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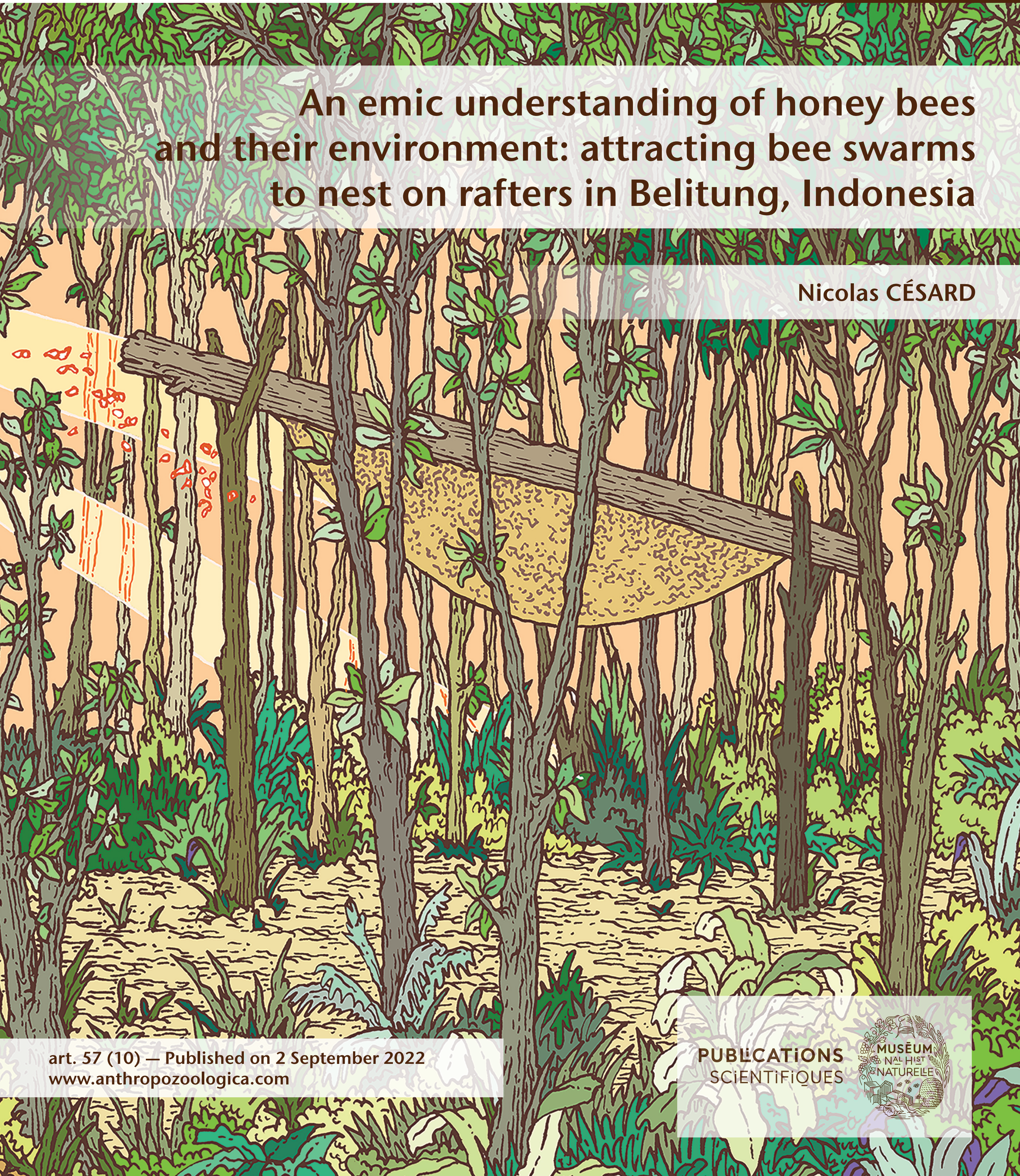

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Tronc à miel de type *bantai* occupé par une colonie d'abeilles. Crédit: Clément Vuillier (2020) / *Rafter of the* bantai *type occupied by a bee colony. Credit: Clément Vuillier (2020)*.

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An emic understanding of honey bees and their environment: attracting bee swarms to nest on rafters in Belitung, Indonesia

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ABSTRACT
The study focuses on a form of managing and harvesting honey from migrating swarms of the giant Asian honey bee (*Apis dorsata* Fabricius, 1793). Closer to bee maintaining or bee tending than to beekeeping, the "rafter" technique consists of positioning, on the ground or in branches, a slightly inclined hardwood plank or a section of tree trunk under which the bees establish a colony by building their single-comb nest. The man-made structure (imitating a tree branch) facilitates the nesting of bees and has the advantage of being more accessible to harvesters than the tall trees or rock cliffs where colonies are generally encountered. The article shows how, in anticipation of the arrival (or the return) of migrating swarms, the harvesters of Belitung Island in Indonesia seek out and prepare a habitat that they consider to be suited to the behavior of the bees. It demonstrates that rafter harvesters have an extensive emic understanding of their environment and of the honey bees' interactions with vegetation. In Belitung, local knowledge of the bees' habitat and the rafter technique is not limited only to knowledge about the type of physical support that is appropriate, but also includes knowledge about how and where it should be placed: the position of a rafter is adjusted at each location to form a shelter that can be compared to a "niche" (in the Gibsonian sense). Belitung harvesters also stress the important role of sunlight in attracting the bees, an explanation also shared by scientists. We hypothesize here that their focus is not on the bees or the swarm as a sentient organism but on their own understanding of the environment's properties.

KEY WORDS
Apis dorsata,
rafter beekeeping,
pollination,
traditional ecological knowledge,
affordance,
sensory perception.

RÉSUMÉ

Une compréhension émique des abeilles et de leur environnement : attirer un essaim sur un tronc à miel à Belitung, Indonésie.

La recherche porte sur une forme de gestion et de récolte du miel des essaims migrateurs de l'abeille géante asiatique (*Apis dorsata* Fabricius, 1793). Plus proche de l'accompagnement que de l'apiculture, la technique du « chevron » consiste à disposer au sol ou dans les branches une planche de bois ou un tronc d'arbre légèrement incliné sous lequel les abeilles fonderont leur colonie en construisant leur nid à rayon unique. La structure artificielle (semblable à une branche) facilite la nidification des abeilles et présente l'avantage d'être plus accessible aux collecteurs que les grands arbres ou les falaises où les colonies ont tendance à se regrouper. L'article montre comment les collecteurs de miel de l'île de Belitung en Indonésie anticipent l'arrivée (ou le retour) des essaims migrateurs en cherchant et en préparant dans leur environnement un habitat qu'ils estiment adapté au comportement des abeilles. Il rend compte d'une compréhension émique large de l'environnement et des interactions des abeilles avec la végétation. Le savoir local à Belitung ne réduit pas l'habitat des essaims et la technique du chevron au seul support : sa position est ajustée à chaque emplacement pour former un abri qui peut être comparé à une « niche » (au sens gibsonien). Les collecteurs soulignent également l'importance de la lumière dans l'arrivée des abeilles, une explication partagée par les scientifiques. Nous faisons l'hypothèse ici que leur attention ne se porte pas sur les abeilles ou sur l'essaim comme un organisme sentient mais sur leur propre compréhension des propriétés du milieu naturel.

KEY WORDS
Apis dorsata,
apiculture sur poutre,
pollinisation,
connaissance écologique traditionnelle,
affordance,
perception sensorielle.

ABSTRAK

Pemahaman emik mengenai lebah madu dan lingkungannya: cara menarik kawanan lebah pada rafter (sunggau) di Belitung, Indonesia.

Penelitian ini berfokus pada suatu bentuk pengelolaan dan panen madu kawanan lebah migran madu raksasa Asia (*Apis dorsata* Fabricius, 1793). Teknik rafter (*sunggau*, *tikung*, *tingku,* dll.), yang lebih mendekati perawatan lebah daripada budi daya lebah, dilakukan dengan menempatkan papan kayu atau batang pohon sedikit miring di tanah atau di dahan. Di bawahnya, lebah akan membentuk koloni dengan membuat sarang dengan sisiran tunggal. Struktur buatan ini (yang mirip dahan) memudahkan proses bersarang lebah dan bermanfaat sebab lebih terjangkau untuk pemanen daripada pohon tinggi ataupun tebing yang merupakan tempat koloni cenderung berhuni. Naskah ini menunjukkan bagaimana pemanen madu di pulau Belitung di Indonesia mengantisipasi kedatangan (atau kembalinya) kawanan migran dengan mencari dan mempersiapkan habitat yang dianggap sesuai dengan perilaku lebah, di lingkungannya. Naskah ini mengungkapkan adanya pemahaman emik yang luas mengenai lingkungan dan interaksi antara lebah dan vegetasi. Di Belitung, kearifan lokal mengenai habitat lebah dan teknik rafter tidak sekadar terbatas pada medium itu sendiri: posisi rafter disesuaikan di setiap lokasi guna membentuk tempat berlindung yang dapat dibandingkan dengan «niche» (sebagaimana dimaksud Gibson). Pemanen madu di Belitung juga menyoroti pentingnya sinar matahari untuk menarik lebah, dan para ilmuwan juga memberi penjelasan demikian. Dalam naskah ini, hipotesisnya adalah fokus mereka tidak pada lebah atau kawanan sebagai makhluk hidup dengan sensibilitas, akan tetapi pada pemahaman mereka sendiri akan ciri lingkungan alam.

