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FULL PAPER

Breeding and Cultivating some Types of Wild Bees that Pollinate a Wide Range of Plants

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Abstract

Our research science is focused on studying the physical and chemical properties of ozmia cornuta and osmia Rufa) and where these two people were living with a wide, beautiful crop of crop crops in 6 cities from the Crimea in Russia, the nearby black and sea in the mountainous heights. The places are Simferopol (capital of the Red Costuulous Republic of the Crima), the Red Forest, the Nearc.Stapo, the Saina and SiveaTop Farms are located in the farms of the Black Sea, the streets and the beach Al-Washta in the Crusader of the Clari Island. The tension of the severity and all the tools and requirements of the research were prepared by two years of study in the year (11/2021).

Key words: Wild bees، osmia cornuta osmia rufa ، nesting methods.

Introduction:

Wild bees are insects that can have some of their species domesticated. These two types of bees live in the wild and are known for their ability to be tamed. The wild bees Osmia cornuta and Osmia rufa belong to the family Megachilidae and are considered beneficial insects for agriculture, as they pollinate various plants. Approximately 90% of the world's plants are pollinated by bees. This significant percentage of pollination performed by bees provides a nutritional value estimated at billions of dollars. Pollination by bees increases agricultural yields, ornamental trees, and maintains ecological balance. In the past few decades, the bee population has declined globally due to the reduction of cultivated areas, the expansion of pastures, deforestation, lack of plant pollination, and environmental pollution.

Wild bees are vital to agricultural ecosystems, playing a crucial role in flower pollination, which helps increase crop production and improve quality. It is estimated that there are around 4,000 native bee species in North America alone, and more than 4,500 in the Russian Federation and European Union countries. Research shows that these wild insects provide more than 1.5 billion US dollars annually through crop pollination.

Importance of the Study

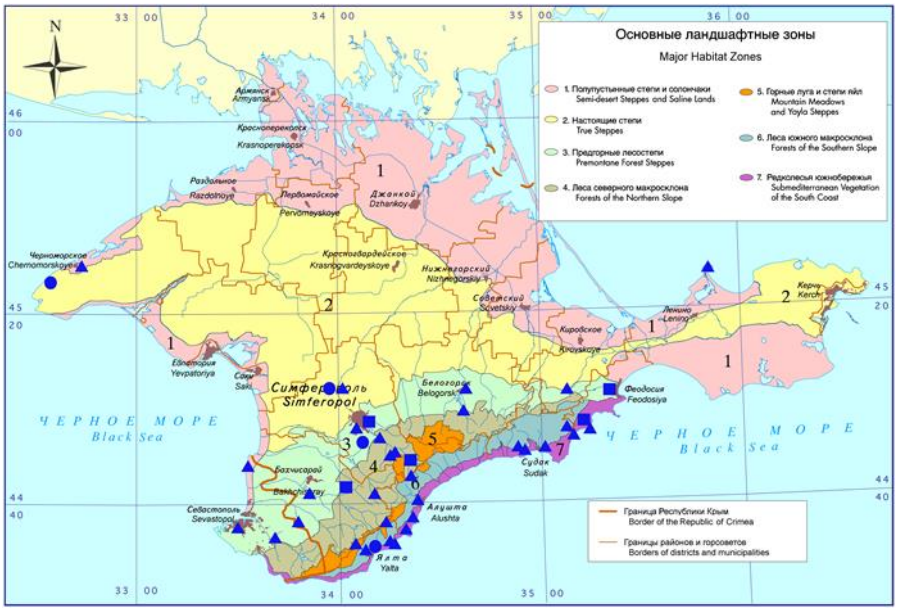
Wild bees are incredibly effective pollinators, contributing significantly to the pollination of various crops such as blueberries, apples, cherries, almonds, watermelons, and pumpkins. Studies have shown that wild bees transfer pollen to these crops at a rate 1.5 to 2 times higher than that of honeybees, particularly in the case of sour cherries and apples.

