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Phenotypic and morphometric characterization of the various strains of quail raised in Algeria

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Abstract

Since the absence of studies dealing with the genetic biodiversity and phenotypical description of different breeds of quails in Algeria, we have initialized this work in order to investigate and to contribute in a characterization of the quails in some states. A total of 206 adult quails, distributed in 09 regions in Algeria from which 11 morphometric measurements and 11 phenotypic characters were selected for this study. The measurements Lie (wing length), Lq (tail length), Lc (neck length), Dg (big finger), Dm (medium finger), Dp (small finger), Lt (total length), Lts (tarsus length), Ab (abdomen), Lgp (chest width), Lbe (beak length), W (weight). A multiple correspondence factorial analysis was performed on the phenotypic characteristics, and reveals two main component that constitute 19.61% and 13.41% of inertia, percentages respectively related to the length of wing, of the tail, of neck, big finger, middle finger, little finger, the total length of abdomen, of the tarsal width, width of the chest, the length of the beak and weight. This analysis has made it possible to establish remarkable phenotypic differences which have implications to be taken into consideration in the characterization and conservation program of the species. We have found that the sex has no effect on the measurements parameters, except the weight. However, the effect pf the strain may have some differences on the morphometric measurements studied. Finally, it should be noted that the present work of morphometric characterization of high quail strains in Algeria deserves to be continued and developed in the future, based on the determination of zootechnical performances (productive and reproductive) of these strains, and also the preservation of this genetic heritage deemed important.

Key words: quail, morphometric measurements, phenotypic, strains, Algeria.

Introduction

Quail belongs to the order of *galliform* and family of *phasianidae* and to the genus *Coturnix* that includes a large number of species. Quail is a rustic bird, small in size, characterized by rapid growth, early sexual maturity, a short generation interval, high laying and less space and feeding requirements compared to other poultry species (Nanda et al, 2015 ; Sarabmeet and Mandal, 2015).Quails have been raised since ancient times. The earliest known representation of quail is found in Egyptian hieroglyphs where quail represents the letter "W" in the alphabet (Shanaway, 1994).Worldwide there are 20 types of wild quail breeds and strains and about 70 domestic, including laboratory and commercial quails. Although all domestic quails come from wild strains, many obvious differences require between them and the wild population that was the first to be domesticated remains uncertain (Chang et al, 2005).

Since the mid-1970s, large releases of shooting quail or ornament have been made from sedentary animals of the Japanese quail *Coturnix japonica*. This led to hybridization between the Japanese quail and the natural populations of the quail of wheat

(Deregnaucourt et al, 2001; Guyomarc'h et al 1996).

Over the past decade, quail has gained economic importance as an agricultural species producing eggs and meat that are valued for their unique flavor (Kayang et al, 2004). Quails are found in all continents. Several lines, breeds and varieties have been developed for different production purposes (Maiorano & al, 2012). Quail meat is known by its flavor (Maiorano et al, 2009). Quail meat reveals a good mineral profile. In fact, it is an important source of phosphorus, potassium and iron which is higher than chicken meat So, as regards the chemical and nutritional aspects, quail meat reveals interesting properties that could facilitate its marketing (Tunsaringkarn et al, 2013).

Quail eggs as for them they have many therapeutic virtues (Djitie Kouatcho, 2015). Since ancient times, quail eggs are known to have properties antiallergic. Today, these properties have been proven by clinical studies conducted on a large number of patients (Bruttmann, 2007).Quail egg yolk is one of the few foods that naturally contain vitamin D. It is very rich in vitamin E. Vitamin E is a fat-soluble vitamin with antioxidant properties and could be involved in diseases heart (Knckt et al, 1994 ; Glynn et al, 2007), cancer (Weitberg and corvese, 1997 ; Lee et al, 2005), ocular disorders (Leske et al, 1998 and Jacques et al, 2005) and cognitive decline (Sano et al, 1997 ; Morris et al, 2006).

The quail of wheat *Coturnix coturnix* belongs to a group of species and subspecies particularly diversified widespread in all the open grasslands of the old world, from North Africa *Coturnix.c. Africana* to Australia *Coturnix.c.cyprilophorus*, passing through the whole Palearctic (Johnesgard, 1988). In Algeria, the quail of wheat nests in the "Tell" up to the high altitudes and in the northern Sahara in the "Djebel Chélia/Aurès" (altitude 2000-2100m). In the Sahara, the species probably nested in "M'Zâb", "Reggan", "Abadla", "Djamaa and Hoggar" (Isenman et al, 2000).

