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The Asian Honey Bee (*Apis cerana*) is Significantly in Decline

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Introduction

For up to two thousand years, the Asian honey bee *Apis cerana* has been raised in indigenous cultures across the Asian continent (Crane, 1995). Beginning around the early 20th century, however, beekeepers across Asia began to import the European honey bee, *Apis mellifera,* a species that lives in significantly larger colonies (30,000–50,000 vs. 2,000–20,000 in *A. cerana*). *A. mellifera* is considered to be more productive than its Asian counterpart, and therefore more suitable for commercial beekeeping (Abrol, 2013; Atwal, 2000).

Whether or not *A. mellifera* is profitable, it's introduction into the native range of *A. cerana* is often problematic, for myriad reasons:

- competition for floral resources;
- interference with *A. cerana* mating by *A. mellifera* drones, who will pursue *A. cerana* queens;
- the introduction and exchange of pests and diseases.

All have contributed to a drastic decline in *A. cerana* health and numbers. Although *A. cerana* produces less honey per colony than *A. mellifera*, its natural robustness, disease resistance, and docile temperament make it very easy to keep, especially in areas where the technology and materials required for keeping European honey bees may be difficult to obtain. In addition to providing priceless pollination services to both wild and cultivated landscapes, *A. cerana* has great economic potential for small- and large-scale beekeeping alike. Indeed, sustained and improved beekeeping with *A. cerana* is crucial to the species' preservation. Promoting the use of native Asian honey bees and using breeding techniques similar to those for *A. mellifera* should maximize the ecological and economic benefits of this well-adapted and genetically valuable species, though current breeding efforts with *A. cerana* have been limited and instrumental insemination is difficult.

What are the drivers of *A. mellifera* imports into Asia, and what is *A. cerana*'s current status? Through a literature review and a survey of 16 Asian countries, this article seeks to answer those questions and demonstrate possible concepts for preserving genetic diversity within *A. cerana*.

Distribution and taxonomy

A. cerana is very similar in appearance to the European honey bee, though it has a smaller average body size. Colonies of *A. cerana* are also smaller, roughly 2,000–20,000, whereas *A. mellifera* colonies can reach upwards of 50,000 members (Koetz, 2013). *A. cerana* naturally occurs on roughly 30 million km^2 of Asian landscape in climatic regions ranging from tropical, moist rainforests to dry grasslands and taiga (Koetz, 2013; Radloff et al., 2010). The species can also be found in northeastern Australia, Papua New Guinea, the Solomon Islands, where it has been introduced (Koetz, 2013). In the 1970s, *A. cerana* was deliberately introduced to Papua New Guinea, where it has since gone feral and spread. Since the mid 1990s, *A. cerana* colonies found in Australia have been destroyed in order to prevent the introduction of *Varroa* mites (Anderson, Annand, Lacey, & Ete, 2012).

Due to its vast, diverse geographic range, there is great genetic variety within the *A. cerana* species. Ruttner (1988) recognized four subspecies: *A. c. cerana*, *A. c. indica*, *A. c. japonica* and *A. c. himalaya*, and many other ecotypes have been described. The most recent classification by Radloff separates *A. cerana* into "morphoclusters," unnamed subspecies sets based on twelve morphological features. As many *A. cerana* taxa are no longer considered valid, morphoclusters allow for a geographic separation of *A. cerana* populations that is fluid, but still biologically meaningful (Radloff et al., 2010) (Figure 1).

Beekeeping with A. cerana *and the influence of* A. mellifera

Across Asia, beekeeping enterprises include stationary, single-family setups with traditional hives; small-scale beekeeping using frame hives that is either stationary or migratory; and intensive, large-scale, migratory beekeeping (Tan & Binh, 1993). Ancient, indigenous beekeeping techniques are still used today, with hive types that include hollowed logs, wall recesses, and a variety of boxes made from locally available materials (Hisashi, 2010; Verma & Attri, 2008). Many box hives are constructed so that they can be managed similarly to movable-frame hives (Akratanakul, Saen, & Pathom, 1990). The hive boxes and equipment designed for *A. mellifera* are highly standardized, but this is not the case for *A. cerana* boxes across Asia, due primarily to the great variation among *A. cerana* populations in size, comb spacing, and local management practices, though further research on the potential for standardization is warranted.