This remarkable creature, bestowed by God with unique attributes and features, possesses qualities not found in many other living organisms. There are approximately 20,000 species of bees living on Earth, divided into seven families, including the Megachilidae family to which these two species belong. This family is notably beneficial to humans, animals, and agriculture.

The massive die-off of both honeybees (Apis mellifera) and wild bees due to environmental pollution and the use of pesticides and agricultural chemicals is a critical issue that requires the attention of governments worldwide. Many wild bee species are currently threatened with extinction, and unfortunately, numerous species have already become extinct.

The global losses of wild bee colonies have sparked genuine public concern as the declines in both social and solitary bees continue globally. The deterioration of insect-mediated pollination can critically affect agricultural and natural ecosystems (Fontaine et al.). This raises important questions about colony losses and underscores the necessity of developing effective and practical approaches to assess the risks faced by honeybees. Advances are needed in developing field, semi-field, and laboratory testing methods.1

(Hendriksma, H. P., Härtel, S., Steffan-Dewenter, (2018). 2 (5), 509-517.)
The figure below shows the locations of the cities of wild bees in the Crimean PeninsulaOsmia cornuta and Osmia rufa
(Yalta. Simferopol. Sevastopol. Al-Washta. Bakhshi Saraya)



An image showing the spread of wild bees that pollinate many plants in the Crimean Peninsula (Black Sea). Figure (1)

(Ivanov S. P.2019)

Problem Statement

The study of these two species of wild bees, which pollinate a wide range of agricultural crops, has primarily focused on their distribution and presence in the Crimean Peninsula along the shores of the Black Sea. This includes their spread in the interior forests, jungles, hills, and green meadows throughout the entire agricultural area of the peninsula.

In previous studies of these two species, the research was somewhat superficial and lacked detail compared to the current study, which has thoroughly examined the lives of these two species. The current study has not only provided a detailed account of these bees but also innovated modern colonies to domesticate a wide variety of wild pollinating bees, including the family to which these two species belong. Additionally, traps have been developed to capture anything that harms the bees in their living and breeding environments. We have also identified the plants most frequently visited or preferred by these two species.

This highlights the difference between previous studies and the current study. The current research has documented some important details concerning **Osmia cornuta** and **Osmia rufa** from the **Megachilidae** family.

Study Objectives:

1. To determine the extent of the distribution and presence of the two species, **Osmia cornuta** and **Osmia rufa**, in the Crimean Peninsula.

2. To outline their daily activities during the day.
3. To evaluate the various factors involved in nest building.
4. To develop better living conditions for these two species

Theoretical Framework

The flight times of the two species, *Osmia cornuta* and *Osmia rufa*, were determined at the beginning of spring. We prepared and set up the Ulya Fabra colony and the new colony we developed about four years ago, creating suitable conditions for them. Tubes and all necessary equipment were prepared to determine the flight times from the nests. We identified the emergence times of males and females from the nests during spring, specifically from the end of March (between March 21 and May 15) each year. This period represents the development and life span of these two species, with only minor differences. *Osmia rufa* emerges from its nests about a week before *Osmia cornuta* and both species complete their life cycle before May 15 each year. Notes and corrections were made on some scientific studies and misconceptions related to the development of these species.

The study involved evaluating various factors related to nest building and constant monitoring to determine when females leave their nests in the colony to collect pollen, when they return, and the types of pollen they collect, including which trees they prefer to visit. It also involved understanding the condition of the initial fertilized eggs, which produce females, while unfertilized eggs produce males. The female lays the fertilized egg (female) at the bottom of the tube, before collecting pollen. She then adds a large quantity of pollen next to the first fertilized egg. After that, she adds a small amount of moistened soil as a barrier after the egg and pollen, followed by the second egg, which is also a fertilized female, placed after the barrier. This process continues as the tube is built.

The average winter temperature of the bees was measured, and the time of emergence after incubation at 20°C was recorded, along with the lifespan after emergence in pollinating male bees. *Osmia* was subjected to 25 artificial winter treatments with varying durations (30, 90, 150, 210, and 270 days) and temperatures (0, 4, 7, 10, and 13°C). For all temperatures, survival was highest with 90 days of winter exposure and at 10°C temperatures.

