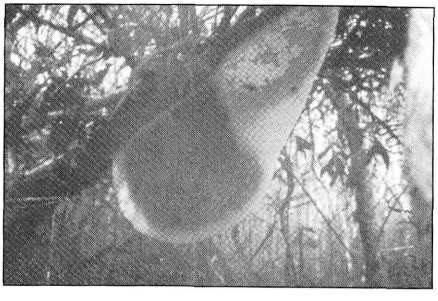

FIG. 8. Comb from which bees have been driven by smoke. The brood area is below left, the honey area above right.

a colony is converting nectar into honey its temperature rises; it then needs much water to cool the nest, since water evaporated from nectar into the open air cannot be recycled. The greater the water collecting activity, the greater the honey harvest expected.

Harvesting practices

The first harvest can be taken within 3–4 weeks after the bees' arrival. It is considered important that the bees cannot smell the beekeeper when he approaches a nest to harvest honey, so he must not drink alcohol or smoke tobacco beforehand, and he must approach the nest from downwind. Smoke from smouldering *Ficus altissima* root or fresh *Melaleuca* leaves is used to quieten the bees, but too much smoke drives them all from the comb. It is believed that only bees covering honey or pollen can sting, and that a person harvesting honey should not stand in water directly below the comb: he may be stung, and young bees that drop off the comb as a result of the disturbance fall into the water; any that do so should be helped to climb on to vegetation so that they do not drown.

As long as the honey flow lasts, the bees quickly rebuild the upper end of the comb between harvests; the whole comb shifts towards the lower end of the rafter by about 0.05–0.1 m after each harvest.

Harvesting is done 3–5 times each season, at intervals of 10–20 days. December–March is the 'dry honey' season, when the honey is aromatic with a rich

FIG. 9. Mid-season harvest. The part of the comb containing honey has been cut away from the brood part and from the rafter. The whole of the brood part remains in place, and the bees will rebuild the upper part for storing more honey.

flavour. Its water content is between 21% and 24%, and samples taken from sealed cells in January contained 23–24%. Between May and the end of July the 'water honey harvest' is taken; this honey has a higher water content, and although the combs are usually larger they yield less honey. Much longer intervals are then left between harvests and, if weather predictions are bad, sufficient honey stores are left for the colony.

Past practice was to cut the comb with a wooden or bone knife, but a steel knife is now used. Three straight cuts are made. The first is at an acute angle to the upper part of the rafter, and separates the brood and honey portions. The second cut is made just below the rafter from the upper end to the first cut, to free the honey comb (fig. 9). A third cut is more or less midway between the lower part of the rafter and the first cut, to loosen a sector of brood comb.

About four harvests can be obtained up to March, giving an average of 6 kg honey per harvest per nest. At the first harvest, only the honey part of the comb is usually taken, but relatively more brood and pollen are removed at each successive harvest. The honey comb is collected in woven rattan or bamboo baskets or — nowadays — metal containers. At home, pollen and brood parts are removed, and the honey comb squeezed by hand to separate honey from wax; 1 kg wax is obtained for every 30 kg honey. Comb containing brood and pollen is eaten fresh or baked, by family, friends and neighbours. Honey is stored in earthenware vessels.

Figure 10 shows an end-of-season harvest, and figure 11 the brood comb left behind. A darkening of the comb is a sign that the colony will soon leave, and the

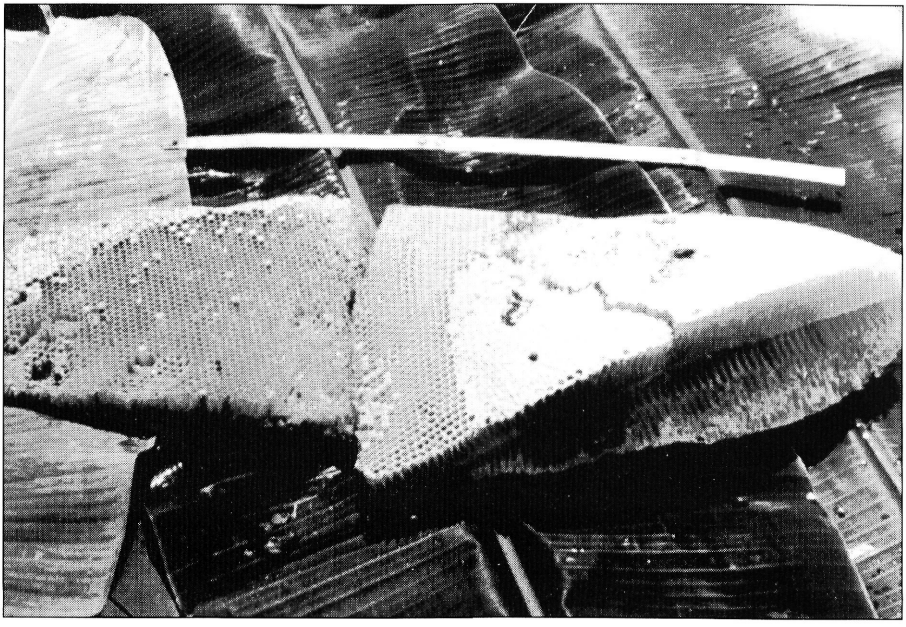

FIG. 10. End-of-season harvest.

