Chapter 8
Honey Bees in Modernized South East Asia: Adaptation or Extinction?

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Abstract Honey bees (*Apis* spp.)—key pollinators—have evolved over millions of years along with flowering plants and Southeast Asia is a key biodiversity hotspot for honey bees. They are known to play a crucial role in maintaining plant biodiversity in forests and agricultural crops for human food production. This chapter describes the history of beekeeping, beekeeping practices, and offers an overview of the impact of changing environments as well as human activities on honey bee populations in Southeast Asia. It presents an overview of the challenges that honey bees currently face in Southeast Asia and contextualizes traditional knowledge and beekeeping practices to harvest bee products that have long been embedded in local cultures. The chapter also examines and introduces how, in recent decades, societies in Southeast Asia have undergone significant transformations, which have severely affected wild and domesticated honey bee populations. It shows how under these conditions some species have adapted to the new environment, whereas other bee populations have been rapidly decreasing. A combination of human activities (e.g., land use and deforestation), newly emerging diseases and climate change have meant that they are struggling to adapt and maintain species survival in the region.

Keywords Asian honey bees · Deforestation · Conservation · Land use
Bee health · Pollinators · Bee diseases · Bee parasites · Biodiversity

Introduction

Honey bees are social insects that not only produce food but also play an important part in religious beliefs and cultures. The history of Asian honey bees is extremely ancient and there are numerous depictions of honey being offered to Buddha, as can be seen in temples in Thailand (Fig. 8.1). Within Southeast Asia region, bees have

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Fig. 8.1 A monkey offering a harvested colony of *A. florea* to the Buddha. This carving depicts an occasion when the Buddha went to the jungle for mediation relating the story of when the elephant and monkey brought him food, which were bananas and dwarf honey bee combs. Photo taken by author at Wat Jed Yod temple, Chiang Mai, Thailand

also been mentioned in legends. These have served as elements of honey-hunting practices in the region and offer us insights into the rich traditions that have arisen out of human-ecological interactions (Oldroyd and Wongsiri 2006).

Honey has also been recorded as an important food in Islamic, Buddhist, and Hindu religious texts (Chantawannakul et al. 2004; Oldroyd and Wongsiri 2006). In Thai Buddhism, monks are permitted to consume honey as a tonic in the evenings, while only consuming one or two meals a day before noon. For instance, during *Vassa* or Buddhist Lent in Laos, Myanmar, Cambodia, and Thailand, a three-month

annual retreat in the rainy season, monks are confined to their temples and beeswax is used to make candles for monks during their meditation (Kobayashi 2013). Honey is also frequently mixed with foods and shared communally during Thai Buddhist festivals. Furthermore, as within other world regions, honey has also been used as a natural sweetener in Southeast Asia. Uses in the region range from topical applications for burns and abrasion, inclusion in traditional herbal medicines, and treating stomach and digestive complaints (Wongsiri et al. 1995; Chantawannakul et al. 2004), and recently, the biomedical activities of Thai honey have been confirmed scientifically. Different antibacterial and antioxidant activities, as well as physiochemical properties of honey are dependent on their nectar sources, such as longan, lychee, coffee, sunflower, sesame, bitter bush, and para-rubber (Wanjai et al. 2012; Pattamayutanon et al. 2015). In northern Thailand, honey is considered to be an elixir if consumed daily with bananas (Chantawannakul et al. 2004). Researchers have noted that humans have hunted honey bees and eaten both honey and broods for feral colonies of honey bees (Crane 1999). There are several traditional recipes using bee brood and honey for local cuisine. For example, in Thailand they are cooked with chicken eggs, which can be made by using a bee brood comb wrapped in banana leaves and steamed in Thailand (Chen et al. 1998). Eating insects are more common in rural rather than urban areas. However, increasing urbanization in the region has meant that entomophagy is in decline (van Huis et al. 2013). Other bee products such as propolis (a plant resin collected by bees), royal jelly, and bee pollen also show various levels of consumption. Propolis has become popular for medical uses as it has been proven to possess antimicrobial and antioxidant compounds (Sanpa et al. 2015; Bankova et al. 2000). Thai propolis, in particular, was found to have bioactive compounds from mangoes and mangosteens (Sanpa et al. 2016).

