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# Nesting Ecology, Behaviour and Factors Influencing the Survival of Yellow-Wattled Lapwing (*Vanellus malabaricus* Boddaert, 1783) in Udaipur District, Rajasthan

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**Abstract**

Yellow-wattled lapwing (*Vanellus malabaricus*) is a medium-sized wader bird and belongs to Charadriidae family and Charadriiformes order. It is a ground-nesting bird that typically breeds and build nests in open areas in various microhabitats, such as abandoned fields and playgrounds, edges of forests, agricultural landscapes and riverbanks and sometimes even around wetlands like lakes and human-constructed dams. Breeding season typically begins in from early March and lasts until the end of June, with peck nesting taking place in April and May months. During nesting season, one parent typically stays close to the nest site to monitor the eggs, hatchlings and nestlings. Typically, clutch size ranges from one to four eggs per nest, with three or four being more common than one or two. Over a three-year study period (March 2022–June 2024), we observed a total of 110 nests, with the highest number occurring in 2023 (48), followed by 2024 (35), and the lowest number occurring in 2022 (27). The number of nests in a given area primarily depends on the presence of breeding pairs and the availability of suitable nesting sites, food, and forage, while factors such as natural predator pressure, livestock, and human activities also play a significant role. Yellow lapwings share their foraging, feeding, resting, roosting and nesting habitat with other ground-nesting birds, including other wading

birds, particularly red lapwings. Yellow-fronted Lapwings exhibit excellent parental care behaviour as well as anti-predator behaviour. During the breeding season they become more aggressive and typically live in pairs, unlike the non-breeding season. Outside the breeding season they typically gather in flocks, with the size of these flocks typically being between 2 and 30 individuals. Various species of natural predators, such as birds of prey, crows, snakes, kites and Feral dogs, significantly influence the developmental stages of lapwings through direct prey. In addition, frequent livestock movements and anthropogenic activities, expansion of urban and industrial areas, land clearing for playgrounds and grassland habitats, and summer fires ultimately influence the lapwing's chances of breeding and survival.

**Key words :** Yellow-wattled Lapwing (*Vanellus malabaricus*), Nesting, Egg, Clutch size, flock, breeding, habitat, Udaipur.

Avian order Charadriiformes classifies lapwings within the family Charadriidae. Lapwings represent a category of wading birds that generally prefer open habitats characterized by plentiful water resources[5,6]. Lapwings typically nest on the ground within short vegetation, making them susceptible to predation and environmental fluctuations. Their diet mainly comprises insects and other small invertebrates, which they detect through sight and sound while foraging in shallow water or on moist soil. The bird's exhibit robust, elongated legs, short, straight beaks and wings with curved edges[17]. Their habitats encompass a variety of environments, such as damp lowland grasslands, lakeside edges, inland sandy regions, riverbanks, steppes, agricultural fields, and arid grasslands[1,6,7,9,19,21]. There are about 22 species of lapwings or plovers in the genus *Vanellus* and many of these birds usually nest in agricultural landscape[30]. The International Union for Conservation of Nature (IUCN) recently classified the yellow-wattled lapwing (*Vanellus malabaricus*) as a species of least concern[3]. Yellow-wattled lapwing is a resident bird species of southern Rajasthan especially in and around the Udaipur district[10]. Ground-nesting birds widely regard nest predation as the primary cause of reproductive failure[5,6,7,8,29]. Many things about bird breeding are affected by predation, including choosing the best place to nest the right number of eggs to lay, characteristics of the eggs and birds' behaviour during breeding[4,6,7,11,20]. Ground-nesting birds have developed various defensive strategies to mitigate the risk of nest predation. Ground-nesting birds employ active nest guarding and aggressive behaviours to deter potential predators and utilize vegetation to conceal nests[5,18,28]. Moreover, they employ behaviourally induced camouflage[22,34]. Some species also use secret nesting sites or lay eggs that look like they belong in their surroundings by using colors or patterns that blend in[12,33]. The yellow-wattled lapwing, (*Vanellus malabaricus* Boddaert, 1783), a native species, is prevalent throughout the majority of the Indian subcontinent. This lapwing, distinguished by its sandy brown color, breeds from April to July. It forms its nest by excavating a shallow,

unlined depression on barren or uncultivated terrain, often encircling it with a ring of small stones[1,13,35]. Jayakar and Spurway[15,16] carried out studies on the reproductive habits of the Yellow-wattled Lapwing, investigating several facets of its breeding biology. Santharam[24,25] Sethi *et al.*[26] provided additional observations, with both studies concentrating on communities in southern India.