FIG. 11. Lower part of the comb left on the rafter after harvesting (fig. 10), to which the adult bees return.

whole comb is then cut off. This is done earlier if it becomes infested with insects that feed on its contents, because the colony would soon leave it.

A. florea nests are abundant in U Minh forest, and there are no restrictions on hunting them except that the owner has the first right to nests on his own plot. The honey collected (less than 1 kg per nest) fetches a higher price than *A. dorsata* honey in the local markets. No form of beekeeping is practised with *A. florea*.

Organization and production

In the U Minh region, rafter beekeeping supplements income from forest farm activities and fishing. Song Trem state forest farm (10 200 ha) employs 360 foresters, of whom 10% are women, and each is allocated a 10-ha plot of forest for private production. Most of the farm area has been reforested since 1982 when the state farm was established, so the majority of trees on private plots are still young, and recent annual honey production often amounted to only 2 kg/ha, although some plots produced 10 kg/ha. (Where *Melaleuca* trees are more than 10 years old, up to 8 rafters/ha can be erected, producing up to 200 kg/ha/year.)

Each farm worker at Song Trem has rafters on his plot, on average 2/ha (20/plot). Some, who also erect them outside their own plot, own up to 200. In general 40–60% of rafters erected are occupied. Tax must be paid on the honey produced; in 1991, this was 30% of its value. The forest workers live in four villages, each with a chief; he is in charge of making rafter regulations for the village and

communicating them to the villagers at monthly meetings. He also determines the dates of harvesting on the various plots, in order to control the amount of honey produced during any one season. Each rafter owner must inform the chief about the number and placing of his rafters, and the amounts of honey and wax harvested. In case of any dispute (e.g. theft from a rafter colony), the village chief makes an investigation and has the right to administer justice, but such disputes are said to be rare. Sometimes a honey hunter may illegally harvest from rafter colonies, or from one of the rarely occurring natural nests. Carelessness by such hunters is believed to have been responsible for numerous forest fires in the past.

According to all reports from beekeepers' collectives and their predecessors, the practices and skills of rafter beekeeping, which include the finding of any wild or rafter nest by observing foraging bees, have been handed down from earlier generations. According to surveys in southern Vietnam made between 1805 and 1836, 68 villages in the U Minh region got their main living from *A. dorsata* beekeeping, paying their taxes in wax[21]. The same rafter practice was described by Fougères in 1902[11] in the same region, then under French rule. At that time, large forest plots were leased to the villages, and the villagers could make use of any natural products except logs or timber. Fougères[11] gave 1898 export figures for honey and wax from Indochina: 14.75 and 2.8 tonnes, respectively, all produced in this southern region of Vietnam which was then Cochinchina. Valette[27] reported wax exports from Indochina of 7.8 and 11 tonnes for 1906 and 1913 respectively, and also 'a little honey'. *A. dorsata* was believed to yield 80% of the honey produced in Indochina, although not all was from rafter beekeeping[24].

The present production of the whole U Minh region is unknown but is estimated to be more than 150 tonnes a year. *A. dorsata* honey is no longer exported from Vietnam.

Use of the *tikung* in central Kalimantan

A rather similar *A. dorsata* management system existed in the lake region of the upper Kapuas river (about 1°N, north of Semitau in Borneo), now in Kalimantan, Indonesia (C in fig. 12). Trees along the rivers provided nest sites for migratory swarms of *A. dorsata* that arrived in November–December. In 1851 Lijnden and Groll[14] reported that when the swarms were due people hung a *tekkong* in trees they owned; this was a long, slightly hollowed pole to which a cross-pin was attached, as described below. Bees clustered on a *tekkong* and built their comb down from it. After 2 or 3 months, the owners of the trees burned the bees or drove them away from the comb, and harvested the honey and wax.

De Mol's 1933 description[18] shows that the region also contained seasonally submerged forests that included sweet-water mangrove vegetation. Plant species were different from those in U Minh, the main honey sources being *Eugenia* spp. and *Carallia* sp. During the dry season — which lasted less than two months, and in some years was absent — the water level could drop by about 10 m, and most species ceased flowering until the first rains again induced abundant bloom.

A. dorsata colonies migrated to nearby mountains for the dry season, and returned as soon as the rains started again. In 1931, when rains were continuous, colonies did not migrate.

FIG. 12. Map showing areas discussed.

