

Original Research Paper

Characterization of isolated colonies of honey bees (*Apis mellifera intermissa*), in Northern Algeria by classical morphometry approach

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Abstract

Bees (*Apis mellifera* L.), Eusocial hymenoptera insects, are a fundamental world resource. In fact, these creatures are dangerously threatened. Thus, this study, has a high-priority to thoroughly understand the Algerian bee populations and establish an adequate management and a rigorous plan to save these species. The present study, consists of determining the possible ecotypes of honeybees in north of Algeria through different approaches. Initially, a typological characterization, a survey is carried out among beekeepers, the survey concerns a number of parameters including the situation and the management of bee colonies., additionally a morphometric method is performed on a set of 445 worker bees sampled at 30 hives in different locations: Bejaia, Blida, Jijel, Mila, Setif, Skikda, Tipaza, Constantine, Batna, and Cheffa. Morphometrics took in consideration are fifteen 15 parameters selected as stated by Ruttner *et al.* (1978) and measured by laboratory tools. statistical analysis results revealed a biogeographic variation within the honey bee colonies targeted at the northern Algerian level. All the results obtained made it possible to discriminate them among local populations and reveal a significant variation which may reflect a salient genetic diversity in groups. In short, this study targets the characterization action of the local race on a genetic standpoint so it can serve as harbingers in adopting the appropriate strategies for the conservation of Algeria's local race besides its diversity management.

Keywords: *Apis mellifera*, characterization, classical morphometry, conservation, diversity.

ملخص:

نحل العسل، من الحشرات التي تتميز بترابط اجتماعي بين أفرادها، من بينها السلالتين المحليتين التلية والصحراوية. يُواجه كل منهما عدة عوامل مختلفة بشكل خطير إثر المشاكل المستمرة المرتبطة بتغير المناخ وبعض الممارسات البشرية. لذلك يعتبر أنه من الضروري معرفة السلالات المحلية بشكل أفضل ومحاولة تقدير مدى أهمية هذا التراث البيولوجي. تهدف هذه الدراسة إلى وضع خطة مناسبة لإدارة وتحسين إنقاذ سلالات النحل الجزائري (*Apis mellifera intermissa*)، وكذلك الحفاظ عليها في المجال الحيوي الطبيعي الخاص بها. أولاً، تم إجراء توصيف نمطي لقطاع تربية النحل عن طريق استبيان حول المربين، الطرق المنتهجة، وصحة المناحل في شمال الجزائر. تليها بعد ذلك دراسة مورفولوجية، أخذ عينات مجموع 445 نحلة عاملة من مواقع مختلفة (حوالي 30 منحل): بجاية، البليدة، جيجل، ميلة، سطيف، سكيكدة، تيبازة، قسنطينة، باتنة، وشفا. كشفت نتائج التحليل الإحصائي لقياس الخصائص المورفومترية الكلاسيكية لخمسة عشر 15 مؤشر مورفومتري عن تباين جغرافي بيولوجي داخل مستعمرات نحل العسل، وجعل من الممكن التمييز بين النحل المحلي وكشف تبايناً كبيراً قد يعكس تنوعاً بيولوجياً وراثياً بارزاً ومقارنة بين المجموعات المدروسة.

الكلمات المفتاحية: النحل، السلالة التلية، السلالة الصحراوية، دراسة مورفولوجية، المورفومترية الكلاسيكية، تنوع بيولوجي

Introduction:

The honey bee *Apis mellifera* is a social insect, living in large and harmonic communities consisting of hundreds of males (drones), sterile female workers, performing colony maintenance tasks, and a single queen. Besides their significant economic, cultural and social roles, bees are crucial species in many terrestrial ecosystems, from maintaining ecological biodiversity, to food security and nutrition (Klein, *et al.*, 2007). It also contributes in the production of seeds and vegetables (Bommarco, *et al.*, 2012) through the pollination of 90% of the 107 main crop kinds and wild flower within the world (Klein, *et al.*, 2007), supporting forest regeneration, so serving to extend productivity, quality, profitability, and farmers' incomes (Klein, *et al.*, 2003; Hilmi, *et al.*, 2011). In addition, honey bees also provide human kind with honey, pollen, wax, royal jelly and propolis. All these hive products generally have the image of being natural, healthy and clean but it is identified to be mostly

susceptible (Bogdanov, 2006). Therefore, these creatures are intrinsically associated with the environment it inhabits (Sadeghi, et al., 2012), and increasingly investigated as strong bio-indicators to monitor the environmental pollution (Kevan, 1999).

Bees are distributed in a wide range with various climatic conditions and displays numerous subspecies, two of them are known to occur in Algeria, among which *Apis mellifera intermissa* in the north [(Buttel-Reepen, 1906); (Ruttner, 1968)], *Apis mellifera sahariensis* in the south [(Baldensperger, 1932); (Haccour, 1960)], this vast diversification is accompanied by rich morphological variations that were found to play prominent roles in the activities

Nevertheless, a range of factors, such as competition among native and introduced bee species for space and resources (Russo, 2016), climate change (Kammerer, et al., 2021), habitat loss induced by human actions (Bommarco, et al., 2010), pesticide usage, pests and pathogens (Mull, et al., 2022), collectively increase the survival challenges, surpassing the adaptability of many bee species.