Very few previous studies on the morphological and phenotypical characterization of quail are carried out. Apart from a study is realized in Morocco on the biometrics of quail of wheat (the case of irrigated perimeter of Tadla) by ICHEN (2016) and another study conducted in France by Boutin and Tesson (2010). However, no studies carried out in Algeria about the morphometrical and phenotypical characterization of quail in general.

The objective of this article is therefore to study quail strains adapted to the Algerian climate concerning to their morphological and phenotypical characterization to have an idea on the diversity of this spices and to be able in the future take the most appropriate approach to the development of a management and improvement plan .

Study site

This study was carried out on six states spread over Algeria **(Figure 1),** these states are: Tlemcen(West), Setif (East), Blida(Center), Tipaza(Center), Media(Center) and Bechar (South) **(Table1).**

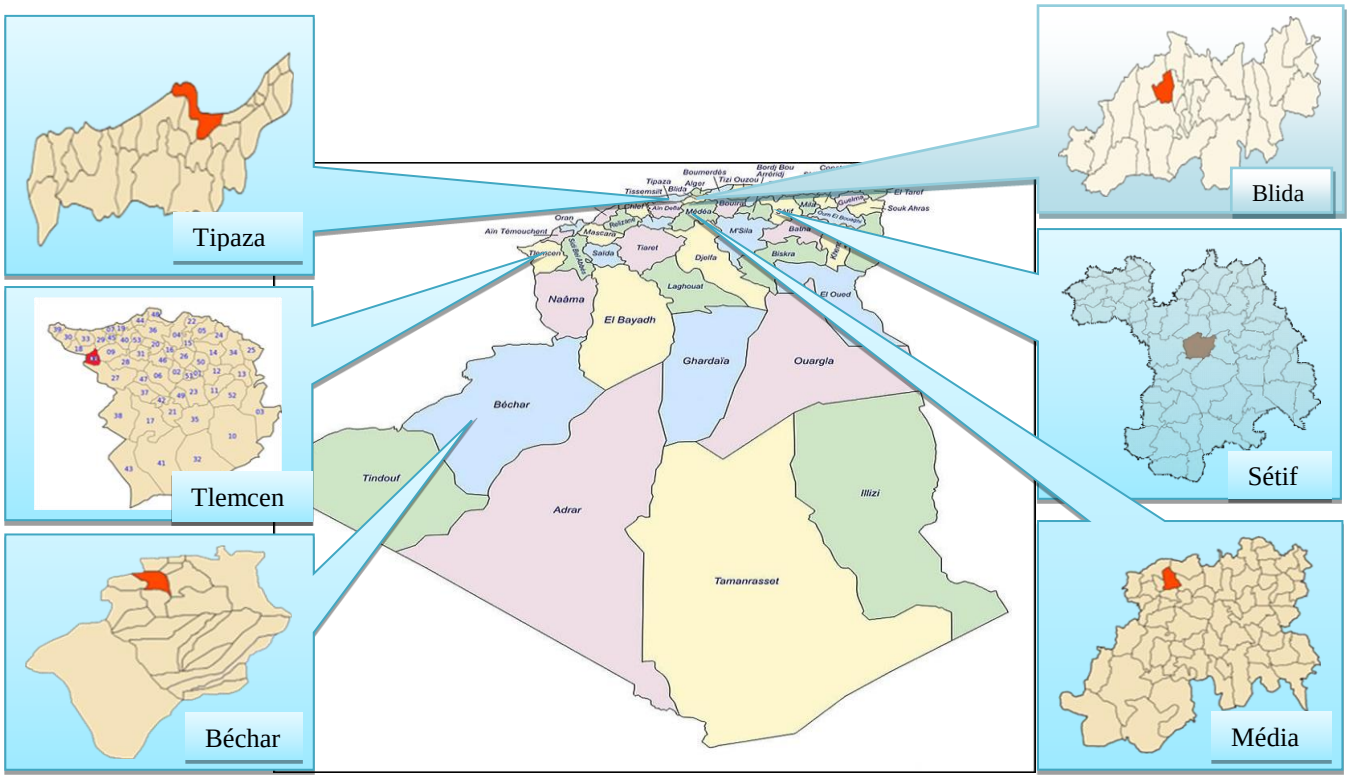

Figure 1. Presentation of study areas by contribution to the national map

Table1. States, regions, samples size and climate parameters of areas, which included in the study.