The decline of *A. cerana* populations has a number of direct and indirect drivers. The rapid transition of forests into rubber and palm oil plantations, short-cycle forestry stands, and other agricultural enterprises has been devastating to pollinator populations in general (Abrol, 2013; Oldroyd & Nanork, 2006). Moreover imports of *A. mellifera* drive *A. cerana* decline by introducing diseases and through sheer replacement due to the higher efficiency of *A. mellifera* especially within the changed agricultural framework (Abrol, 2013; Verma, 1993). European honey bees have been steadily introduced into Asian countries starting in the late 1800s (see Table 1). For example, some of the first European honey bees arrived in India in 1880 and were firmly established by 1960 (Abrol, 2013; Crane,

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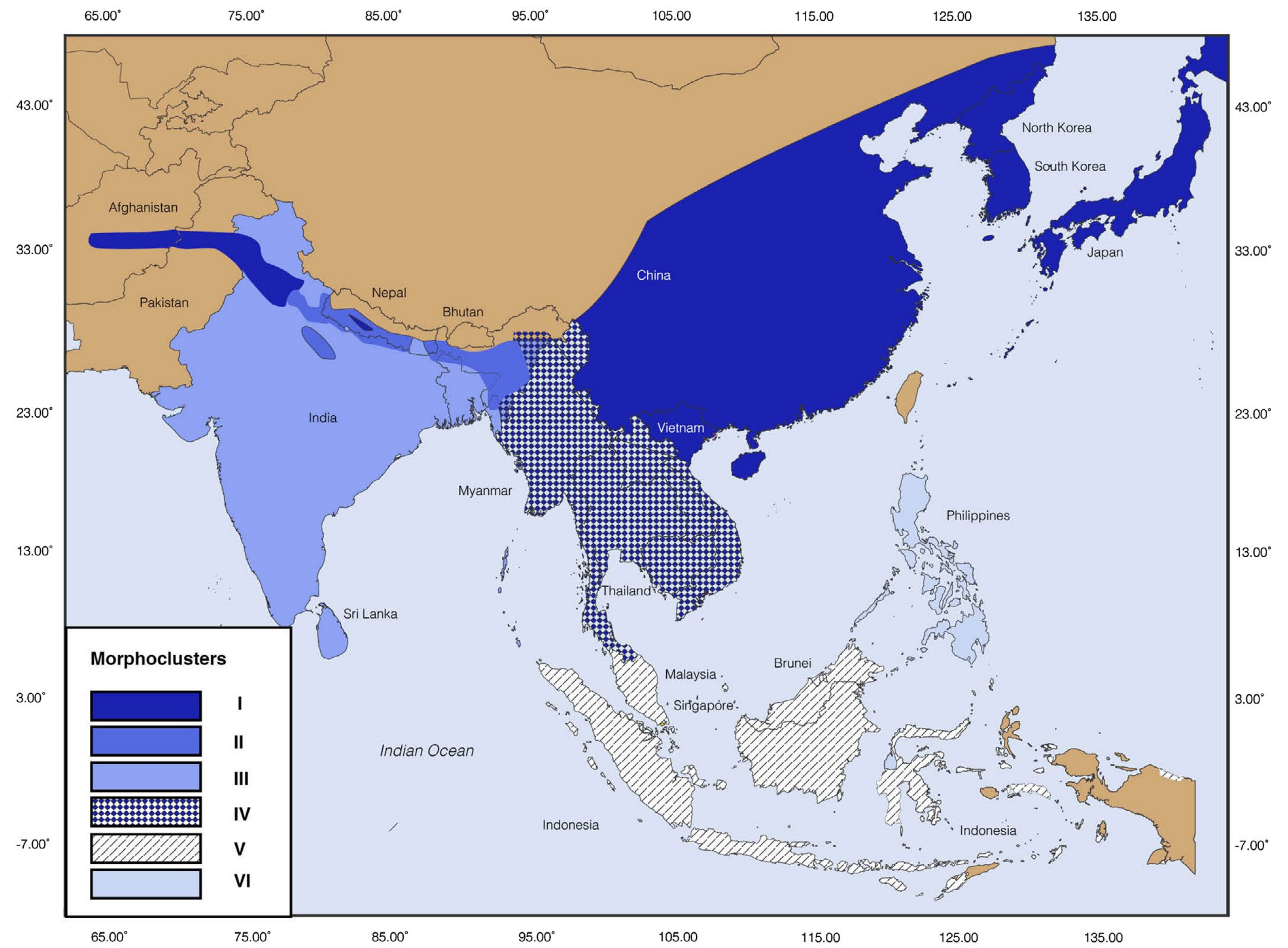

Figure 1. Distribution map of the six *A. cerana* morphoclusters identified by Radloff et al. (2010).

1995; Nagaraja, 2015 and Sharma, 2015, personal communication). *A. cerana* was established in Japan around 1915 (Kimura, 2015, personal communication), in Vietnam in the 1960s (Tan & Binh, 1993), and in Pakistan by the late 1970s (Sivaram, 2012), but only reached Nepal and Bangladesh as recently as 1990 and 1995, respectively (Alim, 2015, personal communication; Sivaram, 2012).

