

Breeding of the Red-headed Falcon *Falco chicquera* in Saurashtra, Gujarat, India

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Two nests of Red-headed Falcon *Falco chicquera* were studied in 1988 near Jasdan in Gujarat, India. The nests were in trees in areas of dense human population. One nest with one young was followed intensively. Activity of the male partner was influenced by the (much more frequent) vocalisations of the larger female. Prey at both nests was almost entirely birds, from the size of pigeons down to sparrows. Hunting patterns, prey delivery, caching, roosting and brooding behaviour are described, along with activity and development of the nestling. Territorial aggression was high within 25 m of the nest, mostly directed against House Crows *Corvus splendens*, and increased with nestling age. The nestling was fed almost exclusively by the female, roughly 4–5 times daily, mainly before 12h00 and (to a lesser degree) after 15h00; it fledged at 48 days, an apparently late date perhaps related to the lateness of the season (end of May, a month later than previously recorded in India).

INTRODUCTION

Little is known about the Red-headed Falcon *Falco chicquera* in India. Although widely distributed, it is uncommon throughout the subcontinent and a rare resident in the north-east (Naoroji 2006). Breeding biology and ecology are little known except for a few published observations by Dharmakumarsinhji (1954), Dharap (1974), Gole (1980), Ingahlallikar (1988) and Subramanya (1982, 1985). The African subspecies—recently suggested as distinct at the species level (Wink & Sauer-Gürth 1980)—has been studied in more detail by Colebrook-Robjent & Osborne (1974) and Osborne (1981). The species is not easy to detect owing to its small size, crepuscular habits and penchant for perching in foliage. It frequents open habitat interspersed with groves of trees, cultivation and villages, avoiding dense forest (Dharmakumarsinhji 1954, Ali & Ripley 1978, Cade & Digby 1982, Naoroji 2006). Here I describe aspects of behaviour during the nestling period based on observations at two nests in Gujarat, one located on 23 April 1988 at Gundala with two three-day-old young (the smaller died soon after hatching), the other located on 28 April 1988 at Alan Baug with three almost fledged young.

STUDY AREA

Both nests were close to Jasdan town, in the Saurashtra peninsula of Gujarat. Gundala village is a bustling cattle camp (necessitated in 1988 by a third consecutive year of drought), approximately 300 m from the Bileshwar temple grove. The Alan Baug complex is a mixed, degraded and disturbed planted grove of 4 ha within the environs of a sheep-rearing station adjacent to the Alan Sagar reservoir, adjoining the village of Bhakhalvad. Gundala and Alan Baug are about 26 km and 5 km respectively from Jasdan, and 19 km apart. The open habitat, interspersed with groves of trees, cultivation, reservoirs and villages, ideally suits the species. Frequent dust storms accompanied by strong winds in April/May occasionally uproot trees and blow down nests. Temperatures of up to 49°C were recorded in May 1988.

METHODS

The Gundala nest was observed from a 14 m high hide built around an amlī *Tamarindus indicus* for support (referred to hereafter as the hide tree) for a total of 126 hours, from 27 April to 14 June 1988, when the young fledged. Daily observations commenced on the eleventh day from 06h00 to 12h00 and sometimes up to 14h00 and even 18h00. Dawn-to-dusk observations were not possible owing

to lack of transport and accommodation, and dependence on my host at Jasdan for facilities. All nest-related activities are therefore given as frequency rate per hour. Roosting and evening observations were made from the ground during the late nestling period. Fledglings from both nests were ringed and measured. The rather inaccessible Gundala nest was not regularly examined to avoid disturbance, so growth rate of the young was not determined. Prey brought to both nests were visually identified whenever possible, and prey remains intermittently collected from both nests were identified. Post-nestling stage observations were made mostly at the Alan Baug nest site.

