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BEEKEEPING IN ALGERIA: EVALUATION OF BEEKEEPING PRACTICES, TRENDS OF MANAGEMENT, AND CHALLENGES

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ABSTRACT

The honey bee plays a very important role in plant biodiversity and the natural and environmental balance. It is considered a biological marker that alerts to the state of the natural environment. In Algeria, *Varroa* is a major problem in beekeeping, as it is a very serious condition due to the development and handling of the ectoparasitic *Varroa* mite. Within the framework of the MEDIBEES project - Monitoring of Mediterranean bee subspecies and their resilience to climate change for the sustainable improvement of agroecosystems - a survey was conducted in 2021, with the objective of characterizing and understanding the beekeeping activity and its main problems in Algeria, compared to other countries of the Mediterranean basin. The survey was disseminated in Algeria by e-mail and sent to all beekeeping associations and beekeepers. Visits were also made to beekeepers to obtain the most accurate answers. In this article, only the results obtained for Algeria will be presented. In total, 200 questionnaires were analyzed. The respondents had apiaries in 19 *wilayas* of the country. The results of this study show the constraints on the development of beekeeping in Algeria in recent years, the drought, the mortality rate was very high, and the presence of pathologies. COVID-19 has had a negative influence on the yield of beekeepers. A very low yield of honey was obtained during these last two years (2019-2020). The survey identified positive trends in beekeeping practices, including regular queen replacement, apiary-level selection, migratory beekeeping, and consistent *varroa* mite monitoring. The beekeeping associations must be on the field for the organization of the beekeeping sector and the improvement of the current situation, encourage beekeepers to utilize disease-resistant bee breeds, support research on alternative *varroa* mite control methods and promote the use of natural and organic beekeeping techniques.

Key words: Honeybee, survey, Mediterranean bees, beekeeping activity, climate change, resilience, Algeria, varoasis

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INTRODUCTION

Honeybees are the most ideal pollinators for agricultural production. Bees simultaneously provide various high-value products, such as honey, royal jelly and beeswax. However, bees have recently been affected by a wide range of biological and abiotic factors [1]. Beekeeping in Algeria has always been of great importance on the socio-economic level, given the climatic conditions and the important flora favorable to its development. In 2012 the term precision beekeeping was described for the first time by Zacepins *et al.* [2]. It is an apiary management strategy based on individual and continuous monitoring of colonies using technological tools. Its primary objective is to minimize resource consumption to maximize bee productivity, which requires a better understanding of the daily needs of the colonies. MEDIBEES is a scientific project funded by the European Commission, within the framework of the PRIMA SECTION 1 2020 FARMING RIA program (theme 1.2.1-2020) "Genetic conservation and animal nutrition; sub-theme A - Conservation and valorization of local animal genetic resources."

For this study within the framework of the MEDIBEES project, which focuses on monitoring the Mediterranean Honeybee Subspecies and their Resilience to Climate Change for the Improvement of Sustainable Agro-Ecosystems, a comprehensive questionnaire was crafted and distributed among beekeepers in the countries collaborating within the MEDIBEES consortium. The primary objective of this questionnaire was to gather insights from key stakeholders in the apiculture industry, aiming to discern the primary challenges and threats confronting this crucial sector.

In analyzing the results, this study sheds light on the impediments that have hindered the development of beekeeping in Algeria in recent years, including factors such as drought, elevated mortality rates, and the prevalence of pathologies. The compounding impact of the COVID-19 pandemic on beekeepers' yields is also explored, revealing a concerning decline in honey production over the last two years. Amidst these challenges, positive aspects emerge, showcasing beekeepers practicing effective methods such as queen renewal, strategic apiary selection, and the implementation of transhumance. Additionally, regular screening for varroasis in honey bee colonies reflects a proactive approach to disease management. This study not only underscores the obstacles facing Algerian beekeepers but also highlights the potential for positive change. It emphasizes the crucial role of beekeeping associations in on-the-ground initiatives, advocating for the organization of the beekeeping sector and the overall enhancement of the current situation. The subsequent sections will delve into the detailed findings of the survey, offering a nuanced understanding of the dynamics shaping beekeeping in Algeria and presenting valuable insights for future sustainability and resilience in the face of evolving environmental challenges.

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MATERIALS AND METHODS

Sampling Procedure

This study employed a multi-stage sampling approach to reach beekeepers across Algeria. In the first stage, targeted sampling was used.

Stratified Sampling

The beekeeper population was divided into subgroups based on membership in beekeeping associations (representing potentially diverse regional practices). Surveys were then distributed to these associations, aiming for a random selection of beekeepers from each subgroup to ensure representation from different areas or types of beekeeping practices in Algeria. Convenience sampling or snowball sampling: Additionally, individual beekeepers were contacted directly.

Population of Study

The study focused on four specific regions: Centre, East, South-West and West of Algeria, type of apiary (Langstroth) and native honeybees (*Apis mellifera intermissa* and *Apis mellifera sahariensis*) in total 200 beekeepers.

Data Analysis

The collected data on bee populations, management practices and environmental factors were analyzed using (R version 4.3.3) and Excel office 2016: descriptive statistics, Correspondence Factor Analysis (CFA) statistic (Figure 4), and the chi-square test statistic (X^2) (Figure 2), to identify trends in management practices, assess potential challenges for bee health, and suggest recommendations for sustainable beekeeping in Algeria.

Location and period of work

To ensure accessibility to a wider audience, the survey was designed bilingually in English and French using Google Forms, and a copy of the questionnaire is included as supplementary material. The study was carried out during the year 2021(April to September), with the objective of characterizing and understanding the beekeeping activity and its main problems in Algeria. The survey was disseminated in Algeria by e-mail and sent to all beekeeping associations and beekeepers. Visits were also made to beekeepers to obtain the most accurate answers. In this article, only the results obtained for Algeria was presented. In total, 200 questionnaires were analyzed. The respondents had apiaries in 19 *wilayas* (state or districts) of the country.

RESULTS AND DISCUSSION

Sociodemographic

By keeping bees, beekeepers play an essential role in saving the species, and to help them, they now have less invasive solutions to monitor and predict hive health

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[3]. Most of the respondents (200 responses, 97%, Figure 1a) were male. The most representative age group was 31-40 age group and the least representative was the 61-70 age group with only 7 responses (4%), followed by 41-50 with responses (13%) (Figure 1b). In terms of education, 35% had higher education and 39% had completed secondary school (Figure 1c). In this study, the highest numbers of apiaries were recorded in the northern region of Algeria (194 beekeepers), these results show that beekeeping activities are largely segregated from the more heavily urbanized areas and restricted to relatively unbuilt areas on the northern region (Figure 1d).