Economic successes using *A. mellifera* colonies have varied wildly, mostly due to the suitability of local climates and the funding available for particular projects. For example, European and American NGOs have implemented *A. mellifera* projects in Cambodia over the past ten years, but the colonies and beekeeping activities diminished once the extension agents and the funding were gone (Oštir, 2015). In temperate climates that suit *A. mellifera*, such as northern India and parts of Japan and China, the species has thrived and fully overtaken *A. cerana* in commercial importance. Japan's hived *A. cerana* population, for example, is now almost exclusively managed by hobbyists (Sasaki, 2014, personal communication). In countries like Cambodia and the Philippines, beekeeping is a relatively new phenomenon, as honey demand has been met by honey hunting, and more recently, foreign imports (Mojica, 2011; Oštir, 2015, personal communication). Here, apiaries and pilot projects use both species, although the tropical humidity and monsoon seasons pose serious threats to *A. mellifera* (Oštir, 2015, personal communication; Wendorf, 2002). While *A. mellifera* is quickly establishing itself in the Himalayan region, *A. cerana* populations are still very strong in the mountainous, sparsely-vegetated areas of Nepal and Bhutan (Partap, 2014, Baral, 2015, and Tamang, 2015, personal communication).

Advantages and disadvantages of *A. cerana* beekeeping

Asian honey bees have a gentle temperament and are less prone to stinging than their European counterparts. The *cerana* bees that do sting have less alarm pheromone in their stings – half that of *A. m. ligustica* – which elicits a less dramatic response from other bees (Ruttner, 1988). *A. cerana* also displays exceptional hygiene, which is crucial to hive health. Asian honey bees clean themselves and each other more thoroughly, and infected brood is either entombed or removed before brood cells are capped (Koetz, 2013).

In order to produce the large amounts of honey for which it is prized, *A. mellifera* requires large foraging areas, standardized equipment, and supplementary feeding. Tropical and wet conditions can decrease *A. mellifera's* foraging activity, leading to an even greater supplementation demand (Koetz, 2013; Ruttner, 1988). Native *A. cerana* subspecies that are well-acclimated to the climate continue to forage under more extreme conditions. When forage is available year round, such as on coconut plantations, it is often possible to raise Asian honey bees with no supplementation at all (Akratanakul et al., 1990). Well-managed colonies that reproduce successfully can be sold (Verma & Attri,

Table 1. Timeline of *Apis mellifera* introduction and establishment in selected Asian countries.

Time	Country/Region	Remarks
1877	Japan	Introduced from the United States (Sasaki 2015*)
1880s	India	First attempts to introduce *A. mellifera*; unsuccessful (Nagaraja 2015*; Sharma 2015*)
1887	Vietnam	First introduced from France (Chinh 2015*)
1896	Northeastern China	(Chen 2015*)
1896–1912	Taiwan	(Chen 2015*)
1911	Northeastern China	Introduced from Russia (Tan 2015*).
1912–1913	Southern China	(Chen 2015*)
1913	China	Introduced from Japan (Hu 2015*; Tan 2015*)
1913	Philippines	Introduced from the United States (Cervancia 2015*)
ca. 1915	Japan	(Kimura 2015*)
1920s–1930s	China	*Apis mellifera* well established (Hu 2015*)
1940s–1950s	Thailand	Introduced for research at universities; not established (Suppasat, Smith, Deowanish, & Wongsiri, 2007)
1960s	Vietnam	Successful establishment (Tan & Binh, 1993; Tam 2015*). 200 colonies successfully introduced from Hong Kong (Chinh 2015*)
1962–1968	Northern India	Successfully introduced to Punjab and Himachal Pradesh (Nagaraja 2015*; Sharma 2015*)
1970s	Thailand	Imports for commercial use from Taiwan (Suppasat et al., 2007)
1977–1978	Pakistan	Introduced by the government from Australia (Mahmood 2015*)
1994–1995	Nepal	(Baral 2015*)
1995	Bangladesh	Introduced by entrepreneurs for commercial beekeeping; has spread throughout most of the country (Alim 2015*)

*Personal communication.

2008), spreading this profitable enterprise throughout communities.

For intensively managed bee colonies, the chemicals required to treat pests and diseases can be used indiscriminately by beekeepers, who lack oversight, training, or both. This can severely affect the quality of the honey (Abrol, 2013). Due to its natural *Varroa* resistance, *A. cerana* requires no treatment with acaricides, meaning that the honey will not be exposed to those chemical residues. *A. cerana* honey is sometimes considered to be of superior quality than that of *A. mellifera*, especially in parts of China and India, and demand is increasing (Abrol, 2013; Hu, 2015 and Puttaraju, 2015, personal communication). *A. cerana* colonies can also be reproduced and scaled up with very little additional input: strong colonies can be divided and brood frames placed into new equipment, along with a new queen or ripe queen cell (Abrol, 2013).