RESULTS

Previously unreported nesting behaviour linked to calls, hunting, feeds, prey, territory, interspecific and intraspecific encounters are described. Although extremely shy in Africa (Osborne 1981), both pairs I observed were confiding and approachable to 5–10 m. The larger, dominant female influenced the male's activities. She brooded and fed the nestling. Prey was frequently cached, even overnight. The male was occasionally repulsed by the female when he attempted to take cached prey from the nest, and was once fed by the female for 11 minutes. The nest-dependency period was a minimum of 48 days, compared to an average of 36 days (range 34–37 days) in Zambia (Osborne 1981). From plotting sightings at Gundala a core territory comprising a radius of a minimum of 1.5 km around the nest-site was estimated. An average distance of 2 km between nearest pairs, i.e. 5.6 km² per pair, has been estimated among eight pairs in Zambia (Colebrook-Robjent & Osborne 1974). Calls associated with specific behaviour are described, as auditory signals are widely used by raptors.

Nest sites

Both nests were located amidst dense human habitation, originally built by House Crow *Corvus splendens* and Shikra *Accipiter badius*. Nests were on a lateral crotch on an overhanging branch at the edge of the main leafy canopy, away from the trunk and three-quarters up the nest-tree, partially concealed from below and completely from above.

The Gundala nest was 13–14 m high in an amlī tree. The nest-tree had been severely lopped for fodder but the nest was almost concealed among newly sprouting stems and leaves. The Alan Baug nest was 7.5 m high in a mango tree *Mangifera indica* within a mixed (mainly mango) planted grove. Nesting elsewhere has been reported in a *Casuarina equisetifolia* 24 m high in Bangalore (Subramanya 1982), and over many years on the market square tower in Pune (Gole 1980). Nests only 3.5–5 m high in stunted trees have been found in arid areas in Kutch (S. Malik pers. comm.).

Vocalisations

The female to some extent influenced the male's activities through calls. Harsh high persistent calls, 12–18 in quick succession and culminating in a crescendo *thwee-twee* (ending with a metallic ring), often prompted a sometimes reluctant male to hunt. A repeated harsh *chrrp* induced the male to relinquish prey. During the entire observation period 90% of vocalisation was by the female (n=133), reaching the highest frequency during the early to mid-nestling stage (Fig. 1). Her calls had greater tonal variation, intensity and volume than the male's, which were softer, more evenly toned and without extreme modulation in pitch. Calls by the female usually heralded the male's arrival with prey. Both adults vocalised during prey transfers. The pair warned off intruding conspecifics and mobbing crows through calls. The highest incidence of calls occurred from dawn till 10h00, decreasing from 12h00 to 15h00 during the hot hours, increasing after 15h00 but much reduced compared to mornings. The frequency of calls by the male was highest during the first 16 days, and by the female over days 17–32 of the nestling period (Figure 1).

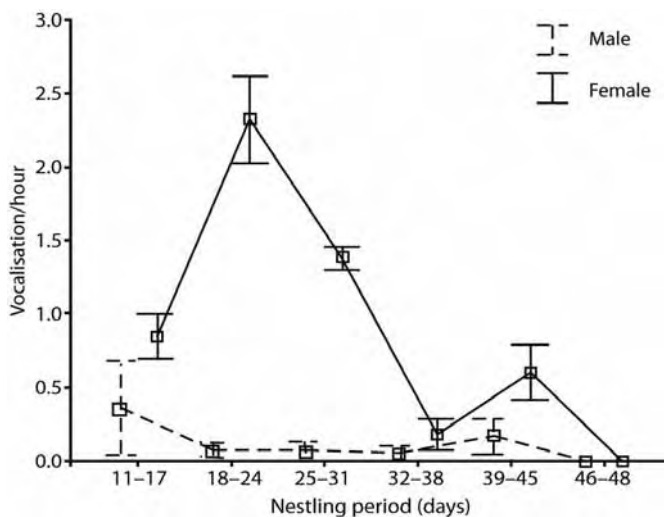


Figure 1. Sexual differentiation in levels of vocalisation in a breeding pair of Red-headed Falcons: male (broken line) and female (continuous line).

Prey and drinking

Prey from both nests consisted almost entirely of birds. At Gundala, only birds (mainly doves) averaging 28–130 gm were brought to the nest. A greater variety of bird species and a bat were recorded from Alan Baug.