Hence, conducting a study of these issues is an important initiative. First, the integrated survey approach shall permit to the data collection to introduce beekeeping practices in north Algeria. Afterwards, the morphological analysis is one of the most basic assays in characterisation and a fundamental tool for organismal biology studies and has improved considerably in the last few years (Bookstein, 1998). It simply aims to identify and characterize bee populations in ten localities situated in north of Algeria: Batna, Blida, Constantine, Cheffa, Jijel, Mila, Setif, Skikda, and Tipaza, by a morphometric study through the classic method to better manage and improve this resource, which can lead to higher efficiency in the yield for hives.

Material and methods:

Survey approach

To document and analyse the beekeeping practices of apiculturists in their apiaries managing process, the constraints and needs in the field and determine its main characteristics. We opted for a quantitative survey based by a uniform questionnaire, established beforehand by (Adjlane, 2012), covering four interesting points: apiarists information, apiaries information including the total number of colonies and the environment in which the bee yards are placed, the beekeeping methods adopted by each apiarist, plus the bee mortality and colony losses. It involves a representative sample of local beekeepers. The survey was carried out both by face-to-face interview or by sharing the questionnaire in beekeeper groups online; it is made available in two languages (French, and Arabic). Almost 70 beekeepers replied to the questionnaire (anonymously), the equivalent of about thousands of beehives located in 22 regions in north Algeria

Data treatment is performed by the *PSPP Version 0.8.5* and Excel 2016. We proceeded an elementary statistical processing for quantitative representation such as frequencies or mean values to describe the data and evaluate possible differences between the variables characterizing beekeeping sector.

Table 1. The geographical and climatic situation of honeybee's samples collection sites

Locality	Altitude(m)	Latitude	Longitude	Bioclimat	Country	Temperature (°C)
Bejaia	298	36.3419	4.5635	Humid	Algeria	16.9
Blida	114	36.3153	2.5546	Sub-humid	Algeria	17.1
Jijel	74	36.4104	6.1628	Humid	Algeria	18.1
Mila	753	36.2116	5.5138	Sub-humid	Algeria	14.5
Setif	955	35.4913	5.3026	Semi-arid	Algeria	14
Skikda	236	36.5324	7.0532	Humid	Algeria	17.2
Tipaza	186	36.2805	2.261	Sub-humid	Algeria	18
Constantine	640	36.3613	6.6296	Sub-humid	Algeria	15.6
Batna	1048	35.5527	6.1506	Semi-arid	Algeria	13.5

Classical morphometry approach

The general procedures followed in the present study consist of field visits to the apiaries supplemented by laboratory work. The most productive field days were scheduled during early spring, between Mars and May 2021 where a remarkable and widespread beekeeping activity was experienced.

Table 2. The morphological characters studied

N°	The Morphological characters	Authors	Figure
01 - 04	The hind leg : (Fe – Ti – ML – MT) Length of (Femur + Tibia + metatarsus) + width of Metatarsus	(Alpatov, 1948)	
05	(LP) Length of the stretched proboscis (tongue)	(Alpatov, 1948)	
06 - 09	(LT3 – T3 – LT4 – T4) (Length + width) of the 3 rd and 4 th tergites	(Alpatov, 1948)	
10	(S3) Length of the 3 rd sternite	(Alpatov, 1948)	
11 - 13	(WL – WT – WD) (Length + width + distance between wax mirrors) of the 3 rd sternite	(Ruttner, 1975)	
14 - 15	(L6 – T6) (Length + width) of the 6 th sternite	(Ruttner, 1975)	

In total, 445 randomly selected subjects of honeybees are collected in 10 localities situated in north Algeria and representing different altitudes (Table 1, Figure 1). Each sample comprises 15 worker bee immersed in tubes filled with 90° absolute ethanol and preserved in a very low-temperature (-20°C) until handling time under a binocular microscope (10- to 100-fold magnification) as recommended. (Adjlane, 2012).

According to the description established by (Cornuet & Fresnaye, 1989), fifteen characters pertaining to hind leg, proboscis, tergites (03 + 04), and sternites (03 + 06) (Table 2) have been the subject of our study in light of their discriminatory power and biological significance (Cornuet & Fresnaye, 1989).

The data of mensuration are obtained by converting digital database from the images into usable scientific data and expressed in centimetres (cm), then processed by specialized software; namely *ImageJ* (Schneider, et al., 2012) and (R Core Team 2020) version 3.6.3. The statistical analysis is performed afterwards by a collection of methods varied between non-parametric methods. For instance: the Kruskal-Wallis test alternative to the ANOVA used to compare the 10 sites for each of the 15 characters along with an additional post-hoc test using Bonferroni coefficients to identify similar groups, have been used according to Ghasemi and Zahediasl (2012), supplemented with principal components analysis (PCA).