One of the greatest technical challenges to beekeeping with *A. cerana* is posed by its tendency to abscond, which is exaggerated by the warm, favorable conditions of tropical areas (Koetz, 2013; Wendorf, 2002). The economic success of *A. cerana* depends overwhelmingly on the beekeeper's ability to manage this behavior (Akratanakul et al., 1990). Predation pressure in the tropics is also extremely high: wax moths, hornets, ants, and parasites can all trigger absconding; in areas where forage is not available year-round, *A. cerana* colonies will abscond if they are not supplemented properly (Akratanakul et al., 1990). The fundamental disadvantage of beekeeping with *A. cerana*, of course, is their comparatively poor performance as a honey producer.

From a purely economic standpoint, *A. mellifera* is a clear winner in many cases, in spite of the high startup costs (Oldroyd & Nanork, 2006). When beekeepers have sufficient capital to invest in the sophisticated systems required for *A. mellifera*, it may not be entirely "justifiable to encourage a less profitable form of agriculture" (Oldroyd & Nanork, 2006; Verma & Attri, 2008). The question that remains is how short-term gains from *A. mellifera* products compare to the long-term costs of the species' effect on honey bee biodiversity both in Asia and worldwide. Unlike the profits, the costs of continued disease exchange and colony losses will be shared by everyone.

Conflict between A. cerana and A. mellifera

When *A. cerana* and *A. mellifera* are present in the same area, several conflicts can occur. Both species rob honey from one another; however, *A. mellifera* is far more aggressive and successful, and can inflict severe damage to *A. cerana* colonies (Koetz, 2013; Ruttner, 1988). As drones of both species are attracted to queens by the same pheromone, in areas where both species' mating flights occur at the same time, dangerous interference can occur. *A. mellifera* drones are stronger fliers and can catch *A. cerana* queens, but they cannot mate successfully in the wild due to incompatible organs (Ji, Xie, Yang, & Li, 2003; Ruttner, 1988; Wang, Li, Zhang, & Wu, 2003). For an *A. mellifera* colony to lose a few drones after pursuing the wrong queen is harmless, but the *A. cerana* queens' ability to reproduce can be compromised entirely if injured by the *A. mellifera* drones (Ruttner & Maul, 1983).

While these conflicts depend on immediate proximity, diseases may spread far beyond the areas where the two species meet. *Varroa destructor* mites, one of the biggest challenges to beekeeping worldwide, were introduced to *A. mellifera* by *A. cerana*; it has also been shown that tracheal mites and Israeli Acute Paralysis Virus have been transferred to *A. cerana* by *A. mellifera* (Bailey & Ball, 2013; Kojima et al., 2011). Thai Sac Brood Virus, which remains a serious threat, wiped out roughly 90% of *A. cerana* in southern India in the 1990s and can also be traced back to *A. mellifera* (Oldroyd & Nanork, 2006; Thomas, Pal, & Subba Rao, 2002). In the other direction, the *Nosema ceranae* fungus, native to *A. cerana*, has spread to *A. mellifera*, which it damages more extensively than its original host (Fries, 2010; Mayack & Naug, 2009). New climate conditions may further exacerbate the behavior of pathogens, and both bees and beekeepers may find themselves woefully unprepared.

Results of the *A. cerana* survey

At present, there have been no attempts to quantify *A. cerana* decline throughout its varied habitats. Between the winter of 2014 and early spring of 2015, a questionnaire was forwarded to apicultural experts that included academic researchers and government extension agents, who we expected to have detailed insight into the beekeeping situation in their respective countries. The survey included the following questions:

1. Which Apis species are in your country? Please estimate the number of colonies.

- ☐ *Apis cerana*: # colonies
- ☐ *Apis mellifera*: # colonies
- ☐ Other Apis: Name, # colonies

2. How has the *Apis cerana* population changed over the past ten years? If possible, please estimate how it has changed (as a percentage or number of colonies).

- ☐ It has increased (%).
- ☐ It has decreased (%).
- ☐ It has remained the same.

3. Are changes in the *Apis cerana* population a result of *Apis mellifera* imports?

- ☐ Yes
- ☐ No
- ☐ Uncertain

4. Which advantages do these honey bee species have in your country?

Apis cerana:
Apis mellifera:

5. Which disadvantages do these species have in your country?

Apis cerana:
Apis mellifera:

6. Which pests and/or parasites are problematic for these species in your country?

Apis cerana:
Apis mellifera:

7. Do you think that *Apis cerana* beekeeping should be promoted or encouraged in your country?

- ☐ Yes
- ☐ No
- ☐ Uncertain

8. Is the preservation of indigenous *Apis cerana* an important subject of discussion? (Multiple selections possible)

- ☐ Not at all
- ☐ Limited to beekeepers
- ☐ Limited to scientists involved
- ☐ Limited to conservation organizations
- ☐ Limited to politicians involved
- ☐ For others:

9. Do you have any additional comments or insights about *Apis cerana* in your country?

In response to our survey requests throughout Asia, we received 31 responses from 16 countries. A severe limitation to the survey results is that reported population values are very rough estimations, as few formal population studies have been carried out, and many smaller *A. cerana* enterprises are not registered with agricultural authorities (Partap, 2014 and Kimura, 2015, personal communication). Nonetheless, in the absence of official and consistent data, the experience of experts still provides valuable insight into the perceived populations.