The following prey species were identified from both nests: Rock Pigeon *Columba livia*, European Collared Dove *Streptopelia decaocto*, Little Brown Dove *S. senegalensis*, Indian Cuckoo *Cuculus micropterus*, Crested Lark *Galerida cristata*, myna *Acridotheres* and House Sparrow *Passer domesticus*. Unidentified species of quail, robin, babbler and a large insect were also recorded. Additionally a Spotted Crake *P. porzana* and a large bat (identified from forearm remains), most likely of genus *Rhinopoma*, *Taphozaus* or possibly *Cotophilus*, were collected from the Alan Baug nest. Rock Pigeon, though plentiful, was evidently too large to be regularly taken. A variety of prey species (mainly birds) has been recorded for the African race (Brown & Amadon 1968, Osborne 1981, Brown *et al.* 1982, Cade & Digby 1982, Steyn 1982).

Between 15h00 to 18h00, mostly 15h00–16h00, the pair together or singly drank daily from a puddle created by a crack in the waterpipe below the nest, and sometimes from a trough for cattle. The species has often been reported drinking at waterholes in the Namib (Willoughby & Cade 1967).

Hunting, prey delivery and caching

Hunting strategies are described by Dharmakumarsinhji (1954), Ali & Ripley (1978), Brown *et al.* (1982), Cade & Digby (1982), Subramanya (1985) and Naoroji (2006).

After the Alan Baug young fledged, the adults' hunting activities became increasingly crepuscular. At Gundala the frequency of hunts was highest during the mornings, lowest in the afternoon and intermediate in the evenings. The male hunted as early as 05h00 and as late as 19h45 during the dusk. When unsuccessful in the nest vicinity, he hunted further afield. Of hunts recorded (n=92), the male hunted alone for 40%, female alone 30%, and the pair together 30% (Figure 2). The duration of hunts could be short (0.5–1 minute), the male returning in 1–5 minutes, but up to 43 minutes when hunting further afield. After an unsuccessful hunt the male immediately returned to a favourite lookout perch in the nest vicinity. No extended chases were observed. Birds were caught in flight and sometimes close to the ground.

The brooding female at times hunted with the male in the nest vicinity, both flying off together as if on cue. Usually the male would fly off followed seconds later by the female. Successful or not she would abruptly return within 1–2 minutes to brood or nest-watch, never straying beyond 150–250 m from the nest site. Two successful hunts 100–150 m from the nest were witnessed. The male hunted further afield, well beyond 500 m from the nest mostly in the direction of Hingolghadh and the Bileshwar grove. After 21 days the female occasionally hunted alone in the nest vicinity and more frequently with the male. The male would bring partly eaten prey to the nest, while the female brought prey directly to the nest and plucked it there. During the late nestling stage her hunting frequency increased (Figure 2).

Up to 11h30, 25–30 hunting sorties singly or cooperatively by the pair resulted in 3–4 morning feeds. Before the female resumed hunting average feeds till 12h00 were 2. The female invariably brooded during the hot hours, when the male occasionally hunted. The pair mostly hunted in concert during the late nestling stage from 36 to 48 days.

Attacks were launched from exposed lookout perches on the hide-tree, hide poles, the nest itself and nearby trees, the birds scanning for prey, bending low with jerky, vertical bobbing of the head. These perches also served as feeding posts. Most aerial prey transfers were within 100 m of the nest.

With visibility considerably reduced during a dust storm the female hunted much higher in the air than usual. Inclement weather

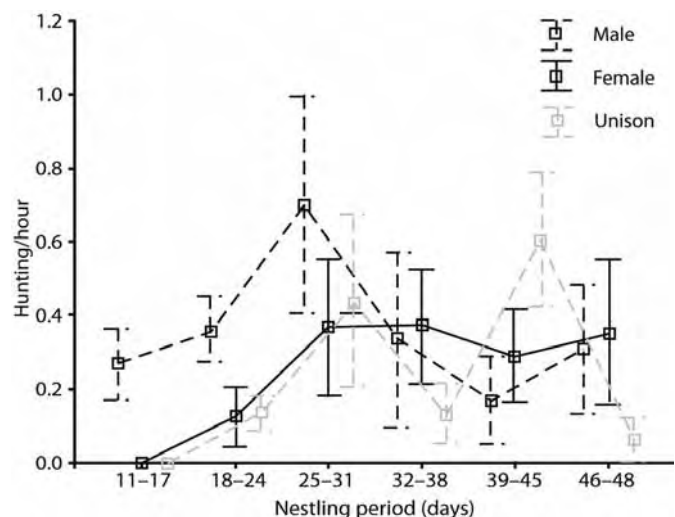


Figure 2. Changes in the proportion of time spent hunting by a breeding pair of Red-headed Falcons: male (broken line) and female (continuous line).