KATA KUNCI
Apis dorsata,
budi daya lebah pada rafter,
penyerbukan/polinasi,
pengetahuan ekologis tradisional,
persepsi sensori.

INTRODUCTION

Both hunting and trapping rely on the cognitive capacities of the human being to perceive an animal's habitat, but also to recreate its landmarks in time and space. The experience of the hunter/trapper, his ability to memorise places and to interpret the landscape, as well as his comprehension of the seasons and biological rhythms, fit into what the anthropologist Tim Ingold names "an ecology of life" (Ingold 2000); an approach that is placed here at the heart of analysis of the knowledge and practical skills studied by ethnoecology (Dwyer 2005).

As a strategy of anticipation, trapping requires being as close as possible to the animal, to the places it crosses or visits regularly to feed or reproduce, but also locations where it shelters to raise its offspring or to rest. Certain traps will thus use the animal's habitat directly "by seduction", by changing it (for one well-known example, see Morgan 1868: 236, 237) or by recreating its architecture artificially (Dalla Bernardina 2013), to be able to capture and kill the target species (in the function given to traps by Leroi-Gourhan [1973: 86]). Other systems concentrate on the broader habitat, elements of the environment or the landscape that humans use or transform to limit the movements of the passing animal and to lead it to a trap or a group of hunters or fishermen. Several examples describe the modification or arrangement on varied scales of fixed (Lee 1979: 208) or live (Artaud 2018) elements, often completed by the installation of barriers or dams (Anell 1960; Connaway 2007; O'Shea & Meadows 2009; Janetski 2011; Nahum-Claudel 2018; Blatrix *et al.* 2018).

Examples in which small groups of humans modify the non-agricultural landscape and the biotic communities for animal and plant species that have value as sources of food or raw materials are abundant in the literature (for examples, see Smith 2011). These manipulations of the environment vary in their methods but also in their objectives. They cannot all be considered traps, because the led or attracted animal is not always held captive or killed. Some practices aim to increase the availability of the resources but also to retain them or keep them for immediate or future use. The skills, tools, and technical devices used to attract the animal, often by deceiving or luring it, are equally technologies of predation and technologies of habitation (Anderson *et al.* 2017; Corsín Jiménez & Nahum-Claudel 2019), even of cohabitation between species.

Some management practices have contributed to associated morphological and genetic transformations for several species associated with their domestication, while others have kept species wild, through an inability to transform them (Smith 2011) or by facility, in view especially of their abundance (Césard *et al.* 2015). Many of these last-mentioned practices seek to improve or extend the habitat of species concerned by indirect "negative" actions (i.e. by limiting contact with the animal or the plant or by focusing on the environment to favour the development of the species) (Haudricourt 1962; Roué *et al.* 2015). This is the case for certain seasonal species of edible insects described as semi-domestic or semi-cultivated (Van Itterbeeck & Van Huis 2012) or those of economic importance, such as honey bees (Hymenoptera: Apidae).

An ancient practice, "hunting" for forest honey and other bee products including wax or bee brood for consumption is equally connected to hunting and to gathering. But the collectors also proceed from a more passive anticipation when they maintain the locations where colonies nest (such as natural cavities or hives for the European *Apis mellifera* Linnaeus, 1758 and the Asian honey bee *Apis cerana* Fabricius, 1793, or nesting sites of stingless bee species), or when they refrain from taking everything (whether honey and/or brood) so as not to damage the colony. This is the case for the giant Asian honey bee (*Apis dorsata* Fabricius, 1793), the largest of the honey bee species, a species living in the open air and building a single comb-nest. In South Asia and South-East Asia, collectors take major risks by going to collect honey from this species' large nests (one to two meters long), which are installed on the undersides of branches of tall trees or on the side of rock cliffs where colonies naturally congregate. *Apis dorsata* is known to hunters for the great mobility of its swarms: in the absence of sufficient food sources, the bees abandon their comb (a phenomenon known in the entomological literature as absconding) and sometimes fly several dozens of kilometres in search of new flowers and new nesting sites (Koeniger & Koeniger 1980). Known nest sites, both those occupied at a given time and those temporarily abandoned, are generally maintained and protected (De Jong 2000; Césard & Heri 2015) because the collectors have observed that after several weeks or months the bee colonies return to settle in the same places (Neumann *et al.* 2000; Paar *et al.* 2000).

This collecting (or honey hunting) of giant Asian honey bee nests is commonly done during massive flowerings when honey and bee brood constitute essential energetic food and contribute additional revenues when sold. However, the difficulty of access to nests and the seasonality of swarms of the giant honey bee make it a forest resource that is difficult to exploit, with irregular yields. This article is focused on a form of harvesting and managing migrating swarms of the giant honey bees that has been developed in several regions where the species is present: in India (Mahindre 2000), Vietnam (Chinch *et al.* 1995 ; Tan *et al.* 1997), Cambodia (Waring & Jump 2004), Thailand (Chuttong *et al.* 2019) and in Indonesia (De Vries 1990; Crane *et al.* 1993; Purwanto *et al.* 2000; Hadisoesilo 2001), where I have studied it since several years (Roué *et al.* 2015). This form of harvesting, called "rafter" or "rafter beekeeping", consists of using a slightly inclined hardwood plank or a section of tree trunk under which the bees settle by building a wax comb and then develop a colony at the height of a person, on the ground or in branches. The installation facilitates the arrival of bees by offering them a supporting structure for nesting and has the advantage of being easily accessible to harvesters.

Harvesting forest honey from a rafter has been the subject of many observations and analyses but their dynamics, both social and ecological, remain to be studied. Often considered practices of beekeeping or apiculture, they vary greatly from one region and one collector to another, depending on local know-how and individual motivations. Certain practices remain opportunistic and are related to hunting (and trapping), while others, better anchored socially and/or initiated by projects supported by non-governmental organizations, try to preserve the bees and are closer to bee maintaining or bee tending (Bradbear 2009) than to honey hunting, although they are still very different from intensive beekeeping (Gratzer *et al.* 2019), which includes active hive manipulation by the beekeepers (control of swarming, colony division, queen rearing, etc.). Unlike collecting on trees or cliffs, which is dangerous for the humans and destructive for bee colonies, which end up burnt by torches or disoriented by the darkness, when the practice is done at night (Oldroyd & Nanork 2009), the rafter technique allows more sustainable practices (smoking by day, harvesting of honey alone) by permitting the eventual return of the bees the following season (Chinch *et al.* 1995; Mulder *et al.* 2001; Petersen & Reddy 2016). It also seems to favour the nesting of swarms at a chosen location.

While research on the rafter technique has concentrated on the position, the shape and the incline of the section of trunk or the plank used, few have been interested in the knowledge of local populations and what they say about the rafter and its environment. My research in Indonesia shows that there are not only different ways to harvest from a rafter but also different ways to conceive the practice. I have observed that the rafter technique is above all a comprehension of the honey bee's ecosystem and the insect's interactions with its environment. Nevertheless, in the search for locations to set up a rafter, the harvesters only have a vague idea of the most suitable nesting sites unless they have tested and experienced them directly.

Their interpretation of the quality of a site generally comes afterwards, once the swarm has settled and then left again.

When asked about what attracts a swarm, the honey harvesters recognize that it is difficult to interpret the sensorial world of the bees (their subjective world or *umwelt*; Uexküll 1992) through their own (human) representations and signs. The hypothesis developed here is that, rather than knowing and controlling them, they attempt to identify and create an environment attractive to the bees. The success of the rafter is dependent on the qualities of the environment as perceived by both humans and insects, a milieu that the two species share and understand (through their respective senses). As described below, the choice of the location of the supporting structure and its installation in the vegetation rely on individual and collective observations that comprise the basis for the harvesters' interpretations of the bees' behaviour. This ethnoecology of the giant honey bee and its habitat is as much an ecology of action as of inaction: the honey harvesters install the rafter but do not have the capacity to act on the swarms.

The research presented here is based on harvesting practices in three Indonesian regions: the Danau Sentarum National Park in West Kalimantan (Borneo) (Van Lijnden & Groll 1851; Mulder *et al.* 2000), a few villages close to Poso Lake in Sulawesi, and the Bangka-Belitung islands in the Java Sea. The article takes as its main context the sub-district (*kecamatan*) of Membalong in the south-west of Belitung Island. The first part sets the honey bee in its environment, from local conceptions of its biology to the swarm's arrival in the vegetation and the role of sunlight in nesting site preference. The second part considers the rafter, not just as an isolated tool, but as part and parcel of its surrounding environment.