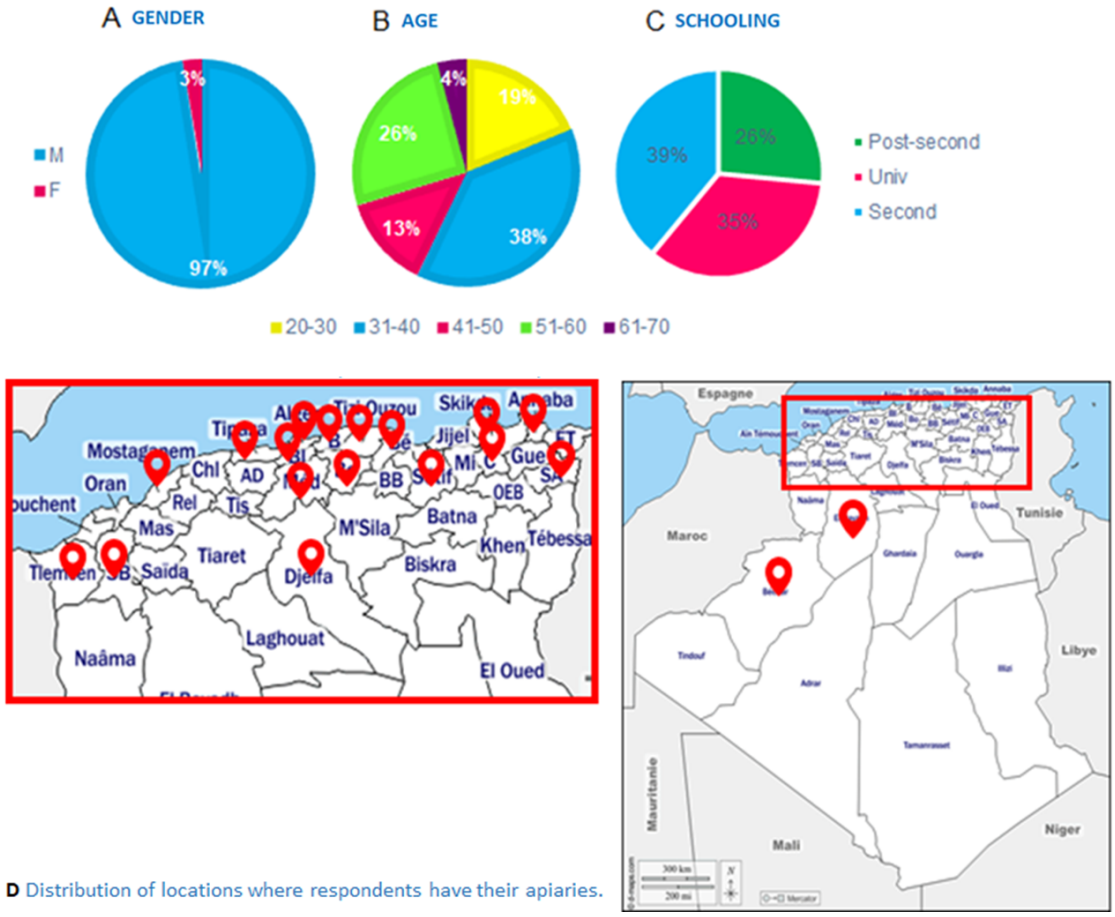

Figure 1: Characterization of respondents by (A) gender, (B) age range, (C) Education and (D) Distribution of locations where respondents have their apiaries

Beekeeping is complex, and requires multiple skills in spheres of not only ecological, but also economic, cultural and social sustainability [4]. Beekeepers play an essential role in saving the species, and to help them, they now have less invasive solutions to monitor and predict hive health [3]. Based on the respondents interviewed as shown in (Figure 1a), adult female participation in the Algerian beekeeping sector was reported to be very low (3%), at levels that were comparable

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to (97%) of adult males. The results showing male dominance of the beekeeping vocation agree with several other studies on the African continent with female percentages of (14%) in Rwanda and (6.7%) in Ethiopia. The very limited number of female beekeepers in the study areas might be due to consideration of beekeeping as the work of men [5, 6]. A recent study by Farrugia *et al*. [7] found that only 8.3% of adult female Maltese are involved in beekeeping activities. Similarly, another study by Guiné *et al.* [8] highlighted the underrepresentation of women in the field, with Italy having the highest percentage of female beekeepers (37.5%) and Spain following closely behind, lowest (10%).

This suggests a diminished interest in apiculture among young adults, mirroring a broader disinterest in the agricultural sector overall. Efforts should be undertaken to engage and attract more young individuals to these sectors, aiming to enhance their long-term economic sustainability [7]. The educational background of beekeepers plays a crucial role in identifying and specifying the development and extension services required for the region [9]. In terms of education, 35% had higher education and 39% had completed secondary school (Figure 1c). Therefore, based on this study, a higher level of education had a notable impact on the successful adoption of improved beekeeping practices.

Characterization of apiaries

Figure 2 shows the distribution of the number of colonies per beekeeper, (The chi-square test statistic, p-value = 2.81e-11***<0.05, there is a statistically significant association between the variables. The distribution of colonies was very variable, the respondents with the lowest and highest number of colonies had 15 and 410 colonies in Langstroth-type hives, respectively. According to the total number of colonies, 53 of the beekeepers had more colonies between 50 and 100, followed by 47 beekeepers who had less than 50 colonies and less than 10 beekeepers who had more than 300 colonies. No beekeepers reported apiaries with more than 500 colonies in this study.

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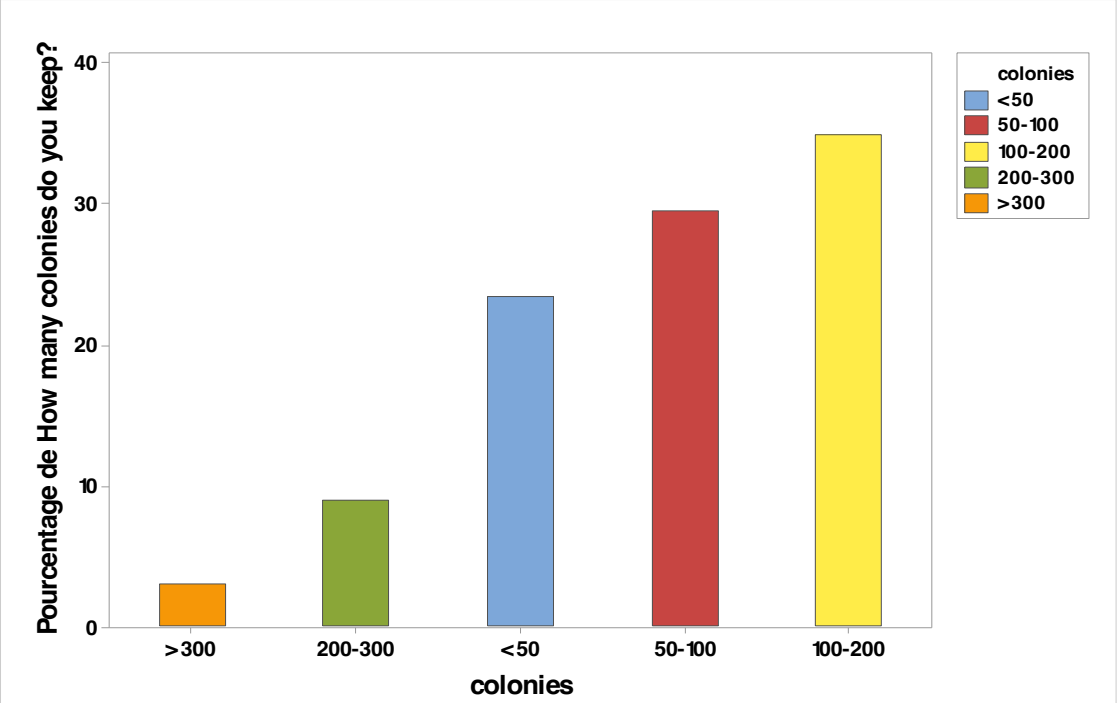

