Building evidence for conservation globally

Journal of Threatened Taxa

Open Access

10.11609/jott.2022.14.3.20703-20810
www.threatenedtaxa.org

26 March 2022 (Online & Print)
14(3): 20703–20810
ISSN 0974-7907 (Online)
ISSN 0974-7893 (Print)

ISSN 0974-7907 (Online); ISSN 0974-7893 (Print)

Publisher
Wildlife Information Liaison Development Society
www.wild.zooreach.org

Host
Zoo Outreach Organization
www.zooreach.org

No. 12, Thiruvannamalai Nagar, Saravanampatti - Kalapatti Road, Saravanampatti,
Coimbatore, Tamil Nadu 641035, India
Ph: +91 9385339863 | www.threatenedtaxa.org
Email: sanjay@threatenedtaxa.org

For Focus, Scope, Aims, and Policies, visit https://threatenedtaxa.org/index.php/JoTT/aims_scope
For Article Submission Guidelines, visit https://threatenedtaxa.org/index.php/JoTT/about/submissions
For Policies against Scientific Misconduct, visit https://threatenedtaxa.org/index.php/JoTT/policies_various

continued on the back inside cover

Cover: Rufous-headed Hornbill *Rhabdotorrhinus waldeni* © Philip Godfrey C. Jakosalem.

Journal of Threatened Taxa | www.threatenedtaxa.org | 26 March 2022 | 14(3): 20773–20779

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

https://doi.org/10.11609/jott.6985.14.3.20773-20779

#6985 | Received 13 December 2020 | Final received 15 March 2022 | Finally accepted 18 March 2022

OPEN ACCESS

SHORT COMMUNICATION

Breeding biology of Sri Lanka White-eye *Zosterops ceylonensis* (Aves: Passeriformes: Zosteropidae) in tropical montane cloud forests, Sri Lanka

W.D.S.C. Dharmarathne [1], **P.H.S.P.Chandrasiri** [2] & **W.A.D. Mahaulpatha** [3]

[1–3] Department of Zoology, University of Sri Jayewardenepura, Sri Lanka.
[1] chathurangadharma@gmail.com, [2] spchandrasiri@gmail.com, [3] mahaulpatha@sjp.ac.lk (corresponding author)

Abstract: Breeding biology of the endemic Sri Lanka White-eye *Zosterops ceylonensis* was studied from January 2017 to January 2018 in the montane cloud forests of Horton Plains National Park, in Nuwara Eliya District of Sri Lanka. A total of 46 active nests were studied. Breeding occurred March–May. The peak egg-laying was in March and April. Mean nest construction period 11±2.87 days (n= 17), nest height was 3.16±1.22 m from the ground. Majority of nests were built on *Sarcococca brevifolia, Berberis ceylanica*, and *Cinnamomum ovalifolium* trees of 4–12 m tall. Most number of pen cup nests were constructed by the fine grass stalks and mosses woven with cobwebs and internal cup lined with grass roots. Eggs were pale blue. Mean clutch size 2.15±0.37 eggs (n= 11). The incubation period was 10.92±0.9 days (n= 11). Nestling period was 28.33±1.55 days (n= 11). Both sexes participate in nest construction, incubation and brood rearing. About 25.53% of nests were depredated (N= 12). The overall nest success was 74.46%. The study reveals that undisturbed cloud forests are critical to conservation of Sri Lanka White-eye.

Keywords: Brood rearing, eggs, endemic, Horton Plains, incubation period, nest construction.

Information on breeding ecology is essential for planning conservation strategies. However, the inadequacy of scientific data on avifauna is the major problem to conserve the birds of Sri Lanka. White-eyes (Passeriformes: Zosteropidae) are a widely distributed family of Old World birds. They are found on the mainland of tropical Africa, southern and eastern Asia, Australia, and on the islands of these continents, including Indian Ocean, Indonesia, Melanesia, and parts of Micronesia (Lack 1971). The largest of the genera is Zosterops, with over 85 species (Clements et al. 2016). There are two species of white-eye occurring in Sri Lanka, the Sri Lanka White-eye *Zosterops ceylonensis* (Holdsworth, 1872) and Oriental White-eye *Zosterops palpebrosus* (Temminck, 1824).