Most importantly for Southeast Asia, honey bees are the main pollinators (Stout and Morales 2009), whose pollination services have been markedly undervalued since they are more known for producing honey rather than for their role as crucial pollinators. At present, it has been estimated that global crop production (approximately 35%) depends on insect pollination (Klein et al. 2007) with more than 70% of the leading food crops worldwide dependent upon insect pollination. As such, there is a dearth of information on the role of honey bee pollination in Southeast Asia.

This chapter will discuss the use of honey bees and beekeeping in Southeast Asia, with special reference to modern beekeeping techniques that were introduced to the region in the late twentieth century. It focuses on environmental changes affecting the region, potential honey bee pathogens, and parasites that have affected honey bees and the challenges of beekeeping as an industry for local communities. Based on this discussion, this chapter argues that the beekeeping industry must develop a positive holistic approach, which includes input from all stakeholders: scientists, policymakers, beekeepers, and business partners, to manage environmental costs and also present and future conservation of honey bee species in Southeast Asia.

Evolution and Diversity of Honey Bees in Southeast Asia

Honey bees have been evolving for more than thirty million years. The first fossil species of the genus discovered in Europe was *Apis henshawi* (Cockerell 1907, 1909). Another bee fossil *Apis javana* (Stauffer 1979) of the Cenozoic era was found in Malaysia. This species is believed to be a close ancestor of *Apis cerana* (Fabricius 1793). Approximately every million years 20–25% of all species are replaced, numerous extinctions and other speciation events take place (Rosenzweig 1995), and nine extinctions have occurred during the Miocene and Oligocene of the Cenozoic era, over 41 million years ago (Engel 1998; Spellerberg and Sawyer 1999) (i.e., *Apis armbrusteri* (Zeuner and Manning 1976), *Apis catanensis* (Roussy 1960), *Apis cuenoti* (Théobald 1937), *Apis henshawi* (Cockerell 1909), *Apis longtibia* (Zhang 1990), *Apis melisuga* (Zeuner and Manning 1976), *Apis miocenica* (Zhang 1990), *Apis petrefacta*, and *Apis vetustus* (Engel 1998)). Approximately two million years ago, there were at least nine extant species present since the Holocene and Pleistocene eras (Engel 1998; Spellerberg and Sawyer 1999): *Apis andreniformis* (Smith 1858), *A. cerana* (Fabricius 1793), *Apis dorsata* (Fabricius 1793), *Apis laborisa* (Smith 1871), *Apis koschevnikovi* (Tingsek et al. 1988), *Apis florea* (Fabricius 1787), *Apis nigrocincta* (Smith 1861), *Apis nuluensis* (Tingsek et al. 1996), and *A. mellifera* (Linnaeus 1758). In the modern period, through translocation by humans and economic activities, *Apis mellifera* has become a cosmopolitan species, whereas the other eight extant species have maintained ecological niches in Asia.

Southeast Asia has the largest diversity of honey bees covering all nine native species and one introduced species (*A. mellifera*), which has now become widespread in Southeast Asia (Fig. 8.2). All are regarded as one of the key pollinators that maintain forest ecosystems in the region and are grouped according to their nesting structures (i.e., open and cavity nesting) (Rahman and Rahman 2000; Buawangpong et al. 2014). Cavity nesting Asian honey bees (i.e., *A. cerana*, *A. koschevnikovi*, *A. nigrocincta*, and *A. nuluensis*) are commonly found in protective cavities in small caves or tree hollows honeybees (Oldroyd and Wongsiri 2006). *A. cerana* is more cosmopolitan, compared to the other native species and distributed throughout Southeast Asian countries. The other three Asian cavity nesting honey bees are restricted to other areas in Southeast Asia (Fig. 8.2). The giant honey bee (*A. dorsata, A. laboriosa*) that frequently hang their open air nests on the branches of tall trees and cliffs, nowadays have adapted themselves to nest on high concrete buildings (Wongsiri et al. 1996) and are geographically limited to warm climates (Crane 2003). The two dwarf Asian honey bee species (*A. florea* and *A. andreniformis*) have open air nests. *A. florea* is also found in Southeast countries (Crane 2003) and recently, there is evidence that supports the recognition of the giant Philippines honey bee *Apis breviligula* as a separate species from *A. dorsata* (Lo et al. 2010). In the 1990s, the European honey bee (*A. mellifera*), which can be domesticated, was introduced into the region. The species diversity of bees is

