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Comparison of Homing Behavior and Morphology of Pakistani Highflyer Pigeons: Searching the Unique Genetic Traits

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Abstract: **Pigeon breeding is culturally significant worldwide, including in Pakistan, where highflyers have been valued because of their exceptional flight capabilities and genetic traits. The Present study aimed at exploring the unique genetic traits. Eight representative pigeons of different breeds were selected, which includes Teddy, kalsira, lakha, kamghar, Sialkoti, Salar, Cheena Chapra and Golden. The total time for training was 7 weeks and after the training, data of two successive releases was recorded. The starting time for the flight and the landing back to home time was also recorded. It was seen that the Sialkoti pigeon breed fly with exceptional ability of 11hr27min during first release, followed by Teddy pigeons that flew about 1hour and 9min, Kalsira (ancient breed from Mughal era) flew about 10hr 04min. The morphological parameters (plumage color, Iris color, head type, tarsi, claws color) were also examined. This study is important in two aspects. Culturally, this study shows high flyers' importance in preserving traditional knowledge of Punjab heritage. From a scientific point of view, this study contributes to the understanding of the genetic conservation of avian genetics and flight behaviour. Further research on the molecular level may confirm the present studies.**

Keywords: Homing pigeon, Training Program, Learning behaviour, young pigeon, Flight behaviour, domestication.

I. INTRODUCTION

The pigeon has been closely associated with humans for over 10,000 years (Kabir, 2021; Gaietto, 2019) with a global population of around 400 million pigeons. Domestic pigeons trace their ancestry back to the wild rock pigeon, and their initial domestication is believed to have occurred approximately 5,000 years ago in the Mediterranean region (Si et al., 2021). They were the first avian species to be domesticated.

Over thousands of years, homing pigeons were selectively bred from domestic pigeons to develop the complex behavioral trait of homing ability over long distances, while pigeons bred for ornamental or food purposes have lower homing abilities (Gazda et al., 2018; Shao et al., 2020).Pigeons have served various purposes, including sports and message carrying during World War I and II, as well as in ancient Egyptian and Roman times.

(Duan and Qiu, 2019). There are several hundred breeds of pigeons worldwide, selectively bred and classified according to various grouping systems, such as fancy, roller, tripler, and highflyer breeds.

In Pakistan, alongside other domestic pigeon breeds, native highflyers stand out for their remarkable endurance and navigation abilities, flying to high altitudes with strong homing instincts. These highflyers, including breeds like Sialkoti, teddy, kamaghar, Ali waly, golden, batery, motiwaly, and Qasuri, receive training for racing and have been selectively bred to enhance their homing capabilities (G. Wallraff, 2023). In early 20th century pigeon racing is growing as a popular sport throughout Western Europe and in United State (Kabir & Makhan D, 2020). Flight duration varies among these breeds, prompting researchers to investigate the underlying factors causing these variations (Guilford et al., 2004). Highflyer pigeons exhibit distinctive characteristics, including strong chest bones, short beaks, and variations in flight wings, body patterns, and eye colors across different breeds (Bartels ,2023). Across Asia, pigeon enthusiasts keep and cherish these birds for their "Shauk" or passion, dedicating their love, time, and resources to their hobby (Narayan & Kavesh, 2019).Charles Darwin (1868) discussed pigeon domestication in his book "On the Origin of Species," comparing the process of natural selection to domestication (KABIR, 2015). He observed how humans selectively bred pigeons for specific morphological and navigational traits, much like natural selection operates to eliminate certain characteristics during speciation. Darwin noted that breeders chose pigeons based on size, plumage, and bill types. In his time, there were more than 150 different breeds of domestic pigeons; a number that has since grown to over 350 recognized breeds. Darwin also observed that morphological and behavioral traits found in selectively bred domestic pigeons could also be seen in unrelated pigeon species and rocks (Helms & Brugmann, 2007).

Identification of flying pigeons is done on base of their eyes, muscles, and wings, but there is a need to further investigate their homing ability. Expanding our knowledge of domestic pigeon flight behavior and the effects of different breed lines on racing performance is essential. Addressing key challenges like maintaining a balanced diet and cleanliness can have a positive impact. Analyzing flight time and flight patterns can provide insights into pigeon navigation, spatial memory, and their use of environmental cues to return to their home loft. Such research is valuable for breeders in selecting suitable breeds for breeding programs and pigeon racing. By studying the flight times of different breeds, we can gain insights into flight traits and their genetic basis, contributing to a better understanding of the significant variation within avian species. While extensive research has been conducted on avian species in general, there has been limited focus on breed comparisons in this context. I.

