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Presence of sexual dimorphism but no ecotypes among free-ranging Muscovy ducks in Guatemala

Raúl Jáuregui[1], Mario E. Gonzáles[2], Carlos R. Lorenzo[3], Ana M. Folgar[4], Anna Isern[5], Pere M. Parés-Casanova[6]*

[1,2,3,4,5,6]Instituto de Investigación, Centro Universitario de Oriente (CUNORI), Universidad de San Carlos de Guatemala, Guatemala

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***Corresponding author:** Pere M. Parés-Casanova
Instituto de Investigación, Centro Universitario de Oriente (CUNORI), Universidad de San Carlos de Guatemala, Guatemala

Abstract

In this study, we investigated the sexual dimorphism and differences in geographical areas between males and females of Muscovy ducks raised freely in three different local communities in Guatemala. The analysis was based on 14 important morphological traits -arm length, shank length, total height, head length and head width, body length and width, dorsoesternal length, croup height, body, breast and abdominal perimeters, metatarsus perimeter and body weight- obtained from a sample constituted by 137 males and 225 females. Males presented higher massiveness than females but were less stocky and legged. Sexual dimorphism was well manifested. The smaller body exhibited by the females as compared to the males can be a reflection of their adaptive strategy to the stressful environmental and nutritional conditions, as smaller size would reduce the maintenance feed requirements and increase feed efficiency in their free-range system where feed resources are limited in terms of quantity and quality. The discriminant analysis revealed also that males could not be grouped into different geographical groups, while females from Camotán appeared separated from the rest, but we consider this as a mere topotype group (e.g., associated with artificial selection and breeding) rather than an ecotype (e.g., associated to local ecological conditions).

Keywords: *biodiversity; criollo; drake; fowl; local breed*

Introduction

A breed is a homogenous group of livestock with definable, specific, and identifiable physical traits (FAO, 2006) where its individuals can be distinguished on the basis of morphological and biometrical traits. Improvement of domestic animals to meet human needs is dependent on description of breeds because their study gives clues to their selection.

Duck production is largely a traditional enterprise and has not yet been so industrialized as that of chicken (Yakubu, Kaankuka, & Ugbo, 2011) (Veeramani, Prabakaran, Selvan, Sivaselvam, & Sivakumar, 2014). Probably is for that that duck is still a neglected species in research on domestic animals. Moreover, if the volume of work pertaining to the phenotypic and genetic constitution of the indigenous breeds of Guatemala is still very small, information on indigenous domestic ducks of Guatemala is null.

The wild Muscovy duck (*Cairina moschata* Linnaeus 1758) is native to the Americas (Donkin, 1989). Its distribution comprises both coasts of Mexico, Central America and most tropical regions in South America (Hernández, Muñoz, Valencia, Posso, & Muñoz, 2007) (Schaaf et al., 2018). The wild species, called too Greater Wood Duck or Forest Duck, has the hindlegs projected more to the front with respect to the base of the body than the ducks of the genus *Anas*, has strong and sharp claws, well-developed hind fingers and broad wings (Donkin, 1989), and an average male size of 66 to 86.5 cm, a body weight of 2 to 4 kg, and the male being considerably larger than the female (Donkin, 1989) (Baéza, Williams, Guémené, & Duclos, 2001) (Almeida et al., 2014).

Its derived domestic species is called *criollo, pato real, pato perulero, pato almizclado, pato mudo* and Berbery duck. It is a rustic animal that does not require complicated installations for breeding, is very resistant to many diseases, has a high prolificity, and presents a good precocity in fattening as well as a great capacity to take advantage of food rations (Igwe, Okoli, & Okeudo, 2003) (Almeida et al., 2014) (Abdeltawab, Salha, Allam, & Fandy, 2017). Domestic ducks are primarily raised for meat and eggs, although, they provide other materials of economic value such as feathers (Etuk, Abasiekong, Ojewola, & Akomas, 2006).

In small villages around Guatemala, Muscovy duck represents an interesting meat and egg source. Its feeding base is scavenging, comprising of anything edible found in the immediate environment, as well as small amounts of grain supplements provided by the locals. So, feed supplies from home and the environment varies according to activities in the household, season of the year and the life cycle of insects and other invertebrates on the surrounding areas. Under this present system Muscovy duck probably performs rather poorly.

Phenotypic character study is the basis for the differentiation of groups and/or breeds and provides support for conservation and selection programs; it is a technique used to characterize zoogenetic resources in many countries. In this field, multivariate analysis techniques have been very useful in support of characterization studies of breeds. Multivariate analysis (cluster analysis, main component analysis, canonical analysis, discriminant analysis and correspondence analysis) refers to all statistical methods that simultaneously analyse multiple measurements in a single individual and that are interrelated. It has been widely used in studies of breed characterization and genetic diversity as it provides descriptive analysis of the differences between populations, considering all variables together, providing a data overview.

The first step for effective conservation of Muscovy duck in Guatemala is to perform a characterization based on the phenotypic morphological traits (Oguntunji & Ayorinde, 2014). The use of body measurements available has lead several researches in chicken (Jáuregui, Flores, Vásquez, & Oliva, 2015) (Fitsum, 2015), turkey (Ogah, 2011), pigeon (Uribe, Senar, & Camerino, 1985) (Parés-Casanova, 2013) and duck (Cuesta, 2008) (Yakubu, 2011). Hence, the work was proposed to study morphometric traits of this species in Guatemala.

So, the objectives of this study were:

(1) to examine the morphometry of the free-range Muscovy duck from Guatemala and the sexual dimorphism; and
(2) to determine possible ecotypes (understood as a locally adapted population assumed to be a result of the action of natural selection).