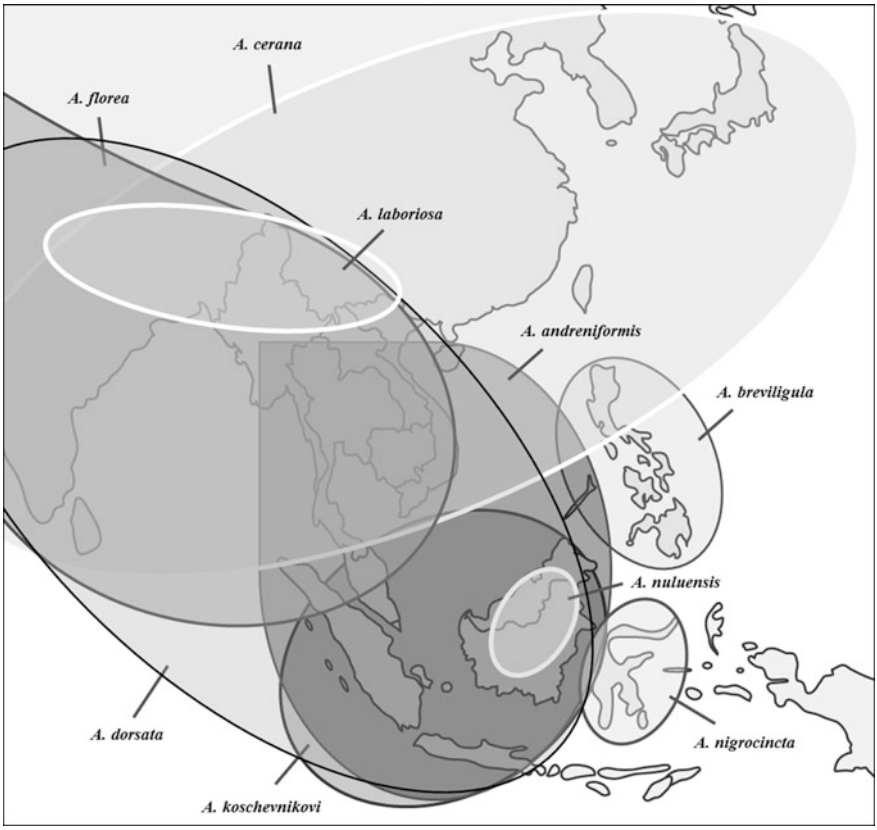

Fig. 8.2 Distribution map of Asian honey **bee species in Southeast Asia**
Source Author

highest in the tropics and decrease toward the poles (Spellerberg and Sawyer 1999). This pattern of honey bee distribution holds the key to the survival of honey bees.

Hunting Wild Bees

Southeast Asian societies have commonly exploited wild bees through a honey-gatherer lifestyle near forested areas. Local people in Southeast Asia still maintain gathering practices to exploit wild honey bees (Chantawannakul et al. 2004). *A. dorsata* and *A. florea* are opportunistically harvested or actively sought out by honey hunters (Fig. 8.3a, b). Harvesting wild honey from the giant honey bee is usually risky and a destructive operation as it requires cutting the combs (Oldroyd and Wongsiri 2006). The harvesting period in Northern Thailand falls during February–April annually, which is a dry season and where the moisture in the

Fig. 8.3 **a** Dwarf honey bee (*A. florea*). **b** Giant honey bee (*A. dorsata*). The photos were taken in Chiang Mai, Thailand. Photo by the author