1(Spear, D. M., Silverman, S., Forrest, J. R. K., 2016, 187 (6), 797-803).

Female bees start their activity early in the morning, just before sunrise, at temperatures of +3°C and above. During their daily flight from the colony, they begin collecting pollen from nearby trees and flowers. The proximity of trees and the presence of water provide the females with an opportunity to collect a large amount of pollen. It was found that a short heat wave (1 hour at 45°C) can delay the emergence of adult males but not females. The bee colony was somewhat resilient to a range of high-temperature exposures from which larvae did not survive .

1 (Houston T. F., Ecology and behavior of the bee, 2008, Vol. 15, pp. 591–609).

The females can visit 10-15 flowers during each flight period, with each visit lasting between one and seven minutes. Upon emerging from their nests (tubes), the females are met by males who are ready to mate. Remarkably, males fertilize females from different tubes rather than from the same tube, as the females perceive males from the same tube as their siblings. After mating, the females circle around the colony, and if they circle multiple times, they pick up cues to locate their colony. Once identified, they start collecting pollen from various nearby plants and begin nesting in one of the colony tubes. They deposit the pollen, initiating the life cycle of the next generation of these

species. This process begins four days after the first egg is laid at the neck of the tube (female). The egg hatches into a larva, which then remains a pupa for about one to two weeks, feeding on the pollen provided by the original mother. After more than two weeks, from early June each year, the pupa gradually matures into an adult bee and remains in its nest until the beginning of spring. This is how the life cycle of both mentioned species is completed.

1)Gaul A.M. University Vernadsky (Russia. Simferopol) 2019.170.(

Development of Living Conditions for the Reproduction of *Osmia cornuta* and *Osmia rufa* from the Megachilidae Family

To enhance the living conditions and reproductive success of *Osmia cornuta* and *Osmia rufa*, which pollinate various fruit trees, ornamental trees, and different seed-bearing plants, several strategies have been developed. Among these strategies, we designed our own colonies, which have been patented. The construction of these colonies has facilitated the domestication of these species, thereby increasing their numbers.

We also selected the most suitable locations for placing these bee colonies, choosing sites close to agricultural biodiversity and away from noise. It is crucial to have a nearby water source, even if minimal. Continuous monitoring and strategic placement are essential, considering the nesting preferences of these species. One colony is not sufficient; multiple colonies should be placed in various directions, taking into account sunlight, humidity, ventilation, wind, and rain.

Many beekeepers feel closely connected to nature, spending a lot of time outdoors, with a shared interest in purchasing insects and a fair understanding of ecological processes. These skills are often praised in citizen science projects focusing on bees. However, amateur experts sometimes struggle to identify target species, such as European honey bees, whereas beekeepers can easily distinguish between these two species of bees (1).

(Bosch J. –2018. – Vol. 32, N 4. – P. 711–716)

a

b

c

d

How to Build the Nest from the Inside: A Diagram 2

(Ivanov S. P.2019

In the image above, we can observe how the female bees lay their eggs. The first egg is placed in the inner cavity of the tube (the hollow stem). The female then collects pollen and places it next to the egg. She creates a barrier using wet clay and then deposits the second egg (female) in a row towards the beginning of the tube. Finally, she lays a smaller egg and a small amount of pollen to produce males at the front of the tube.

Traits of Wild Bees:

The body of the female Osmia cornuta is covered in dense hair, measuring 32-36 mm in length and 16-20 mm in width. In contrast, the female Osmia rufa is 22-26 mm in length and 11-14 mm in width. Both species collect pollen all over their bodies, allowing them to gather a larger quantity of pollen with each visit to flowers compared to honeybees, which collect pollen in pouches on their hind legs. To pollinate 1 hectare of plants, such as fruit trees, 1500-1600 females of Osmia cornuta and Osmia rufa are required, compared to about 20,000 honeybees.