A. cerana *population changes*

Based upon our respondents' estimations, *A. cerana* populations across all the countries surveyed have decreased by 55%. Replacements range from minimal (roughly 5% in Bhutan) to extreme (95% or higher in Thailand, South Korea, Afghanistan, and Pakistan) (Figure 2). Over the past ten years, populations in a few of these countries have stabilized or even begun to recover somewhat (Figure 3). However, the overall trend is still decreasing (10 out of 16 countries surveyed, 62.5%), and some populations appear close to extinction (less than 5% remaining). Analysis of variance showed no significant correlation between directions of population change or percent *A. cerana* remaining and climate zone (Köppen-Geiger classification).

Advantages and disadvantages of each species

With regard to the benefits and drawbacks of beekeeping with each species, our respondents' answers were consistent with the literature. The most frequently mentioned advantages of *A. cerana* were the species' suitability to local conditions, including forage (25 of 31 respondents; 81%); ease of management (18/31; 58%); resistance to pests and diseases (17/31; 55%); honey (sufficient quality and/or demand) (13/31; 42%); and pollination services (13/31; 42%). The most commonly named disadvantages of *A. cerana* included absconding and swarming behavior (25/31; 81%); low honey output per colony (16/31; 52%); sensitivity to Thai Sac Brood Virus (7/31; 23%), and sensitivity to other diseases and pests (7/31; 23%).

As for *A. mellifera*, the single most important advantage mentioned was high honey yield per colony (22/31; 71%), followed by suitability for commercial and industrial beekeeping (including migratory beekeeping) (10/31; 32%) and the generation of other bee products, such as royal jelly (24%). Likewise, the most important disadvantage of *A. mellifera* was said to be pest and disease sensitivity (26/31; 84%), followed distantly by high demand in terms of input and maintenance (e.g. supplemental feeding; treatment against diseases, etc.) (11/31; 35%) as well as high forage and migration requirements (colonies must be moved to obtain sufficient forage) (9/31; 29%).

On the issue of whether the presence and continued imports of *A. mellifera* are a major driver of *A. cerana* decline, our respondents were rather evenly divided. Regarding the task of *A. cerana* conservation, 93% agreed that the topic is of great importance to scientists, while only 25% saw it as a concern for policy makers. 84% of the respondents agreed that *A. cerana* use should be promoted. The respondents also provided valuable independent feedback about other aspects of *A. cerana* conservation which support our study. 16% of respondents pointed out that reliable population data from formal surveys are crucial and identified the lack thereof as a major conservation challenge. 16% also independently stated that *A. cerana* breeding programs are necessary; some also emphasized the need for multi-national breeding initiatives. Another aspect brought up by 40% of our respondents was the importance of beekeeping with