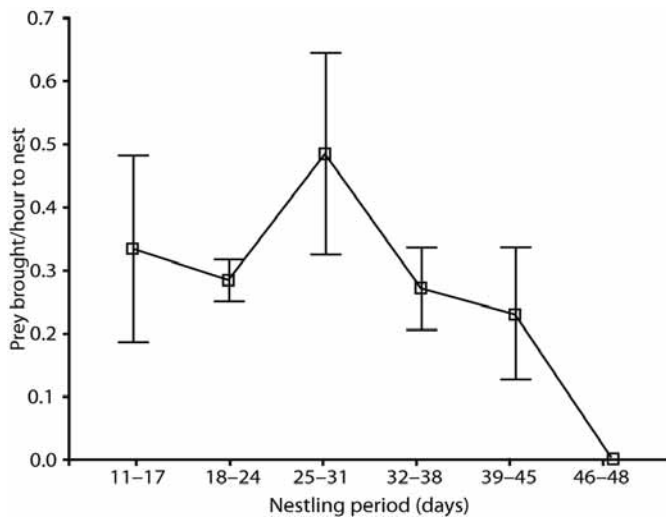


Figure 3. Number of prey brought per day to the nest.

(rain or gusty storms) delayed hunting, the first feed occurring at 12h00 using cached prey.

Prey visits averaged 4–5 daily, with highest frequency in the mornings, a lull between 12h00 and 16h00, and less frequently during the evenings as late as 19h30. The male would alight with prey on his feeding post on the hide-tree (rarely at the nest), whereupon the brooding female would leave the nest to snatch it from him. After 38 days prey deliveries were irregular. The frequency of prey brought to the nest was highest till the late nestling period, tapering off as the nestling fledged (Figure 3).

Whole and partly eaten prey were cached in at least four different trees (including the hide-tree) 5–15 m from the nest, sometimes up to 150 m away, secured in sharp to right-angled crotches in trees. Prey was never left in the nest and was either entirely devoured or carried away by adults. Osborne (1981) and Steyn (1982) reported excess prey always being cached in nests with young. Caching was observed as late as 19h48.

Roosting

The pair roosted after 19h00, usually 19h30–20h00. Until the nestling was almost fledged (37 days) the female invariably roosted on the nest. The male roosted on either the hide or nest-trees, a jamun *Syzygium cuminii* and an amla 18 m and 3.5 m respectively from the nest. At 38 days he roosted once on an arduo *Ailanthus excelsa* 55 m from the nest, and thereafter (39th day onwards) invariably with the female on another amla 34 m from the nest.

Territorial aggression and nest defence

Perching prominently served primarily for lookout purposes for hunting and secondarily as territorial advertisement. In a small sample of 14 nest defences, the female did 9, the male 4, both birds 1. A 25 m radius around the nest was vigorously defended mostly against crows (see below). The overall territory protected extended up to a radius of 70 m from the nest. Most territorial aggression occurred during mornings and evenings, with increased frequency after the nestling was 24 days old (Figure 4). When the fledgling began its first flights, it was escorted and closely guarded by the female from frequent attacks by crows—hence her elevated aggression at this time.

Brooding

Of 59 hours on the nest, 48 were spent brooding by the female. Her average brooding duration was 114 minutes. Of total time on the nest, female brooding constituted 77%, feeding 9% and perching 14%. As the nestling matured, she brooded less (Figure 5). Brooding terminated at 43 days, six days before the young left the nest.

