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Miscellaneous deformities of free-living birds: Impact on survival rates and body condition

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ABSTRACT

Deformities affecting the beak, legs, feathers, and other features in wild birds have been reported in case studies from various regions around the world. In recent years, such conditions have been documented in a wide range of avian species, including songbirds, storks, and raptors. The increasing frequency of these conditions raises important questions: Can affected birds survive, and if so, do they maintain body conditions comparable to those of healthy individuals? In our study, bird ringing activities were conducted for five days each month, totalling 105 days between April 2023 and December 2024. We determined the rate of occurrence of deformities in birds caught in nets. We present the distributions regarding age, species, affected organs, and possible causes; these are compared to healthy ringed birds. The findings of this study indicate that the majority of birds afflicted with deformities are capable of sustaining their normal life cycles, and suggest that birds may be more capable of compensating for foot deformities than beak deformities. Additionally, through the recaptured birds, detailed information about living with deformity has been obtained. Recapture intervals ranged from 2 to 484 days. In the present study, deformities were recorded in 12 different bird species, and this represents the first documented instance of beak deformity in the Cirl bunting (*Emberiza cirlus*).

Key words: adaptation; deformities; survival; wild birds

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Introduction

In Deformity refers to a condition in which a part of the body lacks the expected or normal shape. In birds, deformities may be congenital or acquired, and result from various factors (SPEER and POWERS, 2016; GOROSITO et al., 2025). The primary causes include: genetic mutations, traumatic injuries, infectious diseases (viral, bacterial, or parasitic), nutritional deficiencies or imbalances (e.g., hypovitaminosis A), neoplasia, exposure to chemical pollutants such as agricultural pesticides, issues during incubation, and improper wear of the rhinotheca (ZYLBERBERG et al., 2018; PURİFİCAÇÃO, 2019; KHAMBATYA et al., 2024; VAN HEMERT et al., 2025).

"Beak" and "bill" are often used interchangeably in ornithological contexts, and both usages are generally considered correct. However, in some scientific disciplines, subtle distinctions are made: while *beak* may refer to the mouthparts of birds, turtles, certain insects, some fish, and specific mammals, the term bill is typically reserved for birds and the duck-billed platypus (WORELL, 2013). Beak or bill deformities can present themselves in various forms, including excessive elongation or abnormal shortening of the rhinotheca, gnathotheca, or both, as well as lateral or vertical misalignment, which can prevent proper closure of the upper and lower beaks (RIBEIRO ÍTHALO et al., 2021). The beak is critical in essential behaviours such as preening and foraging. Therefore, fractures or malformations of the beak can significantly impair these behaviours, negatively affecting a bird's health and nutritional status and, in severe cases, may even lead to death (JONES et al., 2015). Such deformities include crossed beak, overgrown upper or lower beaks, and curvature of the mandibles, either upward or downward (HANDEL et al., 2010; KHAMBATYA et al., 2024).

Foot deformities can have important consequences for a bird's survival and reproductive success, including loss of perching and grasping ability, and difficulty with positioning during egg laying and incubation (JOHNSON, 2020; ZYLBERBERG et al., 2021; BURRİS et al., 2022). In wild birds, foot malformations are classified into categories such as keratin disorders, bent or absent nails, partial toe loss, and complete loss of toes or feet (JOHNSON, 2020). Causes may be congenital, acquired, or related to viral, bacterial, parasitic agents, or trauma. One cause of foot malformations identified in previous studies are injuries caused by climatic conditions, such as frostbite. Such injuries can occur when the feet and claws are exposed to low temperatures for long periods. Low temperatures cause blood to drain away from soft tissues, and freezing can cause tissue death. Toes and claws may fall off as a result (BRADLEY et al., 2005; WORELL, 2013).

Reports of beak and foot anomalies suggest that health issues in wild populations may be an early sign of more significant underlying ecological problems. Crossed beaks and other congenital malformations have been observed in waterfowl around the Great Lakes, and subsequent studies have documented high levels of persistent organochlorine pollutants in the waters of this region (CUSTER et al., 1999; JIGUET et al., 2019). Records of deformed birds in the wild have been increasing over time (POURLIS, 2011; PURİFİCAÇÃO, 2019; KHAMBATYA et al., 2024). We argue that long-term studies, such as those conducted at bird ringing stations, which allow for the collection of regular data, have significant potential in determining the underlying causes, identifying and monitoring epizootic disease patterns, and revealing new environmental stress factors. We recorded the rate of occurrence of deformities in birds caught in nets, and analysed their distribution by age, species, affected organs, and possible causes, comparing these results to healthy ringed birds.

