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Research Article

Breeding biology of White-crested Kalij (*Lophura leucomelanos*) and Koklass Pheasant (*Pucrasia macrolopha*) in and around Ayubia National Park, Pakistan

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Abstract

We studied the breeding biology of the White-crested Kalij Pheasant (Lophura leucomelanos) and the Koklass Pheasant (Pucrasia macrolopha) from April 2022 to August 2023 in and around Ayubia National Park, Pakistan. This study aimed to document breeding parameters, including elevation, aspect, temperature, humidity, clutch size, nest-surrounding vegetation, and soil type. A total of 21 nests of *L. leucomelanos* and *P. macrolopha* were recorded, including 19 nests of L. leucomelanos and 2 nests of P. macrolopha. *L. leucomelanos* nests were found at altitudes of 1753-2487 m, with clutch sizes of up to 9 eggs. The mean egg length was 43.66±0.34 mm, width 31.54±0.26 mm, and weight 32.45±0.33 g. The overall dimensions of the nest—length 22.44±0.76 cm, width 19.13±0.88cm, circumference 80.66±2.41 cm, and depth 6.35±0.47 cm—were recorded. The dominant vegetation surrounding nests was diverse, including species such as *Abies pindrow*, *Pinus wallichiana*, *Taxus baccata, Aesculus indica*, *Prunus padus* L.*, Juglans regia, Quercus dilatata, Viburnum grandiflorum* Wall., *Sarcococca saligna*, *Rubus pedunculosus*, *Rubus fruticosus*, *Rumex hastatus, Adiantum venustum, Bistorta amplexicaulis, Fragaria nubicola, Geranium wallichianum, Impatiens edgeworthii* Hook, *Impatiens bicolor, Pteris acanthoneura, Viola odorata* L. and *Bromus hordeaceus* L. Nest materials primarily included *Abies pindrow*, *Pinus wallichiana*, *Taxus baccata*, *Viburnum grandiflorum* Wall., *Sarcococca saligna, Adiantum venustum, Pteris acanthoneura* and *Aegilops cylindrica.* Outcomes for *L. leucomelanos* eggs included 71 hatched, 07 unhatched, 20 predated, 01 damaged, and 18 collected by locals, illustrating significant anthropogenic threats. *P.*

macrolopha nests showed lower reproductive output, with five eggs hatched at altitudes of 2207m and 2254m. Breeding activity highlights the need to protect against threats such as egg collection and predation to improve breeding success. This study stresses the ecological importance of preserving breeding habitats for these pheasant species in the study area.
Keywords: Breeding biology, White-crested Kalij and Koklass Pheasant, Ayubia National Park, Khyber Pakhtunkhwa, Pakistan

Introduction

White-crested Kalij pheasant (*Lophura leucomelanos*) is also called 'Gallo pheasant' (Honser et al., 2020), native to South Asia and comprises nine subspecies (Zeng et al., 2016). The white-crested kalij pheasant (*Lophura leucomelanos hamiltonii*) is present only in Pakistan. *L. leucomelanos* prefers a wide variety of habitats, including coniferous forests, mixed deciduous forests, mixed temperate, subtropical chir pine forests, and temperate oak forests in the Himalayas (Kukreti, 2015) at an altitude between 245- 3050 m (Bagaria et al., 2021). Males produce loud breeding calls around their territory, also throughout the summer (Furqan et al., 2022). The Breeding period of *L. leucomelanos* is from March to April, and hatching occurs from the end of May to July (Kukreti, 2015); clutch size (6-9 eggs) and incubation period vary from 20 to 22 days (Furqan et al., 2022), and it constructs nests in Himalayan temperate oak mixed forest, temperate coniferous forest, and mixed deciduous forest (Kukreti, 2015). The eggshell of *L. leucomelanos* is buffy white or creamy, oval-shaped, elongated, and pointed towards one end. The surface texture of most eggs was smooth, while a few eggs had a rough texture and hatched synchronously. Nest materials are composed of chir pine, oak leaves, sticky hop bush, munj sweetcane, and undifferentiated materials (Akhter et al., 2023). Nests can be built in different ways, such as shallow scrapes on the ground, tufts of overhanging grasses, or stones on a hillside (Furqan et al., 2022).

Koklass Pheasant (*Pucrasia macrolopha*) is a medium-sized bird that comprises ten subspecies (Zaman, 2008), and prefers habitats of coniferous forest with a thick cover of understory shrub, ranging from 2200m to 3400m altitude (Badrulislam et al., 2024), including subtropical thick forest of oaks, deodar, spruce, fir, and pine in the western Himalayas and Hindukush, Pakistan (Azhar et al., 2022). *P. macrolopha* give loud chorus/predawn calls during the breeding season and during autumn. The breeding period lasts from April to June, and they construct nests on the ground (Shansaz et al., 2021), laying eggs between mid-May and clutch sizes of ten around thick bushes and water resources (Shah et al., 2014). The nest of *P. macrolopha* is usually composed of small sticks, feathers, twigs, and grasses (Badrulislam et al., 2024).

Breeding biology of the species is affected by several factors such as predation risk, nesting material, landscape, food availability, and selection of site for the nest (Akhter et al., 2023). According to available research data and a review of previous work, few reports are available for Ayubia National Park (Afza, 2016). Baseline data on the breeding biology of *L. leucomelanos* and *P. macrolopha* are prerequisites for conservation planning in and around Ayubia National Park. Therefore, this preliminary study was designed to document the breeding biology of both species in and around Ayubia National Park, Pakistan. This study will help inform a comprehensive conservation and management strategy for both species in their natural habitat.

Material and methods

Study area

Ayubia National Park (Fig. 1) is located in the Galliat region of Abbottabad district, Khyber Pakhtunkhwa, Pakistan. Geographically, it spans between 34°1' to 34°3.8'N and 73°22.8' to 73°27.1'E, with elevations ranging from approximately 1450 to 3033 meters. The park covers 3,322 hectares, has an average annual temperature of 11°C, and receives about 1,500 mm of winter snowfall (Farooque, 2007).

Study design

The study aimed to gather data on the breeding biology of *L. leucomelanos* and *P. macrolopha* in and around Ayubia National Park. The selected study sites were divided into Bagan and Bakote compartments, sub-compartments, localities, sub-localities, and specific locations with varying altitudinal ranges and habitat types during the breeding season.