However, there has been no further research on the nesting ecology and hatchling success rate of yellow-wattled lapwings in southern Rajasthan, particularly in the Udaipur region. We conducted the present study in the Udaipur district due to the absence of comprehensive information on the nesting ecology of the yellow-wattled lapwing. We conducted the present study in various microhabitats, including abandoned fields and playground areas, the edges of forest areas, grassland, agricultural landscapes, riverbank areas, wetland areas such as lakes, and human-constructed dams in Udaipur district, Rajasthan, to evaluate the nesting and breeding of yellow-wattled lapwings (*Vanellus malabaricus*). Additionally, we gathered data on the threats and factors that impact the survival of yellow-wattled lapwings in the study area.

Study focused on the nesting and breeding aspects of yellow-wattled lapwings (*Vanellus malabaricus*) in various microhabitat of Udaipur district, Rajasthan. Nesting of yellow-wattled lapwing typically spans from March to June. We conducted present study over a total of three years, from March 2022 to June 2024, to assess hatchling success, factors affecting its survival and predator pressure on yellow-wattled lapwings in various microhabitats such as uncultivated land, playgrounds, agricultural landscapes, grassland, wetland habitats and riverbank areas. Different approaches employed to study the behaviour and breeding biology of lapwings and other charadriidae family species, such as point count, line transect, focal and scan sampling and nest count[5,6,7,8,23,36]. We used similar methods to evaluate hatchling success and anti-predatory behaviour in yellow-wattled lapwings. Lapwings, including yellow-wattled lapwings are ground-nesting birds that typically breed in diverse open habitats. These methods yield important information regarding breeding patterns, nest site selection and reproductive success. Similar to other lapwing species, yellow-wattled lapwings show distinct anti-predatory behaviours aimed at safeguarding their nests and offspring from potential threats. Ground-nesting behaviours in open habitats render them especially susceptible to predation, highlighting the need for effective defence strategies. Consequently, we employed various sampling techniques, including focal and scan sampling, nest count methods and random transect methods. We also conducted direct visual observation to assess predator attacks on lapwing nestlings and adults, in addition to these methods. Defensive strategies encompass distraction displays, aggressive mobbing of predators and camouflage techniques for concealing nests and chicks. This study utilized a combination of sampling methods to comprehensively assess yellow-wattled lapwing breeding behaviours and their responses to potential threats. Additionally, we employed focal and scan sampling methods[2], along with direct visual inspection, to investigate the anti-predatory behaviour of yellow-wattled lapwings in response to various predators. We conducted all observations of yellow-wattled

lapwings from a safe distance to prevent any disturbance of breeding birds or nesting locations. We made these efforts to minimize any potential stress or disturbance to nesting birds, ensuring the conservation and protection of their natural breeding habitat. We did not collect any eggs or hatchlings during this study period. We made observations from a safe distance using a long-distance zooming camera (Nikon P1000) and Nikon 8x40 binoculars. We collected data in the morning, from 6:00 am to 10:00 am and in evening, from 4:00 to 6:00 pm, as yellow-wattled lapwings are more active during these periods, engaging in various behavioural activities such as foraging, food consumption, egg incubation and water consumption, compared to the daytime. We used nest photographs to count the eggs and hatchlings in each nest. We examined each nest after two to three days to determine the hatchling success rate among yellow-wattled lapwings. Studies may have observed different nest defence and parental care activities in the early morning and late afternoon. The nest was considered successful when at least one egg hatched. The hatchling success rate was estimated using the following formula.

