Indian Journal of Animal Sciences **86** (4): 445–448, April 2016/Article

Morphological characterization with special reference to color variations in domestic geese (*Anser anser domesticus)*

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Received: 14 April 2015; Accepted: 2 September 2015

ABSTRACT

A study was planned to record and document the morphological characteristics with special reference to color variations in domestic geese. Knob, dewlap and paunch were present in 44.71, 3.07 and 13.59 % of birds respectively. No curled feathers in the tail were seen in any of the geese studied. Ample color variation was observed in the plumage, eye and bill but not in shanks. Color of the plumage along the body, head, neck, abdomen, and across the wings varied from all cinnamon to all white through all intermediate gradations. Bill color also varied from all black to all yellow through all intermediates. Color of eyes was either grey or brown. No variation was noted in the shank color. It was orange in adults and yellow in goslings. The peculiar colour pattern and markings in domestic geese might be useful in identification of individual birds as is done in horses. Sexual dimorphism on the basis of plumage color and presence of curved tail feathers was absent.

Key words: Characterization, Color, Geese, Morphology, Plumage, Variation

In avian systematics, plumage coloration has been used to distinguish and describe subspecies. Color variation in birds and the genetic basis of such variations have been studied in detail (Davila *et al.* 2014, Zhang *et al.* 2015). Unlike fowl and duck, lesser color variation has been reported in geese. Perusal of literature reveals meagre scientific studies (Wang *et al.* 2014, Huang *et al.* 2014) being carried out across the world on the morphology and color variations in geese. Apart from some studies on wild geese, the situation is more dismal as far as research on domestic geese is concerned. In order to characterize the domestic geese on the basis of morphological traits, the present study was carried out.

MATERIALS AND METHODS

The study was conducted in the geese rearing districts of the Kashmir valley viz. Srinagar, Ganderbal and Bandipora. During the survey, 2336 geese were observed, out of which 746 adult geese of both sexes were closely monitored and studied for morphological characteristics (external features and color variations). The photographs from different views/angles in order to discern various variations were recorded. The photographs also included close views of eyes, beaks, shanks and feather patterns across the wings, and along the neck and abdomen. These photographs were later analyzed to grade the available variations. Information regarding the sex of the individual birds was obtained from the owners. The data was tabulated, classified and analyzed by drawing percentages wherever required.

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RESULTS AND DISCUSSION

External appearance

On observation of the birds individually and in flocks, variations were found in the external appearance, in terms of presence and absence of certain morphological features like knob (rounded protuberance at the base of bill), dewlap (loose growth of skin extending from the base of the lower bill to the upper throat) and paunch (fatty lobe between legs).

The distribution of knob in the observed geese is given in Table 1. In females, knob was present in 51.16%, while in males only 42.11% showed its presence. The contention held by many of the geese rearers that knob was a distinctive feature of males proved to be wrong, since a higher proportion of females showed its presence as compared to males in the present study. Knob found in the wild swan goose (Crawford 1990) is reported to be greatly exaggerated in the African and Chinese breeds (Echols 2015) but the wild graylag goose and its descendents lack this trait (Crawford 1990). Veechi (1930) concluded that inheritance of knob was dominant while Jerome (1953) classified knob as an autosomal partial dominant trait and suggested the symbol *Kb* for it.

Very few birds showed the presence of a dewlap, while it was absent in most birds. Variation was also seen in the

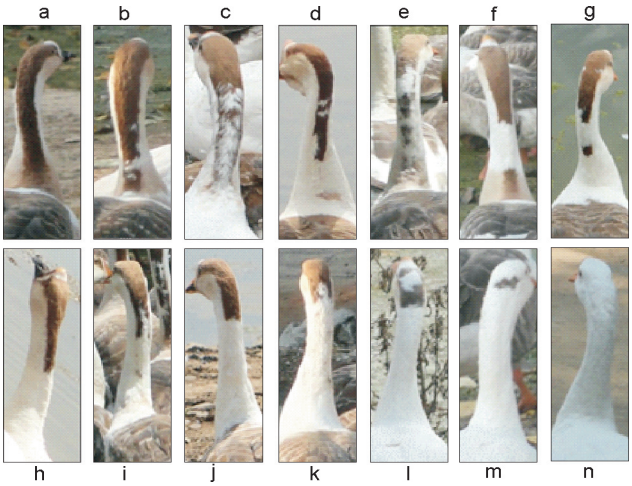

Fig. 1. Variations in the color pattern along back side of neck (a): Cinnamon color spread along the whole neck (b to m): Gradations in the extent of cinnamon color along the neck in the decreasing order from b to m (n): Cinnamon color totally absent (c, d, e): Different patterns of cinnamon color distribution along the neck.

shape of dewlap in terms of being single lobed or bi-lobed. Dewlap has been reported to be a prominent feature in Exhibition Dewlap Toulouse (folded dewlap that increases in size and fullness with age), Standard Dewlap Toulouse and African geese (Crawford 1990, ALBC 1993). The dewlap in African geese is reported to be smooth crescent shaped which may become rugged in shape as the bird ages (ALBC 1993) and has been used as an evidence for its descent from Greylags via the Toulouse (Crawford 1990). Dewlap appears to be a quantitative trait as per the reports of Crawford (1990).