honey is low and less likely to be fermented. Bee hunters observe the bees from the time of their arrival at the tree and often choose hives which are full of honey. In particular, hunters harvest honey immediately prior to the colony's migration which can be observed through bee behavior such as when the queen's brood laying rate is reduced (Saraithong et al. 2012). Such operations can minimize brood loss. Hunters prefer to take down the beehives at night, especially moonless ones, or early mornings. In Thai local cultures, it is also believed that bee sites or bee trees have angels living in them and protecting the trees. Before the operation, some hunters will pray or chant for permission and for a safe and successful operation. They use bamboo ladders to climb trees or rope wrapped around the trunk and climb the trees and light their torch and brush the comb. In peninsular Malaysia and Sumatra, for example, hunters often strike the branch with the torch to cause sparks and chant for the bees to "follow the stars" (Buchmann and Nabhan 1996; Oldroyd and Wongsiri 2006). When most of the adult bees are brushed off the comb, the hunter will cut off the comb having a basket hanging under it. In some parts of Southeast Asia, only honey is consumed, but in many other areas of the region, both honey and the brood are consumed, e.g., Thailand (Oldroyd and Wongsiri 2006). Honey is filtered with white cotton and the brood is cut into small squares. In Vietnam, Borneo, Sumatra and Sulawesi, Malaysia, and Cambodia, rafter beekeeping[1] of *A. dorsata* is also carried out (Hadisoesilo 2000; Waring and Jump 2004). Honey collectors take their harvests just before the colonies are due to migrate. In Southeast Asian countries, where rafter beekeeping is practiced, this is the most practical way of sustainable harvesting of *A. dorsata*. One rafter can yield approximately four kgs of harvested honey and they can potentially produce up to several harvests per year (Oldroyd and Wongsiri 2006). The wild honey from the giant honey costs about US $5 dollar per kg (personal observation; Oldroyd and Wongsiri 2006)

Hunting dwarf honey bees (*A. florea*) is relatively easy, since they nest in lower sites such as tree branches in orchards and are not aggressive. Hunters shake nests vigorously and once the queen is airborne the adult worker bees will follow and leave the comb. Hunters often cut the supporting branch and bind it into a bamboo tripod. In Thailand, 40,000–50,000 nests are sold annually in local markets (Chen et al. 1998; Oldroyd and Wongsiri 2006). At present, wild honey is still popular as it is perceived to be a pure and healthy product in Thailand (Chantawannakul et al. 2004; Oldroyd and Wongsiri 2006).

Traditional honey bee hunting and beekeeping are important in the spiritual and economic life of Southeast Asia. However, beekeeping practices are less well developed in the region than in temperate zones. Only one species has been domesticated in the region, where the open-nesting species are hunted for their honey. The availability of wild bees that can potentially be easily hunted is a key factor in harvesting honey.

[1]Rafter beekeeping is where hunters place tree-poles in the ground at a slight angle creating an environment for honeybees to migrate and populate.

As Southeast Asia is abundant with wild bees it is not necessary to domesticate cavity-nesting bees as can be seen in other parts of the world (Chantawananku l et al. 2016). Societies in the region also use other sweeteners that are derived from other crops, such as sugarcane, sweet sap from coconuts, and palm sugar. However, many local Southeast Asians build hives to attract bee swarms. Bait hives vary from the hollow log hives deployed in either a vertical or horizontal position, or simple man-made containers built of local materials that are available such as clay pots and straw baskets (Chantawannakul et al. 2004). Honey can be harvested by opening hives and cutting out the honey combs. The cavity nesting Asian honey bee, *A. cerana*, has been kept through a traditional approach for a long time to produce honey and wax for trade items. The Tai, ancestors of the modern Thai-Lao-Shan ethnolinguistic group, have practiced beekeeping with *A. cerana* in Xishuang Banna of the southern Yunnan Province in China for more than one thousand years (Wongsiri et al. 1987). Nevertheless, beekeeping in hollow log hives is not widely practiced in Thailand, Malaysia, and the Philippines. In Thailand, farmers often keep them with their agricultural areas such as the coffee plantations in Doi Saket, Chiang Mai, and they can harvest about 2.4 kg/colony/year, which is much lower than that of the European honey bee (35–40 kg/colony/year) (Fig. 8.4). Wild honey are also commonly harvested from *A. cerana*, *A. andreniformis*, *A. nuluensis,* and *A. koschevnikovi* in Malaysia. They all are proven to contain high polyphenol contributing to their antimicrobial activities (Yap et al. 2015)

Fig. 8.4 *Apis cerana* beekeeping in Chiang Mai, Thailand. Photo taken by the author