The island of Belitung is in the strait of Karimata between Sumatra at the west and Kalimantan (Borneo) in the east. It has a specific type of heath forest (known as *kerangas* in Indonesia). These forests grow on very acid ground and form a specific habitat for many endemic species that are adapted to live in nutrient-poor soils (Rahayu *et al.* 2018). Distributed along the beaches and in the plain areas up to an altitude of 100 metres, the heath forest of Belitung has few species of large trees, but several species of Myrtaceae that can reach about a dozen metres in height (Rahayu *et al.* 2018). The heath forests of Indonesia are recognized as unique and fragile ecosystems (IUCN 2014). Heath forests are considered as not particularly well-suited to farming, and on Belitung this forest type has been progressively converted to plantations, especially for palm oil (70% of the forest cover damaged by tin mining and plantations between 1995 and 2015 according to Hermon 2016). The coast of the island is dominated by mangroves and in certain localities by white sand and boulders. Belitung's population is mainly comprised of Belitung Malays (Melayu Belitung [MB]) and descendants of Chinese (Tionghoa) people who came to work in mining activities in the 19th century. Beyond the two cities of the island, Tanjung Padan and Manggar, most of the Belitung Malay people live on agriculture and fishing and on certain forest products such as honey. Used mainly up to the 1950s for collecting wax, rafter harvesting today provides supplementary revenue through the sale of forest honey (from €3 to €5 a 500 ml bottle). Each village of the Membalong sub-district has several honey harvesters, and the practice of harvesting is regulated by custom (*adat*) that is often strong, especially in the island's interior.

Field investigations and visits were held over several years between 2010-2017 during short sojourns and at different times of the year. Free and semi-directive interviews were conducted in three villages of the Membalong sub-district to document local knowledge on the main flowering and nectar-producing species, on bees and their habitat, as well about technical skills[1]. This ethnoecological knowledge, sometimes close to the observations of entomology and the ecology of insects, is transmitted between harvesters of the same village and is found with a few variations all over the island. During my visits, I assisted and participated in many harvesting sessions and met regularly with some thirty harvesters. The results below reflect their knowledge and views.

THE HONEY BEE AND ITS ENVIRONMENT IN BELITUNG

On Belitung Island, the rafter (locally called *sunggau*) technique used to attract migrating swarms is based on precise knowledge of the bees, the environment and their interactions. It takes into account a broad perception of the insect's environment, its habitat. Observation and monitoring of the flowering of key plants and their occurrence allow harvesters to anticipate for each new season the arrival (or the return) of the swarms (*kelompok madu*, or more familiarly *madu* MB) and to prepare for this event.

Local understanding of the honey bee

The harvesters first observe the bees (*induk* MB) at a distance when they have settled under the rafter; then, close-up, on the comb (*lai* MB) at the time of harvesting, and after the honey (*madu* MB) and the bee brood have been collected. When the hive is smoked, the older bees, which are more vigorous, flee, while those that are newly-hatched remain on the nest, as they are too weak to fly. This observation may explain the local theory according to which a swarm is mainly composed of male bees, with a lesser number of females that, unlike the males, are unable to sting[2]. For the harvesters, the organization of the bees is conferred meaning through the harvesters' model of the human family. On the comb, the bees are arranged on top of the other, each cell

1. The scientific identification of plants is based on the richly illustrated work of Yohana Sulistyaningsih and her colleagues (Sulistyaningsih *et al.* 2019). To better identify the openings in the vegetation and to put oneself in the place of the harvesters, I have used hemispheric photography, a method used in forestry to measure the opening of canopies. In the same way, I have asked a draughtsman to distinguish the different types of rafters.

2. Harvesters consider male bees as defensive but entomology has shown that a colony is mostly composed of female bees, worker bees that lack the full reproductive capacity of the queen bee but sting to defend the colony. Male honey bees, or drones, do not have stings. Workers and drones live a few months and the queen bee three to four years.

(*sarang* MB) being composed of a couple and a child (*anak*). As part of their routine, the male bees regularly leave the comb in search of sources of nectar and pollen, while the females stay on the comb where they look after the children (the colony's brood). The harvesters have observed that, depending on the duration of flowering, each female bee can lay up to three times in the same cell (*tempat anak*). Brood cells mainly produce male bees, the females being born from the largest ones (mainly cells referred to by scientists as drone cells). These new bees live for a year, a duration that according to the harvesters allows them to return to the same location the following season. Each swarm is led by a chief (*kepala kelompok*), a male bee that consults the other bees before taking a decision.

The honey harvesters recognize in the swarms of bees (collectively called *madu* like honey) different phases of activity. All the swarms are initially bees "that come with the wind" (*madu angin* MB). These are migratory swarms that come to the region in search of the flowers on which they feed on and further will establish their colony. Certain colonies, according to the harvesters, come from the island of Belitung; others, from more distant regions such as Bangka or Sumatra islands in the east or from Kalimantan in the west. The new bees, which are born on the combs during a flowering period, leave (swarming phase) and form migratory swarms in their turn, until the moment when they return to their site of birth (*kembali ke tempat asal*). The swarms are then known as swarms "that return" (*madu pendak* or *madu labon* MB). These swarms leave again at the end of the flowering period, some in search of flowers in other regions; others, again according to local theory, settle not far away to rest. The bees cluster together at the top of a tree and the colony falls asleep (*madu tidur* MB) (probably diapausing) for a period that ranges from two weeks to three months (generally around January), due to a lack of flowers, but also, due to the new bees that are still too weak to be able to fly further away.

On the island of Belitung, the origin of the swarms and the rafters that host them refer to the figure of Siti Fatimah. Local tradition attributes the ownership of the swarms to the daughter of the prophet Muhammad, as the bees feed on her sweat and she in return feeds on their wax. According to tradition, just after becoming pregnant, she asked humans to make rafters and to look after them regularly (*piara terus*). Still today, certain harvesters of the region of Membalong utter sacred formulas (*mantra*) when they fell a tree to signify to the resident spirit (*jinn* MB) that Siti Fatimah is taking over to serve as a rafter. Forest products such as honey are among the most important economic resources locally, equivalent in value to agricultural or marine products. Each year, during the ceremony of Maras Tahun, the customary authorities of each village of the island celebrate and call by actions of grace the harvests of the coming year. It is common then that after a mediocre year, the honey harvesters ask the customary authorities to excuse them for their past faults and call for flowers in abundance and nectar in quantity to attract the bees.

Following the flowers

The harvesters know that swarms arrive in large numbers during flowering periods of certain important plants, at times of massive flowering, and depart when these periods end. During their visits to the forest, they observe the emergence of buds at sites they know (trees that they have previously identified) and follow the growth of the flowers until the petals fall. They know which floral species are often visited by the bees and the potential resources they offer. Accordingly, harvesters distinguish between species that produce nectar (*air* MB) and those that produce pollen (*muk* MB). They explain that the swarms arrive or return for the flowering of the main nectar flowers (*bunga air* MB), but the bees, once they have settled on their comb, initially forage from pollen flowers (*bunga muk* MB) to fill their first cells.

The harvesters have observed that swarms that return from one year to the next for the same flowerings, sometimes arrive in advance. The swarm then waits a few days on a tree for the flowers to bloom (a homeless cluster referred to by scientists as a bivouac) before settling in a more appropriate location (a protected place such as a rafter or the branch of a tree, see section "Attracting the bees to a rafter"). Once the first flowers have bloomed, the bees build their comb but must still wait before collecting pollen or nectar. In fact, as flowering of different plant species happens rarely simultaneously, the bees can limit their production of honey when the nectar flowers appear before the pollen ones, or inversely, stock first the pollen while waiting for the nectar flowers. The best seasons for honey (*musim madu* MB), start by collection of pollen, followed soon after by a continual bloom of nectar flowers. The harvesters count at least two weeks between the appearance of the first pollen-providing flowers and the moment that they harvest the honey. They further wait one or two additional weeks if the appearance of one of the two resources is delayed.

Once the flowers have appeared, the bees enlarge the wax comb and deploy themselves among the cells that they fill quickly. The male bees bring in pollen and the female bees start to lay eggs. The harvesters observe the arrival and departure of the bees on the nest and note that the bees use the collected pollen to feed their larvae while keeping the nectar that they transform into honey for themselves. This nectar is dried in the cells before being "drunk" by the bees as needed. By observing the comb, the harvesters have also noticed that the cells on the comb containing pollen descend gradually as the bees open them to consume their contents and then reuse them to stock honey. The cells of honey are then gradually enlarged, and after several days, capped (*kepo* MB). On the comb, the brood then occupies about three-quarters of the surface. From the higher cells, new bees start to emerge. Most of the bees then form a black static layer on the occupied part of the brood.

The harvesters observe the flowers appearing and then fading. They note that the flowering of the most nectariferous trees lasts about a week and that the cells of the comb are engorged with honey once the flowers of the same species are dry. The harvesters are especially vigilant at the end of the flowering period because they know that without new flowers, the bees will soon leave for other forests. The bees could wait for another few days on the comb, giving time especially for the larvae to transform into adults, but without pollen and without additional sources of nectar, they will soon open the cells to consume the honey and depart. On the contrary, if other flowers appear, the swarm will stay on the comb and the bees will once again collect pollen and nectar. They produce honey again that they stock in the cells formerly filled with pollen and in those of the newly exited bees. The female bees lay new eggs and the colony starts a cycle that according to the harvesters will last about twenty days.

