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Breeding Long-legged Buzzard *Buteo rufinus* in forests of southwestern Iran: feeding habits and reproductive performance

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Abstract: The breeding biology, behavior, and diet of Long-legged Buzzard *Buteo rufinus* were studied during 2 breeding seasons in forests in southwestern Iran (n = 3 nests) from April to June in 2012 and 2013. All nests faced west to east on the upper edges of cliffs. Eggs were laid during 7–11 March. The clutch size was 3 eggs and incubation period was 31 ± 1 days. Brood reduction was observed in one of the nests (in the first year), and mortality of the smallest chicks occurred during the second week after hatching. The young fledged successfully at 49.5 ± 0.5 days of age and left the nest at approximately 52 ± 2 days. Information about diet during the breeding season was obtained by collecting pellets, prey remains, and video recordings. Mammalian prey, especially Persian squirrel (*Sciurus anomalus*), and lizards and snakes made up most of the diet of Long-legged Buzzards.

Key words: Breeding, diet, Long-legged Buzzard, southwestern Iran

1. Introduction

The Long-legged Buzzard *Buteo rufinus* is a medium-sized raptor; its breeding range extends through North Africa, East Europe, and Asia (Snow and Perrins, 1998).

The Eurasian subspecies of the Long-legged Buzzard (*Buteo rufinus rufinus*) is a common bird of prey in Iran, which is currently distributed in the regions of northern, western, and southwestern Iran (Khaleghizadeh et al., 2005; Hosseini-Zavarei et al., 2008; Mansoori, 2013). The species usually dwells in lowland dry and semidry steppes, and desert steppes (Snow and Perrins, 1998). However, in recent years, with a sharp decline in the population of squirrels (due to illegal trafficking) and insecurity in the region due to the increased availability of rifles and killing of the birds, the breeding of birds of prey in the region has declined sharply.

Forsman (1998) pointed out that the Long-legged Buzzard prefers semideserts and hills or cliffs and often visits open and dry areas. Its nest is usually on the ground (hills and cliffs), although sometimes trees are used as nest sites (Mansoori, 2013). Snow and Perrins (1998) noted that the Long-legged Buzzard hunts over meadows, but only marginally overlaps into farmlands (Forsman, 1998).

The breeding ecology of Long-legged Buzzards has rarely been recorded (Vatev, 1987; Alivizatos et al., 1998; Harrison and Castell, 1998; Shevtsov, 2001; Vetrov, 2002; Domashevsky, 2004; Syzhko, 2005; Hosseini-Zavarei et al., 2008; Wu et al., 2008). The egg-laying period normally occurs from March to May and the average clutch size is 3 or 4 eggs. The length of incubation is about 28–30 days (Ferguson-Lees and Christie, 2001), and the nestling period ranges between 40 and 46 days (Cramp and Simmons, 1979; Ferguson-Lees and Christie, 2001); however, Vatev (1987) reported a period of about 49–53 days.

The study of the diet helps to provide information about the distribution and abundance of prey species (Bontzorlos et al., 2005) and evaluation of its impact on domestic and game species (Valkama et al., 2005). It also shows pollutant transfer through the food web (Newton, 1979). Specifically, information about a predator's preferred prey is needed for a better understanding of its feeding ecology, which in turn could help with its protection (Alivizatos and Goutner, 1997; Wu et al., 2008; Bakaloudis, 2009, 2010; Birrer, 2010). As slowly reproducing avian apex predators, most raptors can be considered potentially endangered, and it is highly important to preserve breeding habitats for successful predator conservation and management (Wilkinson and Debban, 1980).

Very little information is available about the ecology of buzzards in Iran. Only recently Hosseini-Zavarei et al. (2008) and Khaleghizadeh et al. (2005) studied the habitat use and diet of the Long-legged Buzzard in Miandasht Wildlife Refuge and Kharturan Biosphere Reserve in northeastern Iran.

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This paper discusses the breeding biology and diet of the Long-legged Buzzard in the forest habitat of southwestern Iran. Such studies could have an important role in the development of conservation strategies for this species.

2. Materials and methods

The study area was located in forest habitat of southwestern Iran in southern Yasouj (30°36′09″N to 30°21′31″N, 51°39′45″E to 51°19′58″E). The climate in the area is temperate, with a mean temperature of 14 °C and a mean annual precipitation of 515 mm. Elevation ranges from 800 to 2463 m above sea level. The most common vegetation types are bush communities (*Astragalus* spp., *Acantholimon* spp., *Amygdalus* spp., and *Rosa* spp.). Trees are mostly *Quercus brantii* Lindl. var. *persica*, *Lonicera nummulariifolia*, *Amygdalus elaeagnifolia*, *Pistacia atlantica*, *Pyrus glabra*, *Ceracus microcarpa*, *Crataegus azarolus*, and *Acer monspesulanum*.