Z. ceylonensis is a small passerine highland endemic (Figure 1). It is a resident breeder in montane forests and usually found in pairs during the breeding season. Outside the breeding season, it may be found in large, scattered flocks (Ali & Ripley 2001). This species can be distinguished by duller green mantle and more extensive yellow on the breast. It has a darker patch between the eye and the bill (Wait 1922). Though mainly insectivorous, also eat nectar and fruits. It is sociable, forming large flocks. The global population size has not been quantified, climate change, habitat alteration are current threats to the species (Birdlife international 2016).

It appears to be more sociable than the Oriental White-eye (Henry 1971; Ali & Ripley 2001). Furthermore, it appears to be equally at home in bushes and undergrowth as well as in the foliage of large trees. Its food consists of nectar, berries, insects, and caterpillars.

Editor: R. Jayapal, Sálim Ali Centre for Ornithology and Natural History, Coimbatore, India. **Date of publication:** 26 March 2022 (online & print)

Citation: Dharmarathne, W.D.S.C., P.H.S.P. Chandrasiri & W.A.D. Mahaulpatha (2022). Breeding biology of Sri Lanka White-eye *Zosterops ceylonensis* (Aves: Passeriformes: Zosteropidae) in tropical montane cloud forests, Sri Lanka. *Journal of Threatened Taxa* 14(3): 20773–20779. https://doi.org/10.11609/jott.6985.14.3.20773–20779

Funding: University of Sri Jayewardenepura, Sri Lanka.

Competing interests: The authors declare no competing interests.

Acknowledgements: We would like to thank the University of Sri Jayewardenepura for financial support through the university grant (ASP/01/RE/SCI/2016/20). We extend our gratitude to the Department of Wildlife Conservation for granting permission to carry out this study (permit no-WL/3/2/14/15).

The breeding season is bimodal. The first extends from February to July with a peak in April. The second season is in August and September. Investigation of breeding biology was the main objective of this study.

The nesting behavior of many forest bird species are still completely unknown, and detailed information concerning the breeding biology and reproductive success of most species is lacking. Collecting information on breeding biology and ecology is an important part of many studies of the population ecology of birds. This is often essential in identifying effective conservation measures for threatened and declining species (Sutherland et al. 2004). Although it is an endemic species with a very restricted distribution, making it more susceptible to becoming endangered, the basic natural history of *Z. ceylonensis* is still poorly known and, to date, no detailed study of its breeding biology exists.

Materials and Methods

Study site

The study was conducted in Horton Plains National Park (HPNP) from January 2017 to January 2018. HPNP is located at an elevation range of 2,100–2,300 m and encompasses montane grassland and cloud forest (Gunatilleke & Gunatilleke 1986). It is rich in biodiversity and many species found here are endemic to the region. The mean annual rainfall is greater than 2,000 mm. Frequent cloud cover limits the amount of sunlight that is available to plants. The mean annual temperature is 13 °C but the temperature varies considerably during a day, reaching as high as 27 °C during the daytime, and dipping as low as 5 °C at night. Dry season occurs from January to March. The ground frost is common in February. Mist can persist in the day during the wet season (De Silva 2007).

The vegetation of the park is classified into wet patana and cloud forests (International Water Management Institute 2010). HPNP is considered as one of the Important Bird Areas (IBAs) in Sri Lanka (BirdLife International 2009).

Methods

Nest sites were searched on three consecutive days in each month from March to May from 0600h to 1800h.

Nests were searched in the interior of the forest patches. Five 25 x 25 m quadrats were marked in each habitat using a global positioning system device (GPS). Proportioned time was spent between habitats for nest searching (Kozma & Mathews 1997).