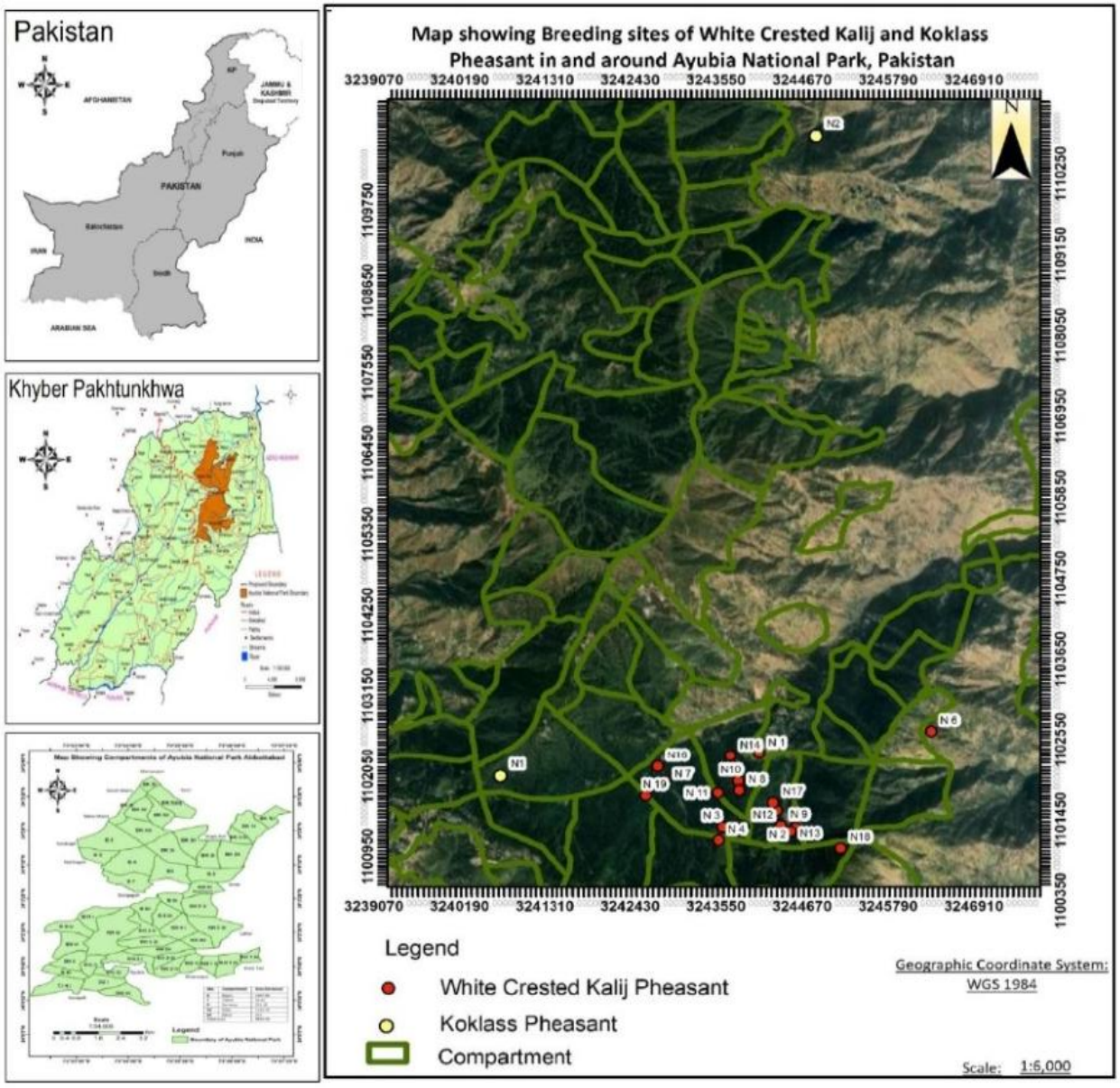


Figure 1. Map showing breeding sites of *L. leucomelanos* and *P. macrolopha* in and around Ayubia National Park, Khyber Pakhtunkhwa, Pakistan.

Methods

Sampling for Breeding Biology

Nest survey design

During the surveys, breeding calls were recorded, and nests were located by scanning the area during the breeding seasons (April 2022 to August 2023) in various potential habitats of *L. leucomelanos* and *P. macrolopha* within the study area. We identified nests of both species using two sampling methods: systematic surveys and random point counts, based on information from locals, shepherds, hunters, and wildlife staff. We assigned each targeted nest an identification

number (Khan & Gabol, 2021). Upon locating the nests, GPS was used to record precise locations (Mahmood et al., 2019), and nests were monitored twice a week in the early morning before the egg-laying period. This allowed for data collection on the nest sites, including their placement (ground or shrubs), without disturbing either species (Furqan et al., 2022). During each examination, we recorded comprehensive data, including clutch size, egg dimensions (length and width), hatching and fledging success rates, instances of egg collection, predation, damage, cup depth, and nest diameter (Khan & Gabol, 2021). Nest construction material and dominant associated vegetation were documented using information from Mahmood et al. (2019), collected, preserved as herbarium sheets, and verified through the herbarium of Hazara University, Mansehra. Eggs were handled with gloves and their dimensions were measured using a Vernier caliper, while weight was measured with a precision scale. Nest materials were recorded concurrently with the breeding data collection. The breeding success was calculated using the formula described by (Akhter et al., 2023).

$$\text{Breeding success} = \frac{\text{No of fledglings}}{\text{Total no of eggs}}$$

Nest vegetation

A random sampling method was employed to select nesting sites within the study area. The sample plot sizes were 10x10m for trees, 4x4m for shrubs, and 1x1m for herbs and grasses (Badrulislam et al., 2024).

Nest surrounding soil

To assess and compare the fertility of various nest soils, soil samples were gathered from nesting sites in Ayubia National Park. These samples were collected 0-15 cm deep after hatching from the nest locations. Subsequently, the collected samples were air-dried, ground, and sieved through a 2 mm mesh size in the laboratory for both physical and chemical analyses. Physical analyses included soil texture, saturation percentage, and pH, while chemical analyses focused on organic matter content, available phosphorus, and available potassium in the soil samples (Almas et al*.,* 2023).

Statistical Analysis

Statistical analyses, including calculations of mean and standard error, were conducted using MS Excel.

Results

Nest structure

The breeding behavior of *L. leucomelanos* and *P. macrolopha* was documented from April 2022 to August 2023 in and around Ayubia National Park, Pakistan. Breeding calls of both species were recorded in March and April, with nesting activities commencing in May and June. Incubation typically started in May and June, with hatching occurring predominantly from late May to mid-June. A total of 21 nests were located and observed in the study area (Fig. 1), comprising 19 nests of L. leucomelanos (Table 1) and two nests of P. macrolopha (Table 9). One nest of each species was found near Ayubia National Park. During incubation, only females were observed near the nests, with one female recorded at a nest (Fig. 2), while no males were observed within a 10-m radius of any nest. In all monitored nests, females left early in the morning for about one hour to forage. After hatching, chicks remained in the nest without feeding for one day.

Nidology

Nest construction activities by female *L. leucomelanos* and *P. macrolopha* were not directly observed because they gathered materials while hiding. After construction, we analyzed measurements and materials used during the females' early-morning foraging trips. All nests were situated in dense shrubbery, among rocks and covered by herbs and grasses, likely to evade predators.

White-crested Kalij pheasant (*Lophura leucomelanos*) Nests

Nests of *L. leucomelanos* were observed at altitudes ranging from 1753m to 2487m in the Bakote and Bagan compartments of ANP and surrounding areas (Table 1). Most nests faced northwest, with some oriented northeast, southeast, or southwest. The maximum temperature around the nests reached 31.6°C, while the minimum was recorded at 18.2°C. Maximum humidity around the nests was 83%, with a minimum of 24% (Table 2). Females at the nest and newly hatched chicks were recorded (Fig. 2). Clutch sizes ranged from 1 to 9 eggs, with records of successful hatching, damage, and eggs collected by locals (Table 3). The mean egg length was 43.66±0.34 mm, width was 31.54±0.26 mm, and weight was 32.45±0.33 gram (Table 5). 117 eggs were recorded, with the following outcomes: 71 eggs hatched, 07 eggs remained unhatched, 20 were predated, 01 was damaged and 18 were collected by locals (Table 6). The overall dimensions of the nests were as follows: length 22.44±0.76 cm, width 19.13±0.88 cm, circumference 80.66±2.41 cm, and cup depth 6.35±0.47 cm (Table 7).