A total of 3 nests of Long-legged Buzzard were monitored during the breeding seasons of 2012 and 2013. The locations of all nest sites found in the survey area were recorded using a GPS. The region was surveyed on foot or using 4WD vehicles during April to June in 2012 and 2013. All the nests were active during the monitoring period. We monitored the nests for a total of 231 h (excluding the time of video recording) over 94 days during the 2 breeding seasons, with an average of 4.5 ± 0.5 h each day. For observation, a camouflaged blind 40–50 m away from the nest was selected to prevent any negative impact on bird behavior. With the help of 10 × 40 EL Swarovski binoculars, we recorded breeding behavior and prey delivery to nestlings and tried to identify all prey items by direct observation. Monitoring was carried out throughout the nestling period, until the fledglings left the nest. We recorded the number of visits to the nest per hour, percentage of visits with prey, and prey delivery rates per hour. Plumage lines and spots, especially the tail feathers of nestlings, were examined when possible. For collection of pellets and prey remains and recording of hatching, fledging date, and nest success, we checked the nests by rock-climbing during the 2 breeding seasons. The number of fledged young was defined as the number of chicks directly observed to have successfully fledged.

We studied the diet of Long-legged Buzzard in southwestern Iran by collecting prey remains and pellets inside and around the 3 nests, and by video recording. The video recordings were obtained by mounting a video camera (Sony HDR-CX550V, 10× optical zoom). The camera was mounted on a tripod near the nest. After the camera had been mounted and adjusted towards the nest, the recording started and we got quite far from the nest area. The nests were video-recorded for 120 h over 2 years.

Prey remains and pellets were collected at plucking posts inside and close to the nests (usually <30 m from the nest).

A total of 70 pellets and 72 prey remains were collected. The data on prey items were pooled for all 3 nests. Due to restrictions on direct observation (Marti, 1987; Rogers et al., 2005), it was not possible to identify some small prey items, leading to errors in the estimation of some prey items, while video recordings helped us to identify some of these species.

In the Zoology Laboratory of Yasouj University, each pellet was soaked in water and teased apart with fingers and forceps (Sabo and Laybourne, 1994). The main contents of pellets were hair, bones, scales of reptiles, exoskeletons of insects, and feathers. The contents of each pellet were recorded. In counting prey frequencies in pellets, for small preys, all similar parts of the same species in a single pellet were considered to be from the same individual prey, while parts in different pellets were considered as belonging to different individuals (Redpath et al., 2001); for large preys, all parts of the same species in different pellets could be pieced into a single individual.

For analysis of prey remains, prey remains were collected inside or near nests, and then prey remains were identified based on the shape and color of the tarsus, bill, rectrices, remiges, and other notable characteristics of feathers of birds; prominent features of insect exoskeletons; the color of the fur, skin, and hair of mammals; and the tails of mammals and lizards. We adopted the method of counting prey frequencies in food remains; all body parts from each prey assemblage could be pieced into prey individuals (Page and Whitacre, 1975). By using published data regarding the weight of each taxon, a biomass for each species was determined (Cramp and Simmons, 1980; Mañosa, 1994; Collins and Latta, 2006).

3. Results

3.1. Nest characteristics

All nests faced west to east on upper cliff edges with heights of 58–65 m and 90° cliff slopes. The distance of the nests from the cliff peak was 3–5 m. The entrances to the 3 nests were narrow. Dimensions of the nests were about 0.3 m in diameter and 0.3 m deep. The nest cups were ≤10 cm deep and were composed of soft woody materials. A tuft of grass roots, wool, and cloth was found in each nest cup. The outer edges of the nests were made of wood from local trees such as *Quercus brantii* Lindl. and *Lonicera nummulariifolia*.

3.2. Species identification, courtship, egg laying, clutch size, and hatching success

In our study, the plumage type of all adults was dark phase, i.e. entirely dark brown with heavily barred white tails. The courtship began in late February. The eggs were laid on

7–11 March. The mean clutch size was 3 (n = 3 clutches). Eggs were off-white, marked with red-brown spots. Reproduction success was calculated on the basis of the number of nesting attempts that fledged young. Of the 3 nests found with eggs, there was 94.44% hatching success; 2 nests had 3 chicks and one of them (in the first year) had 2 chicks.

3.3. Incubation

Incubation began in early March and ended on 11–13 April. The male bird spent much of the day near the nest site perching on rocks or trees. The length of the incubation was 31 ± 1 days.