Fertilized eggs produce females, while unfertilized eggs produce males. A colony consists of both males and females. The proboscis of Osmia cornuta is 3-5 mm long, while that of Osmia rufa is 2-3 mm long. Bees generally have five eyes—two main eyes for outside work and three smaller eyes in a triangle above the main eyes for working inside the hive in the dark. They also have six legs and four wings. The weight of an Osmia cornuta bee can reach up to 180 grams, while the weight of an Osmia rufa does not exceed 130 grams. Both species are larger than their males.

When preparing tubes of specific lengths (4-25 cm), it should be noted that if the tubes are insufficient, the female may resort to any hole, even as small as 4 cm, to lay her eggs in that small cavity.

Megachile Sculpturalis Smith, 1853, was detected nesting in a trap nest and "bee hotel" in Simferopol. The nests were constructed from resin with the addition of mud and sawdust. The females visited flowers of Eryngium Campestre L., Inula Helenium L., and Carduus Acanthoides L., while pollen samples from one female contained pollen only from Ballota Nigra L. This invasive species in the Crimean Peninsula marks the easternmost point in its European range and possibly the most prominent event in its distribution (1130 km from the nearest previously known point in Hungary). This is the first known invasive bee species in Russia. The giant bee, Russia, distribution, nesting biology, Megachile (Callomegachile) Sculpturalis Smith, 1853 (Hymenoptera: Megachilidae).

Cavity-nesting species in the Megachilidae family are the main part of invasive bees worldwide due to the ease of accidental transport of their nests. Monitoring invasive bee species is crucial to better understand their potential impacts on native bees (Portman et al., 2019). Number of papers on giant bee fauna in Russia (Ivanov S. P., Fateryga A. V. - 2019. - N 395. - P. 7-13).

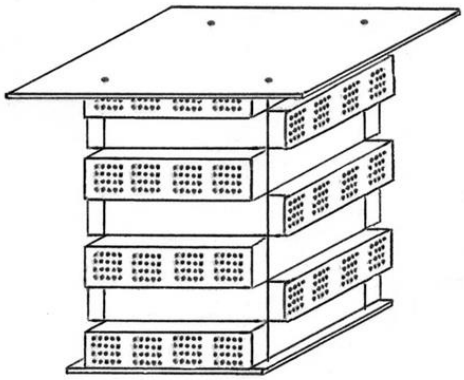
Our scientific research on two types of solitary wild bees involves a comprehensive study of these species from all scientific aspects. We have highlighted the chemical and physical properties they possess and developed special colonies for solitary bees. Previous studies used very old colonies, whereas our innovation in building more attractive colonies has shown a significant increase in the number of bees. After increasing the number of females in the new colony, we observed a substantial increase in pollen collection from flower plants.

4- Ulya Fabra colony Figure .

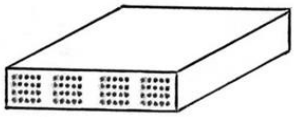
(Ja’ul. 2019)

We would like to point out that we have obtained several patents named "Utility Model for Wild Bee Hive" with number 186446 from the Russian Federation. These patents cover the nesting of certain types of wild bees and the preparation of artificial bee colonies. The bees naturally accept these artificial nests, making it possible for them to be housed in these pre-prepared nests made from hollow cane stems. The females lay their eggs in these nests, where their offspring can be raised comfortably. Each colony contains over 1200 hollow tubes, although some smaller colonies may have around 50 nests or tubes.

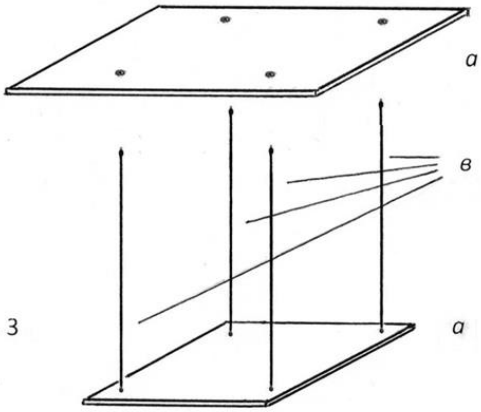
The wild bees were attracted to the new colony with ease, and the females identified their nests with great precision, preferring it over the Ulya Fabra colony. This well-executed work and planning enabled these two species to multiply successfully in the peninsula.