Approachable nests were observed directly. Unapproachable nests were observed through a 10 x 50

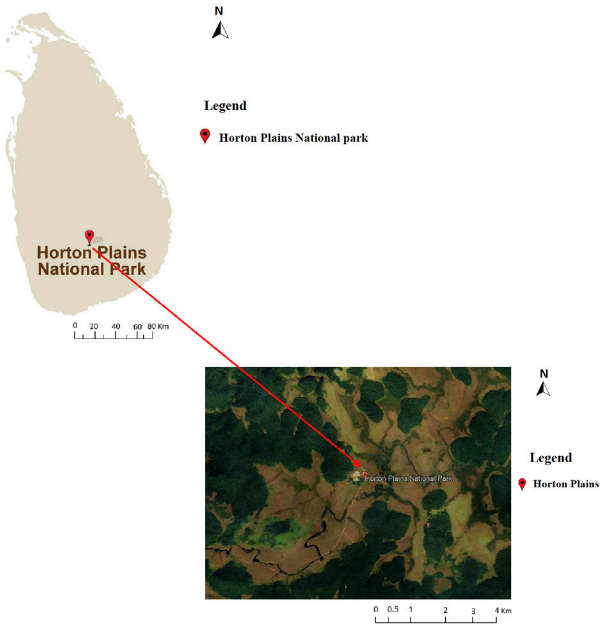

Figure 1. Study site of the Horton Plains National park, Sri Lanka.

binocular. Pole and mirror method was used to check the nest contents. Nests were monitored until they were no longer in use. The time interval between nest checks was optimized by fieldwork logistics. Near the dates of egg-laying and hatching, nests were checked more frequently, when possible, to estimate the nesting phenology precisely. Focal animal sampling method was used to study the breeding behavior of the species (Altman 1974).

Nesting materials were identified by observing adult birds carrying nest materials from the resources during the nest construction period. Nesting habitat variables were recorded in each nest site. Nest parameters such as nest length and nest width were recorded. Canopy cover recorded using a spherical densitometer. Standard methods were used to estimate fruit cover and flower cover (Struhsaker 1975), shrub cover (Zollner & Crane 2003) and habitat insect availability on trunks/twigs and leaves were recorded. Environmental variables near nesting habitats were recorded using pocket weather meter (Krestel ™ 4000, USA). Nest site characteristics, such as nest height from the ground, height of the nesting tree and distance for the nearest nest of same species were recorded.

Available habitats were classified as cloud forests (CF), cloud forest die-back (CFD), and grasslands (GL) in the HPNP. The observer stayed at a hidden position and behaviour of the breeding couples were studied using a binocular (Nikon™ - Monarch, 10 × 42).

Surface temperatures of eggs were measured using

EXTECH Infrared thermometer initially after incubation adults left the nest. Incubation patterns such as on-bout and off-bout duration, nest trips rate and nest attentiveness were studied. Moreover, after the eggs hatching on-bout and off-bout duration, feeding trips rate and nest attentiveness of *Z. ceylonensis* were observed in the nestling period separately. The diurnal period was divided as, dawn (0600–0900 h), morning (0901–1200 h), mid-day (1201–1500 h), and evening (1501–1800 h). A nest was considered successful if at least one young fledged. Nesting observations were made with no disturbance to the birds and nests.

Data analysis

Differences were considered at p<0.05 significant level, mean and standard deviation (M±SD) values were reported throughout. Microsoft Excel™ was used to store data. Principal component analysis (PCA) was performed to analyze nesting habitat variables of *Z. ceylonensis* and graphical illustrations were performed in Minitab 17™.

Results and Discussion

A total of 47 active nests were recorded during the study period breeding occurred mainly from March to May comparatively low nesting observations were recorded during the second season from August to September. The peak egg-laying was in March and April (Figure 2).