The surrounding soil near the nests had a pH range of 7.5 to 8, a saturation percentage of 65 to 85%, and a clay texture. Soil characteristics included a carbon content ranging from 0.66 to 2%, organic matter content ranging from 1.14 to 3.44%, nitrogen from 0.06 to 0.172%, phosphorus at 0.275%, and potassium at 145 to 178% (Table 8). Female preyed at the nest; damaged eggs and nests; chicks; dead chicks; predators; and surrounding vegetation were recorded from the study area (Fig. 3).

The dominant vegetation surrounding nests of *L. leucomelanos* included *Abies pindrow, Pinus wallichiana, Taxus baccata* L., *Aesculus indica, Prunus padus* L., *Diospyros lotus, Juglans regia, Salix denticulata, Quercus dilatata, Quercus ilex, Populus ciliata, Andrachne cordifolia, Daphne papyracea, Viburnum grandiflorum* Wall., *Sarcococca saligna, Rubus pedunculosus, Rubus fruticosus, Clematis cordata* Royle., *Skimmia laureola, Jasminum humile, Sorbaria tomentosa, Lonicera webbiana* Wall., *Rumex hastatus, Adiantum venustum, Bistorta amplexicaulis, Dryopteris ramosa, Duchesnea indica, Fragaria nubicola, Geranium wallichianum, Impatiens edgeworthii* Hook., *Impatiens bicolor, Pteris acanthoneura, Polygonatum verticillatum, Ranunculus muricatus, Verbascum thapsus* L., *Valeriana wallichii, Rumex acetosa* L., *Sauromatum venosum, Urtica dioica, Podophyllum emodi, Viola odorata* L., *Pteris cretica* L., *Agrostis pilosula* Trin., *Aegilops cylindrica* and *Bromus hordeaceus* L (Table 9).

The materials used for nest construction included *Abies pindrow, Pinus wallichiana, Taxus baccata* L., *Aesculus indica, Prunus padus* L., *Juglans regia, Diospyros lotus, Quercus dilatata, Salix denticulata, Andrachne cordifolia, Viburnum grandiflorum* Wall., *Sarcococca saligna, Rubus pedunculosus, Clematis cordata* Royle., *Daphne papyracea, Adiantum venustum, Pteris acanthoneura, Impatiens edgeworthii* Hook., *Bistorta amplexicaulis, Dryopteris ramosa, Bromus hordeaceus* L., *Agrostis pilosula* Trin and *Aegilops cylindrica* across all nests (Table 9).

Koklass pheasant (*Pucrasia macrolopha*) Nests

Nests of *P. macrolopha* were recorded at altitudes of 2207m and 2254m in the Bagan compartment of Ayubia National Park and its vicinity. The nests were oriented towards the north-south (NS) and northwest (NW). The temperature around the nests ranged from 27.4°C to 22.6°C, while humidity varied from 70% to 59%. In nest-1 (N1), a clutch size of 2 eggs was observed, while in nest-2 (N2), five hatched eggs were recorded (Table 10). The mean egg length was 44.0±0.00 mm, width was 32.0±0.00 mm, and weight was 34.50±0.00 grams (Table 11). The nests of *P. macrolopha* had the following dimensions: length 17.14±1.905 cm, width

14.60±1.90 cm, circumference 45.87±12.04 cm, and cup depth 7.23±1.905 cm (Table 12). The eggs are pale yellow to buff-colored with reddish-brown spots (Table 13). The two nests, eggs, hatched eggs, and surrounding vegetation were recorded from the study area (Fig. 4).

The dominant vegetation surrounding *P. macrolopha* nests included *Pinus wallichiana, Prunus padus* L., *Diospyros lotus, Rosa Moschata, Sarcococca saligna, Rumex hastatus, Viburnum grandiflorum* Wall., *Rubus pedunculosus, Clematis cordata* Royle., *Androsace rotundifolia, Fragaria nubicola, Galium aparine* L., *Adiantum venustum, Valeriana wallichii, Pteris acanthoneura, Viola odorata* L., *Urtica dioica* and *Ranunculus muricatus.* The materials used for nest construction primarily included *Pinus wallichiana, Adiantum venustum, Sarcococca saligna,* and *Pteris acanthoneura* (Table 14). The surrounding soil near the nests had a pH ranging from 7.5 to 7.8, saturation percentages of 75% to 95%, and a clay texture. Soil characteristics included carbon content ranging from 0.66% to 1.33%, organic matter content from 1.14% to 2.29%, nitrogen at 0.114%, phosphorus at 0.203% to 0.238%, and potassium at 158% to 185% (Table 15).



Figure 2. The study documented the presence of chicks, *Lophura leucomelanos* females at the nest, eggs, hatched eggs, and surrounding vegetation recorded from the study area.



Figure 3. The study documented preyed female, damaged eggs and nest, chick, died chicks, predator and surrounding vegetation recorded from study area.



Figure 4. The study documented nests, eggs, hatched eggs of *Pucrasia macrolopha* and surrounding vegetation recorded from study area.

Table 1. Breeding design, GPS coordinates, compartment, sub-compartment, localities and precise locations of *L. leucomelanos* nests in and around Ayubia National Park.

Species	***L. leucomelanos***							
						GPS coordinates		
Nest No.	**Around area**	**Compartment**	**Sub-compartment**	**Locality of the nest**	**Exact place**	N	E	**Altitude**
N 1		Bakote	Bakote 2ii	Khan kalan	Nala	34.079592	73.432251	1912m
N 2		Bakote	Bakote 2ii	Khan kalan	Hasu Wala Nala	34.070183	73.436923	2065m
N 3		Bakote	Bakote 3ii	Thoob	Niaz Bhiekh	34.070683	73.426567	2303m
N 4		Bakote and Bagan	B/w Bakote 3ii, Bagan 5	Thoob	Nala	34.069067	73.425933	2222m
N 5		Bakote	Bakote 2iii	Khan kalan Moriean	Placha wala Larh	34.074333	73.436983	1907m
N 6	Around area			Singlekot	Thari	34.081285	73.456722	1790m
N 7		Bakote	Bakote 3ii	Dayar Seri	Ayub Beikh	34.076751	73.418756	1779m
N 8		Bakote	Bakote 3i	Khan kalan	Ghari wala Nala	34.075083	73.429167	2012m
N 9		Bakote	Bakote 3ii	Diyar seri	Rani Pali Bhiekh	34.070517	73.434833	1875m
N 10		Bakote	Bakote 3i	Khan kalan	Pani-ullian Bari	34.076267	73.429167	1885m
N 11		Bakote	Bakote 3i	Khan kalan	Kundiyan kasi	34.074917	73.426183	2002m
N 12		Bakote	Bakote 3ii	Khan kalan	Hilla Wala Nawa	34.070633	73.429517	2146m
N 13		Bakote	Bakote 3i	Khan kalan	Thoob dhana	34.069717	73.436083	2307m
N 14		Bakote	Bakote 3	Seri Baglian	Bari Tarkhada	34.079455	73.428217	2024m
N 15		Bakote	Bakote 3i	Khan kalan	Kundiyan kasi	34.072367	73.434333	1825m
N 16		Bakote	Bakote 3i	Singlekot hill kass	Barmi wali ochari	34.078567	73.417850	1933m
N 17		Bakote	Bakote 3ii	Dayar Seri	Tota Bhiek	34.073367	73.433867	1753m
N 18		Bakote	Bakote 3i	Singlekot hill kass	Baglian Thariean Pani	34.067367	73.443056	1917m
N 19		Bagan	Bagan 6	B/w Khan khurd, khan kalan	Tanthan wala Nala	34.074983	73.415951	2487m

Table 2. Aspects, form, maximum and minimum temperature and humidity of nests of *L. leucomelanos* in and around Ayubia National Park.