Figure 2: Distribution of the number of colonies per beekeeper

Beekeeping can be done in two ways, sedentary: the hives remain in the same place all year round, migratory beekeeping: the beekeeper opts for moving the colonies according to the floral vegetation. Concerning the type of beekeeping, most of the respondents (139, 69%) practiced sedentary beekeeping and migratory beekeeping (61, 31%). Productive beekeeping now has recourse to seasonal migratory beekeeping, sometimes massive, towards protected natural areas. With the increasing requests of the beekeepers, the managers of the protected natural spaces express recent concerns about the ecological interferences between the honey bees (*Apis mellifera*) and the many other species of foraging insects [10].

Subspecies used by beekeepers

Most beekeepers had only one subspecies of the honey bee in their apiary, the majority of beekeepers 190, (95%) had Tellian honey bees or *Apis mellifera intermissa*, and in only (5%) of the cases, Saharan honey bees (*Apis mellifera sahariensis)*. A majority, 146, (73%) of beekeepers indicated that local bees are endangered, while 53, (27%) did not consider local honeybees to be endangered.

Rearing and frequency of queen replacement

A high percentage of respondents practiced replacement of queens (69%). When replacing queens, it is most common to do so every three years (43%) and every two years (25%). Given this result, it is easy to understand that the majority of respondents did not rear queens (69%). It should be noted that this result is not entirely consistent with the result of the previous point.

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Characterization of the local Tellian bee *Apis mellifera intermissa*

As most beekeepers, 190 (95%) kept the Tellian bee, only the results of the characterization of this subspecies will be reported, as the results for the Saharan bee are not very representative (5%). Beekeepers were asked to rate between 1 and 5 (1 being weak and 5 being strong) nine characteristics of the local honey bee (Figure3). It was noted that the totality of the beekeepers' responses selected three scores (score 1 being very weak, score 3 being medium, and score 5 being very strong). The Tellian bee predominantly scored 5 (very strong) for five traits (tendency to swarm, heat tolerance, honey production, drought resistance and adaptation to the local environment). It was scored for adaptation to the local environment, which corresponds to a score of 3 (intermediate or medium) for *varroa* tolerance. With regard to gentleness, the *intermissa* honey bee was predominantly classified as 1 (low), it is known to be aggressive. The results are in agreement with the already known characteristics of *A. m. intermisa* and show that although it does not have a very high classification for many beekeeping characteristics, it is considered well adapted to the environmental conditions in Algeria.

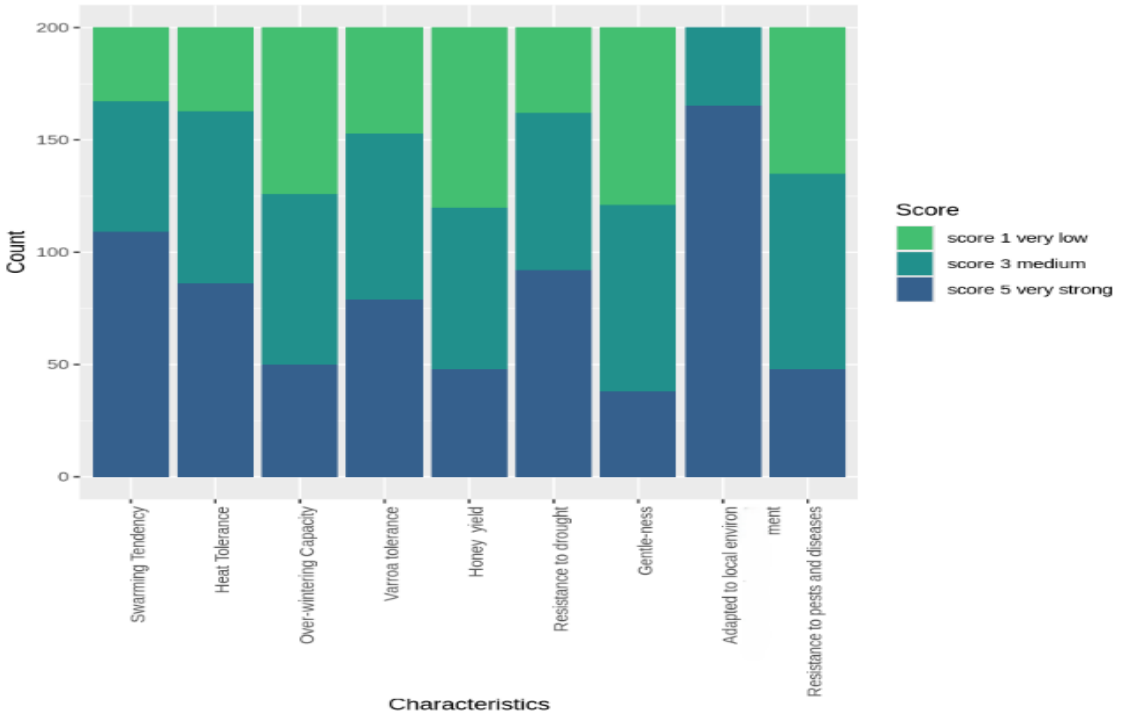

Figure 3: Distribution of the classification of the Tellian bee, *Apis mellifera intermissa* for nine characteristics

These outcomes align with the well-established characteristics of *A. m. intermissa*, underscoring its notable adaptation to the environmental conditions prevailing in Algeria. Local honey bees have adapted to their specific environment over many generations, developing unique traits that allow them to thrive in their local climate,

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forage on local flora [11, 12, 13]. While it may not receive exceptionally high ratings across all beekeeping traits, the Tellian bee's commendable adaptation to the local environment remains a noteworthy attribute. These distinctive characteristics collectively contribute to the unique profile of *A. m. intermissa* within the realm of bee species [14]. In the context of this research, the indigenous honey bee subspecies, *A. m. intermissa*, received the highest ratings for various parameters, particularly in terms of its adaptation to the local environment. This aligns with established data indicating that indigenous subspecies demonstrate higher levels of adaptation to local conditions compared to introduced foreign ones [15, 16].