Although an initial quantity of honey can principally be harvested a week after the appearance of nectar flowers, the larvae are still in the cells. In Belitung, most harvesters then pay less attention to the flowers than to the development of the bees and prefer to wait, at least an additional week, but often longer, for the first adult bees (imagos) to fledge from the brood cells, to be sure the bees will return. Others watch out for the emergence of a large cell (a queen cup) that is the source of the appearance of a new generation (*satu generasi*) of bees. Several harvesters have in fact noted that the end of a major flowering period is marked by the bees' development on the comb or its perimeter of a cell that is larger than the others that they call *jubol*, containing a bee that some harvesters consider to be male (others consider it to be female). These cells do not appear at each flowering period. On the territory of the village of Tanjung Rusa, the short and scarce flowerings of the *mentepong* (*Strobocalyx arborea* Buck.-Ham.) or the *samak* (*Syzygium urceolatum* subsp. *palembanicum* (Miq.) P.S. Ashton) generally allow only one *jubol* to appear, but also sometimes none, if the colony has not developed accordingly (the swarm is then described as *bentut* MB). Conversely, the longer flowerings (because they are successive) of common floral species in the region such as *gelam* (*Melaleuca cajuputi* Powell) are conducive to the successive appearance on the comb of several *jubol.*

The arrival of the swarm

The number of *jubol* on the comb relates to the duration of flowering periods, but also to the geographical origin of the swarms that build them. According to criteria that are morphological, amongst others (mainly form and size of the comb and colours of the bees) the harvesters distinguish several types of swarms: local swarms, often smaller, which move depending on the resources from one region to another in Belitung, and larger swarms (i.e. with more bees) that come from the neighbouring islands for longer flowerings, and then leave to return to where they come from. The presence and the arrival of these different swarms depends on the flowerings, which themselves depend on the climatic variations that the harvesters associate with the dominant winds (*angin* MB). The harvesters observe that the migratory swarms (*madu angin*), especially those that come from Sumatra or Kalimantan, arrive starting in June during the warm season (southerly winds) and leave again at the end of September. Some swarms, such as those of Belitung, are also present from October to March (i.e. during the cold season with rains from the west and north). Hot weather returns around April, but the storms that are still frequent can compromise flowering. In June the flowers reappear, and the migratory swarms return to the island.

According to the harvesters, most flowerings are annual, but vary in abundance and duration depending on the species and time of year. The presence of certain flowers and corresponding honey flows also change depending on the villages, in other words according to the limits of their territories and the biotopes that cover them. Certain nectariferous species allow rapid harvesting, while others have two or three harvests per flowering from the same comb. Despite their knowledge of the flowers, the harvesters recognize that there is some uncertainty, from one season to another, for some species in the same area. On the territory of the village of Perpat, for example, the *gelam* and *pelawan* (*Tristaniopsis* sp.) are expected to flower in December and in May-June respectively, but they often bloom earlier or later, in other words, out of season (*empang* MB).

The distribution of the most nectariferous flowers and the corresponding honey flows follows a geographical axis that goes from the head (*dampar* MB) to the feet (*kaken* MB) of the island, or from the interior to the coasts and the sea. In the interior, the wooded hills (*utan gunung* MB) of Membalong host several species such as *pulas* (*Guioa pleuropteris* Radlk.) and especially *pelawan*, the bitter honey of which is sought after for its medicinal virtues. Going further towards the coasts in the east and the south, the vegetation is replaced by heath forests (*teraja* MB or *kerangas* in Indonesian) where species such as *cingkang* (*Syzygium* sp.) or *samak* grow, especially in the driest zones such as the *padang* (MB) or in marshy areas (*utan danau* MB) which host many *gelam*. The seaside zones (*daerah pantai* MB) still include many mangroves (*utan bakau* MB) where the bees forage, especially at the flowers of the *teruntum* (*Lumnitzera littorea* Voigt). These flowerings correspond to other flowerings of pollen flowers, such as those of the *betor* (*betor padi* MB, *Calophyllum pulcherrimum* Wall. ex Choisy) or *jemang* (*Rhodamnia cinerea* Jack) and many others.

From one region to another of the island of Belitung, certain species disappear or become rarer and the swarms stop there less frequently. Following the opening of plantations of oil palm trees, and to a lesser extent of individual plantations (mainly of oil palm trees and pepper trees) and vegetable gardens, some of the most nectariferous species have disappeared. This is the case of species such as the *gelam* or *pelawan* which in the past could flower at the same time, or almost, in a vast region, and mobilised harvesters of several surrounding villages. Their harvest is now limited to certain villages with territories that are still forested, or certain coastlines that are now protected (*hutan lindung*). Due to the reduction of forested habitats on the island, in recent years, seasons that are too long and not differentiated have been added. These favour droughts and fires, or on the contrary frequent precipitation which, according to the harvesters, destroys the flowers and prevents the bees from leaving their nest.

Attracting the bees to a rafter

The harvesters, when they are occupied in the village or in their vegetable gardens, regularly observe the passing of migratory swarms. They know that without major flowering periods the swarms do not stop but that at the start of the season, anticipating the flowers, swarms descend into the vegetation in search of locations to establish their colony. If a site is suitable, a migratory swarm may choose to settle under the branch of a tree (which is then recognized as a bee tree, *sambit, sambitan* MB) or it may prefer a rafter (*sunggauan, sunggaran, sunggau* MB), an artificial support (a section of tree trunk in Belitung) placed at the height of a person or a few metres from the ground to attract the swarm. Partially prepared, the placing of a rafter is well identified by the harvesters and its low and inclined position facilitates harvesting. Unlike a swarm in a tree (*madu sambitan* MB), which is often perched several metres above the ground, it remains easily accessible.

The periods between two major flowerings are the best times to search for sites to place and prepare rafters. A week or two before the swarms arrive, the harvesters check the solidity of the sections of tree trunks that have already been installed as nesting structures and look for additional locations not far from the flowering plants to build new ones. To attract the bees, the harvesters do not seek so much a type of forest as a site that facilitates the arrival and installation of the colony in the forest cover. The harvesters roam the forests, often not far from their homes, in search of swarms on the trees. For this, they observe the arrivals and departure of the foraging bees and follow them to their nest, which is often attached to a branch. The harvesters also look for access paths in the vegetation by which the bees can enter the undergrowth and settle on a rafter. These access paths, of varying width, depth, and height, depending on the vegetation present, are called, depending on the regions of the island, *rendap* or *renak*, and form circulation corridors that guide the bees towards the support structure to be set in place by the harvesters. Regularly compared to doors (*pintu*), these arrival points constitute the entrance (and exit) of the location where the rafter will be installed. The harvesters name several types of access paths, but mainly meet and use three: direct access, indirect (or semi-open) access and a well access path (Fig. 1).

The *rendap laut* (or *arung*, *renak ngelandas*, MB, literally translated as “direct”) refers to a broad passage, several metres wide, situated above low vegetation that is often composed of grasses or shrubs (Fig. 1A). The alternation between low and high vegetation often corresponds in the forest to small glades or to a transition in the tiering of the vegetation. The line of flight of the bees towards the rafter is free of obstacles and is generally from the front of the rafter (its upper part). This same type of direct access path can also be found in treetops (*sambit*) where the bees nest. In the forest, this does not last for long because, according to the harvesters, vegetation growth obscures the passage after two or three flowerings (or after a few months). The access path can however be maintained.

Frequently encountered in forests of small trees, such as forests of the *kerangas* type or in young secondary forests (*bebak* MB), the *rendap* or *renak rabas* (MB) (or indirect access) corresponds

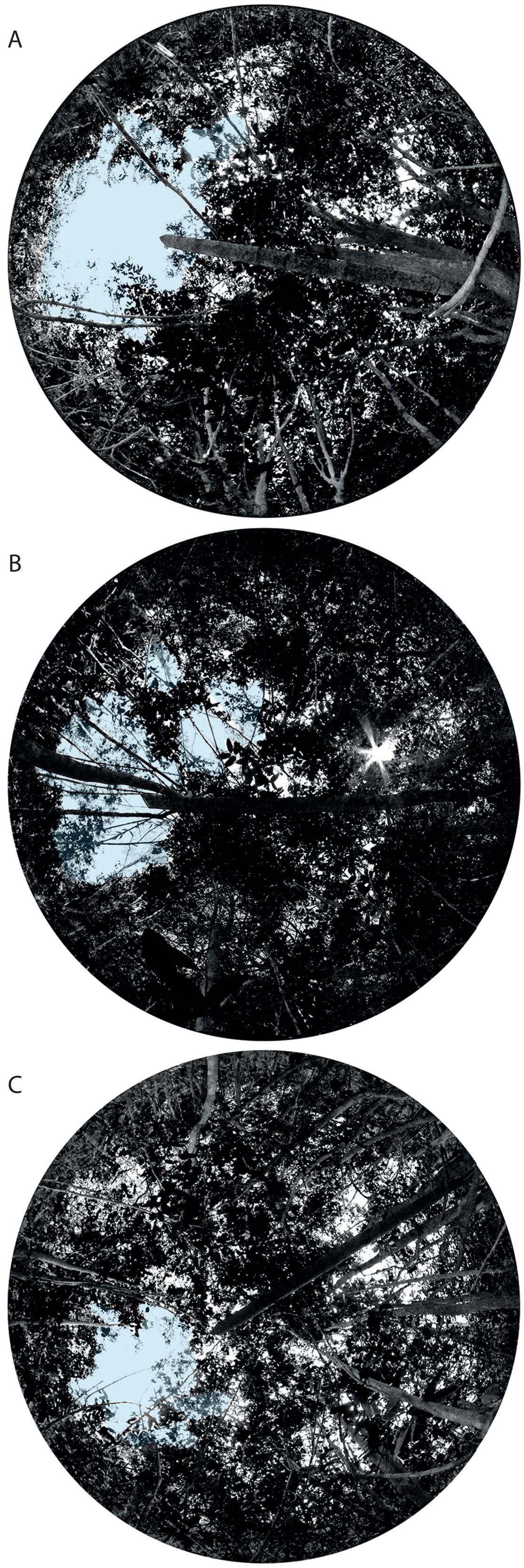

Fig. 1. — Hemispherical photographs of three *rendap* (in pale blue): direct (**A**), indirect (or semi-open) (**B**) and well (**C**) access paths. Credits: N. Césard.