Tight brooding usually commenced by 07h30, occasionally earlier subject to weather and the nestling’s age. The female would half-squat, position herself and settle lightly over the young with wings partially spread. During the hottest hours, 12h00–16h00, during May/June, with temperatures 45–49°C, the nestling was constantly brooded. Brooding position frequently shifted, always facing away from the sun.

In May, frequent high gusts of wind (1–3 minutes’ duration) necessitated constant brooding from 06h30. The brooding female was often unsettled, making visible efforts to maintain balance. Mobbing by crows interrupted brooding, once for 30 minutes. The male briefly relieved the female (3–5 minutes) on three occasions between 15h00 and 17h00. During one such absence the female was observed drinking.

The nestling was first left alone at 19 days and subsequently for varying periods up to 117 minutes, despite strong winds. The female occasionally brooded but mostly perched 7–9 m from the nest. During the middle nestling stage, brooding was synchronised with the hot hours, the female standing or crouching over the nestling. From 29 days she discouraged it from settling under her; thereafter it kept in her shadow.

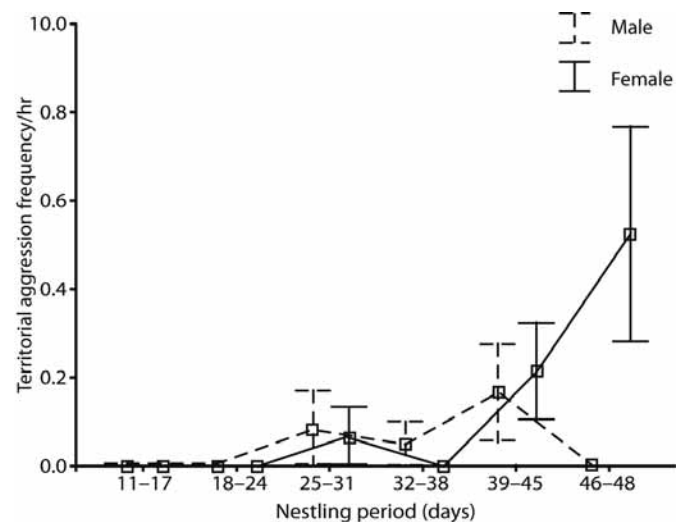


Figure 4. Sexual differentiation in levels of aggression in a breeding pair of Red-headed Falcons: male (broken line) and female (continuous line).

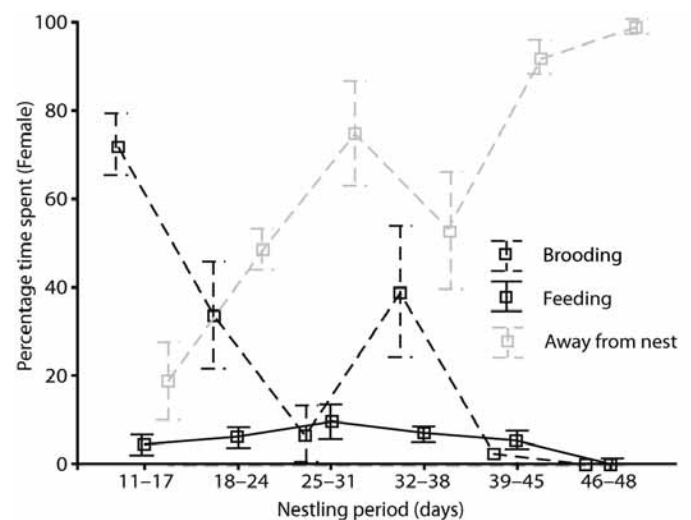


Figure 5. Proportions of activities by female over the nestling period.

After 31 days brooding tapered off. On the 40th day the female was absent from the nest but perched nearby. The next day she brooded from 12h30 to 15h30. At 42 days she brooded for the last time, from 13h00 to 13h30.

Feeding the nestling

The female almost invariably fed the young; the male did so just once, for only two minutes. Feeds averaged 4–5 daily depending on hunting success. Deliveries were observed as early as 05h30 and as late as 19h45. Unsuccessful hunting delayed the first feed till 09h11 and once till 12h00. The nestling was fed manageable fleshy morsels; the bones, tarsus and toes of birds up to dove size were swallowed whole by the adults.