The state	The region	Sample size	The climate
Tlemcen	-Ain fza and tirni.	64 subjects (quail of wheat, hybrid quail, giant quail)	-Temperature of 16.0°c -484 mm precipitation and rainfall
Sétif	-Municipality of Salah Bey (south), -L'Eulma (center) -Bougâa (north)	60 subjects (quail oh wheat and Japanese quail)	-Temperature of 13.3°c -469 mm precipitation and rainfall
Blida	-Beni Tamou	20 subjects (the hybrid quail)	-Temperature of 17.9°c -791 mm precipitation and rainfall
Médéa	-The center of the state	20 subjects (white quail)	-Temperature of 14.4°c -736 mm precipitation and rainfall
Tipaza	-The center of the state	14 samples (quail of wheat)	-Temperature of 18.5°c -631 mm precipitation and rainfall
Béchar	-The region of Knadsa	10 quails (quail of wheat)	-Temperature of 20.2°c -87 mm precipitation and rainfall

Measurements

Our work is based on the data of morphological characteristics collected from 206 adult individuals distributed on the Algerian territory as follows: Tlemcen (27 quail of wheat and 27 hybrid quail, 10 giant quail), Setif (40

quail of wheat and 20 Japanese quail), Blida (20 hybrid quail), Tipaza (14 quail of wheat), Medea (20 white quail) and Bechar (18 quail of wheat) (Table 2).

Table 2. Number of birds and classified according to their (sex, regions).

Stations	Strains	Males	Females	Total
Salah Bey (Sétif)	Quail of wheat	10	10	20
L'Eulma (Sétif)	Quail of wheat	10	10	20
Bougâa (Sétif)	Japanese quail	10	10	20
Ain Fza (Tlemcen)	Quail of wheat	17	10	27
Ain Fza (Tlemcen)	Giant quail	10	10	20
Turney (Tlemcen)	Hybrid quail	10	07	27
Médéa	White quail	10	10	20
Bni tamou (Blida)	Hybrid quail	10	10	20
Tipaza	Quail of wheat	8	6	14
Knadsa (Béchar)	Quail of wheat	8	10	18
Total		103	103	206

A total of 11 measurements were taken on each bird as described by Tesson & Boutine(2010) these measures were: (Lie): wing length, (Lq): tail length, (Lc): neck length, (Dg): large finger, (Dm): middle finger, (Dp): small finger, (Lt): total length, (Ab): abdomen, (Lts): tarsus length, (Lgp): chest width, (Lbe): spout length, (Pd): Weight.

Statistical analysis

*Descriptive analysis***:** for the purpose of calculating the various statistical parameters (mean, maximum, minimum, standard deviation, etc.), this analysis was carried out using the software: Excel (Version 2010).

*The purpose of variance analysis***:** is to compare the means of different morphometric measurements made on different strains with each other. The parametric data were compared by performing a variance analysis (ANOVA) to a factor followed by the multiple comparison test (S.N.K) to determine the significant differences between the means of different strains in an analysis of variance. The results of the measurements are expressed as Average and Standard Deviation. These tests were performed using the SPSS (statistical package for the social sciences) version (21).

Multivariate analysis:

- An analysis in principal components (PCA)**:** it enables the variability of measurable or quantitative parameters to be analyzed in order to group homogeneous individuals with the same quantitative characteristics studied, to make a classification and identify individuals who are quite similar (the most homogeneous individuals).
- A factorial analysis of multiple matches (FCA): associated with a hierarchical upward classification (HAC) using the SPAD software (version 5.0). The objective of this analysis was to characterize the major points of association and similarity between qualitative variables in order to group individuals with the same qualitative characteristics, and to specify also the major characteristics of each group or strain.

Results and discussion

Descriptive analysis

The minimum, the maximuma, the means and standard deviations of the morphometric measurements of quails are reported in Table 3, we observe that our results and the results obtained by Ichen (2016) in Morocco are

completely different, for example we found that the average standard deviation of the weight is varied between 181.34±43.45g Vs 101.13±0.39g, the length of the wing is 14.17± 1.00mm Vs 111.45±0.16mm, the length of the tarsus and 2, 45±0.36mm Vs 32.98±0.06mm.

Table 3: Descriptive analysis of morphometric measurements of all strains of quails studied.

Variables	Minimuma	Maximuma	Average ± standard deviation
Weight	110,00	342,00	181,34 ±43,45
Lie	11,07	16,70	14,17±1,00
Lq	1,18	4,80	2,76±0,45
Lc	1,17	2,98	1,65±0,35
Dg	1,47	7,28	2,63±0,44
Dm	1,19	2,94	1,82±0,29
Dp	1,00	1,60	1,11±0,06
Lt	14,30	21,05	17,98±1,64
Ab	10,33	22,15	14,95±3,16
Lts	1,12	3,27	2,45±0,36
Lgp	3,61	5,10	4,26±0,27
Lbe	1,00	2,13	1,14±0,14

(Lie): wing length, (Lq): tail length, (Lc): neck length, (Dg): large finger, (Dm): middle finger, (Dp): small finger, (Lt): total length, (Ab): abdomen, (Lts): tarsus length, (Lgp): chest width, (Lbe) : length of beak.