Materials and methods

Study area. This study was carried out on approximately 2000 acres of land in Ormanya Nature Park on the shore of Sapanca Lake, between Kocaeli and Sakarya provinces in the Marmara Region of Türkiye. As shown in Fig. 1, the area is bordered by the Black Sea to the north, the Sea of Marmara to the west, and Sapanca Lake to the east. It lies along the migration route of many passerine and non passerine species. The study site is located at Lat: 40.7406—Lng: 30.17101. (DMS: 40º 44' 26.16" N, 30º 10' 15.64" E).



Fig. 1. Map showing the study area

Capture of birds and evaluation of deformities. The study was conducted with the approval of the Republic of Turkey's Ministry of Agriculture and Forestry, General Directorate of Nature Conservation and National Parks (E-21264211-288.04 [Biodiversity Research Permits]; 9144344, dated: 10.03.2023). The field work was carried out over 105 days, with five days of sampling each month, from April 2023 to December 2024. The nets were checked at hourly intervals from sunrise to sunset during the ringing period. Birds captured in the nets were then placed into special breathable cloth bags before being transported to the ringing station. Licensed ringers performed morphometric measurements (wing length, tail length, wing formula), assessed fat and muscle scores, measured body weight, and applied rings to the birds. Observed deformities were documented, and in some cases, photographs were taken.

For cases (n=45) involving nail detachment, toe detachment, distal limb loss, finger deformity, and hyperkeratosis, the intact foot was evaluated for pododermatitis, as these deformities are hypothesized to cause unbalanced load distribution on the contralateral foot. Pododermatitis severity was graded according to the criteria established by RODRIGUEZ-LAINZ et al. (1997).

The classification of deformities is typically determined by their etiology. However, given the difficulty of determining this non-invasively in wild birds, the present study adopted a categorisation system based on affected organs and morphological and functional traits. Although a loss of wing and tail feathers was observed in many individuals, this was not classified as a deformity or abnormality, as the extent of feather loss was consistent with natural moulting patterns in birds. No structural impairment or discolouration of the feathers was detected. Birds that underwent measurement and ringing were released back into the wild. Recaptured individuals were also reassessed, and any morphological alterations were recorded. In the course of the analysis, each species was evaluated, with subsequent comparisons being made within the same species.

In standard ringing procedures, birds are evaluated for fat and muscle scores. A fat score is an observational technique that assigns a score between zero and eight. The bird is held in a hand, and its abdomen and chest area are gently blown on to see how much fat it has accumulated under the skin and overlying organs, such as the furcula, breast, liver, intestine and cloaca. A score is given accordingly, based on how much of each organ can be seen (KAISER, 1993). Muscle scoring, like the fat score, is a qualitative measurement, with scores ranging from zero to three. Birds with a muscle score of zero have sharp sternums and inwardly contracted muscles. The sternums of birds with a muscle score of one are still easily distinguishable, but not as sharp as those of birds with a zero muscle score. The muscles are neither sunken nor rounded. Birds with a muscle score of two have prominent sternums, but they have not reached full fullness. The sternum of birds with a muscle score of three is difficult to distinguish, and the muscles are fully rounded (BAIRLEIN, 1995). Birds assigned a fat score of zero or one and a muscle score of two or

three during ringing are considered healthy. During this study, each species with these fat and muscle scores was evaluated individually during the ringing period. The weights of individuals from each species with these scores were measured and averaged, thus obtaining the minimum healthy weight for each species. Each bird with deformities was then compared within its own species, and birds weighing less than the minimum average weight of healthy individuals were considered to be living below normal physiological standards.

Conditions such as discoloration, roughness, keratinization, hardness, softness, and partial loss were clearly and explicitly described in organs where these deformities were observed. The results obtained are presented in Table 1.