Frequency of feeds was highest 05h30–11h00, lowest 12h00–15h00, with a slight increase 15h00–19h30. Not all prey were brought to the nest. Until the nestling was 19 days old the female mostly fed at the nest. Thereafter she also fed off the nest. The total number of kills exceeded the food deliveries to the nest.

Duration of feeds largely reflected prey size and varied unusually from 1 up to 22 minutes, usually 3–17 minutes, averaging 10 minutes per feed ($n=44$) at the nest (female and young combined), and 8.14 minutes ($n=41$) for young alone. During feeds the nestling attempted to swallow the tarsi of birds which were withdrawn from its gape and swallowed by the female, although she continued to offer tarsi. After 35 days the nestling fed independently, the female increasingly just dropping in prey (Figure 6). She mostly fed off the nest, feeding first before delivering prey to the nest. After the young fed she retrieved the prey remains. The 45-day-old fledgling was given the first feed of the day by the female after its first flight at 09h50.

The Alan Baug female transferred prey to the free-flying fledglings on the nest-tree and nearby trees. Increasingly the adults' deliveries became crepuscular.

A delayed prey transfer by the male (plucking prey or feeding) often resulted in the female snatching the prey. She twice repeatedly repulsed the male, who was attempting to seize the prey, by mantling it and vocalising.

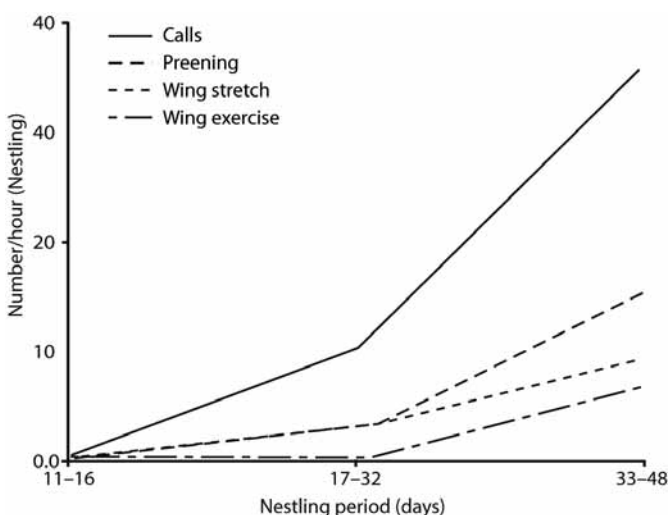


Figure 6. Activities of the nestling from hatching to fledging.

Female feeding male

At one point towards the end of the nesting cycle, the male approached the feeding female and solicited her, incessantly calling and posturing like a nestling. After 10 minutes she fed him for 11 minutes. The young throughout was vociferously begging for food. This unusual behaviour was observed once. Subramanya (1985) reported a male being fed by a female during the incubation stage.

Interspecific encounters

At Alan Baug a Shikra pair drove the independent fledglings from the nest-tree. However, most interspecific interactions were with House Crows. Both the Gundala and Alan Baug pairs aggressively repelled crows within a radius of 16 m from the nest. Crows were prevented from landing on the furthest roosting trees at Gundala. The more aggressive female often interrupted brooding to chase off crows, usually leading the male in the pursuit. The falcons often made contact, cornering individuals and forcing them into low trees, hedges or bushes for cover. Crows generally avoided the immediate nesting area. The falcons' superior manoeuvrability and speed usually deterred crows in groups up to three. The Gundala nest was occasionally mobbed by 8–10 persistent crows, once for 30 minutes. Crows were attracted to the nest during feeds, especially when the fledgling fed on its own. On its first flight the Gundala fledgling was severely mobbed by a pair of crows when it alighted on their nesting tree and was rescued by villagers roused by the clamour of cawing crows. Fledged, nest-independent juveniles at Alan Baug were frequently mobbed by crows.

Conspecifics are not tolerated near the nest. The Alan Baug pair drove an intruding adult away a considerable distance from the nest vicinity. The Gundala nest-tree hosted a dove's nest, but the adult doves and nestlings were ignored although doves were frequently hunted.