Most of the nests were recorded in the CF (65.95%) habitat compared to the CFD (34.05%) habitat. There were no nests recorded in the GL habitats (Figure 3). The study revealed that CF habitats occupied by the *Z. ceylonensis* for their breeding. First two axes of the PCA analysis of habitat variables which were significantly different from available habitat characteristics account for 85.5% of the total variance according to the Eigen analysis of the correlation matrix.

In the first principal component (PC1), wind speed (PC1, 0.466) contributed mostly to where the highest contributed factors for PC1 that variable correlated positively. It correlated negatively with temperature and (PC1, -0.528) and shrub cover (PC1, -0.504). Hence an increase in shrub cover will lead to a decrease in wind speed. Therefore, this habitat attributes influence on nesting habitat selection of *Z. ceylonensis.*

The second component (PC2) gave high scores to sites with high values of canopy cover (PC2, 0.562) and flower cover (PC2, 0.572). The overall PCA result indicated that determining factors of breeding habitat utilization in natural habitats of *Z. ceylonensis* in HPNP were availability of high shrub cover, canopy cover and flower cover (Figure 4).

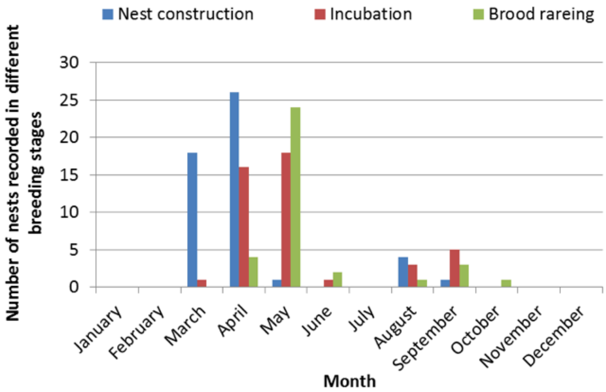

Figure 2. The number of total *Z. ceylonensis* nests recorded during the study in different breeding stages at HPNP, 2017.

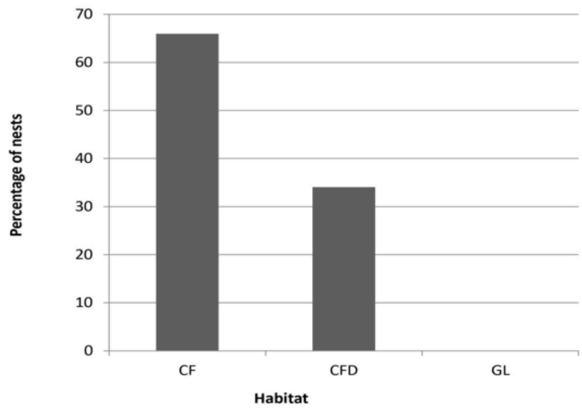

Figure 3. Percentage of *Z. ceylonensis* nests recorded during the study in different habitats at HPNP, 2017.

Mean nest construction period 11 ±2.87 days (n= 17). Both male and females built the nest, during nest construction activity. We did not observe any cases of *Z. ceylonensis* reusing material from an abandoned or predated nest.

Majority of nests were built on *Sarcococca brevifolia, Berberis ceylanica Cinnamomum ovalifolium* trees of 4–12 m tall. Nest height was 3.16±1.22 m from the ground. Approximate distance for the active nests of same species was 4–6 m. There were few records that two nests in the same tree within 4m distance.