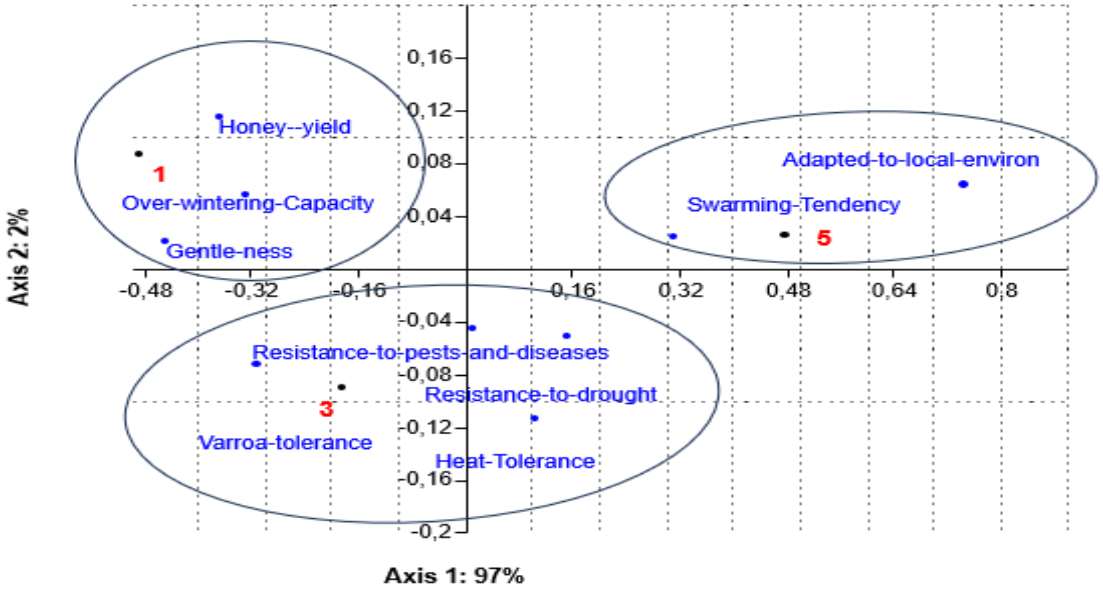

Figure 4: CFA biplot of honey bee behavioural characteristics in Algeria

The text on the axes of the graph helps to interpret the results. Axis 1, representing 97% of the variance in the data, appears to be related to swarming tendency, gentleness and resistance to pests and diseases, while honey yield and overwintering capacity seem to be negatively correlated with this axis. In contrast, Axis 2, accounting for only 2% of the variance, seems to relate to heat tolerance and *Varroa* tolerance. Algerian beekeepers gave high scores to bees with a low swarming tendency, indicating a preference for those less likely to swarm. Similarly, gentle bees are favoured, suggesting a preference for easier handling. Bees resistant to pests and diseases also receive high scores, highlighting a preference for those less likely to be affected. Regarding honey yield, its position on the graph is ambiguous, requiring more data to determine its relationship with other characteristics. The position of overwintering capacity is also unclear, necessitating further studies to clarify its relation to other traits. Heat tolerance seems to be a minor factor, probably due to Algeria's relatively mild climate. Finally, *Varroa* tolerance does not appear to be a significant factor, possibly

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because of the use of alternative treatments. In summary, Algerian beekeepers showed a clear preference for bees with low swarming tendencies, gentleness and resistance to pests and diseases, although additional studies are needed to clarify the relationships with honey yield and overwintering capacity.

Beekeeping events: Ecological annual trends

Beekeepers were also asked to identify the months in which five distinct events occurred: drone production, queen production, queen fertilization, swarming and nectar entry into the hive. The overall picture is presented here, but it should be noted that there were wide variations in responses, as each event occurred at different times of the year, depending on the region in which the apiaries are located. The months of March, April and May had a greater number of responses about all the events surveyed, the month of March was mentioned more often about drone production (31) than August (21), and queen production was very high in March (81) and April (80) than the remaining months. At the opposite end of the spectrum are the months of November, December and January, which were mentioned very few times, with only a reasonable number (>10 responses) for the start of nectar entry into the hive (Figure 5).

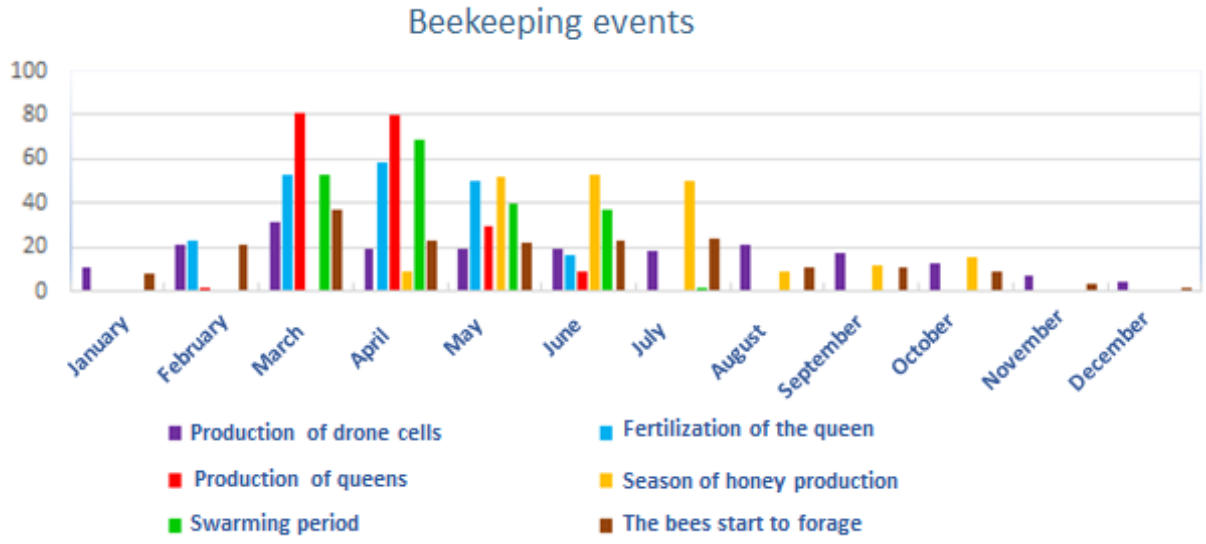

Figure 5: Distribution of beekeepers' responses to different beekeeping events

Bee plants

Floral resources are essential for the feeding of honey bee communities [17]. Honeybees make a significant contribution to biodiversity. Pollination is indeed an essential step in the life cycle of plants and bees contribute fully to this. However, the current threat to biodiversity is the extinction of pollinating insects, in particular honeybees (*Apis mellifera*). This would be devastating for people. Food is determined by the pollination capacity of bees [3]. Permanent grasslands in low-intensity areas should provide insects with regular food resources and a favorable

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environment [18]. A total of 26 different plants were identified by the beekeepers as being the most important for the bees. The answers depended on the region where the beekeeper had their apiaries. For example, mugwort (*Artemisia herba-alba*) is only found on the flats and was indicated by 16 beekeepers who responded to the survey. In total, all beekeepers indicated at least one plant, and those that were indicated more than 10 times are presented in Table 1. Rosemary and Eucalyptus were indicated more than 30 times by beekeepers throughout the country.