Analysis of variance

Variable Variation by Strain

Table 4 summarizes the different means of morphometric measurements performed on the different strains of quail studied (quail of wheat, Japanese quail, hybrid quail, giant quail and white quail) **(Figure2).** It is clear that there is a very highly significant difference ($p<0.001$) for the majority of the means of the different measurements between the strains. Therefore, the strain factor is a very important source of morphological variation.

The common quail **The Hybrid quail** **The Japanese quail** **The Giant Quail** **The white quail**

Figure2: the different strains of quails (original photos).

Table4: Effect of quail strain on morphological and phenotypic measurements of birds.

Variables	Strains						
	The common quail	**The Japanese quail**	**The Hybrid quail**	**The Giant Quail**	**The white quail**	**Overall average**	**P value**
Pd	180.20^{b}±38.56	149.21^{a}±20.65	$187,47^{b}$±35,38	301.32^{c}±50.86	$164,35^{ab}$±31,25	181,34±43,55	0,001(***)
Lie	13.94^{a}±0.86	13.65^{a}±0.41	$14,13^{a}$±1,12	15.48^{b}±0.21	$15,37^{b}$±0,88	14,17±1,00	0,001(***)
Lq	2.88^{b}±0.57	2.77^{ab}±0.40	$2,51^{a}$±0,20	2.94^{b}±2.24	$2,60^{a}$±0,11	2,76±0,45	0,01(**)
Lc	1.80^{b}±0.41	1.97^{b}±0.29	$1,46^{a}$±0,13	1.52^{a}±0.15	$1,41^{a}$±0,12	1,65±0,35	0,001(***)
Dg	2.69^{a}±0.30	3.01^{b}±1.04	$2,51^{a}$±0,14	2.48^{a}±0.16	$2,39^{a}$±0,09	2,63±0,44	0,001(***)
Dm	1.84^{ab}±0.30	$2,00^{b}$±2.40	$1,68^{ab}$±0,21	1.65^{a}±0.13	$1,91^{ab}$±0,18	1,82±0,29	0,001(***)
Dp	1.12^{b}±0.04	1.11^{b}±0.04	$1,08^{b}$±0,03	1.27^{c}±0.12	$1,05^{a}$±0,04	1,11±0,06	0,001(***)
Lt	18.5^{c}±01.56	19.41^{d}±0.57	$17,07^{c}$±0,96	14.7^{a}±0.19	$16,93^{b}$±0,22	17,98±1,64	0,001(***)
Ab	16.87^{b}±3.10	13.61^{a}±1.36	$13,53^{a}$±2,44	19.02^{c}±0.59	$11,91^{a}$±0,45	14,95±3,16	0,001(***)
Lts	2.39^{a}±0.38	2.38^{a}±0.24	$2,38^{a}$±0,35	2.62^{ab}±0.15	$2,82^{b}$±0,24	2,45±0,36	0,001(***)
Lgp	4.28^{ab}±0.28	4.49^{c}±0.22	$4,17^{ab}$±0,22	4.33^{b}±0.10	$4,12^{a}$±0,05	4,12±0,05	0,001(***)
Lbe	1.18^{b}±0.20	1.16^{ab}±0.05	$1,09^{ab}$±0,03	1.11^{ab}±0.02	$1,06^{a}$±0,03	1,14±0,14	0,01(**)

The averages with different letters (a,b,c,ab….) are significantly different (p<…). (Lie): wing length, (Lq): tail length, (Lc): neck length, (Dg): large finger, (Dm): middle finger, (Dp): small finger, (Lt): total length, (Ab): abdomen, (Lts): tarsus length, (Lgp): chest width, (Lbe) : length of beak.

Variation in Variables by sex

The mean morphometric measurements in both sexes of the strains studied are reported in the table below **(Table5).** The sex factor had a very highly significant influence ($p<0.001$) on weight variables and chest width, its influence is marked significantly ($p<0.01$) on the abdomen and tail length. In terms of weight, the width of the chest and the abdomen superiority is marked in females more than males are of average weight of (191.59g±45.18g vs171, 39g±40.51g) respectively. The sex factor has no significant effect ($p>0.05$) on the rest of the variables studied, so there is a remarkable homogeneity between the two sexes for these morphometric variable.

Table5: Mean of variables studied by sex of quails.