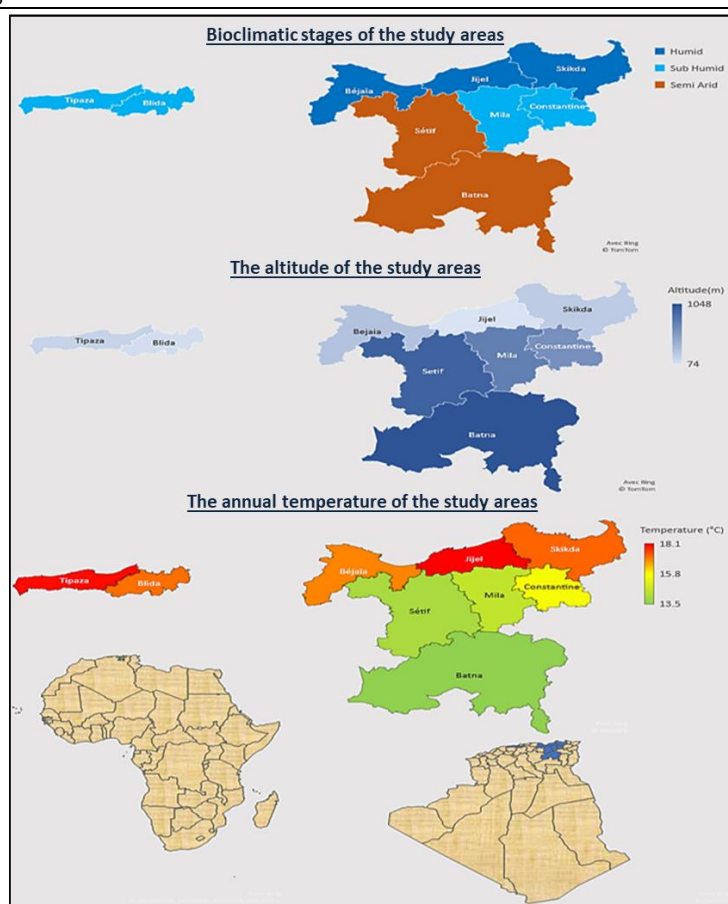


Figure 1. Collection sites of honeybee's samples; altitude and temperature are indicated in meters (M) and degree celcius (°C) respectively

Results:

Typology of the beekeeping sector in north Algeria:

Regarding apiarists information, as shown in (Table 3), participants range in age from 22 to 60 years old. As for gender, the evaluation of the results indicated that the sample at study comprises only men, about two thirds of them (58.6%) hold a university degree, (31.4%) have secondary education, (10 %) generally not educated beyond middle school level (Figure 2a).

Based on the respondents interviewed, the majority (62.9%) practices beekeeping to envision professional career while the remaining third performs it as a side activity and a supplementary source of income (Figure 2b).

Table 3. Beekeepers information

Descriptive statistics					
Age					
	N	Minimum	Maximum	Mean	SD
Age	70	22	60	38.34	9.808
Gender (Frequencies)					
	N	Percentage		Valid percentage	Cumulative percentage
Valid Men	70	100		100	100

As it is shown in (Figure 3a), of the 70 survey participants, (22.2%) are commercial beekeepers (defined as having 100 or more hives), (32.9%) are provided with an average number of beehives of their own (30 to 100 hives), and (44.3%) participants being hobby beekeepers (less than 30 hives).

Transhumant beekeeping in the region includes at least 70% of beekeepers among the respondents (Figure 3b). These beekeepers are predominant in the region of north east of Algeria in response to territorial physical barriers and the necessary adaptation to local climatic and flowering conditions.

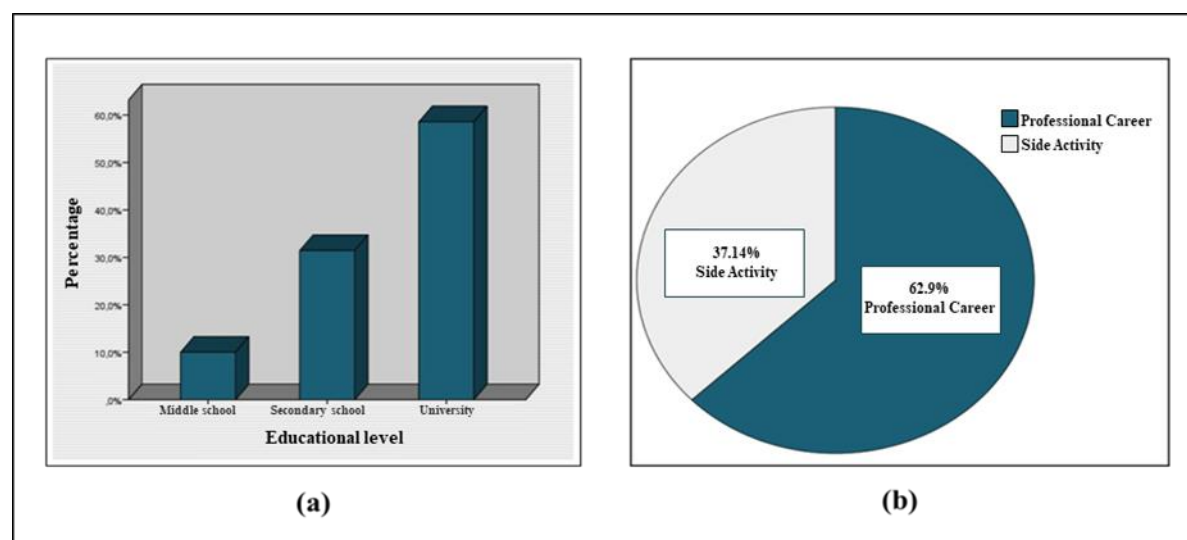


Figure 2. Educational level of beekeepers (a), Integrational level of beekeeping (b)

The survey showed that (40.8%) of the beekeepers keep their hives inside forests, (24.3%) in cultivated fields, (22.3%) in gardens and only (12.6%) are found in orchards (Table 4).

Concerning the types of feeding, the local beekeepers prefer to feed their colonies with only supplemental food (10.8%), only syrup (29.7%), and (59.5%) of local beekeepers feed their colonies with both syrup and supplemental food (Figure 3c). In this same context, it is clearly stated by most of the beekeepers (41%) that they generally introduce the feeding process during winter, (27.7%) of them in autumn, only (8.4%) fed their colonies during spring and summer, while (15.7%) choose to not feed at all (Table 4).