Table 1. Classification and distribution of deformities detected in the study

Affected organs	Type of deformity	Extent of Deformity	Species
Leg (n=47)	hyperkeratosis (n=13)		common chaffinch (*Fringilla coeleps*) (n=12), Eurasian jay (*Garrulus glandarius*) (n=1)
	fracture and reunion (n=13)		European robin (*Erithacus rubecula*) (n=4), Eurasian blackcap (*Sylvia atricapilla*) (n=2), Eurasian blue tit (*Cyanistes caeruleus*) (n=1), great tit (*Parus major*) (n=3), common chaffinch (*Fringilla coeleps*) (n=2), Eurasian nuthatch *(Sitta europaea)* (n=1)
	loss of extremity (n=13)	loss of claw (n=4)	great tit (*Parus major*) (n=4)
		loss of digit (n=1)	great tit (*Parus major*) (n=1)
		limb loss from tarsometatarsus (n=8)	common chaffinch (*Fringilla coeleps*) (n=5), Eurasian blue tit (*Cyanistes caeruleus*) (n=1), great tit (*Parus major*) (n=1), Eurasian nuthatch (*Sitta europaea*) (n=1)
	curvature digits (n=6)		European robin (*Erithacus rubecula*) (n=3), common chaffinch (*Fringilla coeleps*) (n=2), Eurasian blackcap (*Sylvia atricapilla*) (n=1)
Bill/ tongue (n=11)	malocclusion (n=3)		European robin (*Erithacus rubecula*) (n=3), common chaffinch (*Fringilla coeleps*) (n=2), Eurasian blackcap (*Sylvia atricapilla*) (n=1)
	elongation, curved bill (n=3)		willow warbler (*Phylloscopus trochillus*) (n=1), Eurasian nuthatch (*Sitta europaea*) (n=2)
	elongation of the upper bill (n=1)		Eurasian blue tit (*Cyanistes caeruleus*) (n=1)
	keratin loss (n=2)		Eurasian jay (*Garrulus glandarius*) (n=1), European goldfinch (*Carduelis carduelis*) (n=1)
	partial loss (n=2)	upper and lower bill + tongu	common chaffinch (*Fringilla coeleps*) (n=1)
		tongue	song thrush (*Turdus philomelos*) (n=1)

Results

Deformities were identified in 57 out of 3,206 ringed birds. The malformations observed included keratinization of the feet; malunion of leg bones; deformities in the toes (such as curvature), leg amputation, loss of nails or toes. Beak related deformities included abnormal elongation, crossed beaks, keratin loss (non-keratinized areas), beak deformity, and partial loss of the tongue or beak. Several beak and foot deformities are shown in Fig. 2 and Fig. 3. The overall rate of deformities was 1.7%. The species distribution of cases was as follows: common chaffinch (n=23), great tit (n=10), European robin (n=7), Eurasian nuthatch (n=4), Eurasian blackcap (n=3), Eurasian blue tit (n=3), Eurasian jay (n=2), European goldfinch (n=1), willow warbler (n=1), European greenfinch (n=1), cirl bunting (n=1), and song thrush (n=1). All biometric measurements and health-related information were re-recorded during evaluation for the recaptured (previously captured) birds with deformities (n=24). Recapture data also provided information on individuals that developed visible deformities after their initial capture and ringing (Table 2). Recaptured intervals ranged from 2 to 484 days.



Fig. 2. Foot deformities - examples

Blue tit with a leg missing from the proximal 1/3 of the tibiotarsus (Fig. 2A), a finch caught in nets with a leg missing 484 days after being ringed, in good health (Fig. 2B), and a finch with hyperkeratosis on its feet (Fig. 2C)



Fig. 3. Beak deformities - examples

Elongation of the upper beak in a blue tit (Fig. 3A), non-keratinized areas on the posterior ½ of the beak in a goldfinch (Fig. 3B), partial tongue loss in a song thrush (Fig. 3C), cross-beak deformity in a nuthatch (Fig. 3D)

All biometric measurements and health-related information were re-recorded during evaluation for the recaptured (previously captured) birds with deformities (n=24). Recapture data also provided information on individuals that developed visible deformities after their initial capture and ringing (Table 2). Recaptured intervals ranged from 2 to 484 days.