Beekeeping activities and products

The bee has a major role in maintaining biodiversity and agro-systems through pollination [19]. Most beekeepers (97%) did not always perform pollination services as part of their beekeeping activity. Only 6 beekeepers (3%) were hired for pollination services and they declared that they practiced this activity in various crops.

The sizes of bee populations and the amount of honey harvested are key factors in several critical areas. Firstly, they are indicators of the health and viability of bee colonies, which are essential for pollination services that support food security and biodiversity. Larger, healthier populations are better able to perform these services and produce greater quantities of honey and other bee products [20]. Most beekeepers produce about 5 kg of honey per year per colony (66%), and only 26% produce more than 11 kg (Figure 6a). When comparing the honey production of the last 5 years with that of 10 years ago, more than half of the beekeepers (86%) considered that the quantity of honey produced has decreased (Figure 6b). Concerning the products of the hive, 160 (80%) respondents produced only honey, 26 beekeepers produced two products of the hive, mainly honey and propolis (19 responses), and 6 produced three products (Figure 6). As expected, honey is the most exploited hive product among these beekeepers. They reported producing three hive products: honey, propolis and pollen. Royal jelly was produced by only six beekeepers and none of the respondents indicated that they produced venom (Figure 6d). Most beekeepers produced between 0 and 5 kg of honey per year per colony (66%) and only 8% produced between 6 and 10 kg (Figure 6c).

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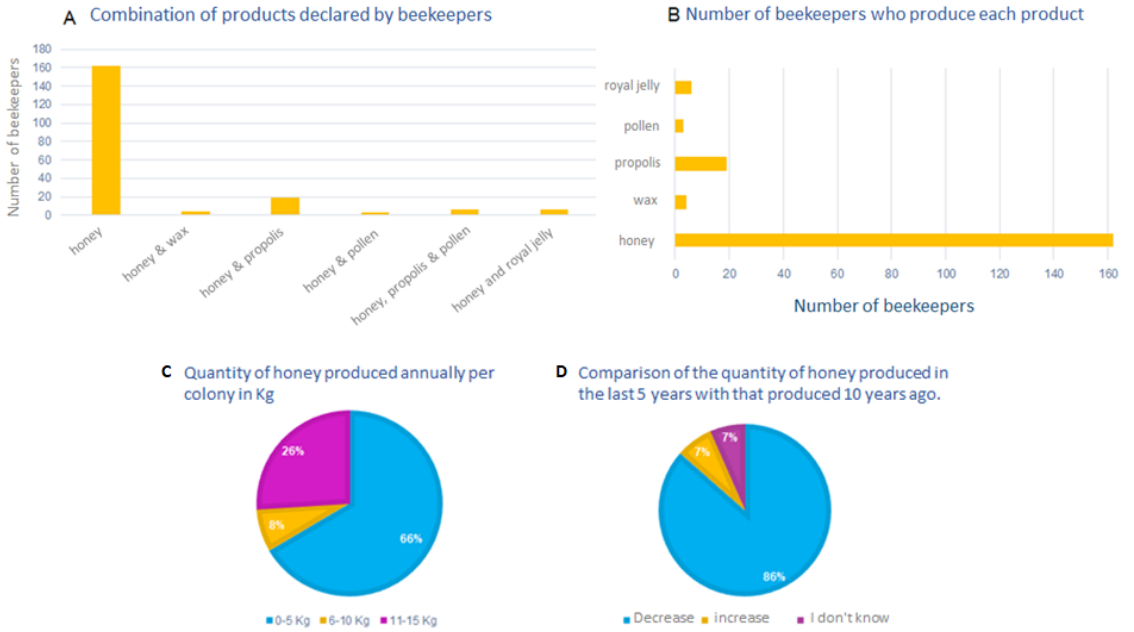

Figure 6: Hive products produced by respondents: Combination of products declared by beekeepers (A), number of beekeepers who produce each product (B), quantity of honey produced annually per colony in Kg (C), and comparison of the quantity of honey produced in the last 5 years with that produced 10 years ago (D)

Threats to honey bees

Bees naturally suffer from a wide range of parasites and pathogens, the latter including protozoa, fungi, bacteria and viruses. By far, the majority of research has focused on those associated with honey bees. Some bee diseases are such as deformed wing virus (DWV), *Nosema ceranae* and *Paenibacillus larvae* [21]. The ectoparasite *Varroa destructor* of the honey bee (*Apis mellifera*) is the main cause of periodic colony losses and therefore remains the greatest threat to beekeeping worldwide [22]. The prevalence of *Nosema* is linked to particular climatic conditions such as high humidity and a long cold period [23]. Most beekeepers (146) considered the local honey bee in Algeria to be under threat (Figure 7a). Beekeepers selected more than one threat and *Varroa* mite had the highest number of responses (141), followed by *Nosema spp* (40). Third with 10 responses for other threats, including climate-related problems, pesticide use, viruses and queen loss, 3 responses for lack of food (Figure 7b). Regarding beekeepers' perception of the months of greatest bee loss, January, December and November were indicated with more than 30 responses. On the other hand, April, May, June and July were the least marked months (Figure 7c).

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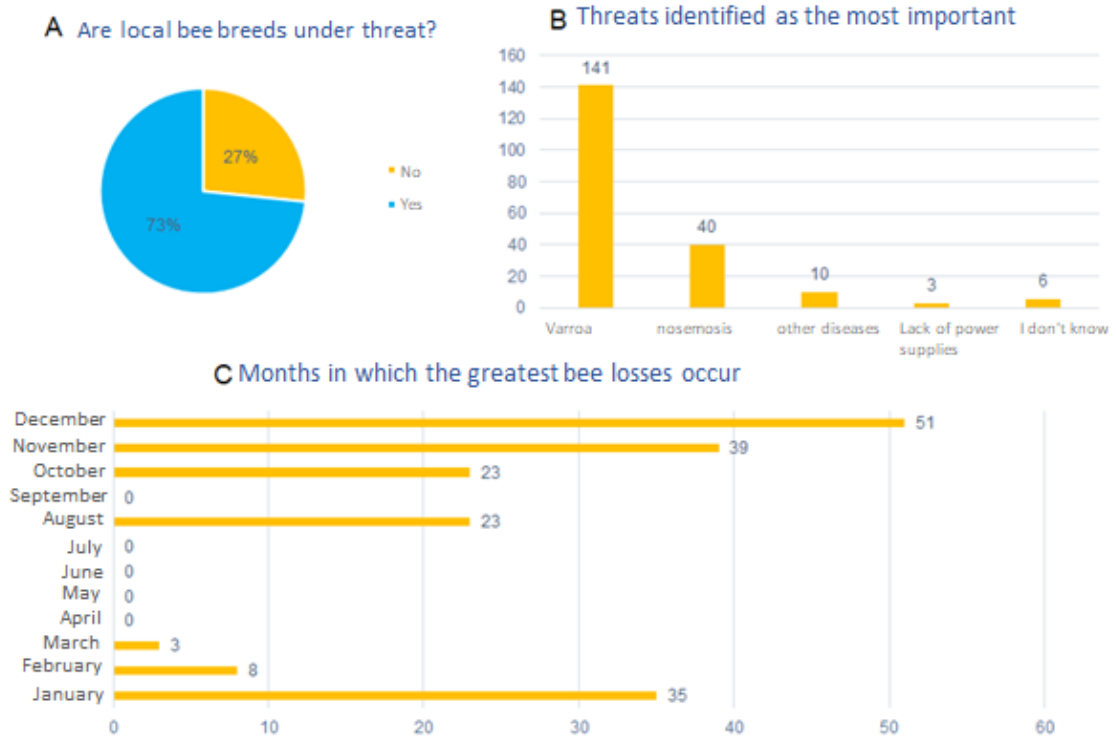