Modern Beekeeping Practices

Modern beekeeping management (keeping bees in a standard bee box) with European honey bees (Fig. 8.5) was introduced to Southeast Asia by European and American missionaries in the early 1990s (Oldroyd and Wongsiri 2006). Since then, modern beekeeping has expanded to many parts of the region, for example, *A. mellifera* was first introduced to Thailand for research purpose at Chulalongkorn University, Bangkok in the early 1940s and successfully expand to other areas in 1975 and now Thailand has more than 200,000 colonies (Oldroyd and Wongsiri 2006; Sanpa and Chantawannakul 2009). Many local Thai have been able to afford investing in the purchase of modern boxes. At present, new beekeeping management techniques meant beekeepers now have modern beekeeping knowledge and skills. However, European beekeeping techniques were applied to *A. cerana* without much success since their low honey production could not balance the cost of modern beekeeping costs and their frequent absconding into nature. The flexibility of European honey bees to adapt to a different environment has made them one of the most popular species in the beekeeping industry in Southeast Asia. Food and Agriculture Organization (FAO) data shows that the global population of European honey bee hives has increased by about 45% during the last 50 years due to economic globalization (Aizen and Harder 2009). As such, European honey bees are now regarded as the most widely distributed alien pollinator in the world (Kearns et al. 1998).

Fig. 8.5 European beekeeping in Chiang Mai, Thailand. Photo taken by the author

Even though *A. cerana* bees produce less honey than the European honey bee it is important to note that they are more resistant to diseases and pests (Chantawannakul et al. 2016), adapt well in the mountainous areas, and require lower levels of investment. Nowadays, about 6000 colonies are present in Thailand (Oldroyd and Wongsiri 2006). In addition, cavity nesting Asian honey bees have been reported to be more efficient pollinators of various fruit and vegetable crops than their European counterparts (Hepbrun and Radloff 2011; Rahman and Rahman 2000). Giant honey bees also have a wider foraging range than European honey bees and this can assist in the pollination of the forest ecosystem. In lowland forests, abundant with trees of the family Dipterocarpaceae, *A. dorsata*, the giant honey bee, is the main pollinator for at least 15 species of trees in Lambir (Momose et al. 1998) and the upper strata of forests in peninsular Malaysia (Appanah 1985). Dwarf Asian honey bees are also excellent as orchard and filed crop pollinators such as longan and mango in Thailand (Wongsiri et al. 1996). The roles of native honey bees in modern agro-ecosystems are also confirmed by the study showing that native bees can provide sufficient pollination for watermelon crops in the absence of domesticated honey bees (Ruttner 1988; Winfree et al. 2007). At present, bee products are honey, brood, propolis, bee wax, royal jelly, bee pollen, and bee venom and they are widely used in commercial products in the region (Oldroyd and Wongsiri 2006). Nevertheless, honey is still regarded more as a medicine than a food and bee products that are consumed by local people vary greatly across the region depending on local cultures and the sphere of religious influence. Royal jelly, pollen, bee venom, and propolis are known to be consumed as part of food supplements and medicinal alternatives.

Environmental Changes: Honey Bee Adaptation

Pests Parasites and Pathogens

As previously mentioned, honeybees are the most efficient of all the bees as pollinators of crops and natural flora (Hepbrun and Radloff 2011), however, in recent years, the decline of the honey bee population has become a great concern (Cox-Foster et al. 2007). Colony collapse disorder (or CCD) or bee losses are reported in many regions across North America and Europe (Genersch et al. 2010; van Engelsdorp et al. 2010), however, there are few reports of managed and non-managed colonies lost in Southeast Asia (Chantawanankul et al. 2016). The main factors that affect the honey bee populations are pesticide application in agricultural fields and changes of plant biodiversity (Oldroyd and Wongsiri 2006). Competition between honey bee species and inter-species transfer of pathogen and parasites have led to these losses (Yang 2005; Stout and Morales 2009; He and Lui 2011; Li et al. 2012).

European honey bees have encountered diseases and parasites which have co-evolved with wild native honey bees in Asia (Chantawannakul et al. 2016). The most serious and widespread parasites today are the *Varroa* mite and the *Nosema*, acclaimed to originate from *A. cerana*. They have been linked with colony loss in many parts of the world (Higes et al. 2008). In some parts of Southeast Asia, *Tropilaelaps* mites, originally parasitized in giant honey bees, are now probably the most destructive pests and prevalent in European beekeeping throughout the region (Chantawannakul et al. 2016). The number of infesting *Tropilaelaps* mites are often higher than *Varroa* mites in Thailand (Burgett et al. 1983; Buawangpong et al. 2015). Bee viruses are also reported to be jumping from native Asian honey bee species to the European honey bee when they are sharing the same habitat as with, for example, the Kashmir bee virus (KBV), first discovered in *A. cerana* (Bailey and Woods 1977). Likewise, the European honey bee also acts as a pest and pathogen reservoir that can later be transmitted back to native Asian honey bees (Chantawannakul et al. 2016), thereby promoting the presence of bee pests and parasites in the region.