II. MATERIALS AND METHOD

a) Study Location

The research was conducted in the Narowal District, situated geographically on the western bank of the River Ravi in the northeastern region of Punjab Province. Narowal District is positioned between 31º- 55' to 32º- 30' north latitudes and 74º- 35' to 75º- 21' east longitudes, encompassing an approximate area of 2,337 square kilometers (source: https://narowal.punjab.gov.pk/geography). Figure 1-5 illustrates the study area on the map.

b) Pigeon Breeds and Housing

The study focused on Highflyer pigeons, which were bred, hatched, and raised within the boundaries of District Narowal, Punjab, Pakistan. The pigeons under investigation were nine months old and resided in enclosed lofts with unrestricted access to sunlight and fresh air. During the study period, they were nurtured and underwent training. Subsequent to their training, they were released for short-term racing, and their flight durations were precisely recorded. Each pigeon was individually marked with the owner's contact information to facilitate tracking.

c) Loft Facilities

Pigeons utilized for this study were taken from different locations of the area. All lofts were positioned on rooftops, featuring sizable windows and one-way gates constructed with metal wire to enable access to open air and perching outside the loft for a panoramic view of their surroundings. The design and layout of all lofts shared a common resemblance.

d) Feeding Routine

The study was conducted over the period spanning from November 2022 to August 2023. The pigeons were provided with continuous access to water throughout the day. Their diet was administered once daily, typically in the evening. Before being fed, the pigeons were allowed to fly or perch outside the cage. Their diet consisted of a mixture of various seeds, including cardamom, almonds, and black pepper, alongside staples such as rice, wheat, and millet. According to local fanciers their diets vary according to season like in winters their owners add sunflower seeds in their diet. However, they didn't feed before their flight.

e) Training Procedure

All pigeons employed in the experiment were bred, hatched, reared, weaned, and trained within the Narowal region. Upon reaching adulthood, approximately 60 days after hatching, the pigeons were permitted to fly freely around their home loft. Training commenced by releasing them in small groups, with early emphasis placed on familiarizing them with their home loft to ensure their return after flights and prevent them from going astray. After approximately 15 days, all pigeons initiated programmed group flights, initially in groups of 11 pigeons. They were allowed out of their cages for specified durations. Over time, their flight durations were gradually extended. A specific call or whistle was used to train the pigeons, associating the sound with food. Consequently, after flights, upon hearing the call, pigeons promptly sought entry into their cages for food. Before flights, they were not provided with sufficient food, and their meals were reserved as a reward for their return. This practice cultivated a habit of returning to the loft post-flight. Subsequently, young pigeons were allowed to fly alongside adult and experienced highflyer pigeons, allowing the transfer of route information from the experienced birds to their less-experienced counterparts. The subsequent phase involved road training to acquaint the pigeons with the areas surrounding their home loft

III. RESULTS

i. Behavior during Flight

Initially during training they flapped their wings, hover in short burst and fly to short distance and came back then they were allowed to fly again. It was noticed that some of them stays on the roof of trap until they get too strong with wings. After about 15 during their programmed flight in groups. It was noticed that they fly little and then again get back gradually until they get comfortable with their surroundings. Eventually, their period of flight was increased. They started flying, circling in the sky and struggled to find direction to go back home. It was observed that the naïve pigeon started exploration of their way to home. When they get too confident to find direction to their home the distance was gradually increased to 3mile, 4mile 10mile, 50 miles to 100 miles [see Table I, II, and III].

ii. Arrival Time

Overall, we performed experiments with 9 local breeds from different releasing sites each time in two successive releases obtained valid flight duration. After release the scattering of pigeons is around the loft. In morning time due to slight wind they struggled to flap their wings when fly in opposite direction of wind. They kept circling around their home loft from about 4km distant. Initially birds fly following each other by keeping certain distance but latter their flight path got scattered. Comparison of successive experimental release shows significant homing ability of pigeons to find their home location with minimal difference in flight performance of group release

of pigeons. Sialkoti pigeon breed stands out with highest flight duration of about 11hours and 27 minutes in two successive releases. They are likely to maintain their flight duration around average following it Teddy pigeon shows remarkable performance with average 11hours 9min. Kalsira pigeon also shows average flight of 10hours then Golden pigeon exhibit average flight duration of 9hours. The total average flight duration of all breeds were recorded 18 hours.

iii. Morphological characters

In the study it was observed that in highflyer breeds the head type is large, mostly flat slightly from top and rounded. Beak is usually strong firmly rooted in head. Upper side of bill is larger than lower side. According to local knowledge best highflyers should have strong body, wide shoulders and strong keel bone. In all the culturally significant pigeons under study have strong chest bone in arched shape. There is shine in neck and throat of pigeons. Plumage was soft and smooth. Eyes of the pigeons were bright clear and slightly bulged. The pupil of the eyes in all pigeons was dark black and rings around while iris color varies among them. Claws were dry while nail color varies mostly grey and black [see Table IV].