Figure 7: Beekeepers' responses to threats to bees: Are local bee breeds under threat? (A), threats identified as the most important (B), and months in which the greatest bee losses occur (C)

Disease prevention and control

Specialist researchers should focus their work on studying the evolutionary cycle of *Varroa jacobsoni*, its resistance to physical and chemical agents, and ways of destroying it in the hive [24]. Most beekeepers (57%) used *varroa* treatments, with 33% of respondents using one treatment and (25%) of respondents using two *varroa* treatments. When applying two treatments, they usually combined monitoring of *varroa* levels (which includes sugar tests or counting dead *varroa* mites) and amitraz (24) for September, June, and August. In total, the beekeepers applied three or more treatments. Twelve beekeepers did not answer the question. Of the treatments indicated, the most used was flumethrin (Bayvarol) (59 responses), followed by tau-fluvalinate (Apistan) (53), and no beekeeper used the drone brood removal method, but 8 respondents indicated queen confinement and brood removal for the months March, April, June and July (Figure 8). It can be seen that the relationship of beekeepers to the health of bees is mediated by their relationship to nature, which is expressed in the discourse on the drugs proposed to combat *varroa* mites and on alternatives to drugs, mainly the breeding of hardy or productive lines of bees, or those resistant to the parasite chemical treatments often have side effects on bees and brood [25, 26]. Evidently, control strategies have evolved since the 1980s and are identified and known to beekeepers. They span a spectrum from natural

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treatments (free of synthetic chemicals) to pharmaceutical drugs commonly used in conventional beekeeping practices [27, 28]. Currently, the survival of managed bee colonies depends heavily on the regular application of effective acaricide measures by beekeepers. There is a wide range of chemical acaricides and biotechnological control methods that can prevent colony loss and reduce economic damage[15].

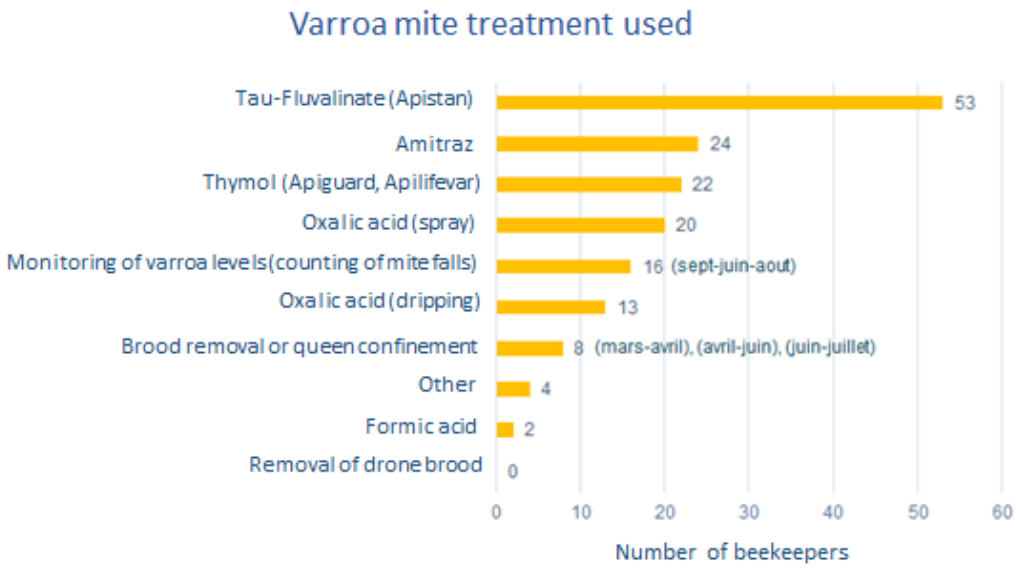

Figure 8: Monitoring and treatments for *varroa* mites used by beekeepers (For treatments that involve the application of brood removal and queen confinement, the months in which they are carried out are indicated in brackets)

Figure 9 shows the months in which *Varroa* monitoring and treatments are applied. *Varroa* monitoring is carried out throughout the beekeeping season, with a peak in August and another in September. The tau-fluvalinate treatment is also carried out over several months, but the greatest number of responses were obtained for the months of September and October. In August the mite drop count was the most used technique by beekeepers, the most applied treatments were flumethrin, tau-fluvalinate, and oxalic acid (drip or spray) (Figure 9).

The assessment of colony infestation by *Varroa destructor* is a crucial element of Integrated Pest Management (IPM) applied to beekeeping. Natural mite shedding, quantified by counting mites on sticky leaves, is considered a reference method for estimating the level of *Varroa* infestation in honey bee colonies [15].

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Figure 9: Temporal distribution of the application of *varroa* treatments

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In this survey, it was also possible to see that the majority of respondents did not use a health platform (67%).

Colony feeding

The main objective of beekeepers is to increase production. In the animal production sector, genetic improvement allows for more controlled breeding and feeding practices. However, in beekeeping, the activity remains heavily dependent on climate and natural resources. A significant majority of beekeepers (60%) supplemented their colonies with sugar syrup. The most common feeding amounts were 10 kg and 8 kg of syrup, with 27 and 23 beekeepers reporting these respective quantities. This variation in feeding practices likely reflects the diverse needs of individual colonies, the number of hives managed, and the prevailing season.

Factors influencing beekeeping activity

Since the 1990s, scientific researchers and beekeepers have considered that the main culprits behind the collapse of bee colonies are the new generation of synthetic pesticides [29, 30, 31, 32, 33, 34]. Figure 10 represents the opinion of beekeepers regarding the impact of certain factors (other than diseases) on beekeeping activity, namely: COVID-19, climate change, agricultural practices, and urbanization. All other factors were identified as factors that negatively influence beekeeping activity, with climate change (89%), urbanization (75%), and COVID-19 (74%) being those that most concerned beekeepers, 43% of beekeepers considered that "pesticide" agricultural practices have not been affected, and 25% of beekeepers' responses also considered that urbanization is not a factor that influences beekeeping activity, followed by COVID-19 (21%). And that 5% of the beekeepers think that COVID-19 positively influences beekeeping activity followed by 2% of the answers for climate change, and no answer for urbanization and agricultural practices.