$$\%\text{Hatchling sucess} = \frac{\text{Total number of eggs hatched in the entire clutch size in study year}}{\text{Total number of eggs liad in a particular clutch size in study year}} \text{ x } 100$$

Hatchling success rate was estimated according to the following criteria: A. newly fledged nestlings near the nests; B. hatchlings that successfully break egg shells in the nests. C. nesting failure was defined as eggs remaining in nests during the study period or nests being destroyed by predators, cattle or anthropogenic movements. These methodologies also adopted for the other wading birds including Red-wattled Lapwing and Black-winged stilt for the assessing hatchling and nestling success rate[6,7].

Yellow-wattled lapwing (*Vanellus malabaricus*) is an attractive winged bird with brown plumage and distinctive yellow wattles and legs[3,13,35]. The yellow-wattled lapwing is an common and resident breeding bird of southern Rajasthan, especially in and around the Udaipur district[10]. Compared to other Charadriidae birds, such as red-wattled lapwings, black-winged stilts, little ring plovers, great thick-knees and Indian thick-knees; the abundance of yellow-wattled lapwings is lower in Udaipur District. This species typically exhibits a wide range of habitat preferences, including open areas adjacent to forest edges, abandoned fields and playground areas, grassland, agricultural landscapes, riverbank areas, and occasionally wetland habitats. Due to their diverse habitat preferences, they typically breed in these areas. However, unlike red-wattled lapwings, their sightings in human-dominated landscapes like urban areas and colonies are rarer. Typically, the yellow-wattled lapwing is highly susceptible to human movement and distrubance in its habitat. Generally, yellow-wattled lapwings construct nests in open and plain areas like playgrounds, abandoned fields and agricultural areas. They are easily accessible for the predators and more vulnerable to nest predation and nest destruction due to human and cattle movements. Yellow-wattled lapwings breed

during the dry season, especially in the summer, which in India lasts from March to May[15,16]. We observed the nesting season occurring annually from March to June. Nesting activity peaked in April and May, with a reduced number of nests noted at the season's start and end. We observed variations in nest site selection and success rates among various habitat types within our study area. Local climatic conditions primarily influence the breeding season of birds, such as the yellow-wattled lapwing. During initial breeding season, they become more active and aggressive compared to non-breeding season. They regularly visit a specific area to select a nesting site. After the four- to five-day regular visit, they choose a particular location for the nest construction. After this step, they begin to scrape the ground, creating a deep depression in the soil. Furthermore, males and females observed the collection of stones, sand pellets and cow dung around the nests. Breeding pair exhibits frequent copulation behaviour during this period. Usually, copulation occurs around the nest site following the frequent mating call. After copulation, male and female immediately start to forage and feed. Yellow-wattled lapwings typically engage in copulation activity in the late morning and early evening. Following this process, yellow-wattled lapwing becomes more aggressive and active in its defence of territory. During this stage, we observed numerous instances of inter- and intra-specific competition. Both males and females participate in nest construction and territorial defence against both members of their own species and those of other species especially towards Red-wattled lapwing (*Vanellus indicus*). Red-wattled lapwing's breeding season coincides with that of the yellow-wattled lapwing. Study revealed interspecific conflict and competition among the red-wattled lapwing (Vanellus indicus), Indian thick-knee or Indian stone-curlew (Burhinus indicus), Great thick-knee or Great stone-curlew (*Esacus recurvirostris*) and black-winged stilts for foraging, feeding and nesting sites.

Identified nesting patterns correlated with the accessibility of food supplies and appropriate environmental circumstances for egg laying and chick rearing. Notably, certain breeding pair of yellow-wattled lapwings exhibited site fidelity, returning to the same vicinity for nesting in consecutive years. This behaviour suggests that the birds may remember and favour successful breeding sites, potentially influencing population dispersal and conservation strategies. The observed differences in nest site selection among various habitats may indicate the species' adaptability to local environmental circumstances and resource availability. Egg-laying process or activity begins after selecting the nest site and building the nest. During egg-laying period, an asynchronous egg-laying pattern was observed among yellow-wattled lapwings. Typically, they deposit eggs at various times throughout the day and on different days.