3.4. Nestling period and fledging

A few minutes after hatching, the chicks were covered with off-white down. During the sixth week, they were walking and flapping at the front entrance of the nest. Three days later, the nestlings had left the nest, and only one fledgling was seen at the nest edge. The fledgling remained at the nest-site for approximately 49.5 ± 0.5 days and was flying at approximately 52 ± 2 days.

3.5. Nestling development and fledging success

Before fledging, the young stayed in the nest during the night, whereas the adults were outside the nest. In the 2-year period of our study, a total of 18 eggs were laid in the 3 nests (each nest with 3-egg clutches); 18 eggs hatched and 17 young fledged.

3.6. Behavior of adults

One of the adults was almost continuously in attendance at the nest during the first week after hatching. Prey was then brought to the nestlings by both parents. During our observation periods, adults brought prey to the nest approximately once every 3.5 h, 3 times a day. If the chicks did not eat the food, the mother would take the food out of the nest and return with it again. Adults hunted at a distance of approximately 2 km from the nest. Prey was carried more often in the talons, but occasionally in the bill. While nestlings were still downy, the prey was fed piecemeal to the brood by the adults. It would take 10–15 min to feed the chicks.

3.7. Diet

Of 178 prey items recorded at the nests (70 from pellets, 72 from prey remains, and 36 from video recordings and direct observations), 166 prey items were identified and 12 prey items were unidentified (Table). The breeding-season diet of the Long-legged Buzzard was dominated by reptiles (56.35% frequency of prey items), mammals (37.47%), and birds (6.18%). The Persian squirrel (*Sciurus anomalus*, subadult), with 29.85% frequency, was the most important prey species (Table). The highest diversity of prey items occurred with reptiles.

Persian squirrel and common vole (*Microtus arvalis*) were the most common mammal species (Table). Bird feather remains found at nest sites belonged to Blackbird (*Turdus merula*), Isabelline wheatear (*Oenanthe isabellina*), and an unidentified passerine (Table). In this study, 9 reptile species were identified; brilliant ground agama (*Trapelus agilis*), large-scaled rock agama (*Laudakia nupta nupta*), spotted whip snake (*Hemorrhois ravergieri*), and small-scaled rock agama (*Laudakia microlepis*) were the most frequent reptiles (Table).

Based on the total biomass of collected prey items, reptiles, mammals, and birds accounted for 56.75%, 41.4%, and 1.9% of the diet, respectively; the most important reptiles were brilliant ground agama (16% of total biomass) and large-scaled rock agama (14.4%), and the most important species of mammal was Persian squirrel (39.4%) (Table).

4. Discussion

In the study area, the population of raptors was very low; while the Long-legged Buzzard was more abundant than other raptors, its population was lower than in previous years. Vertical cliffs in the study area were the only nesting sites for the buzzards. All 3 nests facing east were on vertical cliffs in the forest area and were in sheltered positions to shade them from direct sunlight, as Wu et al. (2008) previously mentioned. Intense sunlight could explain the lack of nesting sites in the western part of our study area.

In the study area, competition with Short-toed Eagle (*Circaetus gallicus*) and Kestrel (*Falco tinnunculus*) in hunting small rodents may have somewhat reduced the breeding and nest-building of Long-legged Buzzards, as Alivizatos et al. (1998) and Wu et al. (2008) previously observed.

In our study, the incubation and fledging times were indicative of a minor difference from the results of others (e.g., Alivizatos et al., 1998; Wu et al., 2008). This difference was probably related to the climate in our study area. In all of the nests, one of the chicks was smaller than the others. Brood reduction was observed in one of the nests (in the first year), and mortality of the smallest chicks occurred in the second week after hatching. Chick mortality is often related to fluctuations in climatic conditions or shortages of food, but it can also be a direct consequence of hatching sequence, in which the youngest and smallest chicks are unable to compete with larger siblings for food even when food is abundant (Mebs, 1964; Vatev, 1987; Stenning, 1996; Wu et al., 2008).

Many methods have been used for the purpose of studying the diet of birds of prey in the literature, including pellet analysis, analysis of prey remains, analysis of the contents of the digestive system, photographic and video recording, direct observation, and confining of individuals

Table. Frequency and percentage of prey items, with mean body weights (g) and total biomass (g) of prey items in the diet of breeding Long-legged Buzzard in southwestern Iran (n = 3 nests).