IV DISCUSSION

Pigeons are one of most thriving avian taxa within avian evolutionary history. The study aims to investigate how selective breeding processes shape the phenotypic and genotypic traits of modern highflyers. Charles Darwin studies effect of natural selection and evolution on traits of organisms over time. This approach helps to understand adaptive changes through time and the best genetic qualities of the present while also demonstrating the influence of human-guided evolution on pigeon breeds (Baptista et al.,2009).

a) Orbital Ring

The orbital ring or eye cere is exposed ring of skin around ocular region in all avian region of columbidae family. Darwin noted that the domestic pigeon breed known as the carrier pigeon had extraordinarily developed eye rings. Other breeds with larger eye orbitals include straulsund highflier and steinhimer bhagdad; Darwin did not study these pigeons, nor did he study the Barb, a different breed that existed at the time (Baptista et al.,2009). In contrast, because of selective breeding, different breed lines in our study demonstrated that current breeds have orbital rings that are normally formed and independent of one another.

b) Orbital Skin color

The orbital skin color of domestic pigeon breeds varies more than that of wild C. livia. For example, in barb breed orbital color is bright red. Columbiform species differ significantly in their orbital skin color. In fruit dove it was light blue in color but generally blue grey in domestic breed (Goodwin, 1983). In contrast in modern breeds of highflyers under study the orbital color present mostly is dark grey and greyish white.

c) Bill Length

Charles Darwin (1868) observed that bills of carrier and runt pigeon breeds of domestic breeds are longer than wild ancestor pigeons during his time. He depicted the bill size in relation to the skull of pigeons. However, certain pigeons, such as Darwin's barb pigeon, may have small bills. According to (Baptista et al.,2009), bill length indicates pigeon feeding behavior; for example, doves with longer beaks tend to consume larger fruit In contrast, Modern domestic pigeon of undergone selective breeding and tends to have bill size proportional to the size of their body as noticed in highflyer breeds selected for study.

d) Nose cere

The nasal cere in Darwin's pigeons was discovered to have a variety of forms and was bred for aesthetic appeal. The nose cere is a swollen and expanded patch of skin around the nose of pigeons. Darwin noticed that the nose cere of the breed Barb is somewhat bigger and has cauliflower-like lumps than the old rock pigeon, despite the fact that extant pigeons have varied degrees of development in the nose cere (Darwin 1868). The Nicobar pigeon has a projecting cere as well, although the fruit dove has a normal cere (Diamond 1973, Baptista et al., 2009). Modern highfliers, on the other hand, have been carefully selected to improve their performance attributes, notably their homing and endurance capacities. The nasal cere of the examined breeds was typically small or normal.

e) Tarsi

In ancient rock dove and domestic pigeons the tarsi is featherless. In Trumpter breed of Darwin era possess extreme feathering on tarsi. However, some breeds have feathers on tarsi (Darwin, 1868). This was in line with our study. Modern highflyers usually don't have feather on their tarsi. However, fancy breeds usually possess fathered tarsi.

f) Tail size

The tails of Darwin's quick domestic pigeon breed were longer, but Namaqua doves did not have lengthened tails. According to Goodwin (1983), tail length may indicate particular flying capacity of pigeons, which is in line with tail of modern highflyers. They generally have a closed tail that is short with width of one or two feather. Today's pigeon tails are more functional to meet the demand for efficient flight.

g) Iris color

The color of the iris in domestic pigeons varies widely. The iris of a rock dove is dark crimson. The iris of a baldhead tumbler is white, whereas that of a homer is orange. They are chosen for their varied eye colors. Bright iris color aids in species identification (Baptista et al., 2009). Modern highflyers are utilized as sports birds, and some local breeders believe that the color of the iris is related to navigational ability and also aids in breed identification. Our study showed there are variations in eye colors of today's pigeon like white, stony white, dark red, greyish with rings around.