Species	***L. leucomelanos***						
Nest No.	**Date**	**Form of nest**	**Aspects**	**Max. temp**	**Min. temp**	**Max. Humidity**	**Min. Humidity**
N 1	28-05-2022	Active	NE	29.1°C	27.7°C	57%	49%
N 2	26-06-2022	Active	SW	24.8°C	24.1°C	59%	56%
N 3	22-06-2022	Active	NW	21.5°C	19.1°C	58%	53%
N 4	04-06-2022	Active	NW	24.2°C	23.9°C	36%	35%
N 5	14-06-2022	Active	NE	25.1°C	23.9°C	50%	45%
N 6	04-06-2022	Active	SE	20.2°C	18.2°C	59%	55%
N 7	22-05-2022	Active	SW	28.7°C	27.5°C	46%	42%
N 8	05-06-2022	Active	NW	22.7°C	22.5°C	36%	32%
N 9	31-05-2022	Active	SW	31.6°C	30.9°C	30%	28%
N 10	06-06-2022	Active	SE	31°C	30.8°C	26%	24%
N 11	01-06-2022	Active	NW	26.5°C	26.3°C	44%	41%
N 12	19-06-2023	Active	SW	26.9°C	24.1°C	40%	38%
N 13	22-06-2023	Active	NW	23.5°C	21.0°C	49%	45%
N 14	15-06-2023	Active	NE	27.5°C	26.0°C	82%	76%
N 15	27-06-2023	Active	NW	29.2°C	27.3°C	62%	55%
N 16	11-06-2023	Active	SE	29.2°C	25.2°C	58%	50%

N 17	28-05-2023	Active	NW	26.3°C	25.8°C	83%	81%
N 18	14-06-2023	Active	NE	25.1°C	23.8°C	60%	57%
N 19	15-06-2023	Active	SE	23.8°C	22.3°C	68%	59%

Max=Maximum, Min=Minimum, temp=temperature

Table 3. Nest characteristics, clutch size, hatched and damage nests of *L. leucomelanos* in and around Ayubia National Park.

Species	***L. leucomelanos***				
Nest No.	**Eggs coloration**	**Adults found in nest**	**Eggs collection, predation or damage**	**Clutch size**	**Fledging success %**
N 1	Creamy-white	Female present	1 egg damaged, 6 hatched	7 eggs	85%
N 2	Creamy-white	Female present	Hatched	6 eggs	100%
N 3	Creamy-white	Fly after entrance	Hatched	6 eggs	66%
N 4	Creamy-white	Not present	Hatched	9 eggs	100%
N 5	Reddish-buff	Female Preyed	Eggs collected by locals	9 eggs	0%
N 6	Creamy-white	Female Preyed	Eggs collected by locals	9 eggs	0%
N 7	Reddish-buff	Fly after entrance	Hatched	4 eggs	75%
N 8	Creamy-white	Fly after entrance	Hatched	6 eggs	100%
N 9	Creamy-white	Not present	Hatched	5 eggs	80%
N 10	Creamy-white	Not present	Hatched	3 eggs	66%
N 11	Creamy-white	Not present	Hatched	1 egg	0%
N 12	Reddish-buff	Not present	Hatched	7 eggshells	100%
N 13	Creamy-white	Not present	Hatched	8 eggshells	100%
N 14	Creamy-white	Not present	Hatched	5 eggshells	100%
N 15	Creamy-white	Not present	Hatched	9 eggshells	100%
N 16	Creamy-white	Not present	Hatched	3 eggshells	100%
N 17	Creamy-white	Female preyed	Predated	9 eggshells	0%
N 18	Creamy-white	Female preyed	Predated	2 eggshells	0%
N 19	Reddish-buff	Female preyed	Predated	9 eggshells	0%

Table 4. Eggs dimensions of *L. leucomelanos* in and around Ayubia National Park.

Nest No.		**Eggs No**									**Mean±SE**
	Eggs dimensions	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	
N 1	Eggs length mm	39	39	40	41	43	43	44			41.29±0.78
	Eggs width mm	29	30	31	31	32	33	33			31.29±0.57
	Weight of eggs gm	29	29	30	30	31	32	32			30.43±0.48
N 2	Eggs length mm	40	42	43	45	46	46				43.67±0.99
	Eggs width mm	29	31	32	34	34	35				32.50±0.92
	Weight of eggs gm	30	32	33	34	36	37				33.67±1.05
N 3	Eggs length mm	44	45	46	47	48	49				46.50±0.76
	Eggs width mm	31	32	33	34	35	35				33.33±0.67
	Weight of eggs gm	33	34	35	36	37	37				35.33±0.67
N 4	Eggs length mm	40	40	41	41	42	42	43	43	43	41.67±0.41
	Eggs width mm	27	28	29	29	30	30	31	31	32	29.67±0.53
	Weight of eggs gm	30	30	30	31	31	31	32	32	33	31.11±0.35
N 5	Eggs length mm	43	44	45	45	46	47	47	48	48	45.89±0.59
	Eggs width mm	31	32	33	32	34	34	34	35	35	33.33±0.47
	Weight of eggs gm	35	35	36	36	37	37	38	38	39	36.78±0.46
N 6	Eggs length mm	38	39	39	40	41	42	43	44	44	41.11±0.75
	Eggs width mm	27	27	28	28	29	29	30	31	31	28.89±0.51
	Weight of eggs gm	29	29	30	30	31	31	31	32	32	30.56±0.38
N 7	Eggs length mm	47	48	48	49						48.00±0.41
	Eggs width mm	31	32	33	33						32.25±0.48
	Weight of eggs gm	30	31	32	32						31.25±0.48
N 8	Eggs length mm	42	43	44	44	45	46				44.00±0.58
	Eggs width mm	30	31	32	32	33	33				31.83±0.48
	Weight of eggs mm	29	30	31	31	33	32				31.00±0.58

N 9	Eggs length mm	42	43	44	45	45	43.80±0.58
	Eggs width mm	31	32	32	33	34	32.40±0.51
	Weight of eggs gm	29	30	31	32	32	30.80±0.58
N 10	Eggs length mm	41	43	44			42.67±0.88
	Eggs width mm	30	31	32			31.00±0.58
	Weight of eggs gm	32	33	34			33.00±0.58
N 11	Eggs length mm	47					47.00±0.00
	Eggs width mm	34					34.00±0.00
	Weight of eggs gm	32					32.00±0.00

Table 5. Overall egg dimensions of *L. leucomelanos* in and around Ayubia National Park.

Overall eggs dimensions	**Eggs length mm**	**Eggs width mm**	**Weight of eggs gm**
Mean±S.E	43.66±0.34	31.54±0.26	32.45±0.33

Table 6. Egg losses of *L. leucomelanos* in and around Ayubia National Park.

Species	***L. leucomelanos***	
	Number	**%**
Number of eggs found	117	100
Hatched	71	60%
Un-hatched	07	5.9%
Predated	20	17%
Damage	01	0.008%
Collected by locals	18	15%

Table 7. Nest dimensions of *L. leucomelanos* in and around Ayubia National Park.