Table 4. Apiaries information

Apiary environment (frequencies)				
Environment of the apiary	Responses		Compliance percentage	
	N	Percentage		
	Forests	42	40.8%	60.9%
	Cultivated fields	25	24.3%	36.2%
	Orchards	13	12.6%	18.8%
	Gardens	23	22.3%	33.3%
Feeding periods (frequencies)				
Feeding period	Responses		compliance percentage	
	N	Percentage		
	Autumn	23	27,7%	32,9%
	Winter	34	41,0%	48,6%
	Spring	1	1,2%	1,4%
	Summer	6	7,2%	8,6%
	No set period (depends on years)	6	7,2%	8,6%
	No feeding	13	15,7%	18,6%
Livestock management (frequencies)				
Livestock management	Responses		compliance percentage	
	N	Percentage		
	Selling swarms	36	33.3%	53.7%
	Purchasing swarms	17	15.7%	25.4%
	Artificial swarming	55	50.9%	82.1%

a. Group of dichotomies tabulated at the value 1.

On another hand, half of the participants (50.9%) declared that they depend mostly on artificial swarming to enlarge the herd, (15.7%) purchase swarms, and the rest (33.3%) are actually specialized in selling swarms (Table 4).

Finally, evidence from this evaluation highlighted the periods where the surveyed beekeepers have witnessed unusual colony losses during the last three years (Figure 3d), (25.7%) of them reported losses during the winter. (20%) lost a number of colonies during autumn, and (15.7%) during the summer season. In contrast, (38.6%) of beekeepers did not report any abnormal losses.

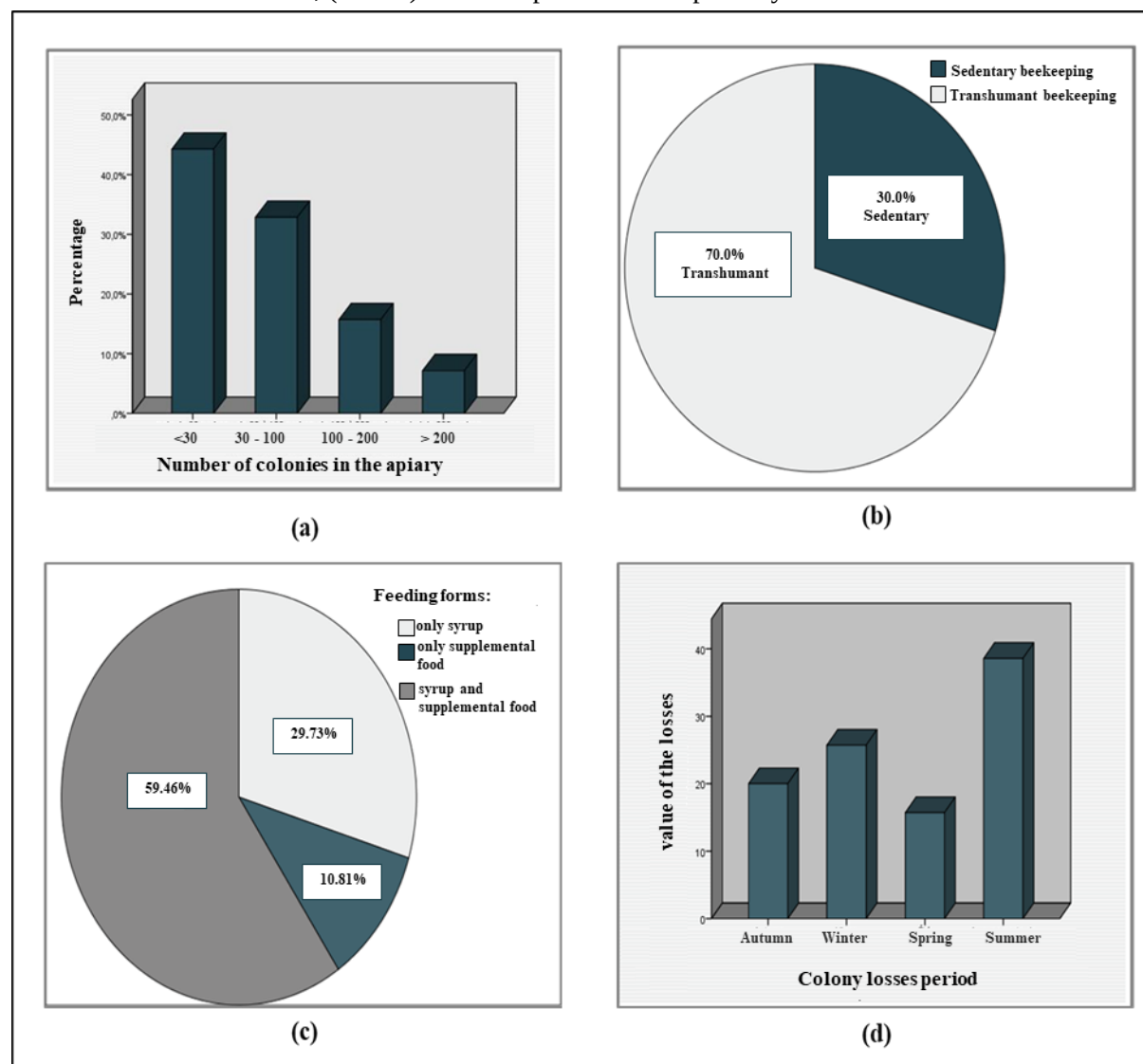


Figure 3. Relative distribution of number of colonies (a), beekeeping methods (b), feeding methods (c), and periods of colony losses (d)

Morphometric characterization of bee populations:

Statistical testing for normality of data was performed. However, both of the Shapiro-Wilk test ($P\text{-value} \ll 0.05$) and the Kolmogorov-Smirnov test reject the hypothesis of normality for all the fifteen continuous quantitative variables with 5% margin of error. In this case, it was useful to have non-parametric methods; namely the Kruskal-Wallis test which compares between the study bee populations in several geographical areas. The latter is often used as a non-parametric alternative to the ANOVA where the assumption of normality is rejected.