We observed a total of 110 yellow-wattled lapwing nests during entire period of study from March 2022 to June 2024. We observed highest number of nests in 2023 (48) followed by 35 in 2024 and lowest number in 2022 (27). Study revealed that the number of nests and breeding pairs fluctuates annually. Usually, it can depend upon natural aspects of the specific location, such as the availability of suitable nesting places and abundance of food materials. The abundance of acceptable nesting materials and the availability of food

can significantly influence the number of breeding pairs during a specific time of year. Temperature, rainfall patterns and habitat quality can all have a significant impact on nesting success of ground nesting birds including the waders[6,7]. Furthermore, human activities such as urbanization and agricultural operations may affect the availability of suitable nesting locations, contributing to annual changes in breeding populations.

The coloration and markings of yellow-wattled lapwing eggs exhibit effective camouflage adaptations[14,26]. The eggs are generally pale brown to sandy-colored, featuring darker speckles or spots[1]. Their nest consists of a basic scrape on the ground, typically lined with pebbles, vegetation or other materials that integrate with the environment[1]. We have observed two types of nests: those constructed from pebbles, stones, or soil balls and those made from grass materials or with eggs placed in the centre of grassy patches. In accord with these studies, we observed that yellow-wattled lapwing eggs exhibited pale brown to sandy-colored darker spots. The speckled pattern on the eggs functions as effective camouflage, integrating with the surrounding terrain where these ground-nesting birds commonly deposit their clutches. This adaptive coloration helps protect eggs from potential predators, thereby enhancing their chances of successful hatching. Study identified two distinct types of nesting structures. Of the total 110 nests, the majority (82) were built on the ground, often lined with stones or soil balls and typically located in dry, open areas such as grasslands, uncultivated land and forest edges. On the other hand, 28 nests were located in close proximity to riverbanks and agricultural fields. Grasses, leaves, and other vegetative materials concealed these nests, with some nests situated near grass and shrub areas.

Preference for dry, open areas may enhance visibility for parent birds to identify approaching threats, while proximity to water sources can facilitate access to water intake and potential food resources. The various nesting strategies show species adaptability to varying environmental conditions and represent the significance of habitat diversity for conservation efforts. Use of grass, leaves and other vegetation materials for nest concealment indicates an enhanced protective strategy against predators and adverse weather conditions. This adaptive behaviour highlights birds' capacity to take advantage of environmental resources for nest construction and camouflage. Presence of nests near grass and shrub areas highlights the significance of diverse vegetation structures in offering suitable nesting habitats for these birds. After the egg laying, generally one parent always remained in the nest and actively incubated the eggs, but sometimes both adults left the nest. Predators have a higher possibility of preying on eggs during this period.

Clutch size of wader birds typically varies from 1 to 5 eggs, including the lapwing and stilts[6,7]. Clutch size of Yellow-wattled Lapwings typically ranges from 3 to 4 eggs[1]. During study, we observed 1 to 4 egg clutch sizes in yellow-wattled lapwings. We observed a total of 110 nests during study, with the majority occurring in 2023 (48), 2024 (35) and 2022 (27). We observed a total of 27 nests in the year 2022, with the maximum number exhibiting clutch size three (11 nests) followed by one (7 nests), four (6 nests) and minimum

Table 1 presents the nesting parameters of yellow-wattled lapwings in Udaipur district, Rajasthan, which include clutch size, nest number, total number of eggs, and hatchling success rate