Species	***L. leucomelanos***			
Nest No.	**Nest length cm**	**Nest width cm**	**Nest Circumference cm**	**Nest cup depth cm**
N 1	20.32	21.59	70.1	5.33
N 2	24.13	21.59	76.2	4.57
N 3	22.86	19.05	64	5.08
N 4	25.4	20.32	91.44	8.63
N 5	24.13	19.05	82.29	5.58
N 6	21.59	17.78	82.29	7.11
N 7	20.32	15.24	91.44	12.19
N 8	20.32	17.78	85.34	6.35
N 9	17.78	13.97	67.05	6.35
N 10	19.05	12.7	73.15	5.33
N 11	24.13	22.86	76.2	8.12
N 12	20.32	17.78	85.34	5.08
N 13	21.59	20.32	96.01	5.33
N 14	26.67	24.13	100	6.6
N 15	19.05	15.24	88.39	4.95
N 16	17.78	16.51	76.2	7.62

N 17	24.13	21.59	73.15	6.35
N 18	25.4	22.86	88.39	5.96
N 19	24.13	21.59	65.53	8
Mean±S.E	22.44±0.76	19.13±0.88	80.66±2.41	6.35±0.47

Table 8. Soil type and soil characteristics of nests of *L. leucomelanos* in and around Ayubia National Park.

Species	***L. leucomelanos***							
	Soil type			**Soil characteristics**				
Nest No.	**PH**	**Sat. %**	**Texture**	**C %**	**Organic matter %**	**N %**	**P %**	**K %**
N 1	8	78%	Clay	2%	3.44%	0.172%	0.28%	178%
N 2	7.5	65%	Clay	0.66%	1.14%	0.057%	0.304%	165%
N 3	7.8	85%	Clay	1.33%	2.29%	0.114%	0.27%	148%
N 4	7.8	85%	Clay	1.33%	2.29%	0.114%	0.27%	148%
N 5	7.5	65%	Clay	0.66%	1.14%	0.057%	0.304%	165%
N 6	8	78%	Clay	2%	3.44%	0.172%	0.28%	178%
N 7	7.8	80%	Clay	1.33%	2.29%	0.114%	0.304%	145%
N 8	8	78%	Clay	2%	3.44%	0.172%	0.28%	178%
N 9	7.8	80%	Clay	1.33%	2.29%	0.114%	0.304%	145%
N 10	7.5	65%	Clay	0.66%	1.14%	0.057%	0.304%	165%
N 11	7.8	80%	Clay	1.33%	2.29%	0.114%	0.304%	145%
N 12	7.8	80%	Clay	1.33%	2.29%	0.114%	0.304%	145%
N 13	7.8	85%	Clay	1.33%	2.29%	0.114%	0.27%	148%
N 14	7.8	65%	Clay	1%	1.72%	0.086%	0.358	145%
N 15	7.8	80%	Clay	1.33%	2.29%	0.114%	0.304%	145%
N 16	7.8	65%	Clay	1%	1.72%	0.086%	0.358	145%
N 17	7.8	80%	Clay	1.33%	2.29%	0.114%	0.304%	145%
N 18	7.8	65%	Clay	1%	1.72%	0.086%	0.358%	145%
N 19	7.6	65%	Clay	2%	3.44%	0.172%	0.25%	173%

Table 9. Dominant associated vegetation around the nest and nest composition material % of *L. leucomelanos* in and around Ayubia National Park.

Nest No.	**Dominant associated vegetation of the nest**	**Nest composition Material %**
N 1	*Pinus wallichiana, Aesculus indica, Sarcococca saligna, Clematis cordata* Royle, *Jasminum humile, Rubus pedunculosus, Rumex hastatus, Bistorta amplexicaulis*, *Geranium wallichianum, Fragaria nubicola, Viola odorata* L., *Pteris acanthoneura* and *Aegilops cylindrica*.	*Aesculus indica* 10% *Diospyros lotus* 10% *Prunus padus* L. 5% *Sarcococca saligna* 25% *Aegilops cylindrica* 20% *Bromus hordeaceu*s L. 30%
N 2	*Pinus wallichiana, Prunus padus* L., *Diospyros lotus, Viburnum grandiflorum* Wall., *Rubus pedunculosus, Clematis cordata* Royle, *Impatiens edgeworthii* Hook, *Bistorta amplexicaulis, Fragaria nubicola, Viola odorata* L., *Impatiens bicolor, Adiantum venustum, Pteris acanthoneura*, *Fragaria nubicola, Polygonatum verticillatum, Valeriana wallichii, Ranunculus muricatus, Aegilops cylindrica* and *Bromus hordeaceu*s L.	*Prunus padus* L. 20% *Juglans regia* 25% *Quercus dilatata* 5% *Pteris acanthoneura* 20% *Rubus pedunculosus* 15% *Impatiens edgeworthii* Hook 10% *Bromus hordeaceu*s L. 5 %