Variables	Sex			
	Male	Female	Overall average	Sig
Weight (g)	$171,39^{a}$±40,51	$191,59^{b}$±45,18	181,34±43,55	0,001(***)
Lie (cm)	14,11±0,98	14,22±1,03	14,17±1,00	0,43(NS)
Lq(cm)	$2,84^{a}$±0,49	$2,67^{b}$±0,38	2,76±0,45	0,01(**)
Lc(cm)	1,60±0,35	1,69±0,33	1,65±0,35	0,07(NS)
Dg(cm)	2,62±0,54	2,63±0,31	2,63±0,44	0,82(NS)
Dm(cm)	1,84±0,28	1,80±0,30	1,82±0,29	0,27(NS)
Dp(cm)	1,10±0,07	1,11±0,05	1,11±0,06	0,33(NS)
Lt(cm)	17,90±1,61	18,05±1,67	17,98±1,64	0,52(NS)
Ab(cm)	$14,40^{a}$±3,08	$15,48^{b}$±3,16	14,95±3,16	0,01(**)
Lts(cm)	2,45±0,37	2,43±0,35	2,45±0,36	0,63(NS)
Lgp(cm)	$4,20^{a}$±0,21	$4,32^{b}$±0,29	4,12±0,05	0,001(***)
Lbe(cm)	1,15±0,18	1,13±0,07	1,14±0,14	0,34(NS)

The averages with different letters (a,b,c,ab….) are significantly different(p<…). (Lie): wing length, (Lq): tail length, (Lc): neck length, (Dg): large finger, (Dm): middle finger, (Dp): small finger, (Lt): total length, (Ab): abdomen, (Lts): tarsus length, (Lgp): chest width, (Lbe) : length of beak.

Principal Component Analysis (PCA)

The main component analysis (PCA) of the variables studied on the 206 quail in the six states revealed that

the first two factor axes of variation explain 39.98% of the information or total inertia **(Table 6).** Axis 1 alone expresses 23.17% of the total variability. It is strongly and positively correlated with the strain variables, Lts and Lie, and is negatively correlated with the Lgp variables, Lc, Lbe, Lq, Dg, Dm, Lt. On the other hand, axis 2 expresses only 16.81% of the total variability and explains the results the following variables: sex, Ab, weight and Dp, these variables have a negative correlation with this axis.

Table6: Own values obtained from the PCA.

	F1	F2
Eigen value	3.24	2.53
% Variance	23.17	16.81
% cumulative	23.17	39.99

• **Class1:** This class includes 97 subjects from different regions: L'Eulma (quail of the wheat), Salah bey (quail of the wheat), Bougâa (quail of the Japanese) and Ain Fza (common quail), Knadsa (quail of the wheat). Individuals in this class are characterized by a weight of (164.84±21.38g), a total length of (17.28±0.47cm) and a chest width of (4.12±0.046cm) **(Table 6).**

• **Class2:** The 46 individuals that make up this class are the heaviest individuals whose weights have an average of (248.35±47.78g) and the shortest because their total lengths have an average of (15.31±0.75cm). the quails of this class are giant quails, common quails and hybrid quails.

• **Class3:** This class includes 45 individuals from four different regions: Bougâa (Japanese quails), Tirni (hybrid quails) and some individuals from Knadsa and Eulma. Individuals in this class are characterized by an average weight of (207.78±32.88g), a total length of (19.11±0.68cm), so are the longest individuals **(Table 6).**

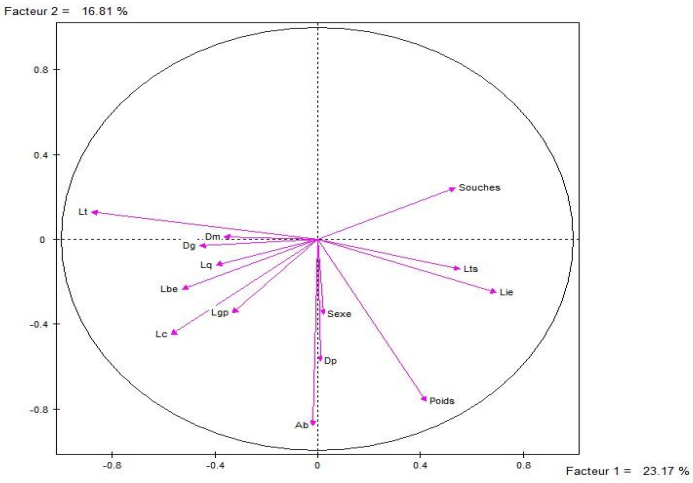

Figure3: Distribution of morphometric measurement variables on CPA axes 1 and 2.