Most of the nests (89.36%) were built on the mosses hanging from the tree branches. *Z. ceylonensis* using this *Usnea barbarta* mosses as a substrate to their nests (72.4%). It will help them to conceal their nest and avoid predation via mossy camouflage in these montane habitats. Hammock like open cup nests constructed by mostly the fine grass stalks and mosses woven with

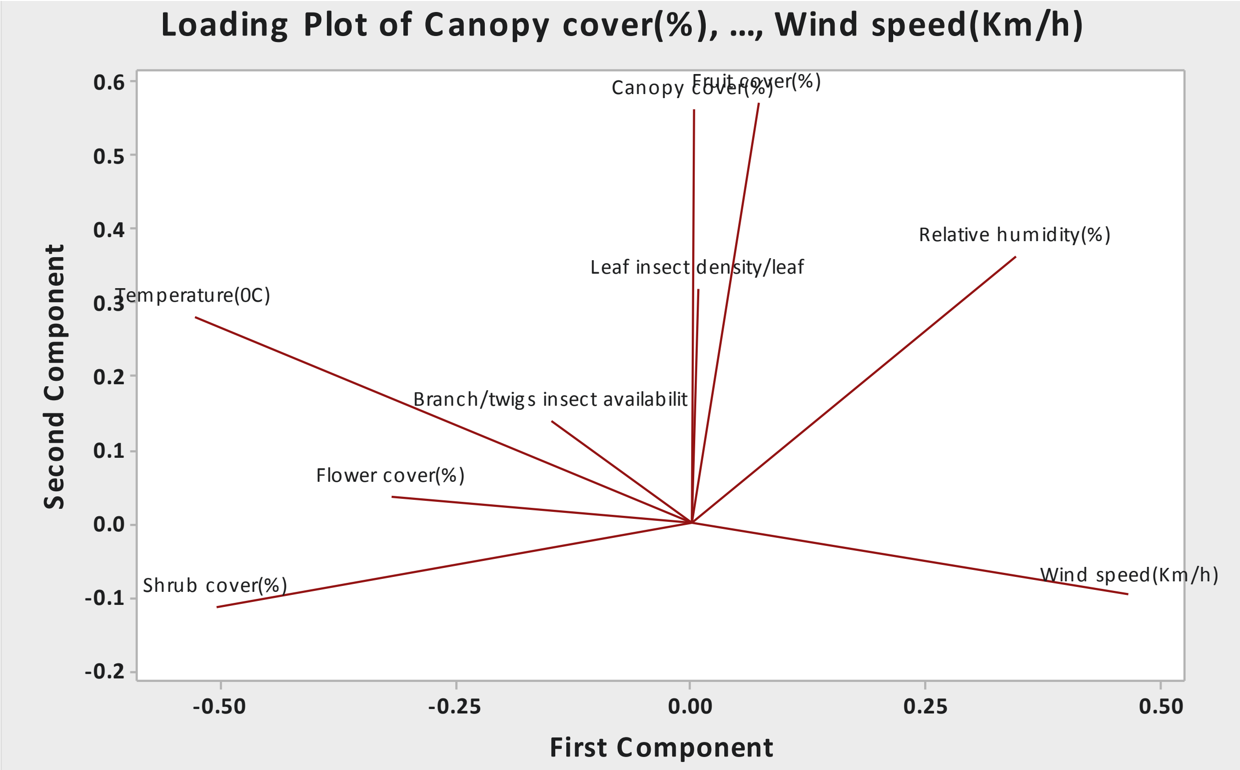

Figure 4. Factors affecting the breeding habitat utilization of *Z. ceylonensis* at HPNP.

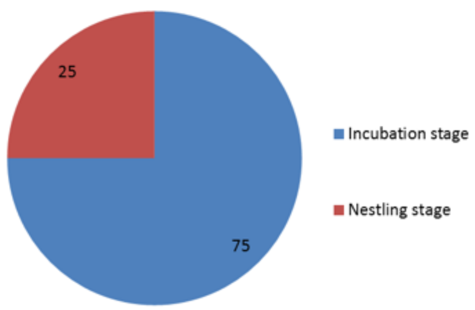

Figure 5. Percentage of *Z. ceylonensis* nests failure according to the habitats at HPNP, 2017.

Table 1. Nesting tress of Zosterops ceylonensis at HPNP.