h) Plumage Color

Domestication has resulted in a wide range of colors and patterns within different breeds. The Rock Dove has a gray body with greenish purple neck plumage and two black wing bars. Shiny wings on the neck and breast aid in mate attractiveness (Goodwin, 1983). Both sexes participate in the incubation process in columbiforms. Females normally incubate from midnight to throughout the night, but males typically incubate from morning to afternoon (Skutch, 1964). According to Goodwin (1960), male pigeons have brighter patterns on their bodies to attract mates, whilst females have dull colors to aid with hiding during incubation (Goodwin 1960). These researches corroborate our findings. Male mostly having brighter plumage also due to selective breeding the pigeon are range of pattern.

i) Flight Performance

From prehistoric pigeons to current varieties, flight evolved. Breeders chose pigeons for selective breeding in order to preserve good flying performance over a long period of time. Highflyer and tippler pigeons were chosen for their capacity to stay in the air for extended periods of time; nevertheless, certain species may perform poorly or be entirely flightless. Darwin discovered that a shortening of the sternum, a decrease in the length of the scapula, or a reduction in the prominence of the crest are associated with poor pigeon flight.

According to (Diamond 1981), wild pigeons on islands lose their capacity to fly due to a decrease in selection pressure from predators (Diamond 1981). Unlike historical pigeons, today's highflyers can tolerate hours and hours in the air and have a strong homing ability.

V. CONCLUSION

In Conclusion, our comparative analysis of ancient and modern highflyers shows the intense effect of selective breeding and evolution on avian abilities and morphology. Modern highflyers represents functional, cultural and aesthetic values. This study highlights the dynamics of human selective breeding and evolution of pigeon over time. Further studies on genetics behind their traits on molecular level might deepen the understanding within this historic avian specie.

VI. COMPETING INTERESTS

There is no potential conflict of interest among Authors.

VII. ACKNOWLEDGEMENT

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TABLE I
BREEDS, THEIR CHARACTERISTICS AND FLIGHT DURATION

Sr. No	Breeds Name	Flying Characteristics of Culturally Significant Breeds
1	Teddy	Their flight time 9-11 hours on average; gain altitude, fly in small groups. Named after their Inventor Rasheed Teddy. There are 5 variants of this breeds present now. They have made records through their high performance in Pakistan.
2	Sialkoti	Because of their exceptional homing ability, they are considered an intelligence breed. They originated in the Sialkot area of punjab. Flight time in young pigeons is 11-14 hours, while flight time in adult pigeons may vary.
3	Golden	These pigeons are very energetic, and active. They Fly about 12-14 hours. They originated from Qasur city. Initially their flight feathers were golden type brownish so they are called as Golden pigeon but latterly these pigeons had been made through selective breeding for better performance. They have white jewels on their neck and white forehead.
4	Cheena Chapra	These pigeon have black spots all over their body. Flight time is about 7-9hrs. They can strongly recognize their home loft even in the evening time.
5	Kalsira	The pure breed is present rarely now. 11 hours of light.
6	Salar	Commonly found with cross of Teddy pigeons. They fly in circles and gain altitude. Flight duration varies from 11-15 hours.
7	Lakha	Have ability to fly perfectly in super-hot weather 9 hours of flight.
8	Kamaghar	Kamghar pigeons originate from Qasur, Pakistan. They flight time vary greaty from 7-12 hrs. These are ancient birds, firstly made through selective breeding by kamanghar Brothers (Arrow house) Feroz Kamangarh and Nawab Kamanghr that's the reason behind their name.

TABLE II
RECORDED FLIGHT DURATION OF TWO SUCCESSIVE RELEASES

Types of Breeds	Release Time	Flight Hours of 1st Release	Flight Hours of 2nd Release	Mean
Teddy pigeon pigeon	6:15 Am	11hr.13min	11hr.06min	11hr.09min
Kalsira Pigeon	6:15 Am	10hr.39min	9hr.29min	10hr.04min
Lakha Pigeon	6:15 Am	11hr.57min	7hr.21min	9hr.39min
Kamaghar Pigeon	6:15 Am	03hr.17min	7hr.21min	5hr.19min
Salar Pigeon	6:15 Am	11hr.46min	6hr.50min	09hr.18min
Cheena Chapra pigeon	6:15 Am	06hr.53min	9hr.01min	07hr.57min
Golden Pigeon	6:15 Am	10hr.59min	08hr.14min	09hr.36min
Sialkoti Pigeon	6:15 Am	11hr.52min	11hr.03min	11hr.27min