| Nesting parameters and study duration | Clutch size | Number of nests | Total number of eggs in nest | Number of eggs hatched | Number of eggs unhatched | Percentage of Hatchling success |
|---|---|---|---|---|---|---|
| Year 2022 | 1 | 7 | 7 | 4 | 3 | 57.14% |
| | 2 | 3 | 6 | 5 | 1 | 83.33% |
| | 3 | 11 | 33 | 27 | 6 | 81.81% |
| | 4 | 6 | 24 | 18 | 6 | 75.00% |
| **Total number of nests, egg, egg hatched, egg unhatched and % of hatchling success in year 2022** | | **27** | **70** | **54** | **16** | **77.14%** |
| Year 2023 | 1 | 4 | 4 | 2 | 2 | 50% |
| | 2 | 6 | 12 | 8 | 4 | 66.66% |
| | 3 | 29 | 87 | 41 | 46 | 47.12% |
| | 4 | 9 | 36 | 26 | 10 | 72.22% |
| **Total number of nests, egg, egg hatched, egg unhatched and % of hatchling success** | | **48** | **139** | **77** | **62** | **55.39%** |
| Year 2024 | 1 | 9 | 9 | 7 | 2 | 77.77% |
| | 2 | 5 | 10 | 6 | 4 | 60.00% |
| | 3 | 11 | 33 | 19 | 14 | 57.57% |
| | 4 | 10 | 40 | 28 | 12 | 70.00% |
| **Total number of nests, egg, egg hatched, egg unhatched and % of hatchling success** | | **35** | **96** | **60** | **36** | **62.50%** |

Figure 1: Breeding pair of Yellow-wattled lapwing

Figure 2: Yellow-wattled lapwing foraging on bread.

Figure 3: Facial features during the breeding season

Figure 4: Eggs of yellow-wattled lapwing

Figure 5: Adult yellow-wattled lapwing incubating eggs

Figure 6: Two-day-old hatchlings try to hide in the gap between stones.

Figure 7: A four-day-old hatchling nestled among dry grasses

Figure 8: An adult yellow-wattled lapwing hides her hatchlings in the presence of a predator

Figure 9: A nest of a yellow-wattled lapwing, about 15 to 20 days old, hides in the grass during the presence of a predator

Figure 10: Adult yellow-wattled lapwings display false incubation behaviour to distract predators from their original nest

number exhibiting clutch size two (three nests). We counted a total of 48 nests in the year 2023, with the maximum number of nests with clutch size three (29 nests) followed by four (9 nests), two (6 nests) and minimum number of nests with clutch size one egg per nest (4 nests). We observed 35 nests in the year 2024, of which the maximum number had a clutch size of three (11 nests), followed by four (10 nests), one (9 nests) and the least number had a clutch size of two (5 nests). In conclusion, yellow-wattled lapwings tend to exhibit clutch sizes of three and four more frequently than those of one and two clutch sizes. Study observed that yellow-wattled lapwings typically laid their eggs at different times and exhibited asynchronous hatching in their young. An asynchronous hatching pattern in yellow-wattled lapwings facilitates walked chick development, which may enhance survival rates in adverse environments. This reproductive strategy may assist parent birds in managing their energy expenditure more effectively during the breeding season. Interval between egg-laying influences the breeding success of the species, thereby affecting population dynamics within

their habitats.