to a passage partially obstructed by trees or branches but with vegetation that is sufficiently spaced to allow the bees to circulate under the rafter (Fig. 1B; Césard 2011: chap. 3). When they arrive on the rafter, the bees enter on its left or right, generally from the bottom, before going upwards towards the support and the comb. The third type of access path is the hardest to find and "improve" (see section "The harvester's position in the niche") and is encountered in the densest forests. The *rendap* or *renak nelage* (or *merigi*, MB, literally translated as "a well") refers to a small gap, which is almost vertical, in vegetation that is surrounded by relatively tall trees (Fig. 1C). Once the passage has been located, the bees dive steeply down to access the rafter and the comb situated below.

These three main access paths in the vegetation can have different names depending on the island localities but there are also variations of form depending on the type of vegetation encountered. For example, at Perpat, a direct access path, where the vegetation progressively closes on the rafter, is called *rendap* "in tail" (*rendap buntut* MB). In addition, certain sites are likely to attract two swarms on the same rafter (the first swarm and the swarm born from it, according to harvesters) when they have access to two paths in the vegetation. The first location is compared to the image of a Sambar deer (*rusa*, *Cervus unicolor* Kerr, 1792) lying in the vegetation in which the antlers indicate two different directions, one by the front and the other by the back (the back of deer path, *rendap melakang rusa* MB). The second location refers to a pandanus palm mat (*kajang* MB) folded (similar to those used for protection from the sun or rain on a boat) and refers to two access paths, one beside the other, that join (folded *kajang* access path, *rendap lipat kajang* MB). The harvesters also pay attention to old forest paths and animal trails. A former corridor trap (*pepa* MB) for small deer (*kijang*, *Muntiacus muntjak* Zimmermann, 1780) can with time be closed by vegetation and form a protected passage for the bees (deer trap access path, *rendap pepa kajang* MB), the same applies to a pedestrian path that is no longer used (*rendap jalan lamak* MB). Once the rafter has been installed, the side by which the bees access the nesting structure also attracts the harvesters' attention: a rafter accessible from the side is called *rendap samping*, while one accessible on both sides of the trunk is designated by the term *telajang* (or *rendap rajang* MB).

The role of sunlight

Without any access path in the vegetation, the bees cannot move about. However, in the opinion of the most experienced harvesters in Belitung, access alone does not guarantee that a swarm will be attracted to a site and settle there permanently. While an experienced observer can identify an access path with relative rapidity and ease, the harvesters, once they have entered the vegetation, look for another fact that many consider to be –like nectar and pollen– a necessity for the bees: sunlight. Before positioning the rafter in the vegetation, the harvesters observe, and sometimes anticipate, the penetration of a sunbeam (*sinar matahari*) through the vegetation. Indeed, the harvesters have observed that the bees, once settled on the rafter, pass through the opening of the access path. However, on their first visit, they follow the shaft of sunlight to find the rafter. Therefore, once the access path for the bees has been identified, the harvesters look for sunbeams penetrating the forest cover, generally all the way to the ground. Roaming the forest in the early morning or at the end of the day, they select the locations that benefit from direct sunlight in the vegetation. Some compare this opening to a window (*jendela*), but unlike the bees' access path that does not have a particular orientation, the shaft of the light through the vegetation follows the sun's course. Most harvesters prefer morning sunlight (from the east) that corresponds better to their routines and activities in the forest, but which is also easier to find in the early hours of the day when the sky is clear and the sunbeams have not yet been blocked by the forest cover.

The penetration of sunbeams through the vegetation depends not only on the time of day but also on density of the vegetation. The location retained must neither be too wide or too narrow, to facilitate the passage of both the bees and the light. In sparse forests with quite low vegetation, the access path of the bees often follows the sunbeam, which strikes the front of the rafter. In denser forests, and in the case of indirect access paths, the sunlight often does not pass by the door *rendap,* but illuminates the side of the rafter through small trees. In forests with high vegetation, the harvesters know it is hard to find a suitable location, unless a tree has fallen or been felled. Often coming from above (well access path), the light arrives later in the day and here again coincides with the access path taken by the bees. To be sure that the shaft of sunlight falls on the rafter, some harvesters climb the tree to hoist up the supporting structure to position it a few metres above the ground. In certain configurations of vegetation, the sunbeams may come from two different sides and thus attract two different swarms onto either the same rafter (a situation called *tangger*) or two rafters placed side by side at the same location. When the trees of a forest are not too tall, a location may benefit from sunbeams, depending on the time of day, from in front of the rafter, as well as from behind. In this case, the bees come from two different directions but leave by the same access path. Sought after because they are likely to attract two swarms, one of which is often considerably larger than the other, situations with dual penetration of sunlight are not always detected in the first instance, but more often only discovered once the harvesters have positioned the rafter in the sunbeam initially identified.

According to the harvesters, not only the type of access path but also the sunlight has an effect on the size of the swarms attracted – and for some, their geographical provenance. As opposed to sites with more direct and more open access, larger swarms are attracted to the best protected locations, such as those with an indirect access path in dense forests, or those in which the position of the rafter is slightly recessed in the vegetation. Furthermore, the characteristics of the sunlight influence the size of the swarms that settle under the rafter: a location with an opening in the front but sunny at the back is especially sought after by harvesters because the large migratory swarms (from Sumatra or from Kalimantan, according to the harvesters) find these conditions ideal for their development. In the absence of a sunbeam falling on the back of a rafter, the harvesters know that the larger swarms will prefer to nest under the branch of a tree rather than on their man-made structure. On the contrary, still according to the harvesters, only small swarms are attracted to sites where the light is insufficient, sunlight is too intermittent or weak, or falling equally on the rafter's front and back.

The duration of the swarm's exposure to the sunlight penetrating through the vegetation is also an important factor. The harvesters consider that sunlight on the nest lasting one to two hours per day is essential for the successful development of the colony. They have observed that the passage of light on the swarm provokes the emergence of a large proportion of the bees from the rafter. When sunlight strikes the nest, the bees move apart, descending towards the bottom of the comb (sometimes as far as the ground) and fly away one after the other via the access path. Then, as the sun continues on its path and the bees depart, the brood cells gradually become visible on the comb. Described as *ngurunsai*, the flight of the bees in response to the light (or the heat) is well known to the harvesters who avoid harvesting the honey, in particular when the bees go far from the nest, because bees cannot all be smoked (and their honey be harvested).

When asked, the harvesters give two complementary explanations for the role played by sunlight and its effects on the bees. The first is that the bees, even those that will not forage, must leave the nest every day to dispose of faeces, which the harvesters observe from the yellow-coloured droppings that they spread when they fly away. The second is that the bees leave the comb to allow the sun to warm the bee brood in order "to dry the young" (*menjemur anak*). The most attentive harvesters note that the phenomenon takes place four to five days after laying, continues every day until most of the new bees have come out and stops shortly before the massive departure of the bees from the nest (reproductive swarming). Once the beam of sunlight has passed, the bees are less active on the comb but continue their arrival and departure "to look for food" (*ngalar ngurunsai* MB).

THE RAFTER, THE SWARM AND ITS NICHE

In Indonesia and in the other regions where rafter harvesting is practiced, the use of an artificial support, a branch or a tree trunk, is directly inspired by the observation of swarms settled on the underside of tree branches. In the lake region of Sentarum (Borneo), the harvesters recall that the origin of the rafters comes from the observation of a branch stuck in the foliage of a tree when flooding receded and on whose underside a swarm had settled. At the different sites studied, a local tradition of honey collecting in tall trees precedes harvesting of rafters and often the two types of practice coexist. The skills encountered at the three sites of my study in Indonesia reveal, however, different levels of accumulated knowledge about the interactions between the insects and their ecosystem, especially ecological factors that determine the installation of migratory swarms.