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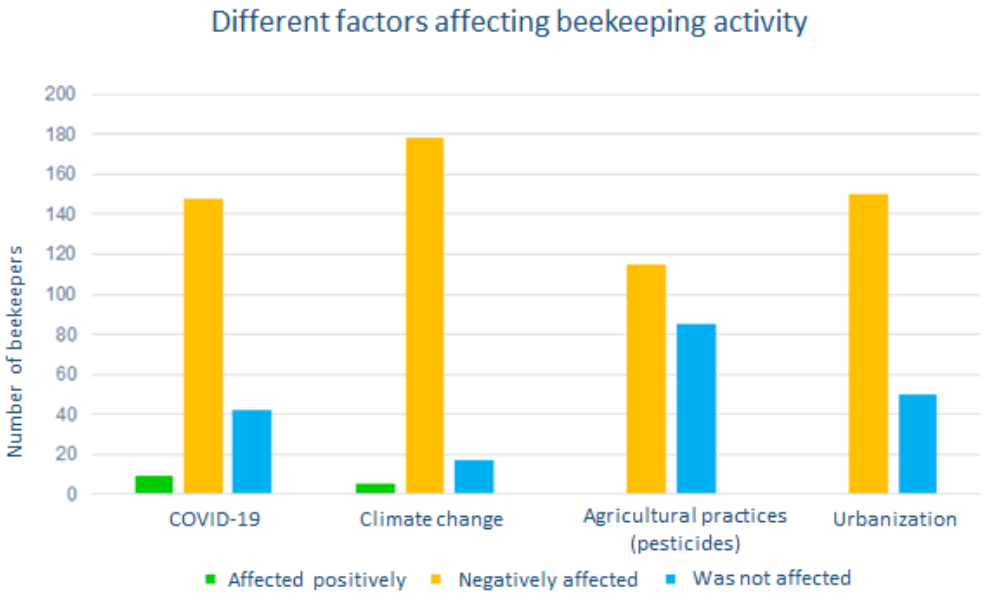

Figure 10: Beekeepers' perceptions of the effects of COVID-19, Climate change, Agricultural practices, and Urbanization on Beekeeping

CONCLUSION AND RECOMMENDATIONS FOR DEVELOPMENT

Beekeepers play a key role in maintaining healthy colonies. By conducting a survey of beekeepers, first-hand knowledge of the practices, trends, and challenges currently influencing Algerian apiculture was documented. Synergistic effects from increased losses of foraging resources, high mite and disease pressure, and other factors appear to be contributing to losses to the local apiculture sector. The results of this study show the constraints on the development of beekeeping in Algeria in recent years, the drought, the very high mortality, and the presence of pathologies. *A. m. intermissa* is highly adapted to arid conditions, and the loss of its gene pool through hybridization with introduced honey bees would be devastating, especially given the threat of climate change. The correlation matrix revealed that overwintering capacity and drought resistance are positively correlated with honey yield, while swarming tendency and *Varroa* tolerance show weak negative correlations. These findings suggest that beekeepers who select colonies with strong overwintering and drought resistance capabilities can potentially improve honey production. However, bee behaviour is just one factor influencing honey yield. COVID-19 has had a negative influence on the yield of beekeepers. A very low yield of honey has been obtained during the last two years. Among the positive points of the survey, were the presence of beekeepers who practiced good beekeeping (renewal of queens each year, selection at the level of the apiaries, migratory) as well as the periodic screening of the varroasis in the bee colonies. One of the main limitations in relying on beekeeping associations to organize the sector is their often-limited resources and outreach capabilities. Many associations face challenges in terms of funding,

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technical expertise, and organizational capacity, which can hinder their ability to fully support beekeepers at the grassroots level. Furthermore, there may be a lack of coordination between different associations and regional bodies, leading to fragmented efforts and uneven support across different areas. In the current study, these challenges were compounded by insufficient access to accurate data and limited participation from certain key stakeholders, which may have influenced the comprehensiveness of the findings and recommendations. It is essential to emphasize the need for comprehensive measures to support the apicultural industry, protect the native Algerian honey bee by preventing further introgression, and adopt a more balanced approach in the current economic strategies being implemented. Furthermore, Furthermore, the current study establishes a foundation for future investigations in this field. Further research is needed to better understand the specific impacts of these threats on honey bees in Algeria.

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Table 1: Plants indicated by more than 10 beekeepers as being the most important for bees

Plant	Answers
Rosemary	36
Eucalyptus	31
Carob tree	20
Wormwood	19
Tamarisk	16
Cloverleaf hedizarum	15
Calandulaarvensis	12

REFERENCES

1. **Moritz RF, De Miranda J, Fries I, Le Conte Y, Neumann P, Paxton RJ Neumann and P Robert** Research strategies to improve honeybee health in Europe. *Apidologie*, 2010; **41(3)**: 227-242. https://doi.org/10.1051/apido/2010010

2. **Zacepins A, Stalidzans E and J Meitalovs** Application of information technologies in precision apiculture. *in Proceedings of the 13th International Conference on Precision Agriculture (ICPA 2012)*, 2012.

3. **Magnier B, Zacharewicz G, Magnier B and G L Zacharewicz** apiculture dirigée par les données et les modèles. *The Conversation France*, 2022; 0-5. https://doi.org/hal-03776562f

4. **Fedoriak M, Kulmanov O, Zhuk A, Shkrobanets O, Tymchuk K, Moskalyk G, Olendr T, Yamelynets T and P Angelstam** Stakeholders' views on sustaining honey bee health and beekeeping: the roles of ecological and social system drivers. *Landscape Ecology*, 2021; **36(3)**:763–783. https://doi.org/10.1007/s10980-020-01169

5. **Bihonegn A and D Begna** Beekeeping production system, challenges, and opportunities in selected districts of South Wollo Zone, Amhara, Ethiopia. *Advances in Agriculture*, 2021; 1-10. https://doi.org/10.1155/2021/2278396

6. **Mushonga B, Hategekimana L, Habarugira G, Kandiwa E, Samkange A and BV Ernest Segwagwe** Characterization of the Beekeeping Value Chain: Challenges, Perceptions, Limitations, and Opportunities for Beekeepers in Kayonza District, Rwanda. *Advances in Agriculture*, 2019; 1-19. https://doi.org/10.1155/2019/5982931

7. **Farrugia D, Martin-Hernandez R and M Zammit Mangion** Beekeeping in Malta: A Review of Current Practices, Trends and Challenges. *Bee World*, 2022; **99(4)**:131–138. https://doi.org/10.1080/0005772x.2022.2113231

8. **Guiné R P, Correia P, Coelho C and CA Costa** The role of edible insects to mitigate challenges for sustainability. *Open Agriculture*, 2021; **6(1)**:24-36. https://doi.org/10.1515/opag-2020-0206

9. **Alemu T, Seifu E and A Bezabih** Postharvest handling, opportunities and constraints to honey production in northern Ethiopia. *Livestock Research for Rural Development*, 2015; **27(5)**.

10. **Cavallin P, Rodet G and M Henry** Maîtriser l'impact de l'apiculture sur les insectes butineurs. *Espaces Naturels*, 2019 ; **65**:51-52.