TABLE III
MORPHOLOGICAL FEATURES OF REPRESENTATIVE BREEDS UNDER STUDY

Breeds Names	Plumage Color	Nose Cere	Iris Color	Bill color	Tarsi Type	Claws Type	Eye Orbital	Head Type
Teddy Pigeon	Dark head and tail while flight wings are white.	Little swollen nose cere.	White or pinkish Iris. Bulged eyes	Small thick bill black colored	Featherless	Purplish, dry claws Black nails	Grey	Flat
Sialkoti Pigeon	Plumage mostly white in color however, some variants have greyish head with sharp white stripes.	Little swollen nose Cere.	Dark eyed with blue colored crystals.	Black colored small sized bill.	Featherless	Purplish, dry Claws, Greyish nails	Grey	Flat
Golden Pigeon	Forehead white and jewels over their neck. Head and tail are greyish black. Flight wings are white with 2 or 3 black feathers.	Small nose Cere	Red colored Iris	Light grey yellowish colored bill, Moderate sized.	Featherless	Pinkish, Dry claws Greyish nails	Greyish white	Rounded flat
Cheena Chapra	black spots all over the bod, dark colored, Greenish shine and jewels on neck	Small nose cere	Greyish white Iris with dark ring	Sharp medium sized black beak.	Featherless	Purplish dry claws, black nails	Grey	Flat head

TABLE IV
MORPHOLOGICAL FEATURES OF REPRESENTATIVE BREEDS UNDER STUDY

Breeds	Plumage	Nose Cere	Iris color	Bill color	Tarsi	Claws	Eye Orbital	Head Type
Kalsira Pigeon	Greyish head and black tail. Greenish shine on neck	Small nose cere	White iris color with dark colored ring	Light grey bill dark from tip. Small sized	Featherless	Pinkish dry claws, white nails	Grey	Round
Salar Pigeon	Flight wings are black. Overall body white with black spots.	Medium swollen	White Iris with dark red ring around	Dark colored thick and small sized bill.	Featherless	Fatty pinkish claws, black nails	Grey	
Lakha Pigeon	Yellowish grey head. Trunk and tail white with one or two bars on flight wings.	Medium swollen nose cere	Dark red iris in form of small dots.	Pinkish white medium sharp bill.	Featherless but in Some variants of fancy breed have feathered tarsi.	Pinkish Dry claws, grey nails	Pinkish white	Round
Kamaghar Pigeon	Dark colored head, greenish purple shine on neck. In tail some feathers are white some are black.	Swollen nose cere		Grey colored thick,small sized bill.	Featherless	Pink dry claws, black nails	Greyish white	Round