The main component analysis (CPA) identified 4 classes **(Figure4).**

• **Class4:** This class consists of 18 individuals, those are the lightest individuals (161.22±35.55g), with a total length of (18.54±1.42cm) and a chest width of (4.27±0.31cm), the individuals of this class belong to the region of Medea (white quail).

Table7: Characteristics of quail classes grouped by CPA.

	Class1	**Class2**	**Class3**	**Class4**
N	97	46	45	18
Pd	164,84±21,38	248,35±47,78	207,78±32,88	161,22±35,55
Lie	14,44±1,188	15,19±0,65	13,93±0,92	13,70±0,79
Lq	2,58±0,20	2,64±0,29	2,89±0,76	2,89±0,42
Lc	1,40±0,11	1,47±0,12	2,07±0,43	1,55±0,26
Dg	2,48±0,14	2,43±0,15	2,78±0,29	2,63±0,35
Dm	1,78±0,21	1,61±0,14	1,86±0,23	1,82±0,26
Dp	1,06±0,03	1,16±0,11	1,11±0,04	1,09±0,04
Lt	17,28±0,47	15,31±0,75	19,11±0,68	18,54±1,42
Ab	11,75±0,42	18,28±1,31	18,81±2,43	13,18±2,12
Lts	2,49±0,39	2,78±0,24	2,22±0,43	2,40±0,36
Lgp	4,12±0,046	4,28±0,33	4,37±0,28	4,27±0,31
Lbe	1,07±0,03	1,08±0,04	1,28±0,30	1,14±0,05

(Lie): wing length, (Lq): tail length, (Lc): neck length, (Dg): large finger, (Dm): middle finger, (Dp): small finger, (Lt): total length, (Ab): abdomen, (Lts): tarsus length, (Lgp): chest width, (Lbe) : length of beak.

Variation of individuals

The analysis carried out on 206 individuals of quails at the level of the six states shows that the first two factor axes 1 and 2 express respectively 19.61% and 13.41%. Inertia **(Table 8)** axis 1 is strongly and positively correlated with the variables of the Japanese quail strain, a Dg long (>2.6 cm), Tt (>19 cm), Lc(>1.8 cm) and Lbe (>1.12 cm), and is negatively correlated with the white strain variable, Lt short(14.3 to 17.8 cm) and Lie long (>1.12 cm). On the other hand, the axis 2 revealed the results of the variables positively correlated with it and which are: Ab short (10.3 to 16 cm) and light weight (110g to 200 g). On the other hand, the variables with a negative correlation with axis 2 are the giant quail strain and the weight greater than 250 g (weight>250 g).

Table8: Own values.

Dimension	**Eigen value**	**Inertia**
1	0,29%	19,61%
2	0,20%	13,41%.
Total	**0,49%**	**33.02%**

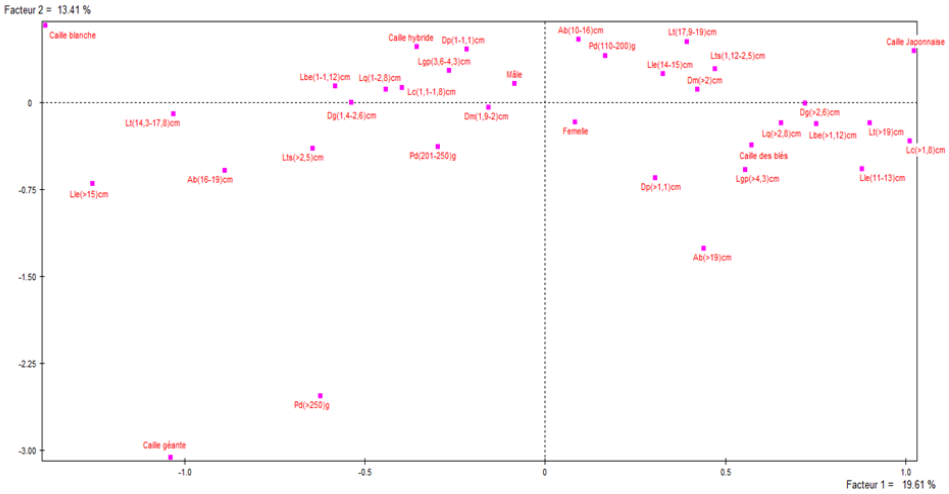

Figure 5: Breakdown of the modalities used in the morphometric measurements on the two axes of the AFM.

The factor analysis of multiple ACM matches **(Figure6)** makes it possible to determine four classes **(Table9).**

Table9: Class characteristics determined by ACM analysis.