Finding the niche

The beekeeping literature on the rafter technique sees its sole function as supplying a support, and the few scientific articles on the subject share this same narrow perspective. They focus on the physical support, its shape or its level of inclination, more than on the environment in which it fits. Like other local people who are keen observers of their environment (Roué *et al.* 2015; Petersen & Reddy 2016; see also Simenel *et al.* 2015; Zocchi *et al.* 2020), most Indonesian harvesters of wild honey identify the symbiotic relations linking the bees to the flowers, and more generally to their forest environment. In Belitung especially, this knowledge is regularly discussed among harvesters from the same village and is used in choosing the sites to install the rafters. Thus, in the forest, an experienced harvester does not just bring a section of tree trunk and place it in the vegetation: he thinks of it in relation to a specific territory where the flower resources and their changes with seasons are well known, and in the same way perceives it inside an enclosed space, the contours of which are largely given by the surrounding environment.

When they roam the forest, the harvesters look in the entanglement of the vegetation for a place they consider to be favourable to the arrival of the bees and in which they will install a rafter to attract them. They know that the migratory swarms settle on the undersides of branches of large trees beyond the reach of predators, but are likely to move lower to sites that show the same conditions for features of the environment that are important for bees. Starting from this observation, some harvesters in Belitung choose a location, anticipating the arrival of the swarm on a tree located nearby. When they look for access paths in the forest that bees could follow to come nearer the ground, they also observe the vegetation in search of an "umbrella" tree (*payung* MB) on which the migratory swarm will temporarily stop and from which the bees will explore the surrounding vegetation. The harvesters have in fact noticed that once the bees (scout bees) have descended to vegetation near the ground by following the sunlight, they test several rafters along which they roam before choosing one of them and returning with the entire swarm to settle there.

Once a new site for rafter placement has been identified, the harvesters look for various small trees nearby that they will fell (a section of tree trunk that serves as the main supporting structure, i.e. the rafter, and other sections of smaller trunks that hold it), bring to the site and raise the rafter within the vegetation. The most experienced harvesters of Belitung choose and assemble the structure as a function of the vegetation and exposure to the sunlight, ecological conditions that they perceive as being well suited to the arrival of the bees and their nesting. One of our informants uses the following metaphor: he compares the location of the rafter to a bee house (*rumah lebah*) of which the access path is the door and the opening by which the sunbeams pass, the window.

The position of the rafter –its orientation, height and angle of incline– is adjusted at each location to form a habitat that can be compared to a *niche*, in the sense given to this term by the psychologist of visual perception James J. Gibson,

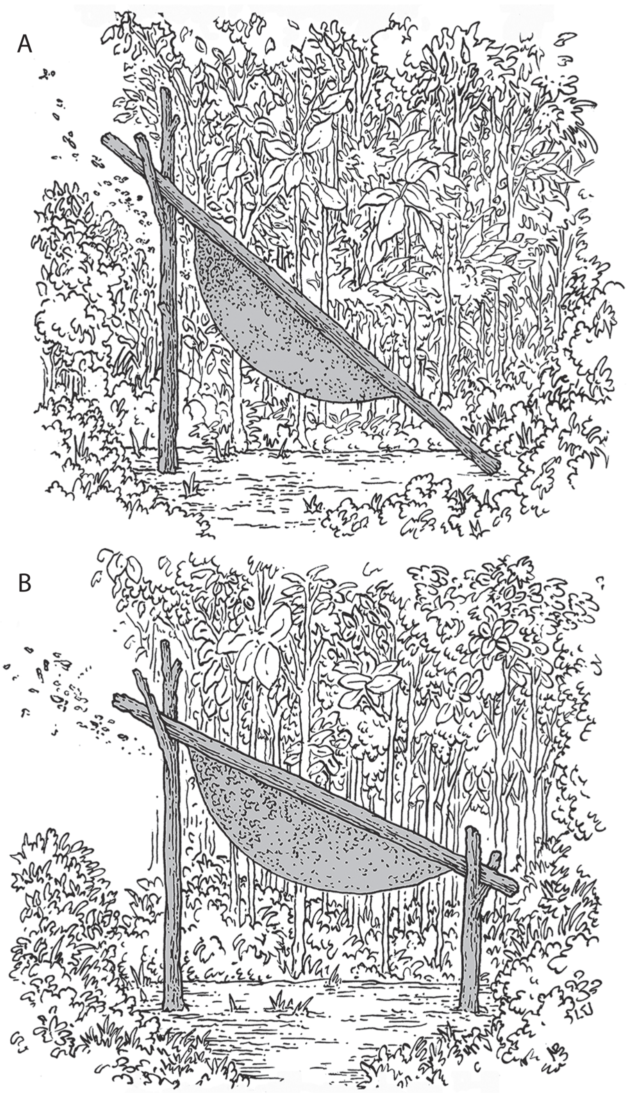

Fig. 2. — Two models of rafters: **A**, *sunggau muke*; **B**, *sunggau bantai*. Credits: C. Vuillier.

i.e. a group of affordances to be perceived as much by the bees as by the harvesters (Gibson 1986: 127, 128). These affordances offered by the location integrate not only the biophysical environment (the objective properties of the rafter placement and of the surrounding environment, as sensed by bees), but also the harvester's perception of the animal and its ecosystem, which brings together objective properties (e.g., sunlight) and non-objective properties (e.g., the shape of the rafter).

A rafter adapted to its environment

In imitating the natural supporting structure for the swarm's nesting, the section of tree trunk or the plank used as rafter "offers" bees a surface on which to build their comb. In Belitung, as in Danau Sentarum (Borneo) and in the Poso Lake region (Sulawesi), the rafter marks the centre of the niche, its heart. Although it is potentially suited to the swarm, the most experienced harvesters in Belitung consider that the rafter alone is not enough to attract the bees. The trunk (or the plank) appears as the central element of a broader whole, which remains largely hidden from unexperienced gazes. Also, most harvesters in Belitung fully realize that although they understand some of the features by which bees assess their environment, from the first flowerings to the supporting structure under which they will nest, it is still hard to put themselves in the place of a migratory swarm, and to reproduce its habitat perfectly. For these harvesters, it is simpler to start from the possibilities that exist within the environment to try to recreate the conditions (even partially) that attract the bees and invite them to nest there.

Once in the vegetation, the harvesters will then direct the rafter towards the bees' access path, before adjusting it. Resting on poles, the section of trunk is brought forward or moved back to offer the future swarm the best protection and the best exposure to the sunlight. The rafter is positioned neither too low –the bees would not have enough space to build their comb– nor too high, as the artificial support must remain accessible for harvesting. According to the harvesters, the vegetation coverage must hide the supporting structure fully or cover it at least three-quarters, with the front section then remaining partially uncovered. Once the rafter is placed on poles, the harvesters continue to follow the sunlight and adjust the rafter's position to the arrival of the sunbeam on the future nest. They raise or lower the trunk, pivot it to one side or another before stabilising the back end, either on another pole, or on the ground. The difference in height between the two supporting poles thus forms the rafter's angle of incline. This is assessed approximately, but according to the conditions of the site the harvesters favour an angle between 15° and 30° (the incline cannot be more than 60° from the horizontal) for better access of the bees between the arrival along the access path and the top end of the trunk section. For the harvesters, the main advantage of this incline is to facilitate the harvest: they have observed that bees concentrate the honey in the upper section of the comb, the honey cells sometimes covering its top end (to form what they call a macaque head, *kepala kerak* MB).

In view of these adjustments, the rafter and the vegetation in which it is inserted seem in our view to reflect not so much the place where the bees live, but rather how they live. While the harvesters of Danau Sentarum and Poso each use only one model of rafter (sections of tree trunks carved into planks of different shapes and types of wood, depending on the region and on individual choice), the harvesters of the island of Belitung distinguish three types of supporting structure. Each model is adapted to its environment and is perceived as the centre of a particular niche and not as an element external to this. Unlike the rafters of Danau Sentarum and Poso, the rafters of Belitung are thought of as crucial elements of the bees' habitat (they can be considered as "attached" objects in the sense given to this term by Gibson [1986: 41]). They are adapted to the behaviour of the swarms, their ethology.