The Descriptive and Inferential Analysis:

The survey data were subjected to descriptive and inferential statistical analysis including minimums, maximums, means, medians and variances of each statistical parameter (Table 5). Therefore, the median was taken as a main tool in the comparison; one appealing characteristic of the latter is that it

is a robust measure, for it is generally less sensitive than the average of the occurrence of few extreme data points and the non-normal distribution.

Table 5. Descriptive statistical analysis results according to Kruskal Wallistests with a Bonferroni correction

Parameter	Min	Max	Mean	Median	Variance	SD	SE	P.value ¹	Signification ²
Fe	0.192	0.319	0.24839	0.247	0.001	0.25489	0.0012	0.0001	***
Ti	0.106	0.315	0.288066	0.293	0.002	0.0401363	0.0018899	0.0001	***
MT	0.066	0.28	0.124558	0.12	0.001	0.025264	0.00119	0.0001	***
ML	0.105	0.275	0.18997	0.189	0.000	0.020848	0.000982	0.0001	***
LP	0.326	0.694	0.48079	0.471	0.005	0.070616	0.003325	0.0001	***
T3	0.14	0.284	0.22342	0.223	0.000	0.020488	0.000965	0.0001	***
LT3	0.604	0.954	0.82263	0.823	0.003	0.05883	0.00277	0.0001	***
T4	0.112	0.298	0.21754	0.217	0.000	0.01746	0.00822	0.0001	***
LT4	0.618	0.991	0.8442	0.853	0.04	0.063119	0.002972	0.0001	***
WT	0.139	0.294	0.22924	0.231	0.000	0.016892	0.000795	0.0001	***
WD	0.009	0.064	0.030985	0.32	0.000	0.0092192	0.0004341	0.0001	***
WL	0.108	0.255	0.14527	0.144	0.000	0.016049	0.000756	0.0001	***
S3	0.159	0.319	0.2595	0.261	0.000	0.01767	0.000832	0.0001	***
T6	0.23	0.365	0.31101	0.311	0.001	0.023869	0.001124	0.0001	***
L6	0.191	0.338	0.258877	0.259	0.000	0.0183187	0.008626	0.0001	***

1: P. value according to Kruskal Wallis test

2: *** Highly significant

Hind leg:

The femur length (Fe) of the collected bees varies between 0.19 cm and 0.32 cm with an average of 0.25 ± 0.03 cm. Bees from Tipaza and Sétif apiaries are characterised by remarkably longer femurs ($p < 0.0001$) compared to those from other localities. Subsequently, post-hoc comparisons using the Tukey HSD test indicated that there are some significant differences ($p \leq 0.0001$) between samples of Setif and Tipaza (the best performing) marked by very significant P.values.

The length of the tibiae (Ti), in like manner, varies significantly from one apiary to another ($p < 0.0001$) with an average of 0.29 ± 0.04 cm. Bees from cheffa, jijel, and mila are distinguished by the shortest tibiae while those sampled in Batna have the longest ones.

Length and width of the metatarsus (ML and MT) differ demonstratively from one apiary to another with averages of 0.19 ± 0.02 cm and 0.12 ± 0.03 cm respectively. Bees with the longest metatarsals are encountered in the locality of Batna. With respect to the width of the metatarsus, the best performing samples are from Tipaza. A Post-Hoc type test was applied based on the Tukey model in order to identify the statistically dissimilar groups. Accordingly, the most distinguished regions are Blida and Constantine noticeably marked by significant P.values.

Tongue (Proboscis):

Length of the proboscis (LP) ranges between a maximum and a minimum value of 0.33 cm and 0.69 cm respectively. Measurements on the tongue, showed a considerable regional difference ($P < 0.0001$) for a 95% confidence interval; for instance, those results of Batna compared to other localities

Tergites:

Length and width of the third tergite (LT3 and T3) vary significantly in accordance with averages of 0.82 ± 0.06 cm and 0.22 ± 0.02 cm respectively. Similarly, length and width of the fourth tergite (LT4 and T4) also vary significantly with averages of 0.84 ± 0.06 cm and 0.22 ± 0.02 cm respectively. The

Kruskal Wallis test resulted in a probability of <0.0001 , a notable outcome for a 95% confidence interval, and revealed differences between populations in question

Sternites:

The third sternite minimal length (S3) in most of the studied localities is 0.16 cm. The average value is 0.26 ± 0.02 cm, where the locations of Cheffa and Blida are the most distinguished regions marked by very significant P.values according to Tukey HSD comparisons, so it is with the longitudinal length of the wax mirror of the same sternite (WL). However, the average transversal length and the distance between wax mirrors (WT and WD) in most studied localities are 0.23 ± 0.02 cm and 0.03 ± 0.001 cm respectively.

Length and width of the sixth sternite (L6 and T6) differentiate essentially with averages of 0.26 ± 0.02 cm and 0.31 ± 0.02 cm respectively.

Processing the statistical data by the Kruskal Wallis test led to a probability of <0.0001 , very significant for a 95% confidence interval, this results differences between the studied populations.