Qualitative characteristics		**Class1**	**Class2**	**Class3**	**Class4**
		86	**10**	**56**	**54**
Weight	Light	-	-	89.29%	-
	Medium	10.71%	-	-	38.89%
	Heavy	-	100%	-	-
Lie	Short	11.63%	-	-	-
	Medium	-	-	100%	38.89%
	Long	-	100%	-	-
Lq	Short	-	36.05%	36.05%	100%
	Long	63.95%	-	-	-
Lc	Short	-	33.72%	-	100%
	Long	66.28%	-	98.21%	-
Dg	Short	-	30.23%	30.23%	98.15%
	Long	69.77%	-	-	-
Dm	Short	-	55.81%	92.86%	-
	Long	44.19%	-	-	7.14%
Dp	Short	-	-	85.71%	-
	Long	61.63%	100%	-	14.79%
Lt	Short	-	100%	-	-
	Medium	-	-	42.86%	-
	Long	79.07%	-	-	19.64%
Ab	Short	-	-	100%	-
	Medium	-	-	-	38.89%
	Long	34.38%	60%	-	-
Lts	Short	72.09%	-	92.86%	5.56%
	Long	-	27.91%	-	-
Lgp	Short	-	44.19%	92.86%	85.19%
	Long	55.81%	-	-	-
Lbe	Short	-	29.07%	29.07%	89.15%
	Long	70.93%	-	-	-

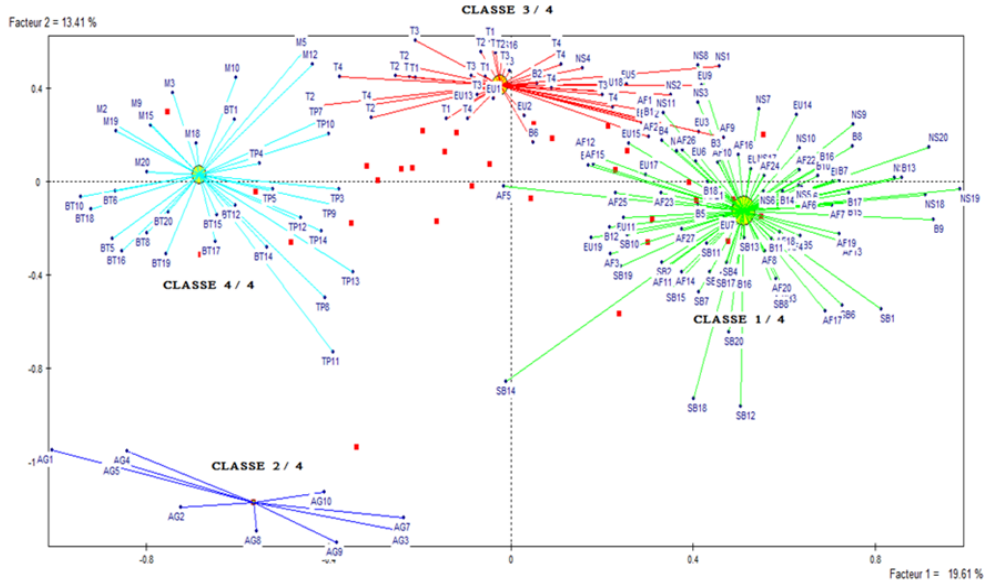

Figure6: Presentation of individuals by ACM.

Class1: This class consists of 86 individuals (most of the individuals in this class are wheat quails), with medium weight of 10.71%, and a short wing of 11.63%, **(Table9).**

Class 2: Class 2 represents only 10 individuals of the quails studied which are essentially the quails of Giant strain, or the heavy weight is dominant with an average of (301.32±5.86g), this character is the most dominant in this class because it characterizes all the quails of this group (100%), the character Lie long, a Dp long, a LT long is also present in 100% of individuals. In the light of all these findings it can be concluded that the class 2 which groups the giant quails is the most homogeneous class.

Class 3: A number of 56 individuals (Japanese quail and quail of wheat) make up this class, all individuals in this class are characterized by a light weight (quail of wheat) (89.29%), the mean Lie and a short Lc are present in 100% of the individuals, the Ab long character is apparent in 60% of the quails that make up this class.

Class 4: In this class, the 54 individuals which compose it are hybrid quails, white quails and wheat quails, the quail of wheat characteristics in 100% of the individuals are: a short Q and a short C, in addition the character Dg short characterizes 98.15% of quails of this class, on the other hand the characters Dm long and Lts short are less frequent and touch only 7.14% and 5.56% of quails respectively.