We observed a total of 27 nests in 2022; seven of these had one clutch size, three had two clutch sizes, 11 had three clutch sizes and six had four. We found 27 nests with a total of 70 eggs; of these, 54 successfully hatched, while the remaining 16 failed due to various factors such as predation, nest trampling, and broken egg shells. Overall hatchling success rate for 2022 was 77.14%. We found a total of 48 nests in 2023; four of these had one clutch size, six had two clutch sizes, 29 had three clutch sizes and nine had four clutch sizes. We found a total of 139 eggs in these 48 nests, of which 77 successfully hatched and 62 remained unhatched. Overall hatchling success rate was 55.39% in 2023. We found a total of 35 nests in 2024, of which nine nests had one clutch size, five had two clutch sizes, 11 had three clutch sizes and 10 nests had four clutch sizes. These 35 nests contained a total of 96 eggs. In 2024; 60 of these eggs successfully hatched and remained eggs unhatched, resulting in a hatchling success rate of 62.50%. We observed that the trends in nesting and hatchling success fluctuate from year to year. Table-1 presents the hatchling success rate for each clutch size, year by year. Similar to other wader birds such as the red-wattled lapwing and black-winged stilt, they frequently removed broken eggshells from their nests after hatching[6,7,31,32]. Newly hatched yellow-wattled lapwings are not able to move quickly. During this period, hatchlings are particularly vulnerable to predators. After one or two days of hatching, the hatchling left the nest and started its own foraging and feeding behaviour in close proximity to her parents. Adult birds always remained in close proximity to hatchlings during this duration. After four to five days, the hatchling is able to move fast and also exhibit anti-predatory behaviour, such as hiding in a cryptic location and rapidly escaping from one area to another. When predators attempt to approach the hatchling, the adult birds in the nest frequently make loud noises and move around. Yellow-wattled lapwings frequently display mobbing behaviour toward predators. Study also revealed that the yellow-wattled lapwings engage in false incubation and pseudo-nest behavior, aimed at distracting the predator from their original nest site. Other members of the Charadriidae family, such as the red-wattled lapwing (*Vanellus indicus*) and black-winged stilt (*Himantopus himantopus*), also adopt a similar strategy to avoid predator attacks on eggs and hatchlings[5,6,7,8]. Hatchlings also display freeze movement when a predator is present and they frequently hide in dry grasses and between gaps in stones. Occasionally, nestlings hide in deep depressions created by cattle pugmarks on the earth. These strategies provide safeguarding from the predators. A number of factors typically influence the overall hatchling success pattern of the yellow-wattled lapwing, including the number of breeding pairs in an area, the availability of suitable nesting sites, changes in the size of the active nest and the clutch, variations in the amount of predation and weather patterns. Pre-monsoon rainfall and anthropogenic activities, such as livestock movement in the nesting habitat of the yellow-wattled lapwing, are often responsible for nest destruction. During study, interspecific and intra-specific competitions observed with other wader bird including red-wattled lapwing (*Vanellus indicus*), Indian thick-knee (*Burhinus indicus*), great-thick-knee (*Esacus recurvirostris*), little ring plover (*Charadrius dubius*) as well as black-winged stilt

(*Himantopus himantopus*). During study, we observed a variety of nest predator birds in the breeding habitat of the yellow-wattled lapwing, including shikra (*Accipiter badius*), black kite (*Milvus migrans*), black-shoulder kite (*Elanus axillaris*), house crow (*Corvus splendens*), large-billed crow (*Corvus macrorhynchos*), Asian koel (*Eudynamys scolopaceus*) and greater coucal (*Centropus sinensisi*). Moreover, we observed the movement of Indian grey mongoose (*Herpestes edwardsii*), ruddy mongoose (*Herpestes smithii*), jungle cat (*Felis chaus*), Indian cobra (*Naja naja*), Russell viper (*Daboia russelii*) and feral dog around the nesting habitat of yellow-wattled lapwing. These species likely prey on yellow-wattled lapwings at various stages of their development. Additionally, the frequent movement of humans and livestock is disrupting the nesting and breeding of yellow-wattled lapwings. Expansion of urbanization, establishment of new colonies and human settlement areas and development of industrial sites are also limiting the suitable nesting sites for ground-nesting birds, including the yellow-wattled lapwing. Moreover, humans and cattle frequently trample nests. Ultimately, these factors are also limiting overall breeding success among the yellow-wattled lapwing.

The present study describes the breeding patterns of yellow-fronted lapwings from March 2022 to June 2024 in Udaipur district, Rajasthan. Future studies should also provide detailed information about juvenile success and failure rates; in particular the clutch size and fluctuations from year to year. Based on these findings, we can formulate habitat management methods such as establishing protected nesting zones and regulating predators. Furthermore, observing breeding pairs and their breeding behaviour could shed light on the challenges faced by lapwings during the breeding phase. Effects of anthropogenic activities, feral dogs, livestock movements and urbanization on breeding habitats and food availability are potential influencing factors on the success rate of lapwing hatching. Collaborative initiatives between researchers, locals and conservation organizations can lead to more thorough and sustainable strategies to protect the yellow lapwing.

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