Table 2. Capture times and weight change data of retrap birds

Species	Deformity	First weight	1. Retrap weight / elapsed days	2. Retrap weight / elapsed days
European robin (*Erithacus rubecula*)	Fracture	14.7	15.6 / 4	-
Common chaffinch (*Fringilla coeleps*)	Leg loss	22.7	21.3 / 484	-
European robin (*Erithacus rubecula*)	Leg loss	23.1	20.5 /300	21.5 / 187
Common chaffinch (*Fringilla coeleps*)	Reunion	16.5	14.6 / 7	-
European robin (*Erithacus rubecula*)	Fracture	15.5	16.2 /201	14.5 /123
European robin (*Erithacus rubecula*)	Fracture	18.6	16.1/26	15.6 / 63
Eurasian blue tit (*Cyanistes caeruleus*)	Leg loss	10.9	11.1 /234	-
Great tit (*Parus major*)	Fracture	18.7	16.6 /35	18 / 23
Great tit (*Parus major*)	Claw loss	18.5	16.3 /2	-
Great tit (*Parus major*)	Fracture	19	18 / 460	-
Common chaffinch (*Fringilla coeleps*)	Hyperkeratosis	22.7	21.9 / 122	19.1 / 186
Eurasian blue tit (*Cyanistes caeruleus*)	Digit loss	10.1	10.5 / 118	-
Eurasian nuthatch (*Sitta europaea*)	Fracture	20	19.3 / 26	-
Common chaffinch (*Fringilla coeleps*)	Hyperkeratosis	23.6	24.4 / 244	22.4 / 180
Common chaffinch (*Fringilla coeleps*)	Hyperkeratosis	22.3	23.5 / 27	-
Eurasian nuthatch (*Sitta europaea*)	Leg loss	19.8	19 / 33	17.7 / 60
Common chaffinch (*Fringilla coeleps*)	Curved digits	22.8	17.9 / 47	-
Common chaffinch (*Fringilla coeleps*)	Hyperkeratosis	23.6	23.3 / 60	-
Great tit (*Parus major*)	Claw loss	16	17.2 /60	16.4 / 277
Great tit (*Parus major*)	Claw loss	17.6	18.9 / 25	17.9 /32
Common chaffinch (*Fringilla coeleps*)	Leg loss	22.6	21.7/4	20/4
Common chaffinch (*Fringilla coeleps*)	Leg loss	21.8	25.1/ 362	-
Great tit (*Parus major*)	Claw loss	17.6	16.8 /250	16.3 / 188
Cirl bunting (*Emberiza cirlus*)	Curved bill	24.4	23.7 / 203	-

In the cases where the gender of the bird could be determined (n=45), no statistically significant difference was found using the chi-squared test (χ^2 = 6.16, P>0.05) performed to examine the relationship between gender and deformity.

We examined whether deformities and limb loss differed by age for 56 cases. (One immature bird was excluded from the statistical analysis). Since χ^2=0.037 and P>0.05, no significant relationship was found between age and the occurrence of deformities or limb loss.

Among 47 of the higher-risk cases, exhibiting conditions potentially causing uneven load distribution on the plantar surface—such as nail loss, toe loss, distal limb loss, toe deformities, and hyperkeratosis—pododermatitis was detected at varying severity levels in three individuals. It was identified as grade 3 in one Eurasian blackcap (*Sylvia atricapilla*, n=1) and as grade 1 in two common chaffinches (*Fringilla coelebs*, n=2). Grade 3 pododermatitis is shown in the captured Eurasian blackcap Fig. 4. Among the 57 cases, 13 individuals (22.8%) had body weights lower than the species-specific minimum, while the remaining 44 individuals (77.2%) had body weights above the species-specific minimum. Morphologically, of the 13 underweight cases, 3 (23%) exhibited partial tongue or limb loss, and 10 (77%) showed structural deformities. When assessed in relation to the affected organ, 7 out of 13 birds with beak deformities and 6 out of 47 birds with foot deformities were found to have body weights below the species-specific minimum (Table 3).



Fig. 4. Feet of a Eurasian blackcap (*Sylvia atricapilla*)

Discussion

Studies have shown that deformities have a significant impact on an individual's capacity to feed, preen, and manage parasites, consequently leading to reduced body mass and survival (POURLIS, 2011; ZYLEBERBERG et al., 2021). However, in our study, of the 57 cases examined, 13 individuals (22.8%) exhibited body weights below the species specific minimum, while 44 individuals (77.2%) demonstrated weights above that threshold. The findings of this study indicate that the majority of birds afflicted with deformities are capable of sustaining their normal life cycles. The data set revealed that 53.8% of birds with beak and tongue deformities had weights below the minimum, whereas for those with foot deformities, this rate was only 12.7%. The findings of this study suggest that birds may be more capable of compensating for foot deformities than for beak deformities.