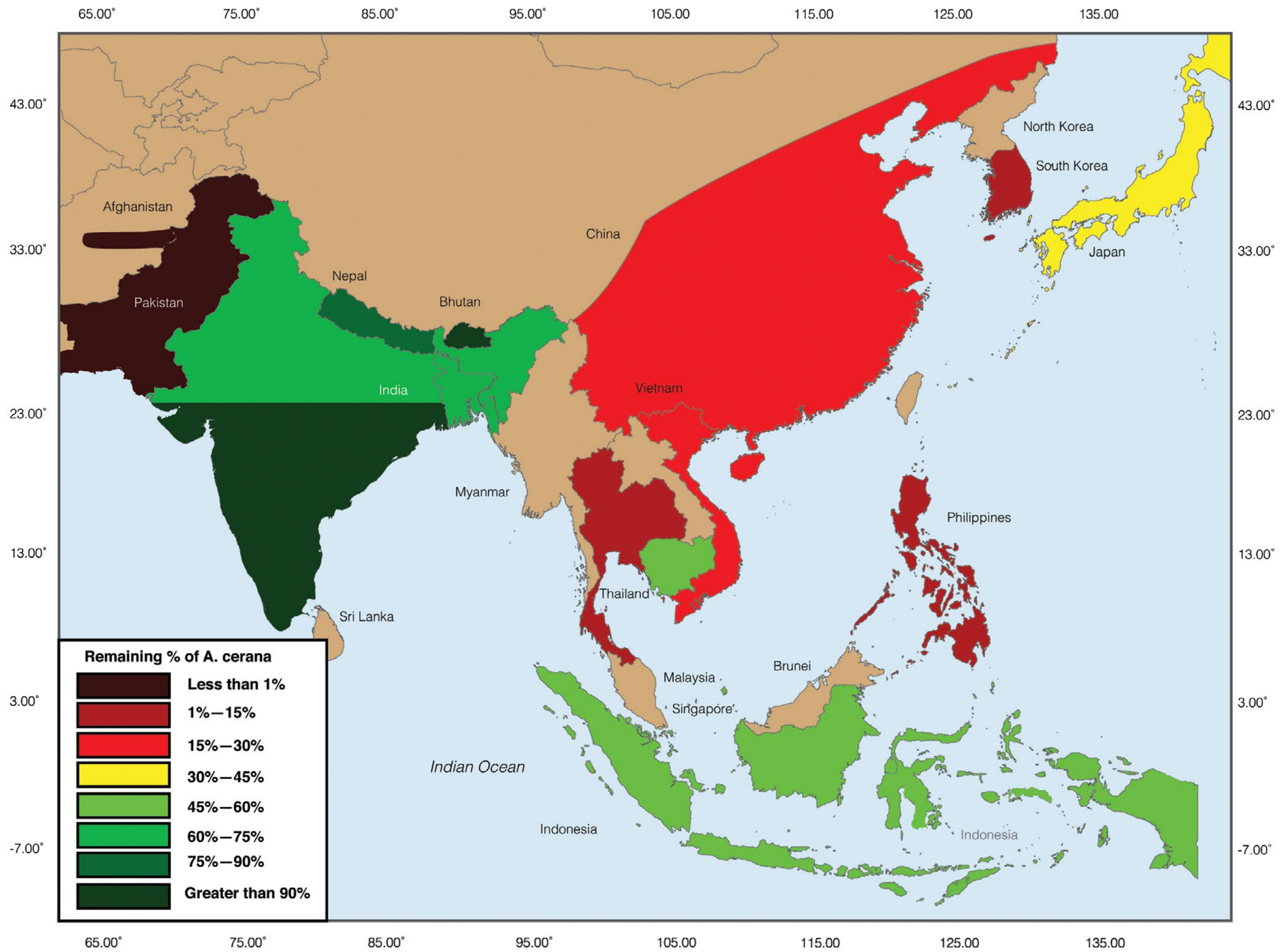

Figure 2. Map of estimated remaining percentages of *A. cerana* compared to *A. mellifera*, based on a 2014–2015 survey of 31 apiculturists in 16 Asian countries. Due to lack of data about wild honey bee species only the commercially kept species (*A. cerana* + *A. mellifera*) could be taken into account. The sum of both species represents 100%, while the map details the proportion of *A. cerana* still extant.

A. cerana as a rural development tool because *A. cerana* better suits the local and often harsh environment. Nearly all respondents acknowledged the benefits of *A. cerana* to both beekeeping and biodiversity preservation.

Discussion

Our survey confirms that the decline of *A. cerana*, which has been observed in Afghanistan, Bhutan, China, India, Japan, South Korea, Myanmar, Pakistan (Abrol, 2013; Verma, 1998), the Philippines (Mojica, 2011; Wendorf, 2002), Taiwan, and Vietnam (Koetz, 2013) is a reality across all of Asia. Our respondents also confirmed the essential drivers of this decline: lower productivity per hive and the management challenges of absconding behavior (Abrol, 2013; Akratanakul et al., 1990; Koetz, 2013), as well as confirming that *A. cerana* is found to be more resistant to pests and diseases than *A. mellifera*. In the near future, it is likely that increased honey demand, especially from developing countries, due to the disproportional increase in world honey prices (FAOSTAT, 2014) will continue to cause beekeepers to switch from *A. cerana* to *A. mellifera* to meet higher production demands. These economically driven decisions by beekeepers will not change, simply because the FAO recommends the preservation of biodiversity. Likewise, forcing beekeepers to keep and use only autochthonous species/subspecies is neither legally feasible nor practical to implement.

It has been suggested that beekeepers could compensate for the low productivity of individual *A. cerana* colonies by increasing their number, as they are easier to care for (Tan & Binh, 1993; Verma, 1993). This strategy of increasing colony numbers to meet higher honey production has always been available, but as the decline in *A. cerana* and its displacement with *A. mellifera* show, it has clearly not been applied. Several disadvantages may explain why it has not been put into practice: first, although the costs per colony with "natural" *A. cerana* beekeeping are lower than with *A. mellifera*, increasing the number of colonies nevertheless increases both costs and time requirements. This also does nothing to address the disadvantages of *A. cerana* itself, such as their tendency to abscond.

An essential point to consider is that the profitability of a single high-performing colony is still greater than that of two or more less productive colonies combined, because each unit requires regular maintenance. This plays an especially important role in situations where the resources (i.e. the availability of nectar sources) surrounding apiaries are limited.