Tree Species	Number of nests (n= 47)
Sarcococca brevifolia	7
Berberis ceylanica	6
Cinnamomum ovalifolium	6
Neolitsea fuscata	4
Syzygium rotundifolium	4
Elaeocarpus sp.	3
Rhododendron arboreum	3
Rubus ellipticus	3
Symplocos bractealis	2
Sinarundinaria debilis	2
Actinoaphne speciosa	2
Strobilanthes sp.	2
Eugenia mabaeoides	1
Rhodomyrtus tomentosa	1
Vaccinium leschenaultii	1

cobwebs and internal cup lined with grass stalks and plant fibre. Nests were always covered by surrounding leaves. Average nest width was 6.42±0.42 cm (n= 17), and average nest length was 3.91±0.22 cm (n= 17). Eggs were unspotted and pale blue. Mean clutch size 2.15±0.39 eggs (n= 16). One nest was destroyed by the predators before we observe the clutch.

Nest observations revealed that both male and female were involved in incubation, brooding and feeding of the young at both the nestling and fledgeling stage. The average incubation period was 10.92±0.9 days (M±SD) (n= 11) and the average nestling period was 28.33±1.55 days (n= 11).

During the incubation period, on-bout duration (35.41±3.28 min (M±SD)) and nest attentiveness (92.21±5.43% (M±SD)) was higher in the evening period. Off-bout duration (22.32 ±5.21 min (M±SD)) was higher in the morning period. Nest trips rate (4.02± 0.54 $^{h-1}$ (M±SD)) was higher in the mid-day. The mean egg temperature under the parental incubation (25.92 ±3.41 C^0 (M±SD)) is significantly different from that of the absence of parental incubation (13.17±0.54 C^0 (M±SD)) (One way ANOVA, p<0.01). Both percentages of attendance and length of sitting bouts increase in bad weather. Pair sometimes meets on a branch near the nest to allopreening.

During the nestling period, on-bout duration (3.14 ± 1.26 min (M±SD)) and nest attentiveness (68.96 ± 10.34% (M±SD)) was higher in the evening period. Off-bout duration (2.49 ± 1.04 min (M±SD)) and feeding trips rate (10.31 ± 1.54 h^{-1} (M±SD)) was higher during the morning.

Z. ceylonensis single-brooded although some pairs made re-nesting attempts after first nests failed. About 23.40% of nests were depredated (N= 11), with evidence suggesting predation by Jungle Crow *Corvus levaillantii* and Greater Coucal *Centropus sinensis*. Furthermore, 2.13% of nests were broken by rainy winds (N= 1). About 75% of nests were failed during the incubation period while 25% nests failed during nestling stage. The overall nest success was 74.46%.

Comparatively higher nest failure was recorded in the CFD habitat (56.25%) compared to CF habitat (6.45%) (Figure 5). Therefore, study reveals that undisturbed cloud forests are essential to ensuring the breeding of this endemic species.

Incubating birds face ecological costs associated with reproductive effort during the breeding season (Conway & Martin 2000). Studies have shown that the first step of success of individual breeding attempts involves the location of nests being used by birds (Krebs & Davies 2009). Generally, factors that help decide the location of nesting site, and probably the choice of mate as well, including local food availability, presence of suitable nest materials and shelter from the physical environment and protection from predators (Collias & Collias 2014).

Z. ceylonensis occupied different tree species to build their nest all the nests shows that nests well protected from the heavy rains by a dense cluster of broad leave over the nest. It is generally placed on a small branch or twig directly under a canopy of foliage. The nest is built largely of fibres with outer surface often covered by the mosses. the open cup nest is typical of most passerine birds, the size of the inner cup is automatically moulded to the body size of the species because of the typical movements used in building, pushing in the nest with breast while rotating and pushing back with the feet (Collias & Collias 2014).