Table 3. Species and deformity types below the minimum weight value

Species	Type of deformity	Weight of deformed bird (g)	Reference values for weights of healthy birds (g)
Eurasian jay (*Garrulus glandarius*)	Keratin loss on bill	139.4	170.74 ±11.14 (min:141.30-max:195.00; n=23)
Eurasian jay (*Garrulus glandarius*)	Hyperkeratosis	135.8	170.74 ±11.14 (min:141.30-max:195.00; n=23)
European greenfinch (*Chloris chloris*)	Malocclusion	23.2	26.27 ±1.60 (min:23.5-max:28.0; n=30)
Great tit (*Parus major*)	Curved bill	14.6	16.94 ±1.08 (min:14,90-max:20.00; n=96)
Great tit (*Parus major*)	Leg loss	14.8	16.94 ±1.08 (min:14.90-max:20.00; n=96)
Common chaffinch (*Fringilla coeleps*)	Curved digits	17.9	21.46 ±1.52 (min:18.0-max:24.4; n=100)
European robin (*Erithacus rubecula*)	Fracture	14.7	15,90 ±0,61 (min:15,1-max:17,8; n=142)
European robin (*Erithacus rubecula*)	Fracture (swelling on joint)	14.6	15.90 ±0,61 (min:15.1-max:17.8; n=142)
European robin (*Erithacus rubecula*)	Fracture	14.1	15.90 ±0,61 (min:15.1-max:17.8; n=142)
Song thrush (*Turdus philomelos*)	Partial tongue loss	56.9	63.89 ±4.59 (min:57.7-max:78,7; n=32)
Eurasian nuthatch (*Sitta europaea*)	Curved bill	16	20.36 ±1.27 (min:18.3-max:23.6; n=40)
Eurasian nuthatch (*Sitta europaea*)	Curved bill	17.6	20.36 ±1.27 (min:18.3-max:23.6; n=40)
Willow warbler (*Phylloscopus trochillus*)	Curved bill	6.9	9.12 ±1.19 (min:7.2-max:11.1; n=29)

The assessment of biochemical parameters showed that the average glucose level in birds supplemented with *S. scardica* was significantly lower (12.09±3.09 mmol/L) compared to the control group (13.49±2.54 mmol/L), with a tendency for 50% of the birds to have glucose levels <11.75 mmol/L in the supplemented group and <13.00 mmol/L in the control group (P=0.0204). Additionally, the average cholesterol level was lower in the *S. scardica* group (2.87±0.60 mmol/L) compared to the control group (3.19±0.45 mmol/L), with a higher percentage of individuals having cholesterol <2.85 mmol/L in the supplemented group compared to <3.10 mmol/L in the control group (P=0.0149). Triglycerides were also significantly lower in the supplemented group (0.61±0.12 mmol/L) compared to the control group (0.78±0.25 mmol/L), with consistently lower values in 50% of individuals, respectively <0.58 mmol/L and <0.78 mmol/L (P=0.0016). Regarding total proteins and albumins, no statistically significant differences were observed between the two groups, as the average total protein levels were 35.27±6.69 g/L in the *S. scardica* group and 34.50±3.87 g/L in the control group (P=0.4587), while albumin levels were 22.78±4.58 g/L and 22.38±2.53 g/L, respectively (P=0.7399).

Conditions such as fractures and tendinitis, or even limb loss, can result in impaired mobility, characterised by limping in one leg. This condition can lead to an uneven distribution of weight on the remaining foot, often resulting in pododermatitis, also known as bumblefoot, and while pododermatitis is a prevalent condition in captive birds and those under human care, its occurrence in free-ranging birds is relatively rare (WYSS et al., 2015). The present study found that the incidence of pododermatitis among the 47 high-risk individuals was 6.3%. Despite the presence of predisposing conditions and the risk of secondary pododermatitis in the cases presented, the low occurrence supports the hypothesis that unsuita-

ble perching and substrate materials—as noted in the literature—are the primary contributing factors. The onset of the disease in captive birds can range from several weeks to years (RODRIGUEZ-LAINZ et al., 1997; NIELSEN et al., 2010). According to the data obtained from recapture, the bird that survived the longest in the wild with a foot deformity but without plantar necrosis was a chaffinch with hyperkeratosis, recaptured after 424 days.