Principal Component Analysis

Statistical treatment by Principal Component Analysis (PCA) produced five components which accounted for 82.2% of the total information (Table 6). Additionally, 51.6% of the cumulated inertia is shared by the two first dimensions (PC1 and PC2). On top of that, the statistical design of the PCA components reveals the presence of three groups of homogeneous variables (Figure 4):

Table 6. Percentage of inertia for each PCA dimension

Component	PC1	PC2	PC3	PC4	PC5
Inertia (%)	27.6	23.9	17.6	8.9	3.9
Cumulative inertia (%)	27.6	51.6	69.3	78.2	82.2

- The first group takes prime position on the positive side of the 2nd dimension (PC2) and mainly targets the hind leg metatarsal and sternite 03 wax mirrors (MT and WD).
- The second group is located on the negative side of the 2nd dimension (PC2) and targets the proboscis and the third tergite (LP and T3).
- The last group, howbeit, dominates the positive side of the first dimension (PC1). It is the most important and informative with a collection of structural variables including sternite 06, tergite 4, femur and tibia.

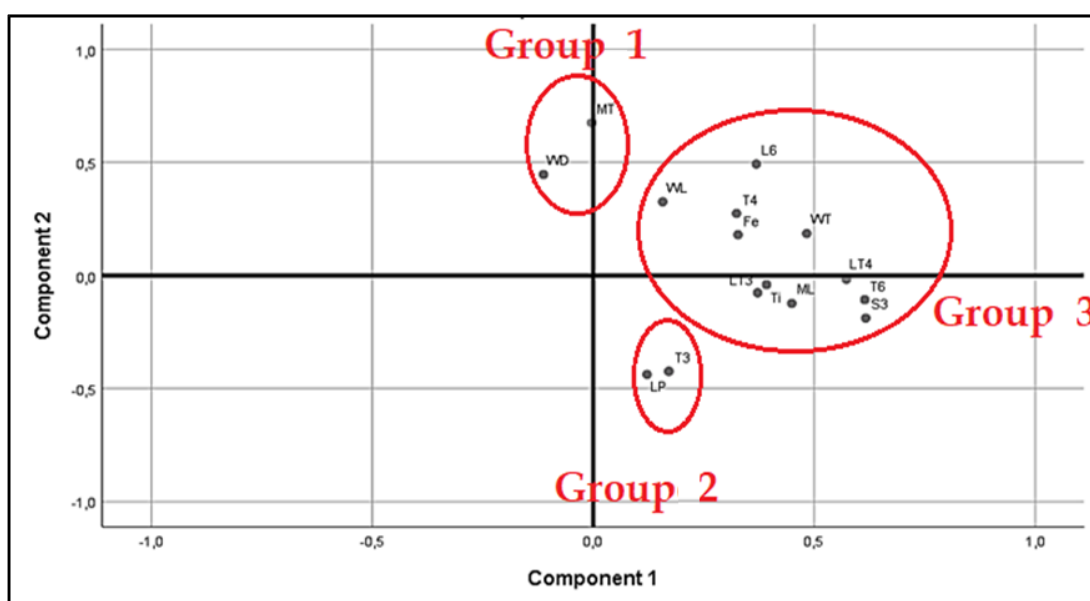


Figure 4. Scatter Plot Chart of the fifteen morphologic parameters within PCA components plan

As a supplementary measure, the plot of cloud points (ant colony modelling) (Figure 5). It proposes at least 4 categories of bees; each of those dominates a specific type of parameter. From one hand, it is remarkable that the localities of Blida, Constantine and Bejaia represent the most developed in physical matters including sternite, tergites, femurs and tibias. On the other hand specimens of Setif, Tipaza and Mila, possess the smallest physical form in terms of anatomical conditions.

Specimens of Batna are exceptional with the largest metatarsals of the hind leg and the wax mirrors, at the same time, the precise representation of samples collected from Jijel and Skikda may be linked to their well-developed proboscis.