Modern Society and Complications

Forests are an important source of livelihood for millions of people and play critical roles in regulating the world's climate, especially in Southeast Asia (Miura et al. 2015; Romijin et al. 2015). Honey bees depend on plant nectars and pollens for their carbohydrates, proteins, and fat diets. Plant resin is also collected by cavity nesting honey bees for their nest structure, propolis. This plays an important role in the defense of colonies due to their antimicrobial properties (Sanpa et al. 2015). Human agricultural activities and urban expansion have led to rapid deforestation, which is depriving honey bees of their food sources. However, few studies have shown the positive effects of urbanization on cavity nesting honey bees within urban areas (Winfree et al. 2007).

Deforestation is presently considered to be a major threat to loss biodiversity and habitat fragmentation (FAO 2010). Southeast Asia's mountainous mainland region stretches across Cambodia, Lao PDR, Myanmar, Thailand, Vietnam, and China and represents the largest tropical forest in the mainland Southeast Asia (Rerkasem et al. 2009). At present, wood removal is highest in many Southeast Asian countries and is on the increase. FAO data indicate that Indonesia and Myanmar were ranked in the top ten countries in the world that emitted CO_2 from land use during the years 1990–2012 (FAOSTAT 2015). With rapid deforestation and with permanent cropping, land use in the region is rapidly transforming landscapes. Thus, forest areas or natural habitat for wild bees have been greatly reduced. The expansion of cash crops (e.g. rubber, cabbage, corn, and maize) are also greatly increasing and acting as a catalyst for change (Ahrends et al. 2015). Farmers in the region have been given seeds and fertilizers on credit and the traders will come to purchase their harvest (Vongvisouk et al. 2016). Market networks have been responsible for

introducing modern technology to the region. However, the downturn of this operation is that villagers tend to invade forest areas and practice monoculture-dominated agriculture, greatly reducing plant diversity. This results in the decline of food sources and habitats for wild bees. Each honey bee species may be affected by deforestation to different degrees. Deforestation greatly affects the cavity Asian honey bee, *A. cerana*, as old-growth forests provide cavity containing trees for nesting sites (Oldroyd and Wongsiri 2006). *A. koschevnikovi* is restricted to intact rainforest as in Borneo (Otis 1996). However, *A. florea* which does not need cavity for nesting, seems to adapt well in disturbed habitats (Oldroyd and Wongsiri 2006). Regarding previous observations, *A. dorsata* has been reported to be in decline due to the clearing of Asian Dipterocarp forests (Oldroyd and Wongsiri 2006). Likewise, *A. laboriosa* population is declining in Nepal because of deforestation in the middle-hill zone between 1000–2500 m (Underwood 1992; Thapa 2001; Valli and Summers 1998). In addition, the negative impacts of modern agricultural interventions, e.g., the use of chemical fertilizers, pesticides, and environmental pollution have been reported in many countries including Southeast Asia and are a major source of the decline of honey bee populations (Aizen and Fiensinger 1994; Partap and Partap 1997, 2002; Ricketts et al. 2008).

Invasive plant species may also have additional direct or indirect impacts on feral honey bees. Pollen varies in protein content amongst plant species and this affects the pollen foraging behavior of honey bees. If they are a higher quantity and quality of invasive species than native plants, this could act as a food source. In Northern Thailand, a sensitive plant (*Mimosa pudica*) is one of the major pollen sources for honey bees. On the other hand, if pollens and nectars of the invasive plant species are not suitable for honey bees they can also have a negative impact on honey bee survival (Stout and Morales 2009).