A wide range of avian species have been reported to exhibit deformities, including hummingbirds, toucans, woodpeckers, pigeons, wood rails, thrushes and boobies (VASCONCELOS and RODRIGUES, 2006; PURİFİCAÇÃO, 2019; GEUSTER and FAVRETTO, 2021; MOURA et al., 2022; GOROSITO et al., 2025) In the present study, deformities were recorded in 12 different bird species. Of these, the case of the cirl bunting (*Emberiza cirlus*) represents the first recorded instance of a beak deformity in this species.

A healthy chaffinch, weighing 22.7 grams, which had been ringed in June 2023, was recaptured 16 months later, having lost 1.4 grams. The specimen exhibited a loss of the distal third of its right tibiotarsus. This finding indicates that the deformity was not congenital but rather acquired (Fig. 2c). Untreated wounds in wild birds may lead to secondary bacterial infections. As HEMANTH GOWDA et al. (2024) demonstrated, even a minor, initially invisible wound has the potential to develop rapidly into a severe infection, which may then progress to septicaemia or maggot infestation.

In the seven birds with recapture records confirming acquired limb loss (e.g. toe or leg amputation), examination of the stump showed complete coverage of the bone by soft tissue and skin, with no signs of infection or wound complications. It is hypothesised that since the wound did not make contact with the ground due to shortened limb length, contamination was minimised. Furthermore, it is conceivable that secretions from the uropygial gland contributed to the prevention of infection, as they contain antimicrobial compounds secreted directly by glandular cells to protect feathers and skin (SHAWKEY et al., 2003; SOLER et al., 2010).

A fundamental question concerning birds with acquired or partial limb loss (n=15) pertains to their capacity for physiological compensation of hypovolemia. The extent of blood loss in cases of tissue or organ loss can vary from mild to severe. However, avian species demonstrate a higher degree of tolerance to hypovolemia than mammals. Clinical signs of anaemia or shock are not typically observed until 50–60% of total blood volume has been lost. In a study on pigeons, even a 60% blood volume loss did not result in clinical symptoms, and haematocrit levels returned to normal within seven days. This exceptional tolerance is hypothesised to depend on three primary adaptations: the capacity for rapid extravascular fluid absorption from muscle tissue with a large capillary surface area; a blunted autonomic response that reduces signs such as tachycardia, tachypnea, or hypothermia; and the ability to release large numbers of immature red blood cells swiftly into circulation (ROBERTS, 2016).

The aetiology of deformities is multifactorial and frequently uncertain. The aetiology of the condition may be traced back to a number of potential causative factors, including disease or infection, improper incubation techniques, trauma, nutritional deficiencies, environmental pollutants, and genetic factors (PURİFİCAÇÃO, 2019; SMITH et al., 2019). In the present study, cases evaluated as hyperkeratosis with a ‘scaly leg’ clinical appearance were found to be indicative of mite infestation. A total of 15 cases were determined to be trauma-induced and acquired, as indicated by the results of the recapture records. The cause of the remaining cases has yet to be determined, underscoring the necessity for further investigation through laboratory diagnostics and molecular studies.

When fractures are encountered during ringing, intervention should depend on the type of injury (BUSSE and MEISSNER, 2015). All fractures observed in our study were closed, with no displacement of bone fragments. As BUSSE and MEISSNER (2015) noted, such fractures may heal naturally, so no interventions were attempted, and no birds underwent amputation. A great tit with a femoral fracture detected by palpation and a body weight of 19 grams, was ringed on the uninjured leg and released. It was recaptured 460 days later with a healed fracture and a body weight of 18 grams. This supports the view that in closed fractures of the

femur—a bone protected by strong muscle groups—birds can be released without intervention.

As POURLİS (2011) demonstrates, beak and tongue deformities can either develop gradually or result from acute trauma. Consequently, to determine whether a case is acute or chronic, it is essential to take into consideration any signs that suggest recent injury. In the present study, two cases of partial beak and tongue loss were found with intact and clear choanae, a normal tongue-grab reflex, and normal tongue mobility. The absence of abrasions or open wounds near the beak and nares indicated that the injury was likely the result of a prior trauma.

In short-billed birds (e.g., budgerigars), regeneration is possible following avulsion in the distal third of the beak (DEMİR and ÖZSEMİR, 2021), however, regeneration is not possible in long-billed birds, such as toucans, which may require a prosthetic replacement (CROSTA, 2002; SHARMA et al., 2024). In certain cases, assisted feeding or even an esophagostomy tube is necessary during the healing process in some captive birds (SPEER and POWERS, 2016).