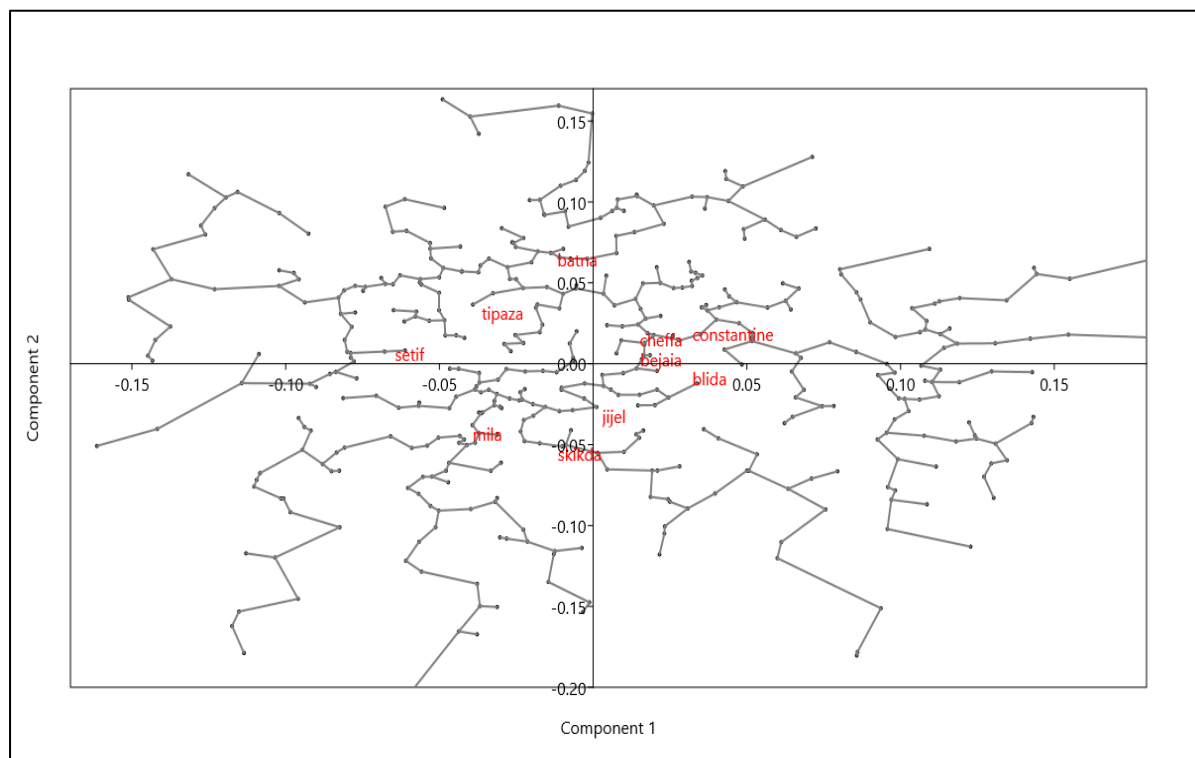


Figure 5. Graphical display of cloud points via the PCA method

The ascending hierarchical classification among bee populations

The ascending hierarchical classification of the study bees measured on the basis of the 15 morphometric characteristics structured this diversity into four homogenous groups (clusters) which correspond to Euclidean distances with a computational algorithm that exceeds 1000 units of Bootstrap (Figure 6). Although, each morphotype contains morphologically similar bees, all the morphotypes are approximately a mixture of bees of several localities. Group I comprises bees sampled from Skikda, Constantine, and Setif, since their performance is likely the same. Group II includes specimens of Tipaza. They appeared very homogeneous and distinguished following statistical terms. Specimens of Blida and Cheffa are classified in almost the same clusters, and they form the group III which is very logical considering the similar geographical and ecological conditions. Finally, group IV consists of specimens of Batna. All dispersed over the 3 clusters.

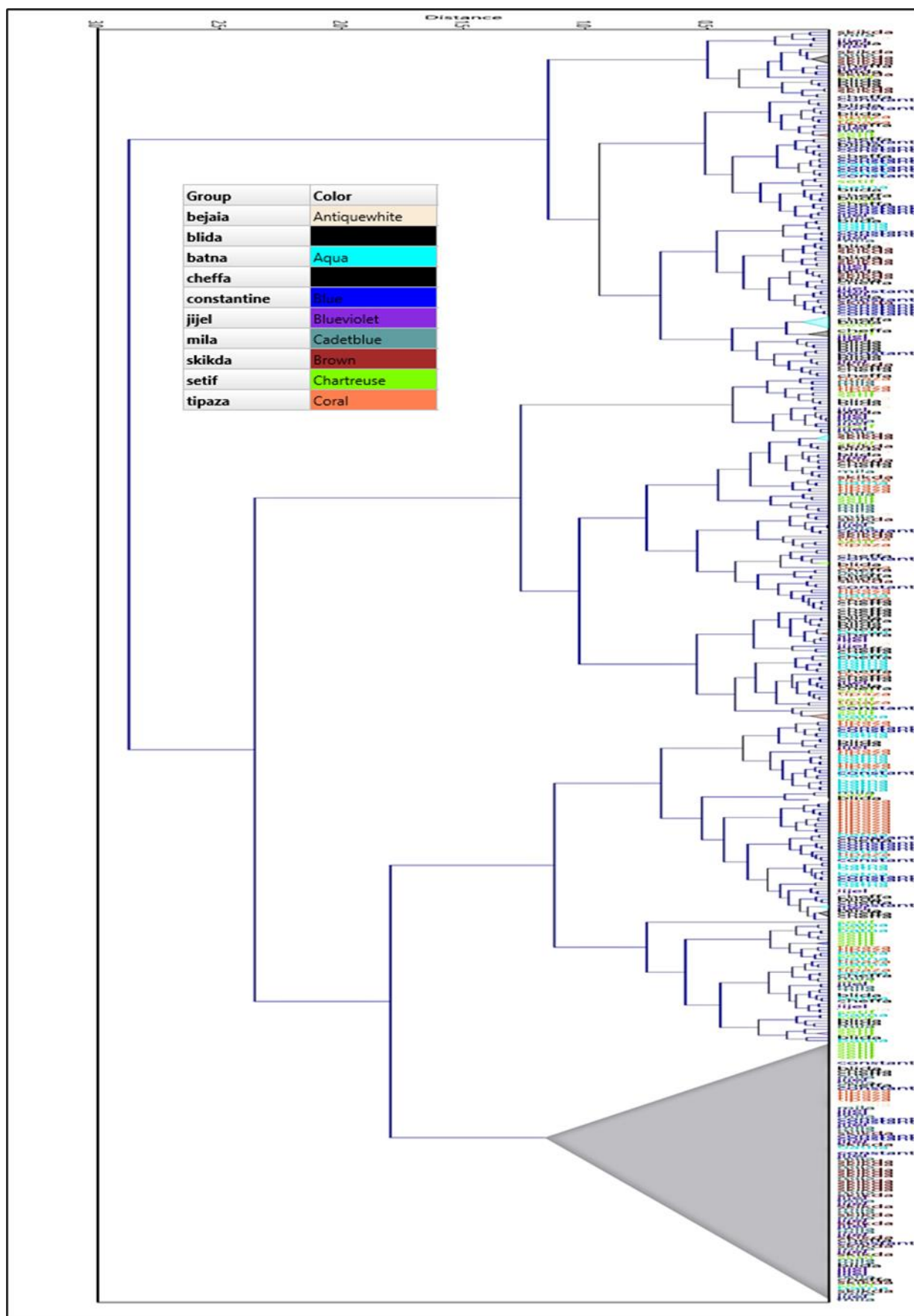


Figure 6. Hierarchical ascending classification according to average distance within bee populations studied