Based on the results of this study, there are five quail strains in Algeria, each of which has different characteristics. Wheat quail is characterized by a long abdomen (16.87±3.10 cm), a long neck Lc (1.80±0.41 cm), a long Lt (18.5±01.56 cm), a long beak length (1.18± 0.20 cm) and an average weight of (180.20±38.56 g). A clear difference between the two sexes in terms of weight was found, the males have an average weight of (171.39±40.51 g) and the females have a weight of (191.59±45.18 g), this difference (superiority of the females) may be explained by ovarian cluster development in females. Other morphometric parameters, including chest width (4.32±0.29 vs 4.20±0.21 cm) and abdomen (15.48±3.16 vs 14.40±3.08 cm), as well as tail length, are more important in females than males. These four morphometric variables are the source of heterogeneity between males and females in wheat quail.

The Japanese quail is a light strain with an average weight of (149.21±2.65 g), a total length of (19.41±0.57 cm) and an average abdomen width of (13.61±1.36 cm) and is characterized by a total length of (19.41±0.57 cm). In terms of weight the hybrid quail (this hybrid strain is cross between wheat quail and Japanese quail)

expresses an average weight of (187.47±35.38 g), that is, it is characterized by an average weight with a wing length of (14.13±1.12 cm), an average Lt of (16.93±0.22 cm) and an abdomen width of (11.91±0.45 cm). Giant quail is the heaviest strain, it is characterized by an average weight of (301.32± 5.86 g) an average total length Lt (14.3-17.8 cm), an equally average chest width Lgp of (3.6-4.3 cm) and a length of the beak (1.11-0.02 cm).The white quail is characterized by a white color; this strain has a total length of (16.93± 0.22cm) and a tail length of (2.60±0.11cm). There are similarities and differences between these strains in terms of morphometric characterization.

The results obtained by the AFM and the other multidimensional analyses, show that there is a similarity between the quail strain of the wheat and the Japanese quail in most of the morphometric characters, and there is a significant difference between Japanese quail and white quail for most of the characteristics studied, including a long Lgp (for Japanese quail) Vs a medium Lgp (for white quail) and a long Lc (for Japanese quail) versus a medium Lc (for white quail). Giant quail differs completely from other strains studied, and constitutes a single class with a very remarkable morphometric homogeneity rate, which explains why this strain is exploited in its pure state (strain not crossed).

Compared to studies carried out all over the world on the morphometric characterization of quail there is a study on the quail of wheat conducted in Morocco by ICHEN (2016) on 262 adult individuals. The present study found that the weight of adult wheat quail is 180.20±38.56 g authors found that average weight was 101.13±0.39 g is very different from our results. In the other hand, the length of wing in this study was 13.94±0.86 cm vs 111.45±0.16 cm for the study of Moroccans.

Another study conducted in France by Boutine and Tesson (2010) on the quail of wheats shows that the latter has a weight of 60-155g, a wing length between 100-119 mm, a total length of 160-100 mm, a length of the beak between 11-13 mm and a tail length between 32-43 mm, compared to our results obtained on the quail of the wheat we find no huge differences, therefore the measurements of the quail of wheat in France and those of the Algerian wheat quail are almost the same, contrary to the measurements found in Morocco. This raises a wide range of questions that need to be answered.

Conclusion

The results obtained in this study conducted in different regions of Algeria (East, West, Central and South) showed that there is a great morphological variation between the strains of quail studied (quail of wheat, Japanese quail, hybrid quail, giant quail and white quail). Therefore, the strain factor is a very important source of morphological variation. A strong homogeneity is noted between the quail strain of wheat and the hybrid strain. The other strains marked a heterogeneity their individual. Indeed, the giant quail strain is completely different from the other strains studied in majority of the parameters under the consideration, in particular the weight, or the strain is marked the heaviest with average weight 301.32±5.86g. The Main Component Analysis (PCA) identified four distinct classes, which explains the existence of a strong heterogeneity in terms of morphometric measurements between strains and among individuals of the same strain. The factorial analysis of multiple AFM matches carried out in this study allowed to determine four classes (depending on the modalities of the qualitative characteristics used). This analysis helped in the characterization of each strain and thus to give the major morphometric characteristics of each strain, and even it also groups the most homogeneous strains that have morphometric similarities, as in the case of wheat quail and Japanese quail. Thus, the giant quail strain is the most homogeneous strain and the most efficient strain because its weight is marked the highest (mean of weight =301.32±5.86g) compared to the other strains studied. In the light of all these findings, it should be pointed out that the present work on morphometric characterization of different quail strains in Algeria deserves to be continued and developed in the future, based on the determination of the zootechnical (productive and reproductive) performance of these strains, and also the preservation of this genetic heritage considered important.

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