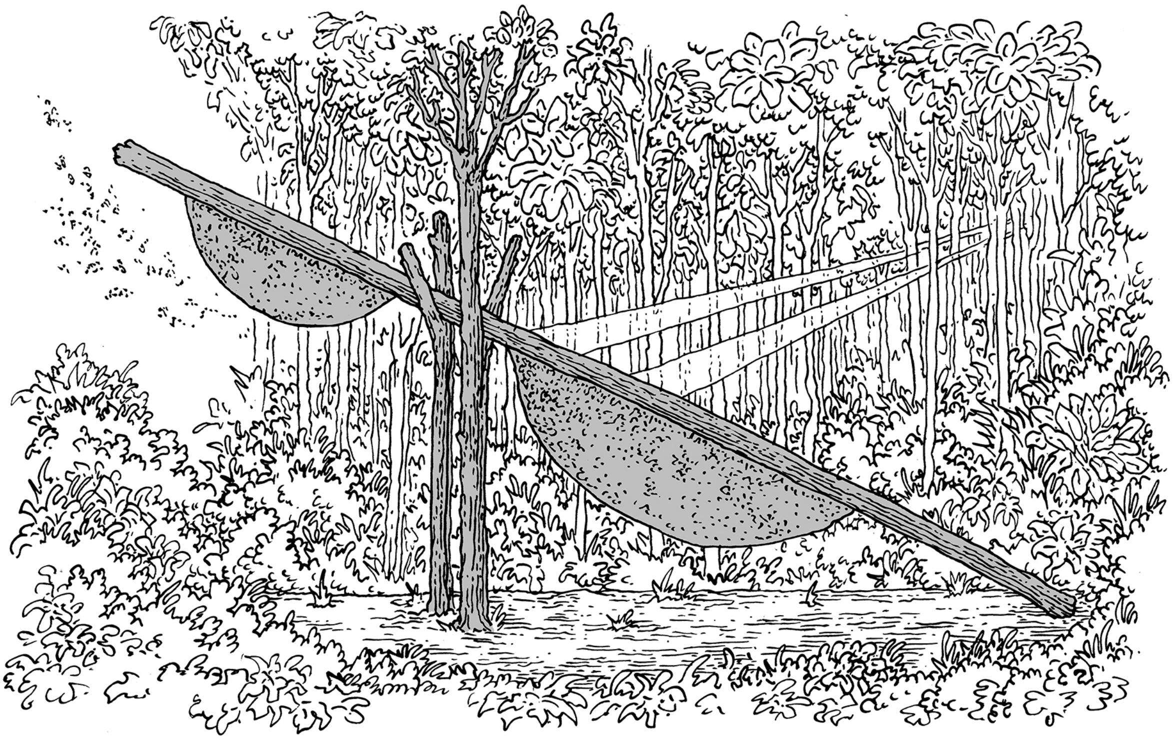

Fig. 3. — A "stowed" rafter (*unggat* type) with two colonies. Credit: C. Vuillier.

The rafter of the *muke* type (or *sunggau muke*) is the simplest model and the quickest to make. It can be adapted to all access paths close to the ground, so the harvesters use it mainly in the low vegetation of the forests of the *kerangas* type and in narrow locations. The section of trunk (more than two metres long) rests against a pole at the front (called *tuga* MB, often at the junction of a bend of a trunk and an auxiliary branch, or sometimes two small trunks that serve as bipod), and its back end rests on the ground. Due to a lack of space, the structure is often small and the rafter's angle large (between 30° and 45°) (Fig. 2A). Because of this, it is hard to adjust the rafter to the sunlight (except on the sides when the access path is indirect). With its upper end positioned close to the opening of an access path, the rafter can only host one swarm, often small. A version of this model, but with two poles, the *bantai* type (or *sunggau bantaian*) of rafter, is used more often. Also adapted to low vegetation, the section of trunk (about two metres long) sits on a pole at its front end and on another shorter pole at the back (Fig. 2B). Building this type of rafter requires more work and more materials, but it offers a large nesting surface. It also allows the height (and angle) to be adjusted to optimize penetration of sunlight. In a village in the eastern part of Belitung, following the same idea, the harvesters bend a small tree to the ground or onto a section of tree trunk cut nearby and use it as a nesting support (which they keep alive).

The third type of rafter, the *unggat* type (or *sunggau unggat*), is a large model (from three to four metres long) designed to attract large swarms and adapted to both low and high vegetation. When space permits, the harvesters prefer it for locations where the access path is direct or of the well type. The trunk can be placed at a height "to look for the sunlight". Vegetation being open at the front end of the rafter, the swarm generally settles a little bit back from this end so as not to be overly exposed. The difficulty for the harvesters is to position the rafter inside the vegetation so that it is not too luminous. The harvesters then refer to a "stowed" sunggau, *sunggau dalam*. Unlike the other models, the rafter sits on a central rest, at the base of a tree or between a trunk and a large branch (Fig. 3). The upper end of the rafter is often high (two to three metres from the ground) and uncovered, so the entry of the bees' access path towards the nest is located below. Closed by the vegetation, the rafter's back end touches the ground, but can be fixed or attached to a supporting structure such as another tree. As this rafter is longer than the others, it can attract two swarms if sunbeams are coming from two directions (*sunggau tangger*). In clear areas, such as by the sea or close to a river, the harvesters sometimes use a supporting tree to cross, most often on the front section, two sections of trunk one on another (*sunggau silang*). The bees can then use one or two access paths to reach or to leave the nest.

The harvester's position in the niche

In Belitung, as in the other regions, the idea that prevails in the rafter technique is that the best site is the one the bees find themselves. So although the harvesters cannot force the migratory swarms to descend into the vegetation, they can manipulate the environment more or less

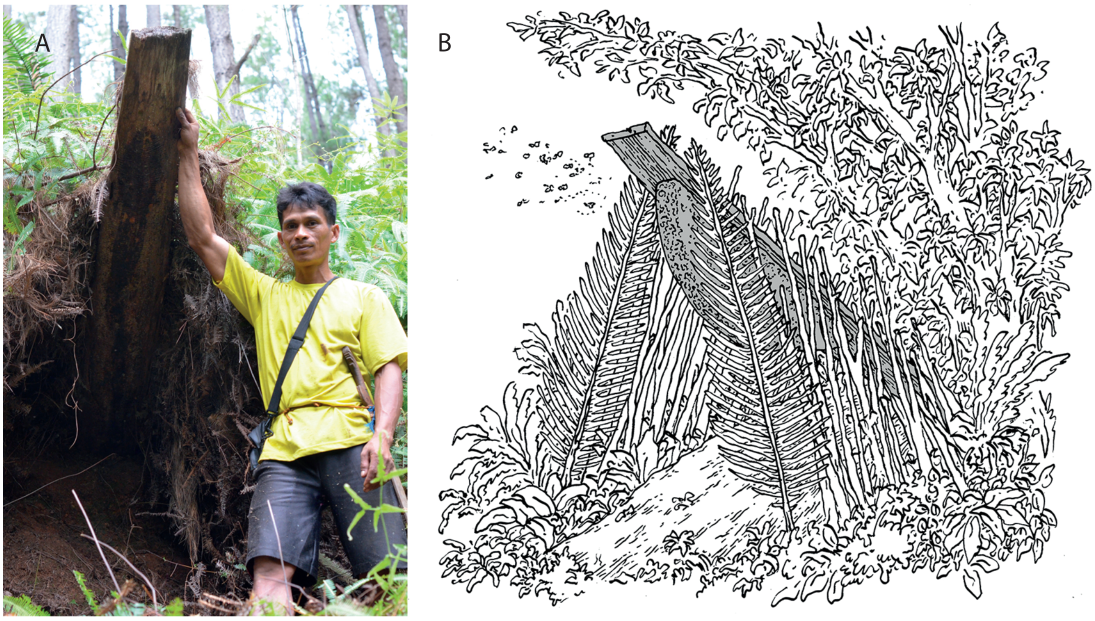

Fig. 4. — A rafter (*tingku*) in Central Sulawesi. Credits: N. Césard (**A**), C. Vuillier (**B**).

directly to attract them. In Danau Sentarum, the harvesters primarily choose trees for their accessibility and often they prune the foliage heavily to form what they call a grotto (*luam* in the local Malay dialect; Césard 2013). In the Poso Lake region, the harvesters formerly planted trees inclined on the slopes of hills in anticipation of the installation of swarms under their trunks. Today they use wooden boards, one end of which is buried deeply (to a length of one metre) and whose visible portion is covered with branches to hide it (Fig. 4). In the villages of Belitung, on the contrary, locations are perceived and thought of in their environment and most of the harvesters exert little action to manipulate the vegetation. When they are in the forest, harvesters try not to change the natural qualities of the sites and content themselves with improving (*perbaiki*) them. When they can, instead of added rafters, the harvesters prefer accessible natural supporting structures (*di dahan, di batang*), such as branches or fallen trees, which they prepare by removing from them climbing plants and some of their foliage.

The capacity of the Belitung harvesters to attract swarms is a reflection of discrete but precise work in identifying and improving sites based on their past experience as well as their personal understanding of the sites. The harvesters seek to perceive the physical properties of the environment such as the niche's contours, "surfaces" that appear to be suited to the swarm that will settle there. In the same way as they represent the forest environment of the migratory swarms mentally to themselves depending on flowering episodes, amongst others, each niche intended to host a swarm is seen to its full potential (a place into which the animal fits "metaphorically", Gibson 1986: 129). Once the location has been identified, the harvesters assess its volume, observing it at length from the inside. They observe especially the intensity of the light in the foliage and intervene on the vegetation with a series of successive actions. They then rely on elements that they know will attract bees and eliminate those that could hamper bees.