N 3	*Abies pindrow, Pinus wallichiana, Prunus padus* L., *Quercus dilatata, Rumex hastatus, Sarcococca saligna, Rubus pedunculosus, Rubus fruticosus*, *Rumex acetosa* L., *Pteris acanthoneura*, *Bistorta amplexicaulis*, *Viola odorata* L., *Fragaria nubicola* and *Bromus hordeaceu*s L.	*Prunus padus* L. 30% *Aesculus indica* 20% *Taxus baccata* L. 10% *Pteris acanthoneura* 30% *Agrostis pilosula* Trin. 10%
N 4	*Abies pindrow, Pinus wallichiana, Sarcococca saligna*, *Bistorta amplexicaulis, Rubus pedunculosus, Rubus fruticosus*, *Fragaria nubicola, Rubus pedunculosus, Clematis cordata* Royle*, Polygonatum verticillatum, Viola odorata* L., *Bromus hordeaceu*s L and *Agrostis pilosula* Trin.	*Pinus wallichiana* 60% *Prunus padus* L. 20% *Quercus dilatata* 10% *Aesculus indica* 5% *Clematis cordata* Royle. 5%
N 5	*Pinus wallichiana, Quercus dilatata, Prunus padus* L., *Sarcococca saligna, Pteris acanthoneura, Clematis cordata* Royle., *Rubus pedunculosus, Adiantum venustum, Viola odorata* L. and *Agrostis pilosula* Trin.	*Quercus dilatata* 60% *Prunus padus* L. 15% *Pinus wallichiana* 10% *Sarcococca saligna* 5% *Clematis cordata* Royle. 5% *Pteris acanthoneura* 3% *Andrachne cordifolia* 2%
N 6	*Pinus wallichiana, Quercus ilex, Diospyros lotus, Rubus pedunculosus, Impatiens bicolor, Rumex hastatus, Urtica dioica, Adiantum venustum* and *Bromus hordeaceu*s L.	*Pinus wallichiana* 60% *Quercus ilex* 35% *Clematis cordata* Royle. 4% *Bromus hordeaceu*s L. 1%
N 7	*Pinus wallichiana, Taxus baccata* L., *Aesculus indica, Prunus padus* L., *Viburnum grandiflorum* Wall., *Daphne papyracea*, *Skimmia laureola, Andrachne cordifolia, Sarcococca saligna, Rubus pedunculosus, Rumex hastatus, Ranunculus muricatus, Impatiens bicolor, Pteris acanthoneura*, *Sauromatum venosum, Pteris cretica* L., *Urtica dioica*, *Adiantum venustum, Viola odorata* L. and *Agrostis pilosula* Trin.	*Taxus baccata* L. 10% *Aesculus indica* 3% *Prunus padus* L. 2% *Adiantum venustum* 85%
N 8	*Pinus wallichiana, Diospyros lotus, Prunus padus* L., *Fragaria nubicola, Rubus fruticosus, Rumex acetosa* L., *Sarcococca saligna, Pteris acanthoneura, Viola odorata* L. and *Aegilops cylindrica*.	*Pinus wallichiana* 30% *Prunus padus* L. 25% *Diospyros lotus* 5% *Sarcococca saligna* 30% *Aegilops cylindrica* 10%
N 9	*Taxus baccata* L., *Juglans regia, Aesculus indica, Diospyros lotus, Prunus padus* L., *Daphne papyracea*, *Viburnum grandiflorum* Wall., *Sarcococca saligna, Rubus pedunculosus, Andrachne cordifolia, Skimmia laureola, Clematis cordata* Royle., *Bistorta amplexicaulis*, *Pteris acanthoneura* , *Pteris cretica* L. and *Bromus hordeaceu*s L.	*Pinus wallichiana* 20% *Aesculus indica* 5% *Daphne papyracea* 70% *Sarcococca saligna* 5%
N 10	*Pinus wallichiana, Prunus padus* L., *Salix denticulata, Sorbaria tomentosa, Rumex hastatus, Jasminum humile, Rubus fruticosus* , *Rubus pedunculosus, Urtica dioica*, *Bistorta amplexicaulis* , *Ranunculus muricatus, Impatiens edgeworthii* Hook., *Sauromatum venosum, Pteris acanthoneura*, *Fragaria nubicola* and *Polygonatum verticillatum.*	*Pinus wallichiana* 70% *Abies pindrow* 5% *Aesculus indica* 5% *Prunus padus* L. 5 % *Adiantum venustum* 10% *Aegilops cylindrica* 5%
N 11	*Pinus wallichiana, Lonicera webbiana* Wall., *Viburnum grandiflorum* Wall., *Rumex hastatus, Sarcococca saligna, Andrachne cordifolia, Skimmia laureola, Clematis cordata* Royle., *Rubus pedunculosus, Viola odorata* L., *Impatiens edgeworthii* Hook., *Fragaria nubicola, Ranunculus muricatus, Dryopteris ramosa, Urtica dioica*, *Pteris cretica L., Adiantum venustum, Agrostis pilosula* Trin. and *Bromus hordeaceu*s L.	*Pinus wallichiana* 65% *Prunus padus* L. 10% *Aesculus indica* 5% *Sarcococca saligna* 10% *Pteris acanthoneura* 8% *Daphne papyracea* 2%
N 12	*Abies pindrow, Taxus baccata* L., *Juglans regia, Viburnum grandiflorum* Wall., *Andrachne cordifolia, Clematis cordata* Royle., *Skimmia laureola, Bistorta amplexicaulis*, *Fragaria nubicola, Viola odorata* L., *Impatiens edgeworthii* Hook., *Pteris acanthoneura* and *Agrostis pilosula* Trin.	*Quercus dilatata* 50% *Abies pindrow* 35% *Daphne papyracea* 5% *Clematis cordata* Royle. 5%

		Bistorta amplexicaulis 5%
N 13	*Pinus wallichiana, Prunus padus* L., *Quercus dilatata, Rumex hastatus, Fragaria nubicola, Rubus pedunculosus, Urtica dioica*, *Verbescum thapsus* L., *Impatiens bicolor* and *Pteris acanthoneura*.	*Prunus padus* L. 10% *Rubus pedunculosus* 60% *Viburnum grandiflorum* Wall. 30%
N 14	*Pinus wallichiana, Prunus padus* L., *Viburnum grandiflorum* Wall., *Ranunculus muricatus, Impatiens bicolor, Viola odorata* L., *Pteris acanthoneura*, *Adiantum venustum* and *Podophyllum emodi*.	*Daphne papyracea* 70% *Pteris acanthoneura* 5% *Aegilops cylindrica* 25%
N 15	*Pinus wallichiana, Lonicera webbiana* Wall., *Viburnum grandiflorum* Wall., *Rumex hastatus, Sarcococca saligna, Andrachne cordifolia, Skimmia laureola, Clematis cordata* Royle., *Rubus pedunculosus, Viola odorata* L., *Impatiens edgeworthii* Hook., *Fragaria nubicola, Ranunculus muricatus, Dryopteris ramosa, Urtica dioica*, *Pteris cretica* L., *Agrostis pilosula* Trin., *Adiantum venustum* and *Bromus hordeaceu*s L.	*Prunus padus* L. 30% *Pinus wallichiana* 25% *Aesculus indica* 25% *Bromus hordeaceu*s L. 20%
N 16	*Pinus wallichiana, Prunus padus* L., *Salix denticulata, Pteris acanthoneura*, *Impatiens bicolor, Viola odorata* L. and *Aegilops cylindrica*.	*Aesculus indica* 10% *Prunus padus* L. 5% *Sarcococca saligna* 35% *Pteris acanthoneura* 10% *Dryopteris ramosa* 5% *Bromus hordeaceu*s L. 20% *Aegilops cylindrica* 15%
N 17	*Pinus wallichiana, Taxus baccata* L., *Prunus padus* L., *Populus ciliata, Viburnum grandiflorum* Wall., *Sarcococca saligna, Rubus pedunculosus, Clematis cordata* Royle., *Ranunculus muricatus, Pteris acanthoneura*, *Impatiens edgeworthii* Hook., *Fragaria nubicola* and *Duchesnea indica.*	*Daphne papyracea* 40% *Pteris acanthoneura* 50% *Impatiens edgeworthii* Hook. 10%
N 18	*Abies pindrow, Quercus dilatata, Prunus padus* L., *Salix denticulata, Juglans regia, Sarcococca saligna* and *Skimmia laureola.*	*Quercus dilatata* 30% *Prunus padus* L. 5% *Salix denticulata* 5% *Sarcococca saligna* 60%
N 19	*Abies pindrow, Taxus baccata* L., *Prunus padus* L., *Viburnum grandiflorum* Wall., *Clematis cordata* Royle., *Fragaria nubicola* and *Rubus pedunculosus.*	*Abies pindrow* 85% *Clematis cordata* Royle 15 %

Table 10. GPS coordinates, compartment, sub-compartment, localities and specific locations of *P. macrolopha* nests in and around Ayubia National Park.

Species	***P. macrolopha***	
Nest No.	N 1	N 2
Compartment	Around park	Bagan
Sub-compartment		Bagan 2
Exact place	Pakhu Nakar	Choa pani
GPS coordinates		
N	34.154943	34.07823
E	73.44497	73.395417
Altitude	2254m	2207m
Date	17-05-2022	17-06-2023
Form of nest	Active	Active
Aspects	NS	NW
Maximum temperature	23.1°C	27.4°C
Minimum temperature	22.6°C	26.7°C
Maximum humidity	63%	70%
Minimum humidity	59%	66%
Clutch size	2 eggs	5 eggshells

Table 11. Dimensions of eggs of *P. macrolopha* in and around Ayubia National Park.

Species	***P. macrolopha***		
Overall eggs dimensions	**Eggs length mm**	**Eggs width mm**	**Weight of eggs gm**
Mean±S.E	44.0±0.00	32.0±0.00	34.50±0.00

Table 12. Dimensions of nests of *P. macrolopha* in and around Ayubia National Park.