The close fit of the nest to bird helps make something of a seal, holding in warmth when the incubating bird is sitting closely. Our findings indicate that *Z. ceylonensis* maintained about 12 ^{0}C warmer than the surrounding air during the incubation. One reason for the prevalence of open nests among small birds of cool climates may be the need of the bird on the nest and its nestlings for the warming rays of the morning sun (Collias & Collias 2014).

Birds have evolved a variety of anti-predator adaptations in their nest-building behavior (Skutch 1976). When considering the *Z. ceylonensis* nests they are hidden in the vegetation, to deceive predators they camouflage their nests covered with *Usnea barbarta* mosses by resembling a mass of natural vegetation. It seems that the importance of nest concealment varies with ecological circumstances and with the type of predators at a given time and habitat. Since there is less abundance of snakes in the Horton plains most of the predator attacks occurred by avian predators. Therefore, nest concealment is a very important factor for nesting success.

The Horton Plains is one of the remaining pristine montane cloud forest habitats in Sri Lanka. Due to tourist activities invaded the population of Jungle Crow increased at human-induced habitat in the HPNP (Chandrasiri et al. 2017). When considering the nest failures of *Z. ceylonensis* most of the nest predation occurred due to predation by Jungle Crow. Unfortunately, nesting colony of Jungle Crow was observed in 2018 in the CF habitat. Many crows are a major threat to endemic animals. Increased number of crows is an indicator of pollution because they are scavengers in the food chain. To establish the protection of *Z. ceylonensis* in this important Montane Cloud Forest, admissible methods to control the number of Jungle Crow are needed.

Good nest sites are often traditional, serving as 'ecological magnets' over many years and regularly continue to attract individuals of the same species (Burnham 2007). Forest on Sri Lanka has suffered rapid degradation and fragmentation in the past decades through the excessive gathering of fuel-wood, clearance for permanent agriculture, shifting cultivation, fire, urbanization and logging. It is feared that habitat loss will continue in the hills and the status of this species therefore requires monitoring. There is no known targeted conservation action for this species. Therefore, conservation of breeding habitats is recommended to protect this species.

Image 1. *Zosterops ceylonensis* at HPNP, Sri Lanka.

Image 2. Mist-netted *Zosterops ceylonensis* individuals at HPNP, Sri Lanka.

Image 3. *Zosterops ceylonensis* nest covered with mosses at HPNP, Sri Lanka.

Image 4. *Zosterops ceylonensis* eggs at HPNP, Sri Lanka.

Image 5. Adult incubating on the nest at HPNP, Sri Lanka.

Image 6. *Zosterops ceylonensis* nestlings (4days) in a nest at HPNP, Sri Lanka.

Image 7. *Zosterops ceylonensis* fledgeling (25 days old) on a branch near the nest site at HPNP.

Image 8. Sri Lanka White-eye broken predated nest attached to twigs at HPNP, Sri Lanka.

References

Ali, S.L. & S.D. Ripley (eds.) (2001). *Handbook of the Birds of India and Pakistan together with those of Bangladesh, Nepal, Bhutan, and Sri Lanka.* Oxford University Press, Delhi, India.

Altmann, J. (1974). Observational study of behavior: Sampling methods. *Behaviour* 49: 227–267.

BirdLife International (2016). *Zosterops ceylonensis*. In: IUCN 2012. IUCN Red List of Threatened Species. 2012. Date of download 2019/01/28. https://doi.org/10.2305/IUCN.UK.2016-3.RLTS.T22714023A94397877.en

Burnham, K.K. (2007). Inter-and intraspecific variation of breeding biology, movements, and genotype in Peregrine Falcon *Falco peregrinus* and Gyrfalcon *F. rusticolus* populations in Greenland. PhD Thesis. University of Oxford.

Chandrasiri, P.H.S.P., W.D.S.C.Dharmarathne, S. Lakmal & W.A.D. Mahaulpatha (2017). Distribution of the jungle crow (*Corvus levaillantii* lesson, 1831) and their potential threats to biodiversity in Horton Plains National Park, Sri Lanka. *Wildlanka* 5(2): 073–077.