Фиг. 1



Фиг. 2



Фиг. 3

Patent for a useful model of a beehive, Figure (5)

(Ja'ul. 2019)

To know the number of trees that the female visits, the following equation must be applied:

$$n = \frac{k}{tv} \times kQA \times 2 \text{ Hectare}$$

N = number of females to visit one hectare of plants

K = number of flowers in one hectare

T=continuation of female work during a day

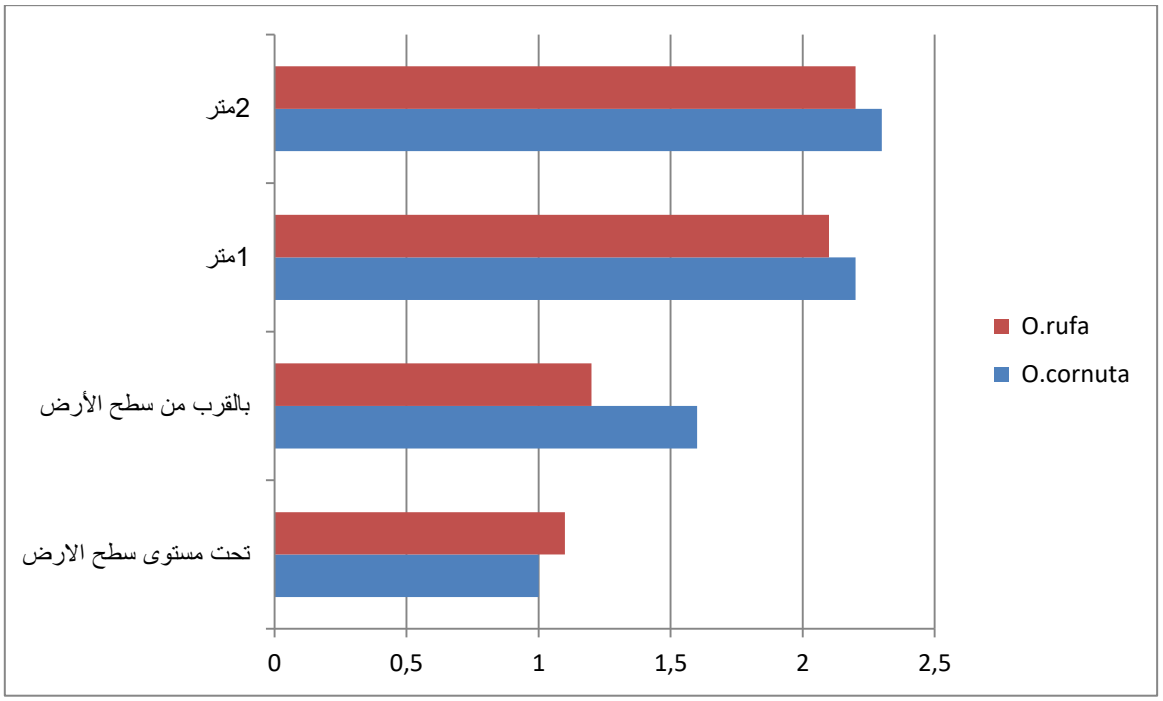
V = the number of flowers that the female visits during an hour of work

KQA=General Activity Coefficient

Indicator effect mm				the description
O.rufa		O.CORNUTA		
$X \pm Sx$	Minimum and maximum	$X \pm Sx$	Minimum and maximum	
295,1 ± 50,9	186–391	307, ±44,4	222–373	Length of nesting tube
243,6 ± 57,1	69–372	258,2 ± 50,5	160–373	The length of the first egg without a gap
56,7 ± 39	12–153	62,8 ± 34,8	16–125	The length of the distance between the first barrier at the node to the other node with the space ((females))
78,1 ± 66,8	83–293	131,8 ± 58,2	38–293	The length of the last nest from egg to egg ((males))
167,4 ± 71,7	14–295	126,4 ± 63	13–298	The ring of the row of the cell

Comparison table between Osmia rufa and Osmia cornuta Figure (6)

(Ja'ul. 2019)



Nesting in tubes and laying eggs, Figure (7).