Species	***P. macrolopha***			
Nest No.	Nest length cm	Nest width cm	Nest circumference cm	Nest cup depth cm
N 1	19.05	16.51	57.91	9.14
N 2	15.24	12.7	33.83	5.33
Mean±S.E	17.14±1.905	14.60±1.905	45.87±12.04	7.23±1.905

Table 13. Nest characteristics, clutch size, hatched and damaged nests of *P. macrolopha* in and around Ayubia National Park.

Species	***P. macrolopha***	
Nest No.	N 1	N 2
Eggs coloration	Pale yellow to buff-colored with reddish-brown spots	Pale yellow to buff-colored with reddish-brown spots
Fledging success	100%	100%
Adults found in nest	Fly after entrance	Chicks with female move away
Eggs collected, predation, damage, or hatched	Hatched	Hatched

Table 14. Dominant associated vegetation around the nest and nest composition material (% of P. macrolopha) in and around Ayubia National Park.

Species	***P. macrolopha***	
Nest No.	N 1	N 2
Dominant associated vegetation of the nest	*Pinus wallichiana, Diospyros lotus, Viburnum grandiflorum* Wall., *Rubus pedunculosus, Clematis cordata* Royle., *Fragaria nubicola, Androsace rotundifolia, Galium aparine* L., *Pteris acanthoneura* and *Viola odorata* L.	*Pinus wallichiana*, *Prunus padus* L., *Sarcococca saligna, Rosa Moschata, Rumex hastatus, Rubus pedunculosus, Fragaria nubicola, Valeriana wallichii, Viola odorata* L., *Pteris acanthoneura*, *Adiantum venustum, Urtica dioica* and *Ranunculus muricatus.*
Nest composition	*Pinus wallichiana* 60% *Adiantum venustum* 20% *Sarcococca saligna* 15% *Pteris acanthoneura* 5%	*Pinus wallichiana* 90% *Sarcococca saligna* 10%

Table 15. Soil type and soil characteristics of nests of *P. macrolopha* in and around Ayubia National Park.

Species	***P. macrolopha***	
Nest No.	N 1	N2
Soil type	PH=7.8, Sat.%=75%, Texture=Clay, C%=0.66%	PH=7.5, Sat.%=95%, Texture=Clay, C%=1.33

Soil characteristics	Organic matter=1.14, N %=0.114%, P%=0.203%, K%=185%	Organic matter=2.29, N %=0.114%, P%=0.238, K%=158%

Discussion

Reproduction is essential for species survival. The breeding season of the White-crested Kalij Pheasant spans from February to June Furqan et al., (2022). Our findings align with previous studies, which suggest that *L. leucomelanos* breed between March and June. Afza (2016) recorded five nests of *L. leucomelanos* with eggs in Ayubia National Park. During the present study, nineteen nests of *L. leucomelanos* were recorded in and around Ayubia National Park, Pakistan. Akhter et al. (2023) recorded 240 *L. leucomelanos* eggs in 42 nests in Margalla Hills National Park, Pakistan. In the current study, 117 *L. leucomelanos* eggs were found in 17 nests in and around Ayubia National Park. Zeng et al. (2016) reported the dimensions of *L. leucomelanos* eggs as length 46.9±1.52 mm, width 35.3±0.90 mm, and weight 32.9±1.21 g, while Akhter et al. (2023) reported mean length of eggs mm 50.18±0.42, mean width of eggs (mm) 35.27±0.31 and mean weight of eggs (g) 28.79±0.16. In our study, the mean egg dimensions were recorded as length 43.66 ± 0.34 mm, width 31.54 ± 0.26 mm, and weight 32.45 ± 0.33 g (Table 5). Post-hatching and nest measurements of *L. leucomelanos* indicated diameters of 21.5±1.3 cm and 20.2±0.9 cm with depths of 9 cm and 6 cm, respectively (Furqan et al., 2022). The present study found that the overall nest dimensions of *L. leucomelanos* were length 22.44±0.76 cm, width 19.13±0.88 cm, circumference 80.66±2.41 cm, and cup depth 6.35±0.47 cm (Table 7). Afza (2016) documented the associated plant species found around *L. leucomelanos* nests in Ayubia National Park, including *Acer caesium, Pinus wallichiana, Adiantum venustum, Abies pindrow, Cedrus deodara, Dryopteris ramosa, Thalictrum cultratum, Pteris acanthoneura, Indigofera heterantha, Isodon coetsa, Viburnum mullaha, Viburnum grandiflorum, Rubus pedunculosus, Sinopodophyllum hexandrum, Strobilanthes urticifolia, Taxus baccata, Valeriana jatamansi, Hedera nepalensis, Geum elatum, Podophyllum hexandrum, Polygonatum multiflorum, Prunus padus, Rosa chinensis, Wulfenia amherstiana, Bupleurum tune, Chrysopogon gryllus, Desmodium elegans, Dryopteris ramosa, Berberis Parkeriana, Persicaria amplexicaulis, Quercus baloot, Senecio analogus, Verbascum thapsus, Lonicera quinquelocularis, Parrotiopsis jacquemontiana, Quercus incana, Fragaria nubicola, and Dactylis glomerata*. A similar study by Furqan et al. (2022) recorded plants near *L. leucomelanos* nests in Kotli, Azad Jammu and Kashmir, were *Ailanthus altissima, Amaranthus viridis, Bauhinia variegata, Berberis lycium, Bombax ceiba, Cynodon dactylon, Dodonaea viscosa, Olea ferruginea, Prinsepia utilis,*

Parthenium hysterophorus, Prinsepia sinensis, Rubus ellipticus, Ricinus communis, Solanum nigrum, Taraxacum officinale, Themeda anathera, Ulmus wallichiana, Zanthoxylum alatum and *Ziziphus*. Our study indicated that dominant associated vegetation around *L. leucomelanos* nests in and around Ayubia National Park included *Abies pindrow, Pinus wallichiana, Taxus baccata* L., *Aesculus indica, Prunus padus* L., *Diospyros lotus, Juglans regia, Salix denticulata, Quercus dilatata, Quercus ilex, Populus ciliata, Andrachne cordifolia, Daphne papyracea, Viburnum grandiflorum* Wall., *Sarcococca saligna, Rubus pedunculosus, Rubus fruticosus, Clematis cordata* Royle., *Skimmia laureola, Jasminum humile, Sorbaria tomentosa, Lonicera webbiana* Wall., *Rumex hastatus, Adiantum venustum, Bistorta amplexicaulis, Dryopteris ramosa, Duchesnea indica, Fragaria nubicola, Geranium wallichianum, Impatiens edgeworthii* Hook., *Impatiens bicolor, Pteris acanthoneura, Polygonatum verticillatum, Ranunculus muricatus, Verbascum thapsus* L., *Valeriana wallichii, Rumex acetosa* L., *Sauromatum venosum, Urtica dioica, Viola odorata* L., *Aegilops cylindrica, Agrostis pilosula* Trin. and *Bromus hordeaceus* L. Akhter et al. (2023) recorded *leucomelanos* constructs nests with needles of *Pinus roxburghii* (65% by mass), *Quercus incana* (20%), *Dodonaea viscosa* (5%) and *Saccharum bengalensis* (5%) on ground and can be found in natural vegetation viz., *Acacia modesta*, *Olea ferruginea*, *Dalbergia sissoo* and *Buxus papillosa*, while Afza (2016) recorded *L. leucomelanos* constructs nests with *Adiantum venustum*, *Fragaria nubicola*, *Viola canescens, Viburnum grandiflorum*, *Desmodium* sp., *Spirea, Lonicera* and *Sarcococca*. Our findings showed that nest construction materials of *L. leucomelanos* were predominantly *Abies pindrow, Pinus wallichiana, Taxus baccata* L., *Aesculus indica, Prunus padus* L., *Juglans regia, Diospyros lotus, Quercus dilatata, Salix denticulata, Andrachne cordifolia, Viburnum grandiflorum* Wall., *Sarcococca saligna, Rubus pedunculosus, Clematis cordata* Royle., *Daphne papyracea, Adiantum venustum, Pteris acanthoneura, Impatiens edgeworthii* Hook., *Bistorta amplexicaulis, Dryopteris ramosa, Bromus hordeaceus* L., *Agrostis pilosula* Trin and *Aegilops cylindrica* for all observed nests.