Although partial beak loss may be a reason for euthanasia in veterinary settings, cases observed in wild birds offer valuable insights into survival potential. Birds exhibiting beak deformities may evolve behavioural adaptations to ensure their survival, such as modifying feeding techniques. For instance, a starling (*Sturnus vulgaris*) reported by WARHAM (1951), with a severely curved upper mandible and a broken or deformed lower mandible, was able to feed using sideways scooping motions. Similarly, an observation was made of a great tit (Parus major) displaying an elongated upper mandible, which it compensated for by tilting its head to one side during feeding. It is also hypothesised that in mating pairs, the unaffected partner may feed the individual with a beak deformity (POMEROY, 1962).

The lack of a significant relationship between sex, age, and deformity/limb loss in our study suggests that these variables are not determinants of deformity development. However, the limited sample size may have led to small effects not being statistically detectable.

Conclusions

Our study examined beak and leg deformities in wild bird populations and found that a high percentage (77.2%) of affected individuals were able to maintain normal life cycles. These deformities are indicative of not only the health of the individual birds but also the condition of their habitats. Abnormalities in wild bird populations arise from complex interactions between spontaneous, traumatic, toxicological, and environmental factors. Our findings suggest that birds with deformities can be used as bio indicators to assess environmental changes that may have biological effects. Future research should focus on observing the behaviour of deformed wild animals in nature, investigating epizootic diseases, and examining environmental and climatic factors that may contribute to the development of these deformities.

Ethical approval

The bird ringing station was approved by the Republic of Türkiye's Ministry of Agriculture and Forestry (E-21264211-288.04 [Biyoçeşitlilik Araştırma İzinleri]- 9144344.

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Authorship contribution statement

All authors contributed to the conception and design of the study. Fieldwork was conducted by Bacak, E., Nalkıran, M. and Özsemir, A. Data analysis was performed by Özsemir, A., and Gerbaga Özsemir; K. Gerbaga Özsemir, K. took the lead in writing the manuscript, with assistance from Bacak, E., and Nalkıran, M., and Özsemir, A. Subsequently, all authors participated in manuscript revision, contributed additional supportive information, and provided final approval for publication.

Data availability statement

The data that support this study will be shared upon reasonable requests to the corresponding author.

Declaration of competing interest

The authors declare no competing interests.

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ÖZSEMİR, K. G., A. C. ÖZSEMİR, E. BACAK, M. NALKIRAN: Različitost deformiteta u slobodnoživućih ptica: utjecaj na stopu preživljavanja i tjelesnu kondiciju. Vet. arhiv 97, 81-93, 2027.

SAŽETAK

U prikazima slučajeva iz različitih dijelova svijeta, u divljih ptica kao najčešći zabilježeni su deformiteti kljuna, nogu i perja. Posljednjih su godina takva stanja dokumentirana kod širokog spektra ptičjih vrsta, uključujući pjevice, rode i ptice grabljivice. Sve veća učestalost ovih stanja nameće važna pitanja: mogu li zahvaćene ptice preživjeti i, ako mogu, zadržavaju li tjelesnu kondiciju usporedivu sa zdravim jedinkama? Podaci su prikupljeni tijekom prstenovanja ptica koje je trajalo 5 dana u mjesecu što je, u razdoblju od travnja 2023. do prosinca 2024., ukupno iznosilo 105 dana. Ustanovljena je stopa pojavnosti deformiteta u ptica uhvaćenih u mreže te raspodjela deformiteta s obzirom na dob, vrstu, zahvaćene organe i moguće uzroke. Ptice s deformitetima uspoređene su sa zdravim prstenovanim pticama. Rezultati istraživanja upućuju na to da je većina ptica zahvaćenih deformitetima sposobna održavati svoje normalne životne cikluse te sugeriraju da su ptice možda sposobnije kompenzirati deformitete nogu nego deformitete kljuna. Osim toga, ponovljeni nalazi utvrđeni ponovnim hvatanjem prstenovanih ptica u intervalima od 2 do 484 dana, pružili su detaljne informacije o životu s deformitetom. Ovim istraživanjem zabilježeni deformiteti u 12 različitih vrsta ptica, pri čemu se posebno ističe prvi slučaj deformiteta kljuna u crnoglave strnadice (*Emberiza cirlus*).

Ključne riječi: adaptacija; deformiteti; preživljenje; slobodnoživuće ptice