Paunch (lobe) was observed to be present only in 13.59% birds in the present study. Lobes are reported to be present in various other goose breeds, being dual in Sebastopol and Roman geese; double in Standard Dewlap Toulouse geese, exaggerated in Exhibition Dewlap Toulouse, Pilgrim and American Buff geese, and single in Shetland and Cotton Patch (ALBC 1993).

Curled feathers in the tail (known as drake feathers), which is a characteristic feature in male ducks (Banerjee 2013, Bihaqi *et al.* 2014) was not present in any of the geese studied. Hence, absence of this feature precludes the possibility of sex determination in geese visually by this method unlike ducks.

Color variations

Plumage color variation: Variation in the plumage color was seen in goslings as well as the adult geese. Two color variants viz. yellow and blackish yellow were found to exist in goslings while adults had either white or cinnamon colored plumage in general. Cinnamon colored plumage appeared to be more predominant among the geese population accounting for about 76.47% of the total birds under study (Table 1). Yellow goslings grew into white adults whereas blackish yellow goslings grew into cinnamon adults according to the farmer's opinion. However, goslings are reported to be mainly grey with yellow trim in case of White European breeds, and bright canary yellow in case of White Chinese breed (Holderread 1981). It appears that the brown color reported in African, Brown, Chinese and Egyptian geese (Echols 2015) might be similar to the cinnamon color of the observed geese in present study.

In the present study, overall plumage color of adult geese appeared to be confined within the two extremes of pure white and cinnamon through all the intermediate gradients (Table 1). Variations were found among the birds, in terms of the extent of cinnamon color along the back side of neck, with cinnamon color spreading all along the neck to its complete absence through all intermediates (Figure 1). Various patterns were also observed in the distribution of this color along the neck. The distribution of gradation pattern along the neck is described in Table 2. Three variations were found in abdominal plumage color viz. light cinnamon, light cinnamon with white crescent and all white color. The white crescent was either present as a narrow ring or a broad patch. Jerome (1954) in a study on the color inheritance of geese, reported that neck stripe (Ns), white breast patch (Wb) and solid pattern (Sp) was dominant to absence of neck stripe (ns), absence of white breast patch (wb) and spotted pattern (sp) respectively.

Similarly, cinnamon color was found to be present across the wings in different variations and gradations as shown in the Figure 2, varying from full cinnamon to full white through all intermediates. Gradation of cinnamon colour is represented in Table 2. Asymmetry in the spread of cinnamon color across the wings (Figure 2) was seen in larger number of geese as shown in Table 1. Gericke (1958)

Table 1. Distribution of various morphological characteristics in the geese population of Kashmir

	Symmetry across wings (%)		Overall plumage colour (%)		Eye colour (%)		Knob (%)	
	Symmetric	Asymmetric	Cinnamon	White	Brown	Grey	Present	Absent
Male	78.95	21.05	84.21	15.79	52.63	47.37	42.11	57.89
Female	83.72	16.28	74.42	25.58	39.53	60.47	51.16	48.84
Srinagar	89.19	10.81	78.38	21.62	48.65	51.35	27.03	72.97
Ganderbal	72.73	27.27	45.45	54.55	27.27	72.73	45.45	54.55
Bandipora	78.38	21.62	83.78	16.22	45.95	54.05	62.16	37.84
Overall	82.35	17.65	76.47	23.53	44.71	55.29	44.71	55.29

Table 2. Color gradations in bill, along neck, across wings and round the head

	Bill color (%)			Neck color (%)			Color across the wings (%)			Head color (%)		
	FY	IM	FB	FW	IM	FC	FW	IM	FC	FW	IM	FC
Male	15.79	68.42	15.79	21.05	23.68	55.26	15.79	34.21	50.00	13.16	84.21	2.63
Female	25.58	60.47	13.95	37.21	18.60	44.19	27.91	27.91	44.19	16.28	79.07	4.65
Srinagar	21.62	59.46	18.92	24.32	27.03	48.65	21.62	29.73	48.65	16.22	75.68	8.11
Ganderbal	54.55	27.27	18.18	63.64	9.09	27.27	28.57	57.14	14.29	36.36	63.64	0.00
Bandipora	16.22	72.97	10.81	29.73	16.22	54.05	16.22	21.62	62.16	13.51	83.78	2.70
Overall	23.53	61.18	15.29	31.76	20.00	48.24	24.71	29.41	45.88	17.65	77.65	4.71

FY, Full yellow; IM, Intermediate; FB, Full black; FW, Full white; FC, Full cinnamon.