The rich biodiversity within *A. cerana* allows for significant improvements through selection. As evidenced by survey responses, the different subspecies are prized for their disease resistance and local adaptations, which evolved under highly diverse environmental and disease conditions across Asia. The world's most commercially successful European honey

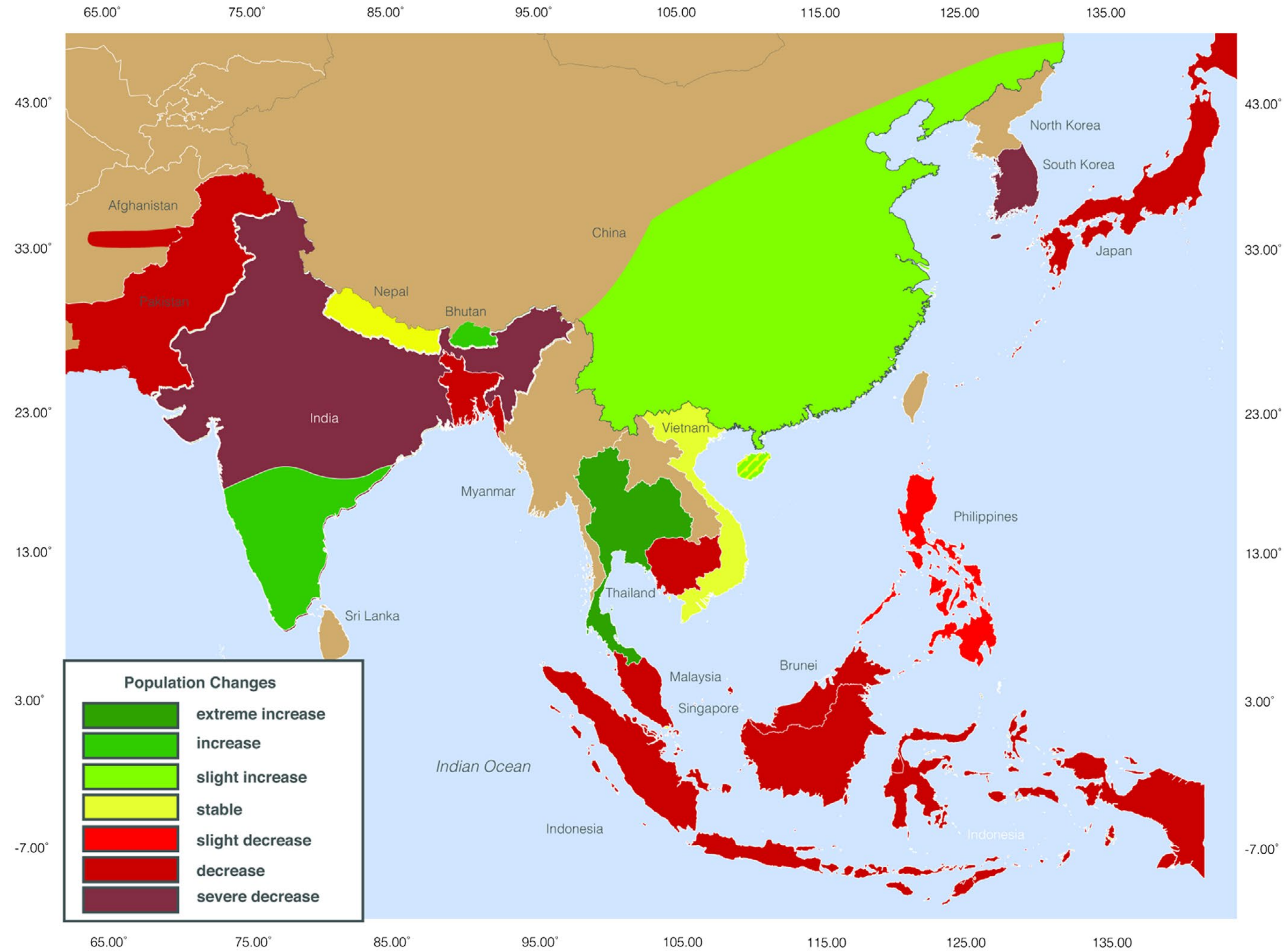

Figure 3. Map of estimated *changes* in *A. cerana* populations over the past ten years, based on a 2014–2015 survey of 31 apiculturists in 16 Asian countries. Respondents were asked to estimate the percentage by which *A. cerana* populations had increased or decreased, based on their experiences and personal observations.