Activity and development of nestling

Changes in nestling activity over time are shown in Fig. 5. The nestling defecated into the nest throughout the nestling stage. At 37 days it once defecated over the nest-rim. By 20 days it often wing-stretched, the frequency and duration increasing till it fledged. When perched, it wing-stretched with the tail spread and cocked at the same angle and direction as the extended wing and leg. Wing-exercise started at 29 days, increasing till fledged. At 37 days this activity lasted 2–3 seconds, occasionally up to 11 seconds in wind, the intensity and duration of gusts greatly determining the duration and frequency of this activity. From 12 days the nestling preened with increasing frequency, and was occasionally preened by the female. By 19 days it regularly preened at varying intervals during the day, for 8–20 minutes.

The nestling cheeped in anticipation of a feed. As it developed, the frequency of calls sharply increased. At 20 days the cheeps were more frequent and extended, modulating to a quick staccato when prey was brought. By 29 days the nestling was overall more vocal, especially when feeds were delayed or on seeing the adults, which often responded to its persistent calls (a sharp, high-pitched *che che chwee*) by hunting or delivering cached prey.

By 37 days the frequency, variation and volume of calls had increased. Its calls were indicators of the adult's proximity to the nest. Calls were continuous when adults (even without prey) were in view. Irregular prey visits or adults feeding first would result in monotonous, continuous calls *twee twee twee...*, a softer, similar-pitched version of the female's, rising to a crescendo after 8–9 single notes. Prey delivered after a long delay was greeted with a rapid succession of urgent, progressively higher-pitched staccato notes terminating in a strident whine.

Feeds

Begging by pecking the bill of an adult resulted in a feed. At 10 days the nestling unsuccessfully attempted to swallow tarsi and feet of birds. By 21 days it was swallowing large chunks of flesh and feathers, and once the tarsus of a lark-sized passerine. At 29 days it was fed a Crested Lark but swallowed the tarsi and feet only with an effort. Subsequently it swallowed the legs and feet of a House Sparrow.

At 35 days till independence it increasingly fed itself. When prey visits were delayed it grabbed and tugged at the female's bill (with foot braced on her side for leverage) and pecked her breast, causing

her to fly off. At 40 days it fed itself on a babbler-sized bird for 38 minutes. Subsequently average feeding duration was 10 minutes ($n=10$). From 42 days the increasingly nest-independent fledgling visited the nest primarily to feed. It first fed away from the nest at 48 days. Thereafter its dependence on the nest for feeds decreased.

Nestling period and fledging

Two newly hatched nestlings were observed in the Gundala nest on 27 April 1988, the first probably having hatched 2–3 days earlier. On 7 May the nest contained one chick which fledged successfully on 14 June, thus giving the minimum nestling period of 48 days (although it first moved outside the nest at 42 days). Until its full independence at 55 days this fledgling was fed mainly away from the nest, but roosted in the nest at night.

The fledglings at Alan Baug were nest-independent within 15 days of their preliminary forays from the nest. Trees in the nest vicinity (including the nest-tree) were frequented, but mainly a large peepal *Ficus religiosa*. Feeding was decidedly crepuscular, the birds mostly perching in foliage throughout the day. The nest-tree was decreasingly used for perching and feeding. Eighteen days after nest-independence, the juveniles travelled beyond the nesting grove.

First flight was at 45 days. At 06h25 the female flew to the nest and ruffled the juvenile; then, between 06h30 and 08h30, the latter sluggishly flew a distance of over 200 m. It did not fly the next day but the day after at 05h55 it flew about 200 m, followed by two short flights until 07h06. At 09h15 it flew twice and perched alongside the male 45 m from the nest. On most flights it was escorted by the adults, mainly the female. Thereafter it flew frequently, decreasingly using the nest for feeds but mainly for roosting, till fully nest-independent at 55 days.

