Article

How can honey bees explain the process of animal domestication by humans?

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Abstract

Animal domestication depends on complex relationships between humans and animals. There are many questions related to the domestication still incompletely solved especially since animal domestication occurred at specific regions in the past, and the percentage of domesticated animals is low. It is not easy to change characteristics and behaviors of wild animals, and humans can only train them to do specific tasks in most cases. Some species of honey bees, genus *Apis*, are wild and others are domesticated. In this article, domestication steps of honey bees by humans was used as a model to explain the early domestication process for other animals and to present answers to unsolved questions.

Keywords beekeeping; selection; characteristics; history.

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1 Introduction

Some animals can simply be kept by humans and some of them can serve humans, for example donkeys. Donkeys for a long period of time were the main transportation means and they can be easily kept by humans in closed and open environments. Horses are another example, and the hybridization between horses and donkeys gives domesticated hybrids which can also be kept by humans. On the other side, wild animals similar to donkey (i.e. Zebra) can not be kept by humans. Also, the hybridization between domesticated donkey and zebra do not give a domesticated animal but a wild animal. In general, the occurrence of animal domestication can be explained by the long relationship between humans and animals. Human societies have developed over years in many aspects including culture, agriculture, medicine, engineering and genetic sciences. In parallel with this development, the relationships between humans and animals have been also developed, but no new wild animals were domesticated. Only improvements in the known domesticated species and subspecies have been happened as a result of the development of sciences. There are many questions related to the process of animal domestication, which is presented in this article and answered in light of understanding the

domestication steps of honey bees.

2 Domestication of Honey Bees

Humans started to keep the cavity-nesting bees inside tree trunks or closed hives, about 7000 to 10000 years ago. In fact, there are two types of bees (Abou-Shaara, 2018): 1) free living bees, and 2) cavity-nesting bees. The second ones have specific characteristics (domestication characteristics). Domestication characteristics are similar to desirable characteristics described by Hale (1969) and Price (1984, 2002). These characteristics are 1) bees living away from sun in cavities, 2) bees live in groups and store a plenty of honey, 3) not very aggressive, and 4) bees do not tend to abscond (i.e. immigration in honey bees). Therefore, humans selected cavity-nesting bees (especially, *Apis mellifera*) to domesticate them and they did not select the wild bees which do not have the domestication characteristics. The wild bees, on the contrary, live in open air, build only one comb, store few amount of honey, generally more aggressive, and tend to abscond. Therefore, humans selected the suitable bee type, and then housed them in nests (hives). The hives developed in parallel with human culture development. During the time of Pharaohs, ancient Egyptians used long clay hives (Page and Laidlaw, 1980). By time, wooden hives with different shapes were used in Europe, and the modern type of wooden hives (Langstroth hives) was developed in the U.S.A by Lorenzo Langstroth during 1850s. This hive type is widely used nowadays worldwide and can be developed (Ellis et al., 2003; Lorenzon et al., 2004; Erdogan et al., 2009; Omran et al., 2011; Altun, 2012; Abou-Shaara, 2013; Abou-Shaara et al., 2013). More information about the domestication of honey bees can be found in publications of Crane (1975, 1984). Generally, domestication of honey bees did not harm their genetic diversity (Oldroyd, 2012).

On the other side, humans enhanced the characteristics of honey bees by selective breeding and by hybridization between honey bee subspecies (Abou-Shaara and Bayoumi, 2019). For example, In Egypt and up to 1930s the common subspecies in Egypt was *Apis mellifera lamarckii* (the Egyptian bees). But this subspecies was not as good as the European subspecies. Therefore, stocks of Carniolan honey bees, *Apis mellifera carnica*, were imported from Europe to Egypt (Sheppard et al., 2001) to enhance the characteristics of the Egyptian bees. Nowadays, hybrids of Carniolan bees are existed in Egypt and replaced the indigenous bees (Page et al., 1981; Sheppard et al., 2001; Abou-Shaara and Ahmed, 2015). From the previous presentation, it is clear that the domestication of honey bees contained the following steps; 1) wild and cavity-nesting bees occurred naturally at different locations around humans, 2) humans stole honey from bees without keeping bees in hives, 3) humans selected the suitable bee type for domestication (i.e. bees with domestication characteristics), 4) humans developed hives for bees, and 5) humans enhanced the characteristics of bees using selective breeding, and currently using modern genetic techniques. The same steps could be happened with other animals, and the role of humans started at the stage of selecting the suitable animals for domestication.

3 Domestication Regions

The earliest site for animal domestication is southwest Asia's Fertile Crescent, and large domestic mammals predominantly Eurasian (about 18% of domesticated animals) while in the subequatorial Africa no mammal species was ever domesticated (Diamond, 2002). This means that domestication occurred at specific regions. In case of honey bees, cavity-nesting bees select safe locations away from predators as much as possible for nesting (e.g. mountains, and high trees). Similarly, animals with domestication characteristics escaped from predators to live in protected areas. Therefore, many domesticated animals are originated from Asia where few natural predators are existed, while few of them are originated from Africa where more predators (e.g. lions, leopards, crocodiles, snakes) are existed. The establishment of human civilization has a role in gathering all good animals with domesticated characteristics together from their protected areas to live with humans. This

opinion can explain why domesticated animals (e.g. domesticated cows and buffalos) can be stay for long periods indoors and outdoors without any trail to escape unlike wild ones. In other words, these animals used to be away from predators in safe and protected locations, and hence they do not tend to escape from humans.