Fig. 2. Variations in the color pattern across the wings (a): Full cinnamon (b to k): Gradations of cinnamon color across the wings in decreasing order from b to k (l): Full white (a, e, j, k, l): Symmetrical colour distribution across the wings (b, c, d, f, g, h, i): Asymmetrical colour distribution across the wings.

has also reported lateral asymmetry in the plumage color of a small breed of South African Gray geese, attributing the genetic mosaic to occur from gene mutation.

Variations in the color of head were also seen ranging from all cinnamon to all white through all intermediates (Table 2). However, in the variants with all cinnamon head, light and dark shades were present, with darker crown (upper part of head) and lighter lore (face). In Chinese geese, a narrow band of creamy-white feathers have been reported to separate the glossy black bill and knob from the main head plumage (ALBC 1993).

The presence of all intermediates is an indication of multiple gene inheritance of the plumage color, as also been reported in ducks (Lancaster 1963). Paxton (2009) suggests that there are multiple sources for genetic control of plumage coloration in birds, from single-locus to polygenic effects, and different genes presumably control different types of pigment coloration and structural coloration. According to McGraw (2006), melanin is responsible for all the spotting, striping, and high-contrast patterning typically observed in a wide variety of birds, from owls to waterfowl to passerines. Chang *et al.* (2010) reported that a second gene or multiple genes may control marking pattern and melanin deposition in individuals capable of melanin production. Wang *et al.* (2014) speculated that, in geese, *TYR* and *MITF* genes play a vitally important role in plumage color determination. However, Huang *et al.* (2014) suggested that the genetic variation of *MC1R* is also significantly associated with the plumage color in domestic goose.

Geese in the present study did not show sexual dimorphism on the basis of plumage color. Sexual dimorphism on the basis of plumage color is also absent in many other breeds of geese, some of which are African, Chinese, Embden, Pomeranian, Roman, Toulouse, Turkish and Yili geese (Buckland and Guy 2002). However, sexual dimorphism in terms of plumage have been reported to be present partially in some breeds of geese like Adler, Arzamas, Kholmogory and Sebastopol, and completely in some breeds like Co, Rhineland, Synthetic Ukranian, Vishtines, White Hungarian (Buckland and Guy 2002), Pilgrim, West of England goose, Cotton Patch geese (ALBC 1993).

Bill color variation: Bill color ranged from complete black to complete yellow through all intermediate grades in the present study. The gradation of the yellow colour is depicted in Table 2. However, bill color was reported to be orange in most of the other breeds of geese, some of which are Embden (Echols 2015) Landes, Pomeranian, Sebastopol, Toulouse, Vishtines, and Yili goose (Buckland and Guy 2002). Some of the other breeds however are reported to have black bills like Yan, Wuzhong, Kuban,

Lionhead, African and fawn variety of Chinese geese, while yellow or black bill in Likewu goose breed, yellow bill in Hwo goose, orange bill with a black tip in Fighting goose, and varied colored bills in Local geese of Kural and Massakory, and Mandelia have also been reported (Buckland and Guy 2002).

Eye color variation: Only two variations were noted in the eye color of geese under study viz. grey and brown. However, grey eye color appeared to be predominant accounting for about 55.29% of the total birds under study (Table 1). Sexual dimorphism on the basis of eye color in the birds studied was absent, unlike in Pilgrim goose breed, where eyes are reported to be blue in ganders and dark brown in females (Holderread 1981). Eye color variation viz. either brown or grey has also been reported in the domestic duck of Kashmir (Bihaqi *et al.* 2014).

Shank color variation: No variation was recorded in the color of shanks which were universally orange in all the adult geese but paler in all juvenile birds and yellowish in all goslings. Shank color is reported to be orange in most of the geese breeds except in Turkish and Hwo geese where it is yellow, and in Wuzhang geese where it is black, and also in Co geese where it is grey (Buckland and Guy 2002).

The objective of the present study was to record and document the morphological characteristics with special reference to color variations in domestic geese. Knob, dewlap and paunch were present only in some proportion of the population. Cinnamon color of plumage and yellow color of bill was present in gradients varying through all intermediates in domestic geese of Kashmir, which is an indication of multiple gene inheritance of the plumage color. Eye colour varied between grey and brown but no variation was seen in the colour of shanks being orange in all adults, paler in all juveniles and yellow in all goslings. The peculiar colour pattern and markings in domestic geese might be useful in identification of individual birds as is done in horses. Sexual dimorphism on the basis of plumage color and presence of curved tail feathers in males was absent.

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