DISCUSSION

The Red-headed Falcon is unspecialised in its choice of nest-trees. I agree with Ali & Ripley (1978) and Dharmakumarsinhji (1954) that it prefers breeding in large and small densely foliated trees, e.g. mango, neem *Azadirachta indica* and *Ficus* in disused, concealed nests of mainly House Crow and Shikra. In India the species seldom breeds in Palmyra palms *Borassus*. In Africa it breeds mainly in *Borassus*, its distribution closely linked with that of the palm, although it also uses nests of corvids in *Acacia*. Also it is not generally associated with human habitation (Brown & Amadon 1968, Brown 1970, Colebrook-Robjent & Osborne 1974, Osborne 1981, Brown *et al.* 1982, Steyn 1982), whereas the Indian subspecies often nests in close proximity to villages and in densely populated cities like Bangalore and Pune (Dharap 1974, Govindakrishnan *et al.* 1978, Gole 1980, Subramanya 1982). The distribution of corvid and Shikra nests, together with the territorial behaviour of the species itself, probably determines nest-spacing in this falcon, as with the Greater Kestrel *Falco rupicoloides* (Hustler 1983).

The minimum nestling period was 48 days, compared to 36 days reported for the African subspecies (Colebrook-Robjent & Osborne 1974, Osborne 1981). Drought conditions and delayed nesting (after the optimal period) perhaps retarded the nestling's growth. As the species's range encompasses mainly arid, drought-prone areas, comparative data are required on the fledging period and nesting success of pairs over favourable and unfavourable years in relation to number of young fledged per nest.

The female was clearly the dominant of the pair, reversed sexual dimorphism (RSD) being pronounced, and she greatly influenced the frequency of the male's hunting activity and prey-delivery. Both pairs reverted to a crepuscular routine during the post-fledging period.

The Alan Baug pair fledged three young by the end of April, the Gundala pair one young by the end of May. Dharmakumarsinhji (1954) reports nesting from December–April, Ali & Ripley (1978)

and Subramanya (1982) January–March. In light of this, the Gundala pair nested exceptionally late. By breeding early the species can avoid the storms and high winds of May/June which pose a threat to trees and nests. Also, early nesters can avail themselves of migrant passerines coinciding with the early nestling period. Furthermore the varied habitat at Alan Baug supported a more diverse prey-base than Gundala. Study may illuminate the causes and extent to which breeding schedules vary in relation to fluctuations in the climate and environment, and the effects of climate on clutch and brood size.

The role of calls in regulating social behaviour and dominance through courtship, communication, bonding among pairs and nest defence cannot be underrated. Among most raptors, the larger females (especially when RSD is pronounced) exert dominance over males through behavioural and vocal means (Amadon 1975, Cade & Digby 1982). The Gundala female undoubtedly controlled the male's activities to a great extent through vocalisations by summoning him with prey, forcing prey transfers and inducing him to hunt. Through contact and territorial/aggression calls, she was able to induce the desired responses from the male.

The Red-headed Falcon nests in disturbed village groves and in avenues lining roads. Loss of cover within its range limits the choice for suitable nest-sites as trees are cut or lopped for fuel and fodder, exposing nests to pilfering by village boys and predators. The smallest Alan Baug fledgling was captured by village urchins and subsequently died. In arid regions where trees are scarce and stunted, excessive cutting and lopping can disastrously affect nesting success. Two exposed nests on lopped trees not more than 4 m high, at the edge of the Little Rann of Kutch, were deserted due to human disturbance (S. Malik pers. comm.). In drought-affected Saurashtra, stall feeding of cattle proved immensely successful. If willingly implemented with government support, the overgrazed land would recover over a period of time, benefiting the villagers, livestock and wildlife. Lopping must be controlled near known nest sites.

ACKNOWLEDGEMENTS

This paper is dedicated to the memory of the late Shivraj Kumar Khachar who located the Gundala nest, promptly informed me, and provided hospitality and facilities to make this study possible. Godrej A. Dastoor computerised the data input. The late Dr Ravi Sankaran reviewed the final draft. Dr Ajith Kumar advised and streamlined the data analysis. S. M. Satheesan and Manoj Muni at BNHS, and Peter Colston at the British Museum, helped identify the prey remains. Mansuk Bhai neglected his construction job to help erect the machan. Shabir Malik provided information on his observations of the species. Special thanks to the two referees, Lloyd Kiff and the other anonymous, for their detailed comments and suggestions.

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