4 The Initial Characteristics of Domesticated Animals

Humans in the past depended on hunting for survive, and the history of humans on earth is not enough to change the innate characteristics of wild animals under any circumstance. Some old human tribes are so far existed in Brazil (around the Amazon River). These tribes do not have any idea about domestication and still hunting for survive. Basically, humans in the past did not have any idea about genetics or animal breeding. The old civilizations, for example the Egyptian civilization (Wenke, 1991), depended on agriculture instead of hunting, and the use of domesticated animals happened intensively. The life period of the old civilizations was not sufficient to affect wild animal behaviors or even their genetics turn them into domesticated ones. These reasons explain why humans just took animals with domestication characteristics from their wild habitats to a new habitats with human, without impacting their innate characteristics.

5 Genetic Differences Between Domesticated and Wild Animals

Animal behavior, biology, physiology and morphology have genetic backgrounds (i.e. specific genes). Thus, domesticated bees (or cavity-nesting bees) have some distinguished genetic characteristics than wild ones. Sure, both of them have some common genes (especially those related to their general morphology, biology and behavior). Environmental factors and natural selection over years can impact these genetic characteristics to form the eco-types or different subspecies (Oldroyd et al., 1991). For example, *Apis florea* (the dwarf honey bees) invaded some Asian countries including Jordan, and morphological studies showed the presence of distinctive characteristics to this species (Haddad et al., 2009).

In general, the present bees are the same as the bees in the past. But the present bees due to the intensive breeding and selection by humans in side, and climate change, diseases and pesticides in the other side become genetically different (e.g., Rinderer et al., 1991). Also, on the levels of physiology, biology, and behavior some changes have been happened. Similar situation is in the other animals, and the present animals are different than the past in some characteristics, and some changes were reviewed in Zeder (2012).

6 Domestication of Wild Animals

In fact, domestication of wild animals is very difficult because without domestication characteristics wild animals will be always wild. Animals caged inside the Zoo, generation after generation, still have their wild trends. They can not be used to help humans or to be as friendly as domesticated animals. These animals can be only trained to do specific jobs. The presence of sharp teeth and jaws in most wild animals, make them as a real danger to humans at any time. Domesticated animals, in fact, have some characteristics to defend themselves but seldom attack humans. Young elephants are reared by humans in some Asian countries, and are trained to do some activities. However, at any time these elephants can be very dangerous to their owners. Humans failed to keep wild honey bees, except dwarf honey bees, because these bees tend to abscond (immigration in honey bees) from location to another, and can not be reared inside boxes or hives. Dwarf honey bees, a small species of bees, occur in Asia and Africa (Whitcombe, 1984; Haddad et al., 2009; Shebl, 2017) and are reared in Oman (Dutton and Simpson, 1977; Abou-Shaara, 2019) using suitable open nesting site. But it is not suitable for traditional beekeeping or for a commercial honey production, and can not be considered as a domestication of wild bees.

7 Mutual Benefit From Domestication

Mutual benefits for humans and animals are the results from the domestication. Humans provide animals with suitable protection, care, and feeding. In the other side, humans obtain some products (honey, milk, meat, and fur) from animals, and also some animals can be used as a transportation means, or as part of sports (e.g. horse racing, and camel racing in gulf countries). This mutual relationship is in agreement with the opinion of Zeder (2012).

The role of humans is to select the most suitable among the domesticated animals and breed them generation after generation. The hybridization between subspecies or species can result in less suitable animals to human. For example, the hybridization between two domesticated bee subspecies one from Africa and the other one from Europe caused a problem (i.e. the Africanized honey bees or known as the killer bees) (Winston, 1992) which can be distinguished than other bee subspecies suing specific genetic and morphological methods (Smith et al., 1989; Crozier et al., 1991; Francoy et al., 2008). These bees are not suitable for beekeeping and have high aggressiveness and wild attitudes. Thus, beekeepers do not select the Africanized bees, and by time this hybrid may be disappear. This can explain that humans, in the past, selected only the suitable animals to serve them. Humans by time improved the characteristics of the domesticated animals using breeding programs. Currently, humans are actively selecting the most productive animals with high ability to tolerate diseases utilizing modern genetic and breeding techniques.

8 Conclusion

The domestication process based on the previous points, and based on honey bees as an example, can be explained by three main steps: 1) selection of animals with domestication characteristics among wild animals, 2) humans reared these animals and provided them with conditions similar to their original locations (e.g. hives, nests, feeding type), and 3) improving characteristics of the domesticated animals utilizing selective breeding, hybridization, and genetic tools. The domestication process presented in this article is similar to the process described by Clutton-Brock (1992). Also, the suggested pathways: Commensal pathway, Prey pathway, Directed pathway by Zeder (2012) are acceptable. But in the present process humans selected only wild animals with domestication characteristics, which were especially created to be handled by humans. Then, characteristics of these animals were developed over time utilizing selection, hybridization, and genetics.

According to this article, understanding the relationship between land topography, availability of predators, and development of human communities in the past at locations where domestication was started can greatly help specifying the history of domestication. Therefore, studying the relationships between predators and the occurrence of animal domestication, and between topography and history of animal domestication are necessary to understand exactly why domestication started at specific locations than others.

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