(Ja'ul. 2019)

Study Procedures and Methods:

Several tools were prepared to assist in the study of wild bees, including hollow reeds, scalpels, saws, various tracking and monitoring devices, wooden boxes, temperature and humidity measuring devices, various scales, mirrors, tweezers, adhesives, cardboard, wooden poles, strings, and surveillance cameras. Despite this, the range of materials used to form trap nests is relatively narrow. The aforementioned studies were conducted using bamboo sticks, pre-drilled wooden blocks, and cardboard tubes .

Nesting Methods:

The nesting tubes were prepared with different lengths, approximately 4-25 cm, to create colonies of about 1200 tubes per colony. In early spring, as the tree flowers bloom, the females begin laying eggs in the tubes. They visit the flowers to pollinate and collect pollen to bring back to the nesting site (pre-prepared colony tubes). The females make several trips between the colony and the plants until the tubes are filled with eggs and pollen, with intervals of pollen between each egg. This process of laying eggs and pollinating flowers continues until the tubes are fully stocked by the female bees of both species.

For **Osmia cornuta**, the operating temperature range is from +4°C up to +48°C.

For **Osmia rufa**, the operating temperature range is from +7°C up to +45°C. If the temperature drops below 4°C, the females refrain from leaving the tubes due to the cold. Conversely, if the temperature exceeds 48°C, the females are affected by the hot summer weather. Humidity depends on the water vapor in the air; if it exceeds 60%, it negatively impacts bee nesting, and if it falls below 2%, it also has a negative effect. Therefore, the optimal humidity for nesting these two species ranges between 2% and 60% water vapor in the air. Regarding soil moisture, the colonies for these two species should be built at a height of 50 cm or more.

While making artificial nests for wild bees, Figure (8)

(Ja'ul. 2019)

Physical and chemical characteristics of wild bees Osmia cornuta and Osmia rufa

Chemical properties	Physical properties	Type
• Measuring the total temperature of the female life of about 270 ± ° C • The vacuum pills are collected in its bottom body and the replacement of honey bees that bear the pipes in small bags in their background and can visit more than 15 flowers per month period. • The reward of the female by a group of males immediately after the home and retained by the material in the period of her life as the female eggs in the tuna (cell) and males in the front of the front tube during the vaccination of plants must be examined soil, especially soil from the seaside and make sure the salts like reputations and clerosals (NACL, MGCL, CACL), sulfate and sulfate (SO3, SO4), and acquisitions (HCO3). • Fathar flies at the beginning of the spring when the ice and the first plant flows and ending at the beginning of the ice in the quarantine of the Crimea Island. • In the Symphor Farm Foundation, the White Closta Flip was found by Osmia Cornuta has produced a crop of 7,6 kg / ha.	• It is built to yellow and covers its body from under heavy hair from black color. • Fetal fell of 120-180 grams. • The male weight does not exceed 130 grams. • The 5 of them are two of two large eyes to work in the day and 3-triangle shape to work in the dark in the cell. • Horn a large sensor of 8 - 16 mm. • It is length of 32-66 mm and its display from 16-20.	Osmia cornuta
• Measuring the total temperature of the female life of about 260 ° C . • The vacuum pills are collected in its lower body and can visit more than ten flowers per period of airline • • The fertility of the 1-3 male is imposed on the excuse from the tube. • Fly flies at the beginning of the spring after Fath Athash Osmia Cornuta a week to two weeks. • When the white clover is vaccinated produced a wrath of 4,6 kg / ha.	• The color of the brown to Yellow covers her body light hair. • The female weight of 60-85 gm while male weight does not exceed 75 grams • The 5 eyes have two large two working days in the day and 3 triangle shape to work in the dark. • Length of Khartoum and Qenseur Running 4-8 mm. • It is length of 22-6 mm and 11-14.	Osmia rufa