Figure 4. Most professional beekeepers in China prefer *A.m. ligustica* for honey- and royal jelly production.

bee subspecies, *A. m. carnica* and *A. m. ligustica*, are well regarded because of their traits that are advantageous to beekeepers. However, before selective breeding was introduced, *A. mellifera* was also a poor honey producer, yielding only 2–5 kg per colony- an output comparable to that of *A. cerana* (Crane, 1984). It is mainly through successful breeding programs within these two subspecies that beekeepers moved them worldwide.

Performance testing and controlled mating have been carried out for *Apis mellifera carnica* since 1950. In 1994, the Best Linear Unbiased Prediction approach (BLUP) for breeding value estimation was adapted to the honey bee (Bienefeld, Ehrhardt, & Reinhardt, 2007). Up to that point, the success of selection in honey bee breeding had been relatively low compared to progress seen with other animals. After the introduction of breeding value estimation, however, genetic improvements in multiple honey bee traits have been achieved (Bienefeld, 2016). Selection for desired traits has led to improvement, indicating that these European Apis subspecies have sufficient genetic diversity to increase characteristics that benefit beekeepers. There is no reason to assume that similar stock selection in the subspecies of *A. cerana* will not lead to improved traits;

Figure 5. *Apis cerana* beekeeping in Vietnam (near Hanoi). This beekeeper found *Apis cerana* more suitable and he sells Cerana honey at a higher price.

Figure 6. *Apis cerana* in Kathmandu (Nepal). The bees were very gentle, but moved less calmly on the combs compared to selected *A.m. carnica* or *ligustica* colonies.

in fact, the great variation in traits already present in the morphoclusters indicate a wealth of genetic material available to selection.

The breeding methods, including performance testing, genetic evaluation and, if possible controlled mating, used in the European honey bee population (Bienefeld, 2016) should be equally successful when applied to Asian honey bees. However, it is crucial that *A. cerana* breeding not focus on creating a single improved strain, which would then displace other *A. cerana* subspecies much like *A. mellifera*. Rather local selection within each region should seek to improve the stock for the local environmental conditions.

Intensive taxonomic studies within *A. cerana* must also be carried out in order to further assess the species' diversity and lay the necessary groundwork for the same type of molecular genetic research being carried out with *A. mellifera*. Due to the species' adaptations to its broad and highly diverse geographic range, it is highly likely that further subspecies will be identified than those classified by Radloff et al. (2010). If necessary, international breeding projects for the preservation of these various subspecies should also be initiated.

A recently established partnership in the European Union offers a potential example of what such a project might look like. Designed to improve and preserve Europe's endangered, native *A. mellifera* subspecies, the SmartBees program (http://www.smartbees-fp7.eu) capitalizes on the strengths and resources of its partner organizations to use and expand upon the existing bee breeding infrastructure.

If a similar program were adapted to the specific needs of Asian beekeepers and the conditions of local *A. cerana* population, such a strategy and partnership could be an invaluable tool for *A. cerana* conservation. Recently launched in the autumn of 2014, the SmartBees project will require time to show its effectiveness, but the strong, multilateral support for the project indicates that many countries value improving honey bee subspecies as a means of protecting biodiversity. The SmartBees' experience with coordination, communication, and above all, cutting-edge breeding techniques, may offer insight for similar, future projects within Asia. Approaching this problem on a regional level is necessary in order to effectively capture the diversity within *A. cerana*.

The majority of our survey respondents appear to agree that breeding *A. cerana* and preserving the species by developing sustainable populations used for beekeeping are an optimum solution. However, such projects will require substantial engagement and financial support. Another obstacle to using sustainable, mid- and long-term breeding strategies with native *A. cerana* is that it remains in the exporting countries' short term economic interest to continue selling and promoting *A. mellifera* abroad. Regrettably, similar situations can be observed for many animals beyond the honey bee, such as the destructive, non-native tilapia (*Oreochromis*) species in aquaculture (De Silva, Subasinghe, Bartley, & Lowther, 2004) and imported, high-performing cattle breeds which displace their better-adapted native counterparts (Shabtay, 2015). This is a dangerous development for everyone involved, not only for the countries which stand to lose their autochthonous subspecies, but also for the countries whose exports cause this decline: they will have fewer possibilities to draw upon once the valuable gene pool of these displaced species disappears. In the face of climate change, this is an especially threatening prospect. As its subspecies have adapted to harsh and varied conditions, *A. cerana* is more likely to be able to cope with future changes to its environment than European honey bees which originate in moderate climates. It's therefore preferable to breed local, well-adapted species for productivity and behavior rather than to breed imported European bees for adaptation to extreme climates and new pathogens (Zakour & Bienefeld, 2014). Pauls, Nowak, Bálint, and Pfenninger (2012) have shown that climate change results in loss of genetic diversity within species. In Asia, the strong human-driven loss of genetic diversity in autochthonous honey bees is likely to meet the climate change-driven reduction of genetic variation. This combination gives rise to the most pessimistic concerns and underscores the need to take prompt action.

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