The harvesters of Belitung first enter the shelter to "clean" the ground and eliminate the plants and branches that are likely to hinder the installation of the rafter, and later the expansion of the comb. If they consider the bees' access path to be too narrow, they cut the vegetation a little (a few branches, more rarely an entire shrub) to facilitate the passage of bees (Fig. 5), and sometimes the passage of sunlight. Few harvesters risk improving the penetration of a sunbeam coming through the vegetation from the back of the niche. The harvesters are also busy around the shelter. They open the access path from the inside with small touches but can also close it from the outside by arranging cut branches in front when they find it too wide. The most direct action on the niche consists, during the hot season, of thickening the sides to protect the nest from excessive heat at the end of the day. The harvesters then cut back the external vegetation towards the shelter or arrange branches around it to form walls (*merebat, merumbun* MB). During the rainy season, the harvesters have a tendency to cut more of the vegetation, driven by concerns that it will regrow between successive visits. They ensure however that the nest is protected from the rain.

At Perpat, the village harvesters know that the access paths in the forest regularly attract swarms but that they are also harder to find and improve. Several harvesters have adapted the rafter technique to dry forests (and more broadly to the dry season) and now prefer a more interventionist practice in the environment. When they do not find access paths in the dense vegetation (of the *teraja* type), they install their rafters in forest areas that are less fertile and more open, such

Fig. 5. — *Rendap rabas*, before (**A**) and after (**B**) being improved (November 2013). The arrows indicate the cuts in the vegetation. Credits: N. Césard.

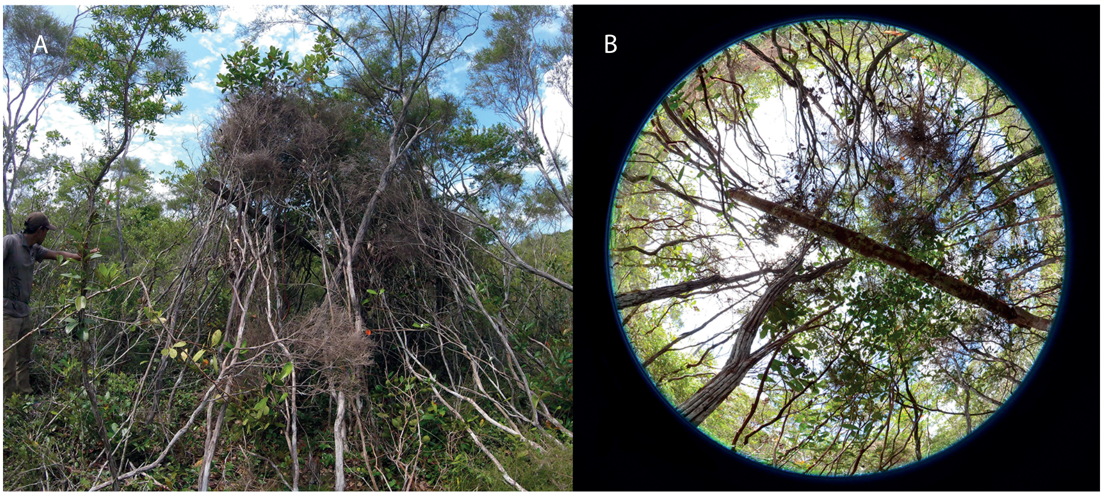

Fig. 6. — Two views on the same rafter (*sunggau muke* with *renak ngelandas*; 28 March 2017). Credits: M. Rhomadona (**A**), N. Césard (**B**).

as those of the *padang*. They place the rafter on two poles (to form a *sunggau muke*) and surround it with slightly spaced branches to protect it from the heat and the arrival of the bees' main predator, the grey-headed fish eagle, *Haliaeetus ichthyaetus* Horsfield, 1821. Arranged vertically against the rafter, the branches delineate the artificial niche that the harvesters compare easily to a house with walls (Fig. 6). Once they have passed through the branches, the bees have a clear access around and in front of the rafter (locally called *renak ngelandas*). The term *renak rintau* is used by harvesters of Perpat to denote an access path in which the highest vegetation is at a good distance from the rafter. The most open sites in the forest have paths that can attract several swarms. Known as ports (*labon* MB), these sites, which are at least one hectare in area (for on average about twenty rafters) but can also be much more extensive, attract migratory swarms from one season to another and serve as indicators of the presence and abundance of the bees in the region each year. If a *labon* has different access paths, the harvesters of Perpat install their rafters in the *padang* two to three metres from each other and let them benefit from the same access path (Fig. 7).

For the harvesters, all the swarms appear different and each one finds the niche that suits them. A swarm is likely to return to the same location the following year when the same flowers bloom. In Belitung, depending on the flowering episodes, a niche can in this way be occupied several times during the year by different swarms. Since a used niche is a niche that has been evaluated as suitable by the bees, the harvesters will seek to make the swarms return. For this, the harvesters maintain the rafters (which they set up and own) and manage the sites (which are considered to be available if the rafter lies on the ground). They start by cleaning the wax on the underside of the nesting structure so that the next swarm finds it clean. Then, periodically before each flowering, they test the rafter's solidity, even replacing it if they think it is too old or damaged. The lifespan of a rafter in Belitung is about three years.

Fig. 7. — Two rafters taking advantage of the same access path. Credit: N. César.

When the supporting structure is replaced, the harvesters choose the same wood species as the previous one, or failing this, a type of wood on whose underside the bees are accustomed to nest. The rafter owners try also to maintain the access path to make the niche last as long as possible. Some particularly attractive locations in the *labon*, especially, are used by bees year after year (with occasional absences owing to vagaries of flowering episodes), a longevity that the harvesters estimate by the number of rafters used in a single niche over time: five rafters on average for the oldest locations, or (since each is used for three years) about fifteen years for each niche.

CONCLUSION

I have shown that on the Indonesian island of Belitung, the skills associated with honey harvesting on rafters rely on precise knowledge of the ecological factors that are likely to attract migratory swarms and incite them to stay (or nest). In the villages of the island, as in other regions where the harvesting of honey from rafters is practiced, the harvesters speculate about how bees choose the locations where they settle. Their reflection closely resembles that of the entomologist and biologist Karl von Frisch when he wondered about what is going on in the head of a Bowerbird when it builds and decorates its habitat (Von Frisch 1974). But while many rafter harvesters consider the plank or trunk to be the external element that incites the colony to settle and build its comb, viewing it as a simple tool, other harvesters, especially in Belitung, "see" and think more broadly. They consider that the vegetation, like the nesting structures that the insects select in their environment, responds to the swarm's need to protect itself. For the bees and for the Belitung harvesters, the efficiency of the niche derives from the impression of safety that it conveys.

For the harvesters of Belitung, the only utility of a branch of a tree or a fallen tree in a forest is for the bees that settle there and the harvesters who know that they might do so. For the latter, humans and bees are able to apprehend in the same manner, via their specific bodies, the properties of what constitutes an "attractive habitat". Despite everything that separates them physiologically and the differences in their cognitive and perceptive capacities, the two species are able to agree on an objective assessment of the characteristics of their shared environment, an argument also developed by Edward S. Reed (1988). Like the hunter who attracts an animal by imitating its cry or examines its tracks to identify it, the honey harvesters discover the habitat of the bee via their bodies and senses. In Belitung, the honey harvesters emphasize the bees' contact (tactile according to them) with the rafter, but above all the importance to bees of sunlight, and therefore of vision, for their appropriation of the niche (see also the vibration as a medium in Thai beetle fighting, Rennesson *et al.* 2012). As we have seen, the harvesters recognize their (physical) differences with the bees. However, as they try to put themselves in the honey bees' place, their attention focuses not only on the swarm or the bees as a sentient organism but on their own understanding of the environment's properties. Their mode of action on the animal is indirect and is performed in the bee habitat through the environment that the two species share.

Most honey collectors elsewhere in Indonesia harvest combs in the trees and do not think (or think little) about the habitat of the swarms. In contrast, most of the Belitung harvesters identify the niche and, except for a few who assemble the niche around the rafter, try not to intervene any more than necessary on it. Indeed, even though the niche and its rafter may fulfill the supposed qualities of a "natural" habitat, the harvesters' chances of success remain uncertain so long as the bees have not yet chosen to settle there. Once bees nest under the trunk, harvesters no longer act on the rafter and leave the bees to work until it is time to harvest. However, unlike a trap that attracts prey in order to retain it (and which would consist of "making it believe to make it act", to use Carole Ferret's phrase [2013]), the niche, just like a beehive, functions as a provisional habitat: the bees are free to leave if conditions, be it food or space, no longer suit them. The niche does not function "by deception of the senses" (Ferret 2013) –the branch being the preferred nesting support of the bees– but by alignment between the sensory capabilities of the bees and the qualities of an environment perceived by humans who are trying to see like bees.

The affordances do not appear gradually as they acquire meaning, but rather they are situated in the environment, as Gibson reminds us. Communication between the two species is through clues that need to be apprehended and then deciphered. In Belitung, it is sufficient for the harvesters to perceive them, and eventually improve upon them. Their perspective is not far removed from research questions addressed by relatively recent fields like sensory ecology (Dusenbery 1992; Uexküll 1992) and bio/ecosemiotics (Maran 2020) on how organisms acquire, process and respond to information from their environment. The emic approach can also help us better understand how certain species, such as pollinators, act as "ecosystem engineers", continuously modifying their environments. It also helps us see why the ecosystems in which these organisms live should be protected (Neeltje *et al.* 2006), and the cultural knowledge that people have about them be recognized.

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