11. **Alaux C, Le Conte Y and A Decourtye** Pitting wild bees against managed honey bees in their native range, a losing strategy for the conservation of honey bee biodiversity. *Frontiers in Ecology and Evolution*, 2019; **7**:1-4. https://doi.org/10.3389/fevo.2019.00060

12. **Everitt T, Wallberg A, Christmas M J, Olsson A, Hoffmann W, Neumann P and MT Webster** The genomic basis of adaptation to high elevations in Africanized honey bees. *Genome Biology and Evolution*, 2023; **15(9):** evad157. https://doi.org/10.1093/gbe/evad157

13. **Wallberg A, Schöning C, Webster M T and M Hasselmann** Two extended haplotype blocks are associated with adaptation to high altitude habitats in East African honey bees. *PLoS Genetics*, 2017; **13(5)**:1–30. https://doi.org/10.1371/journal.pgen.1006792

14. **Bendjedid H and M Achou** Etude de la Diversité Morphométrique de Deux Populations d'Abeilles Domestiques (*Apis Mellifera* Intermissa et *Apis Mellifera* Sahariensis) du Sud Algérien. *Synthèse : Revue Des Sciences et de La Technologie*,2014; **95(28)**:84-95. https://doi.org/10.12816/0027832

15. **Büchler R, Uzunov A, Kovačić M, Prešern J, Pietropaoli M, Hatjina F, Pavlov B, Charistos L, Formato G and E Galarza** Summer brood interruption as integrated management strategy for effective *Varroa* control in Europe. *Journal of Apicultural Research*, 2020; **59(5)**:764-773. https://doi.org/10.1080/00218839.2020.1793278

16. **Hatjina F, Costa C, Büchler R, Uzunov A, Drazic M, Filipi J, Charistos L, Ruottinen L, Andonov S, Meixner M D, Bienkowska M, Dariusz G, Panasiuk B, Le Conte Y, Wilde J, Berg S, Bouga M, Dyrba W, Kiprijanovska H and N Kezic** Population dynamics of European honey bee genotypes under different environmental conditions. *Journal of Apicultural Research*, 2014; **53(2)**:233–247. https://doi.org/10.3896/IBRA.1.53.2.05

17. **Dalmon A, Diévart V, Thomasson M, Fouque R and B Vaissière** Les communautés d'abeilles butinant la même ressource florale échangent-elles des agents pathogènes ? *La Santé de l'Abeille*, 2022 ; **307**:85-95.

18. **Lanore L, Genoud D, Blanchetete A, Novak S, Fleurance G, Loubeyre JF and A Farruggia** Les abeilles dans les prairies d'exploitations d'élevage aux environnements agricoles contrastés. *Fourrages*, 2018; **(236)**:263-268.

19. **Gallai N and B Vaissière** Guidelines for the economic valuation of pollination services at a national scale. *FAO;* 2009: 17. ffhal-02822628f

20. **Decourtye A, Vallon J, Kretzschmar A, Maisonnasse A, Beri CL, Alaux C, Frontero L, Girod V, Le Conte Y and A Dangléant** Surveillance programmée de ruchers pour identifier les facteurs de risques et les indicateurs précoces de pertes hivernales des colonies d'abeilles mellifères. *Innovations Agronomiques*, 2017; **55**:183-200. https://doi.org/10.15454/1.5137776881436677E12

21. **Genersch E** American Foulbrood in honeybees and its causative agent, *Paenibacillus larvae*. *Journal of invertebrate pathology - Elsevier*, 2010; **103**: 10-19. https://doi.org/10.1016/j.jip.2009.06.015

22. **Traynor KS, Mondet F, de Miranda JR, Techer M, Kowallik V, AY Oddie M, Chantawannakul P and A McAfee** *Varroa destructor*: A complex parasite, crippling honey bees worldwide. *Trends in parasitology*, 2020; **36(7)**:592-606. https://doi.org/10.1016/j.pt.2020.04.004

23. **Haider Y and N Adjlane** Distribution of Nosema SP (Causative agent of Nosemosis in honeybees) in Algeria. *in Proceedings of the AGBIOL, 2021*: 734.

24. **Louveaux J** The Bee and the Environment. *Bee World*, *XXV International Beekeeping Congress,*1974; **55(4)**:150-152. https://doi.org/10.1080/0005772X.1974.11097524

25. **Higes M, Meana A, Suárez M and J Lorente** Negative long-term effects on bee colonies treated with oxalic acid against *Varroa jacobsoni* Oud. *Apidologie,*1999; **30(4)**:289-292. https://doi.org/10.1051/apido:19990404

26. **Pietropaoli M and G Formato** Liquid formic acid 60% to control *varroa* mites (*Varroa destructor*) in honey bee colonies *(Apis mellifera)*: protocol evaluation. *Journal of Apicultural Research*, 2018; **57(2)**:300-307. https://doi.org/10.1080/00218839.2017.1376767

27. **Dussy D and E Faugère** Introduction : les apicultures du monde au XXIe siècle : écologie versus business ? *Les Editions la Discussion*, 2019 ; 11-20, 979-10-92006-08-7.

28. **Kretzschmar A, Seuillet T, Frontero L, Faugere E, Maisonnasse A and D Dussy** Synthèse publique rapport VIVA. *Vivre avec Varroa*, *INRA ; CNRS ; ADA ; ITSAP*, 2020; 5.

29. **Pietropaoli M, Gajger IT, Costa C, Gerula D,Wilde J, Adjlane N, Aldea-Sánchez P, Smodiš Škerl MI, Bubnič J and G Formato** Evaluation of Two Commonly Used Field Tests to Assess *Varroa destructor* Infestation on Honey Bee (*Apis mellifera*) Colonies. *Applied Sciences*. 2021; **11(10):**44-58. https://doi.org/10.3390/app11104458

30. **Bonmatin JM, Sánchez-Bayo F, Janairo B and J Isagani** Systemic Pesticides: A Worldwide Assessment. In : Jean-Marc Bonmatin, Francisco SÁnchez-Bayo, Jose Isagani B. Janairo. *De La Salle Universyt Publishing House*, *Editions* 2017; 978-971.

31. **Colin, Edouard M, Marchand P and JM Bonmatin** L'apiculture écologique. *L'Écologiste*, 2007; **21**:41-43.

32. **Eouzan I, Garnery L, Sime-Ngando T and DC Biron** Les pesticides, la cause du déclin de l'abeille domestique ? In : Bernard C, Mougin C, Pery A, (dir.), *Ecotoxicologie, des communautés au fonctionnement des écosystèmes*, Paris, Iste éditions, 2017; **2**:185-198.

33. **Hoppe PP, Safer A, Amaral-Rogers V, Bonmatin JM, Goulson D, Menzel R and B Baer** Effects of a neonicotinoid pesticide on honey bee colonies: a response to the field study by Pilling *et al.* (2013). *Environ Sciences Europe*, 2015; **27(1)**:1-4. https://doi.org/10.1186/s12302-015-0060-7

34. **Haider Y, Adjlane N and N Haddad** Results of the national survey on Algerian beekeeping (breeding practices, health situation). *South Florida Journal of Development*, 2024; ***5*(11)**: e4618-e4618. https://doi.org/10.46932/sfjdv5n11-019