The present results might aid in better tools for the conservation and improvement of this species in the country.

Material and Methods

Sampled animals

We studied a randomly selected sample of 89 adult Muscovy ducks (53 males and 36 females) extensively reared in five different local communities in Guatemala, which have different cultural and orographical features: Chiquimula, El Progreso, Jalapa, Jutiapa and Zacapa. Measurements were restricted to apparently healthy birds. Handling animals was practiced in accordance with ethical routine.

We studied the 10 following parameters, according to standard literature (Cuesta, 2008) (Yakubu, 2011):

- Body length (BL)
- Total height (TH)
- Body width (BWd)
- Breast perimeter (BrP)
- Head length (HdL) and head width (HdW)
- Metatarsus perimeter (MtP)
- Dorso-sternal length (DEL)
- Breast Width (BrWd).
- Body weight (BW).

Four morphological indices (massiveness -ratio of live BW to BL × 100-, stockiness -ratio of BrP to BL × 100- long-leggedness - ratio of total shank length to BL × 100- and condition index -ratio of live BW to arm length × 100-) (Yakubu, 2011) were obtained. Massiveness and stockiness indices were used to assess musculature development (Yakubu, 2011). Condition index was used as an indicator of how animals manage environmental variation and stressors (Yakubu, 2011) (Angel et al., 2015).

Statistical analysis

To assess the differences between sexes and localities we employed a two-way Non- Parametric Multivariate Analysis of Variance (NPMANOVA) with sex and locality as factors and traits, excluding indices, as dependent variables, using correlation distance. Ulterior one-way NPMANOVA and *p*-Bonferroni corrected values were applied to the differentiation between local communities for each gender separately. A correlation table was obtained with Spearman's r_s. Hierarchical clustering among morphometric variables was assessed based on Ward's method. Finally, a Principal Component Analysis (PCA) was performed from var-covar matrix.

All analysis were done with PAST v. 2.17c package (Hammer, Harper, & Ryan, 2001). For multiple statistical testing we used sequential Bonferroni-adjustment and 9,999 permutations, with a 95% level of significance.

Results

The preliminary two-way NPMANOVA reflected statistical differences between local communities and genders (Table 1), so we proceed ulterior analysis with sexes separately. The means, standard deviations and coefficients of variation of the lineal body parameters ducks are presented in table 2. The significance with the minimization of Wilks' lambda corroborated the difference between genders (Wilk's λ=.254; $F_{14,347}$=72.8; p<<.001) and provided validity for the sexual dimorphism. For females there appeared no statistical differences between areas (F=3.919; p=.109) except for those from Camotán. For males, no geographical differences appeared.

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Most of the correlations between the assessed variables were significant (p<.001) and ranged from 2.8% to 73.4%. The presence of positive correlations between the assessed variables justifies the use of multivariate analysis.

Two factors explained 100% of total variance of studied morphometric variables (PC1+PC2=9.2+9.7%). The commonalities found in this study ranged from .617 to -.015 and explained how much a particular characteristic contributes to explain the number of factors being considered. HdW showed low commonality, that is, contributed little to the total observed variance. AbP showed the highest commonality. BrP was the second most important variable in the first principal component. The first factor can be termed 'perimeter factor', and the loading characteristics were highly correlated variables. But these characteristics appear no to be important for describing a breed, but rather the management.

Meatiness trait was better described in males using massiveness (5.14 *versus* 4.09%; p<<.001 for males and females respectively) while in females, it was better explained via stockiness (84.55 *versus* 8.15%; p<<.001 for females and males respectively). Long-leggedness was higher in females (84.43%) compared to males (82.60%; p=.012). The condition index was found to be higher in males (6.08%) compared to female counterparts (4.92%; p<<.001). Higher coefficients of variation were recorded for males than females in all the morphological indices except for condition ratio.

Discussion

Duck is one of the most important domestic avian species in the world (Abdeltawab et al., 2017). Authors have observed that free-range Muscovy ducks in Guatemala are well adapted to the local climatic conditions, feed, and management stresses, with a good resistance to tropical diseases mainly as result of frequent heat stress and drought. In general, it appeared a low phenotypic variation of traits which may indicate, a low genetic variation. The high uniformity of traits in both genders would be an indication of the low environmental sensitivity, which could impair a sufficient selection response.

In Muscovy ducks, sexual dimorphism is well manifested. The smaller body exhibited by the females as compared to the males can be a reflection of their adaptive strategy to the stressful environmental and nutritional conditions, as smaller size would reduce the maintenance feed requirements and increase feed efficiency in this free-range system where feed resources are limited in terms of quantity and quality. The higher leg-body ratio of the females is an indication of longer legs while males have relatively longer body and while the females display a narrower body, which is suitable for egg production; the males exhibit a blockier appearance, which is more a characteristic of meatiness. The higher condition index detected in males is of physiological importance because it measures the metabolic activity (Yakubu, 2011).

Morphological traits among females signal a possible different group in Camotán, but for us would it was a mere a topotype, e.g., a group associated merely with artificial selection and breeding, not with natural selection.

Conclusions

Morphological traits of Muscovy ducks from Guatemala represent genes of adaptation to their own environment and must be viewed as gene reservoir, reflecting unique adaptation to their agro-ecological or tropical environments. Our study revealed that there are marked sexual differences, with no clear ecotype.

Now there is a need to study carcass and egg quality, as well the molecular levels to clarify the similarity with ducks from other areas.

Declaration of interest

The authors report no conflicts of interest. They alone are responsible for the content and writing of the paper.

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