Results:

The study showed that the wild bees **Osmia cornuta** and **Osmia rufa**, which were cultivated in the farms of Simferopol, have demonstrated the following:

1. **Osmia cornuta** outperformed **Osmia rufa** in the number of plants it pollinates, especially fruit crops such as apples, pears, and pomegranates, among many other plants.
2. Farms in Sevastopol, Yalta, and Al-Washta, which are among the six locations where these two species were introduced, did not show noticeable increases in agricultural yields. This is believed to be due to the proximity of these farms to the salty waters of the Black Sea, which contain a high percentage of sulfur oxides like SO, SO2, SO3, SO4, S2O2, iron (Fe, FeO2), and other salts like NaCl and organic compounds that affected the nearby farms, thus hindering the bees' adaptation in those areas.
3. There is a significant level of environmental pollution near the coastal cities due to the presence of many industrial and tourist facilities in the cities along the Black Sea.
4. The farms in Bakhchisaray recorded a very high presence of these two species of wild bees.
5. Regarding the weather conditions that affect these two species, the difference is slight: **Osmia cornuta** flies from its nests approximately 5-10 minutes before **Osmia rufa**.
6. The temperature throughout the life cycle of both species was recorded, averaging around 270°C (the average temperature during the life of each female).
7. In early spring, the first trees begin to bloom, and the females awaken from their dormancy to lay eggs and start visiting the first blossoming trees.

Recommendations:

Our study recommends the cultivation of wild bee species alongside honeybees in our Arab environments, particularly in Yemen. Despite the crucial role that wild bees play, they face numerous challenges such as climate change, habitat loss, and pesticides. The disappearance of half the local species in the American Midwest over the past century highlights the urgent need to protect these species and enhance their role in pollination.

Previous studies have summarized that it is possible to domesticate and establish these species in hollow wooden hives. However, earlier research did not fully explore the methods for domesticating them in modern colonies, including how to create and treat tubes to attract bees comfortably, the types of pollen they prefer, and the optimal placement and orientation of hives.

Our study builds upon where previous research left off, introducing modern models of attractive colonies. We have developed traps to catch parasites affecting bee colonies and measured the pollen brought to the hive, identifying the types of trees and flowers frequented by the bees. These findings and innovations have led to multiple patents (for colony construction, parasite traps, and preferred trees for these bee species).

Conclusion:

Studies show that wild bees can significantly contribute to the food economy, with their role in pollinating crops being comparable to or even greater than that of honeybees. Therefore, it is crucial to acknowledge the importance of wild bees and take necessary actions to protect and support them.

Obtaining crucial results for our scientific research, based on the volume of previous information, studies, and predictions regarding the development and presence of these two species in the peninsula, has enabled us to develop appropriate plans and programs to better understand their lives and correct some misconceptions about their development. With the help of our supervisors, we have conducted meticulous work in this field, resulting in accurate knowledge of how these two species respond to natural and artificial conditions.

Our scientific research, following our planned methodologies, is worthy of attention for the successful reproduction of these species, thereby aiding in tree pollination to increase fruit yield, agricultural development, and environmental balance, especially in our working area in the Crimean Peninsula. Our work in this field continues, thanks to the blessings and guidance of God. We have also managed to transfer some species of pollinating bees to Yemen, where they have adapted well to the natural conditions of climate, temperature, plant diversity, and soil. However, we faced some challenges with transportation, monitoring, and preparing the tubes due to the current conditions in the country. Some species of wild pollinating bees have been planted in various areas of Yemen, such as Tehama, Al-Mahwit, Sana'a, Dhamar, and southern regions like Sabir in Lahij and Shabwa.

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