Vietnam:
A, U Minh
B, Cat Ba

Indonesia:
C, Kapuas river, Kalimantan
D, Lampung District, Sumatra

De Mol[18] gave a fuller description of the *A. dorsata* management practice using *tikung*, in which some people specialized, and each carved his personal mark on those he owned. Two *tikung* 1.6–2.25 m long were made by splitting a pole of odourless hardwood (mainly *Fagraea fragrans*), and a drainage channel was made in the flat upper side. A rectangular notch was cut from each end of the *tikung* and a wooden pin was used to close it, each end of the *tikung* being thus attached to a branch of a living tree. *Tikung* were usually set out during the dry season, in shady cool places below sloping ground, and they were not moved again. Often more than 50% of them were occupied.

In one passage de Mol mentioned that the owners did not harvest honey until the bees had migrated after the start of the dry season, but in another he referred to the use of a torch to drive the bees from the comb, or to kill them. Two persons went in a small shallow boat to harvest combs. One climbed into a nearby tree, carrying the torch; he drove off or killed the bees, fastened a bucket-like rattan basket just below the comb, and then used a hard wooden knife to cut the comb off just below the *tikung*, starting at the upper end. A basket held four or five combs, and when full it was emptied into an earthenware pot in the boat. Honey was pressed by hand and stored in the same pots. Wax was melted, poured into a woven rattan bag, and strained by pressing the bag between two poles whose ends were connected by a rattan ring.

In 1933, 500 families practised *tikung* beekeeping, one family having 40–150 *tikung*, and some extended families over 1 000. Beekeeping supplemented their main activity, fishing. Both honey and wax were important articles of the trade along the river, but in 1931 they fetched such low prices that harvests were not taken from the *tikung*.

According to both 1851 and 1933 reports, most *tikung* beekeepers were Malay fishermen who migrated annually, staying for some months in the lake region and then moving elsewhere. De Mol said that *tikung* beekeeping was also practised to a smaller extent by the native Dayak population, and was reported to exist along small rivers in other parts of Borneo. A recent reference to this system[12] remarked only that it was then seldom practised.

Another similarity between rafter and *tikung* beekeepers was in their organization. All the latter had to inform an appointed counsel about the locations of *tikung* and ownership marks, and he was the authority in case of any dispute, e.g. about ownership or locating of *tikung*.

Other possibilities for the system, and suggestions as to its origin

Beekeepers from U Minh have been asked to introduce the rafter technique, and to train the local population, in northern parts of the Mekong delta where similar *Melaleuca leucadendron* forests exist. The technique has been successfully introduced on a small scale in Tien Giang province where *A. dorsata* nests were rarely reported. In the adjacent province Long An, with 50 000 ha of *Melaleuca* bush forest but no *A. dorsata*, small-scale trials with rafters are planned to determine whether swarms can be attracted to nest on them.

It would be worth finding out whether the *A. dorsata* management system described might be appropriate in any other part of Vietnam, or elsewhere. For instance there is a very large area of mangrove forest in the Sundarbans at the mouth of the Ganges, partly in India and partly in Bangladesh; see Naskar and Gunabakshi[20]. Some hundreds of honey hunters collect 25–60 tonnes of honey annually from unmanaged nests, and some vegetation zones might be appropriate for the use of rafters. Tree species growing in the U Minh mangrove forest are among those recorded as preferred by *A. dorsata* for nest sites in the Sundarbans[7].

Another similar system was started in the 1980s, following large -scale deforestation on an island off the east coast of Sumatra, roughly opposite the mouth of the Kapuas river. In response to the loss of *A. dorsata* nest sites through tree felling, some of the people who had previously collected *A. dorsata* combs fixed up long poles for the bees, as high above the ground as possible. Poles on which incoming swarms nested were lowered to the ground— with the comb and bees — in order to harvest from them[1].

A more primitive practice during the last century, in Lampung district at the southern tip of Sumatra, had similarities to the systems described above. *A. dorsata* honey collectors cleared and cleaned the trunk and branches of trees they owned (where the bees habitually nested), in order to make them attractive as nest sites to incoming swarms. Cattenburch[6] described this practice and de Vries[28] gave details in English.

The similarity between the two traditional beekeeping systems suggests that the techniques and knowledge had a common origin, and that these could have been transferred across 1 000 km of the South China Sea (fig. 12) by Malay fishermen, who regularly visited the Kapuas river in Kalimantan — or by Chinese people (*phong ngan* is Chinese for bee forest). The more primitive practice in Lampung may have been earlier and possibly a predecessor of the beekeeping systems. But the third beekeeping system (off Sumatra) was started after recent deforestation, so perhaps the U Minh and Kapuas systems might have been independent responses to a similar change in habitat which resulted in the loss of *A. dorsata* nest sites. No reports of any similar system are known from the Malay peninsula or from any other region nearby.

Perhaps the environmental and botanical circumstances that allow such systems to be effective occur in very few places. Where there are strong lateral branches high up in tall trees, *A. dorsata* tends to build its nests on them, but such sites were probably always absent from submerged forests of the Mekong delta region; we do not have information from the Kapuas area.

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