	Prey remains	Pellets	Video recordings	Pooled data	Unit weight	Total biomass
	n (%)	n (%)	n (%)	(%)	g	g (%)
Mammals						
Sciurus anomalus	24 (33.33)	16 (22.86)	12 (33.33)	29.85	300	15,600 (39.4)
Microtus arvalis	0 (0)	8 (11.43)	0 (0)	3.81	50	400 (1)
Unidentified rodents	0 (0)	8 (11.43)	0 (0)	3.81	50	400 (1)
Birds						
Turdus merula	0 (0)	5 (7.14)	0 (0)	2.38	102.5	512.5 (1.3)
Oenanthe isabellina	0 (0)	4 (5.71)	0 (0)	1.90	31	124 (0.3)
Unidentified birds	0 (0)	4 (5.71)	0 (0)	1.90	30	120 (0.3)
Reptiles						
Hemorrhois ravergieri	12 (16.67)	4 (5.71)	2 (5.56)	9.32	230	4140 (10.5)
Laudakia nupta	8 (11.11)	7 (10)	4 (11.11)	10.74	300	5700 (14.4)
Trapelus agilis	8 (11.11)	7 (10)	6 (16.67)	12.6	300	6300 (16)
L. microlepis	6 (8.33)	3 (4.29)	3 (8.33)	6.98	200	2400 (6.1)
Platyceps rhodorachis	3 (4.17)	0 (0)	0 (0)	1.39	150	450 (1.1)
Platyceps ventromaculatus	5 (6.94)	0 (0)	0 (0)	2.31	110	550 (1.4)
Dolichophis jugularis	2 (2.78)	0 (0)	0 (0)	0.93	500	1000 (2.5)
Coluber sp.	0 (0)	4 (5.71)	5 (13.89)	6.53	200	1800 (4.5)
Ophisops elegans	3 (4.17)	0 (0)	4 (11.11)	5.09	3	21 (0.05)
Zamenis hohenackeri	1 (1.39)	0 (0)	0 (0)	0.46	90	90 (0.2)
Total	72 (100)	70 (100)	36 (100)	100		39,607.5 (100)

(Rosenberg and Cooper, 1990; Alivizatos and Goutner, 1997; Marti et al., 2007; Selås et al., 2007; Tornberg and Reif, 2007). Given that the application of a single method might involve biases relating to the feeding habits of a raptor's diet (Real, 1996), many zoologists have used multiple methods together to determine which is the most suitable method for evaluating feeding habits (Simmons et al., 1991; Alivizatos and Goutner, 1997; Redpath et al., 2001).

In most of our visits, there were uneaten prey remains (especially squirrel and snake) at the nests, showing that in our study area there was no shortage of food.

Although the present study included only 3 nests, which may jeopardize the scientific accuracy of the conclusions drawn, the results are largely in accordance with previous studies conducted, where reptiles and mammals (especially rodents) have been the main food items and birds have been the most important alternative prey (Cramp and Simmons, 1979; Spidsø and Selås, 1988; Alivizatos and Goutner, 1997; Forsman, 1998; Snow and Perrins, 1998; Reif et al., 2001; Selås, 2001; Khaleghizadeh et al., 2005; Selås et al., 2007; Hosseini-Zavarei et al., 2008; Bakaloudis et al., 2012).

In our study, Persian squirrels (one of the largest rodents in southwestern Iran), which were the main prey of Long-legged Buzzards from the third to the sixth week, were mainly active during the day; however, from the sixth week, reptiles were the main prey. Perhaps this is because, at this time, the baby squirrels (subadult) were larger and more likely to escape from predators. Additionally, in the first 2 weeks no pellets or prey remains were found in the nests, probably due to the buzzards feeding on small

food items such as insects. This diet change has already been pointed out by some researchers (e.g., Alivizatos and Goutner, 1997). We observed that Long-legged Buzzards rarely hunted small birds, because the energy gain obtained from such prey would be low compared to the time and energy spent on hunting (Alivizatos and Goutner, 1997; Selås et al., 2007; Tapia et al., 2007; Bakaloudis et al., 2012). Lizards had high frequency; despite their low biomass, their capture was easier than that of birds. In this study, traces of a rare snake (*Zamenis hohenackeri*) were found in prey remains for the first time. No study has been carried out on the effect of rodent control on raptor populations in western Iran, but in other parts of the world it has been established that changes in *Buteo* populations are related to changes in the densities of favored mammals (e.g., Rough-legged Buzzard [*B. lagopus*] in Potapov, 1997; Upland Buzzard in Gombobaatar et al., 2003).

Because squirrels and lizards (family Agamidae) are the species with the highest populations in oak forests and rocky areas in southwestern Iran, it is natural that they are the main food sources for birds of prey. Alivizatos and Goutner (1997) already pointed out the large number of reptiles in the diet of Long-legged Buzzard in hilly areas.

We recommend that more investigations on raptors' diets be undertaken to determine with certainty their main food items and to illustrate food niche separation. This would help conservationists to develop scientific and practical management plans based on prey species to conserve the raptors.

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