Climate change is also another factor that might impact honey bee diversity in the region (Brown and Paxton 2009). Seasonal shift, rainfall, drought, distribution/extinction of flower species, and other environmental factors are impacting on nectar and pollen flows, the main food sources for honey bees (Thuiller et al. 2005; Le Conte and Navajas 2008). Honey bee species (*A. laboriosa, A. nigrocincta, and A. nuluensis*) that have narrow range of habitat will be greatly affected by climate change as their access to floral sources in their habitats becomes restricted (Oldroyd and Wongsiri 2006). Meteorological modeling forecasts that the average global temperature will increase 1–6 °C over the next hundred years. If this occurs, it will affect the weather patterns including the frequency of extreme weather and impact upon pollinators such as honey bees (IPCC 2001). Therefore, the key risks of the region are warming and drying trends, extreme temperatures, extreme precipitation, and cyclones. Additionally, the expansion of cities and new job opportunities in urban areas has seen many people move from rural areas and leave their agricultural fields impacting upon the maintenance of bee colonies.

Although there are individual pockets of successful European beekeeping operations in the region, the industry is still impeded in some countries (e.g., Laos, Cambodia, and Myanmar) by several factors. These include a lack of infrastructure, a lack of large-scale agriculture, and necessary beekeeping management

knowledge. European beekeeping usually requires capital investments and external inputs which are not easy for local communities to initiate. In particular, management costs and apicultural practices are somewhat beyond the economic means of most local people (fixed cost for beehive equipment 1600 THB (US $48)/hive and the operational cost is 2000 THB/hive/year (US $57) (US $1 = 35 THB)). In addition, beekeeping operations are sometimes not economically viable (Chantawannakul et al. 2004). Surveys show that the most viable beekeeping operations in Chiang Mai, Thailand are medium-sized ones (101–1000 hives), which account for about 66% of the total number of beekeepers. Colony operation costs include local bee pest and parasite controls, sugar that is used to feed colony during dearth periods, land rental costs, and transport expenses for trucks and other heavy equipment due to the migratory nature of the business. Small-scale beekeeping operations remain as sideline enterprises, whereas medium- and large-scale operations can develop into full-time occupations. The pollination service business does not exist as it does in other western countries such as the US. Nevertheless, other factors such as the input of capital must be taken into consideration. Beekeeping management techniques, marketing practices, and seasonal factors such as climate, nectar flow, etc. are important variables as they influence the investment and decision-making of local beekeepers not just in Northern Thailand, but also in other parts of Southeast Asia.

Some local beekeepers cannot obtain high yields of honey. Factors that contribute to low honey yields are a lack of beekeeping knowledge, diseases, and pests, as well as agricultural pollutants. In some parts of Southeast Asia, domestic supply does not meet national demand. As such, shortfalls are met by imports. According to published reports, exports of packaged honey from Western Australia to Malaysia and Singapore in particular, increased over a five-year period until the Asian economic downturn (Chantawannakul et al. 2004).

Future Prospects

Most world regions including Southeast Asia, are experiencing the risks and opportunities of economic globalization. Human agro-economic activities not only affect the global bee population but in some cases, also can disrupt the evolutionary process of honey bee species. Habitat change and the loss and fragmentation associated with agriculture intensification are fundamental risks for native honey bees (Kremen et al. 2002; Murray et al. 2009). Therefore, the conservation of honey bee diversity and their ecosystems is the greatest challenge that we have ever encountered. The “pollinator crisis” is not far-fetched. Honey bee losses, in turn, will affect both wildflowers and cultivated crops, which are dependent on pollination service by honey bees (Potts et al. 2010). The increase of European honey bee populations in the region for commercial purposes might compensate pollination service, provided by feral honeybees, however, European honey bee populations will not cover all. Introduced honey bee species, in this case, the European

honey bee has never been thoroughly assessed in Southeast Asia, in terms of food and nest site competition and this requires urgent research attention. Environmental costs warrant recognition and consideration during the development of agriculture and conservation policies, and also effective measures that can put policies into practice. As mentioned above, the conservation of honey bee species in Southeast Asia not only depends on biological factors but also social, political, and economic ones. New technologies have introduced new regimes of extraction and commodification that directly impact on the region's key pollinators. The beekeeping industry in Southeast Asian countries requires a holistic approach including input from scientists, policy makers, beekeepers, and business partners. As such, a constructive and innovative *modus operandi* is essential to promote the economic vitality of the beekeeping industry and also maintaining the balance of wild bees to warrant sufficient pollinators in the forest ecosystem and guarantee human food sources as human societies and their activities intensively impact upon the region's ecosystems and services.

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