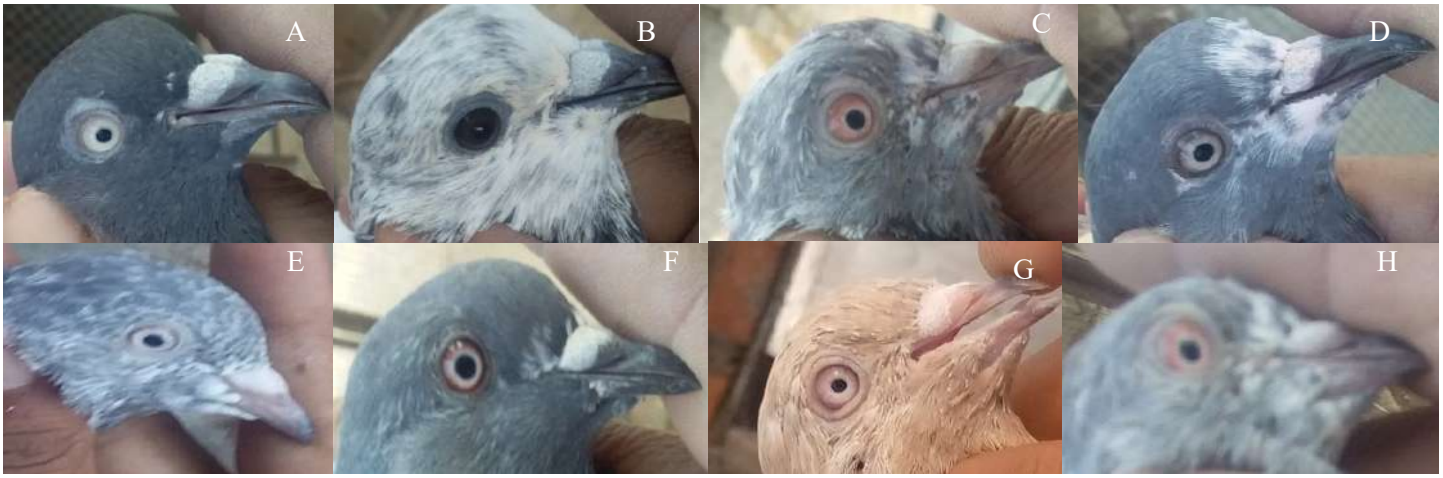

FIGURE 1. Shows Iris color, nose cere, eye orbital, beak length, colour and head shape of culturally significant highflyer pigeon breeds. A) Teddy breed (B) Sialkoti breed (C)Golden breed (D)Cheena chapra breed (E) kalsira breed (F) Salar breed (G)Lakha breed (H) Kamaghar Breed.

FIGURE 2. Shows difference in wing pattern and color of culturally significant highflyer pigeon breeds 1. Teddy breed 2. Sialkoti breed 3. Golden breed 4. Cheena chapra breed 5. kalsira breed 6. Salar breed 7. Lakha breed 8.Kamaghar Breed

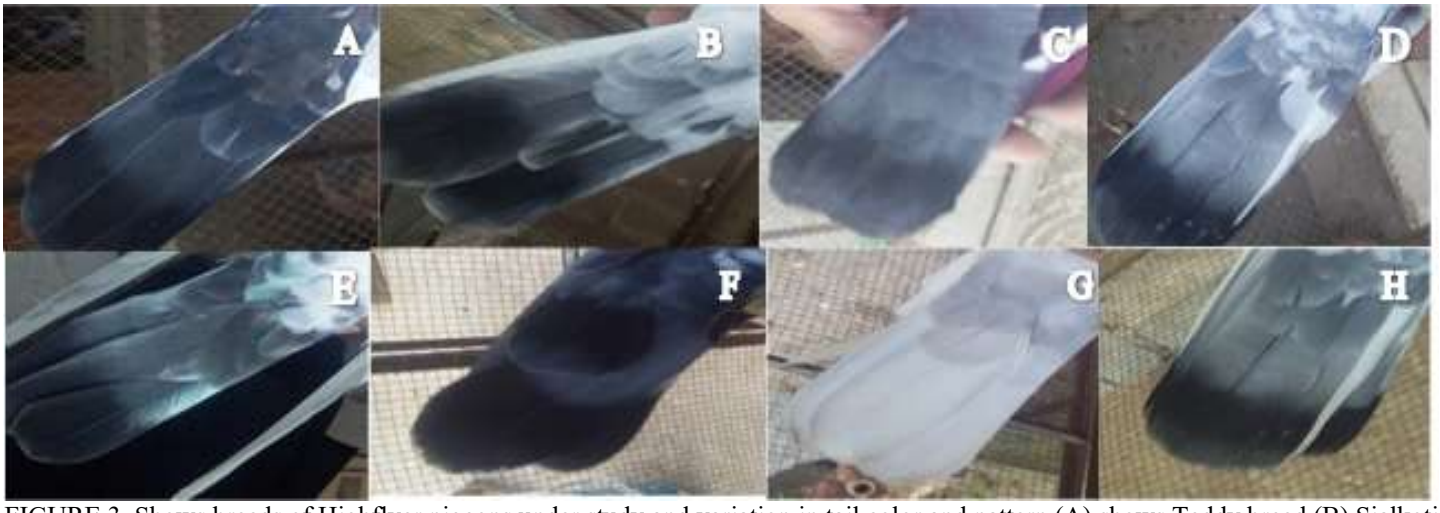

FIGURE 3. Shows breeds of Highflyer pigeons under study and variation in tail color and pattern (A) shows Teddy breed (B) Sialkoti breed (C) Golden breed (D) Cheena chapra breed (E) Kalsira Breed (F) salar Pigeon (G) Lakha Breed (H) Kamaghar ancient

FIGURE 4. Shows variation in claws and nail color of (A) shows Teddy breed (B) Sialkoti breed (C) Golden breed (D) Cheena chapra breed (E) Kalsira Breed (F) salar Pigeon (G) Lakha Breed (H) Kamaghar ancient Highflyer.

FIGURE 5. Shows breeds of Highflyer pigeons under study and variation in Plumage color and pattern (A) shows Teddy breed (B) Sialkoti breed (C) Golden breed (D) Cheena chapra breed (E) Kalsira Breed (F) salar Pigeon (G) Lakha Breed (H) Kamaghar ancient Highflyer.

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