Clements, J.F., T.S. Schulenberg, M.J. Iliff, D. Roberson, T.A. Fredericks, B.L. Sullivan & C.L. Wood (2016). *The Clements checklist of birds of the world.* http://www.birds.cornell.edu/clementschecklist/download/Google Scholar.

Collias, N.E. & E.C. Collias (2014). *Nest Building and Bird Behavior*. Princeton University Press.

Conway, C.J. & T.E. Martin (2000). Evolution of passerine incubation behavior: influence of food, temperature, and nest predation. *Evolution* 54(2): 670–685.

de Silva, A. (2007). *The Diversity of Horton Plains National Park (with special reference to its herpetofauna)*. Vijitha Yapa Publishers. Sri Lanka.

Gunatilleke, C.V.S. & I.A.U.N. Gunatilleke (1986). Horton Plains: some aspects of its vegetation and ecology. *Sri Lanka Wildlife* 3(4): 9–11.

Henry, G.M. (1971). *A Guide to the Birds of Ceylon (Second Edition)*. Oxford University Press, London, UK.

Horton Plains National Park (2010). International Water Management Institute. https://web.archive.org/web/20100805010613/http://dw.iwmi.org/wetland_profile/Horton.asp

BirdLife International **(2009).** IBAs in Sri Lanka. http://www.birdlife.org/datazone/country/sri-lanka.

Kozma, J.M & N.E. Mathews (1997). Breeding bird communities and nest plant selection in Chihuahuan Desert habitats in south-central New Mexico. *The Wilson Bulletin* 109(03): 424–436.

Krebs, J.R & N.B. Davies (2009). *Behavioural Ecology: An Evolutionary Approach*. John Wiley & Sons.UK.

Lack, D.L. (1971). *Ecological Isolation in Birds*. Harvard University Press, Cambridge, Massachusetts, USA.

Skutch, A.F. (1976). *Parent Birds and Their Young*. Austin and London: University of Texas Press.

Struhsaker, T.T. (1975). *The Red Colobus Monkey*. University of Chicago Press, Chicago, 311pp.

Sutherland, W.J., I. Newton & R. Green (2004). *Bird Ecology and Conservation*: *A Handbook of Techniques* (No. 1). Oxford University Press.

Wait, W.E. (1922). *The Passerine Birds of Ceylon. Spolia Zeylanica* 12: 182.

Zollner, P.A. & K.J. Crane (2003). Influence of canopy closure and shrub coverage on travel along coarse woody debris by eastern chipmunks (*Tamias striatus*). *The American Midland Naturalist* 150(1): 151–157.

Journal of Threatened Taxa is indexed/abstracted in Bibliography of Systematic Mycology, Biological Abstracts, BIOSIS Previews, CAB Abstracts, EBSCO, Google Scholar, Index Copernicus, Index Fungorum, JournalSeek, National Academy of Agricultural Sciences, NewJour, OCLC WorldCat, SCOPUS, Stanford University Libraries, Virtual Library of Biology, Zoological Records.

NAAS rating (India) 5.64

Print copies of the Journal are available at cost. Write to:
The Managing Editor, JoTT,
c/o Wildlife Information Liaison Development Society,
No. 12, Thiruvannamalai Nagar, Saravanampatti - Kalapatti Road,
Saravanampatti, Coimbatore, Tamil Nadu 641035, India
ravi@threatenedtaxa.org

www.threatenedtaxa.org

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

March 2022 | Vol. 14 | No. 3 | Pages: 20703–20810
Date of Publication: 26 March 2022 (Online & Print)
DOI: 10.11609/jott.2022.14.3.20703-20810

Article

Communications

Short Communications

Notes

Publisher & Host

WILD ZOOREACH Threatened Taxa