Discussion:

As a first step towards the purpose of this study, our inquiries illustrated that beekeeping is an activity mainly carried out by men, even though it has the potential to contribute to the empowerment of rural women, strengthening their involvement in agriculture. This aspect is coincident in also seven different countries in Europe (Croatia, Estonia, Finland, Italy, Norway, Portugal, and Spain) according to (Guiné, *et al.*, 2021).

Furthermore, only the minority of the respondents beekeepers (7.1%) own more than 200 beehives and considered as commercial beekeepers in the region of north Algeria comparable to the results declared by the national coordinator of the government-industry partnership for plant biosecurity in Australia through The Honey Bee Health Survey 2019 (Anon., 2019)

Besides, over the last years several authors have observed and suggested long-term dangers: increased sensitivity of the hive to pathogens, identifying artificial swarming as one of the main current threats (Tarpy, 2003; Meixner, *et al.*, 2010.) ; A high bee-production is in fact positively correlated with a high transhumance frequency, which remains a major contributor in the spread of various bee diseases (Fernandez, *et al.*, 2012).

Alternatively, our results regarding the beekeeping methods could simply raise concerns about the fact that Algeria does not make an exception, where we noted (70%), this high value ties well with previous studies conducted in the sierra central-north region of Veracruz - Mexico (Chontal, *et al.*, 2020) this idea is further supported by the findings of (Chahbar, 2017)

In the final part of the survey, colony losses were represented with (45.7%) during autumn and wintertime. This value is higher than turkey (18.6%) (Tunca, *et al.*, 2016), and conversely smaller than those reported in a similar study in Algeria four year before (59 %) (Kidoud, 2017) this progress proves a crucial importance in the context of efforts, real attention, and effective risk factor management to improve bee production yield.

In the next step, the morphometric characterization conducted on bees collected from different localities (situated at different altitudes) in north of Algeria in line with the approach set out by the zoologist (Ruttner, 1988), pointed out variations within the populations of *Apis mellifera intermissa* that could be attributed in part to future working methods.

It should be noted that the average size of the complete hind legs (0.726 cm) is a bit lower than the one inferred by (Brou, *et al.*, 2019) in Ivory Coast, which measured (0.738 cm), it remains a key character since it carries the pollen basket and pollen brushes and controls the harvesting capacity and honey production (Mattu & Verma, 1984)

equally important, the tongue, upon which relies the quantity of nectar collected from flowers (Hassanein & El-Banby, 1956; Morimoto, 1968), according to the study of (Brou, *et al.*, 2019), its length was (0.488), this pattern of results accords with our observations, so it is encouraging to make an approximated comparison with the average of the values obtained. by contrast, the latter is considered longer than that reported for other *Apis mellifera* populations in 2020 sampled in the southern Urals –Russia with an average of (0.380 cm) (Gazizova, *et al.*, 2020)

According to the third and fourth tergites length indicators, bees of regions of the south Ural – Russia were also characterized by diversity with an average of 0.64 cm) (Gazizova, *et al.*, 2020). This feature is still lower than those recorded in the present study which varied from 0.82 to 0.84 cm.

Besides, the abdominal sternites length average in bees was equal to 0.26 cm, matches those observed in south Ural (Gazizova, *et al.*, 2020). As there was no remarkable difference in size of wax mirrors of the study bees as well, there are no grounds for suggesting any discrepancy in their ability to produce wax.

To reinforce the credibility of the measures announced, principal component analysis was established which released 82.20% in terms of inertia between the first five dimensions (PC1 and PC5). The latter indices reflect at best the information provided by the fifteen morphological variables (Fe, Ti, MT, ML, LP, T3, LT3, T4, LT4, S3, WT, WD, WL, T6, and L6).

In this same context, the hierarchical analysis also highlighted the grouping of the 30-sample hives based on the measured morphological parameters, and the degree of similarity. These parameters have four distinct groups with a similarity rate of 15. Concerning the situation of group IV, it can thus be suggested that the statistical model could not distinguish region of Batna being a different area, this is an important issue for future research which requires quite strongly the application of geo-morphometric approach.

Conclusion:

The results of this paper allow us to draw a few conclusions about beekeeping field in north Algeria and its natural resources.

Initially, the investigations contributed to our understanding of the processing of beekeeping activities, and the roles played by stakeholders in different localities in north Algeria, considering different socio-economic, cultural and ecologic contexts, as well as the transfer of knowledge and expertise

As regards the second approach, the classical morphometry has emphasized a certain variation in the size of most of the parameters studied. This variation in size is at the origin of certain biological, ecological and social factors, such as: vegetation and climate, or even the different age of bees, genetic heterogeneity, as well as tolerating foreign bees to access the hives.

Despite these promising findings would represent a prominent contribution to expand future database on a larger honey bee population with a view to a better knowledge of local beekeeping resources and the conservation of Algerian bee subspecies in their natural biotope. Further studies are needed to develop a full picture of this biological heritage, with more focus on examining other approaches, namely geo-morphometry, phylogeny.

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