Koklass Pheasant (*P. macrolopha*) initiates breeding early, laying eggs from mid-May through June (Shah et al*.,* 2014). Our findings correspond with previous studies suggesting *P. macrolopha* breed between April and June, with two nests recorded during the study period. Afza (2016) recorded thirty-nine nests of *P. macrolopha* with eggs in Ayubia National Park. However, Shah et al*.* (2014) reported two nests of P. macrolopha in Kalam, Swat, in Khyber Pakhtunkhwa, Pakistan. During the present study, two nests of P. macrolopha with a clutch size of 2 eggs and five hatched eggs were recorded in and around Ayubia National Park, Pakistan.

The clutch size of P. macrolopha is 6-9 eggs; the average size of each egg is 34.2×47.2 mm, weight 36.2 gm, light brown in color, and bears many maroon spots (Tian et al., 1996). In our findings, the average dimensions of *P. macrolopha* eggs were recorded as length, 44.0±0.00 mm, width was 32.0±0.00 mm and weight was 34.50±0.00 grams (Table 11). Shah et al. (2014) reported the nest measurements indicated a circumference of 79 cm, a nest depth of 13 cm, wall thickness of 1.5 cm, outer diameter of 25 cm and inner diameter of 22 cm. However, Tian et al. (1996) documented the outer diameter of the nest as 250×270 mm; inner diameter as 210×230 mm; and depth as 52 mm. In the current study, overall nest dimensions were documented as length 17.14±1.905 cm, width 14.60±1.90 cm, circumference 45.87±12.04 cm, and cup depth 7.23±1.905 cm (Table 12). The habitat surrounding *P. macrolopha* nests includes *Cedrus deodara, Quercus semecarpifolia, Pinus wallichiana, Viburnum grandiflorum, Rhamnus purea, Fragaria vesca, Actaea spicata, Solidago virgaurea, Dipsacus inermis, Geranium wallichianum, Primula denticulata, Primula rosea, Paeonia emodi, Podophyllum emodi, Thalictrum cultratum, Anemone falconeri, Corydalis diphylla, Corydalis stewartii, Corydalis govanianum, Sambucus wightiana, Hypericum perforatum, Impatiens brachycentra, Thymus linearis,* and *Anaphalis triplinervis* in Kalam, Swat, KP, Pakistan (Shah et al., 2014). The associated plant species around *P. macrolopha* nests, documented by Afza (2016), include *Pinus wallichiana, Abies pindrow, Fragaria nubicola, Viburnum mullaha, Dryopteris ramosa, Adiantum venustum, Verbascum Thapsus, Bromus hordeaceus, Valeriana jatamansi, Thalictrum cultratum, Acer caesium, Aesculus indica, Androsace foliosa, Geranium wallichiana, Rhamnus purpurea, Taxus baccata, Bistorta amplexicaulis, Poa pratensis, Dryopteris ramosa, Viburnum grandiflorum, Viola canescens, Prunus padus, Persicaria amplexicaulis, Rosa chinensis, Rananculus muricatus, Impatiens edgwertii, Indigofera heterantha, Cornus macrophylla, Quercus leucotrichophora* and *Quercus dilatata* in Ayubia National Park. Our study identified dominant associated vegetation around *P. macrolopha* nests as *Pinus wallichiana*, *Prunus padus* L., *Diospyros lotus, Rosa moschata, Sarcococca saligna, Rumex hastatus, Viburnum grandiflorum* Wall., *Rubus pedunculosus, Clematis cordata Royle., Androsace rotundifolia, Fragaria nubicola, Galium aparine* L., *Adiantum venustum, Valeriana wallichii, Pteris acanthoneura, Viola odorata* L., *Urtica dioica* and *Ranunculus muricatus* (Table 14). Shah et al. (2014) reported that *P. macrolopha* constructs nests using dry pine needle leaves, dry oak leaves, fallen feathers, and oak twigs in Kalam, Swat, Khyber Pakhtunkhwa, Pakistan. Our findings indicated that nesting

materials used by *P. macrolopha* included Pinus wallichiana, Adiantum venustum, Sarcococca saligna and *Pteris acanthoneura*.

Conclusion

Ayubia National Park and its surrounding areas provide suitable nesting habitats for *L. leucomelanos* and *P. macrolopha*. The breeding season of both species generally extends from March to June, with incubation performed exclusively by females. In the study area, *L. leucomelanos* exhibited relatively larger clutch sizes and higher breeding success than *P. macrolopha*, which showed smaller clutches and lower breeding success. The nesting materials of *L. leucomelanos* included *Abies pindrow*, *Pinus wallichiana*, *Taxus baccata*, *Aesculus indica*, *Prunus padus*, *Juglans regia*, *Diospyros lotus*, *Quercus dilatata*, *Salix denticulata*, *Viburnum grandiflorum*, *Sarcococca saligna*, *Daphne papyracea*, *Adiantum venustum*, *Pteris acanthoneura*, *Aegilops cylindrica*, *Agrostis pilosula* and *Bromus hordeaceus*. In contrast, the nesting materials of *P. macrolopha* primarily consisted of *Pinus wallichiana*, *Sarcococca saligna*, *Adiantum venustum* and *Pteris acanthoneura*. Although suitable breeding habitats are available within the study area, reproductive success remains vulnerable to threats such as egg collection, nest destruction, and predation. Therefore, effective habitat protection, regular nest monitoring and measures to minimize human disturbance and predation are essential for improving breeding success and ensuring the long-term conservation of both species in Ayubia National Park.

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Approval

The current research received provisional approval during the 54th meeting of the Advanced Studies and Research Board (ASRB) held on November 14, 2023, under item No. 2.0, Notification/HU/2023/289.

Ethics statement

During the current study, no *L. leucomelanos* or *P. macrolopha* were hunted. Field data were exclusively collected following specified guidelines. Non-invasive techniques were used to gather data, eliminating the need for special permits and ensuring adherence to scientific ethical standards.

Data availability declaration

During the surveys, breeding calls were recorded during the breeding seasons. Each targeted nest was assigned an identification number. Upon locating the nests, GPS was used to record precise locations. During each examination, comprehensive data were recorded, including clutch size, egg dimensions (length, width, and weight), hatching and fledging success rates, instances of egg collection, predation, damage, cup depth, and nest diameter. The nest construction and the dominant associated vegetation were collected, preserved in the form of herbarium sheets and verified through the herbarium of Hazara University, Mansehra after the nest was abandoned. Locals, shepherds, hunters, and wildlife staff identified nests of both species. The nest soil physical analyses included soil texture, saturation percentage, and pH, while chemical analyses focused on organic matter content, phosphorus, and potassium in the soil samples, which were analyzed at the soil testing laboratory, Azad Jammu and Kashmir.

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