When and how to study the nesting biology of Indian birds: Research needs, ethical considerations, and best practices

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Barve, S., Raman, T. R. S, Datta, A., & Jathar, G., 2020. When and how to study the nesting biology of Indian birds: Research needs, ethical considerations, and best practices. *Indian BIRDS* 16 (1): 1–9.

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Manuscript received on 03 February 2020.

Abstract

The nesting biology of a bird species is likely the most important component of its life history and it is affected by several ecological and environmental factors. Various components of avian nesting biology have proved to be important traits for testing fundamental ecological and evolutionary hypotheses, and for monitoring the efficacy of biological conservation programs. Despite its significance, the nesting biology of most Indian bird species is still poorly understood. The past few years have, however, seen a significant increase in the number of submissions to *Indian BIRDS*, of observational studies of avian nesting biology, which promises an exciting new wave of ornithological natural history research in India. Although there is great need for such research, there are several biological, legal, and ethical aspects to consider before studying bird nests through direct observation or by using new technological and digital monitoring techniques. Here, we outline the merit and need for studying the nesting biology of birds in India, but also suggest best practices, specific to the Indian context, which will help to ensure that the research is done legally, ethically, and in a way that can provide important new information to advance Indian ornithology without compromising the welfare of birds.

Introduction

For a wide array of bird species, ornithologists and birdwatchers have studied and documented many aspects related to nesting biology such as: pair formation, courtship, copulation, nest availability, nest site selection, nest building, nest maintenance, clutch size, incubation period, hatching success, fledgling survival and growth; parental care and parent – offspring behaviour; moult, nest re-use, and population dynamics (Birkhead et. al. 2014). Nesting biology is a highly significant aspect of a bird's life-history and is directly related to ecological aspects such as habitat selection and survival, as well as evolutionary aspects such as reproductive success and sexual selection. The nests that birds make are extremely varied, from swiftlets nesting in caves, grebes and jacanas nesting on open waterbodies or marshes, babblers nesting in tall grass, mound-nesting megapodes, primary or secondary cavity- or hole-nesting birds such as woodpeckers, kingfishers, owls, bee-eaters, and hornbills, ground nesters like lapwings and larks, birds that breed on cliffs, in houses, and on rooftops, to brood-parasites like many cuckoos that do not build nests but lay their eggs in other birds' nests (Lovette & Fitzpatrick 2016).

The nesting season is a particularly vulnerable time for birds as their eggs and young are nearly defenceless against predators, although parent birds may go to substantial lengths to protect nests and young through defensive, or evasive, behaviours and by careful selection of nest sites in secure or hidden locations. It is also an energetically demanding and sensitive period as adults provision the nestlings, revisit the same location multiple times, and spend considerable time incubating eggs, and feeding young. During this crucial nesting period, when birdwatchers and researchers observe birds to study and document their nesting ecology or behaviour, it is possible that the presence of human observers and their methods of observation may affect birds in different ways. Scientific and ethical concerns have been raised that human observer-related disturbances may compromise the accuracy of research findings or the welfare of the birds concerned (Götmark 1992; Farnsworth & Rosovsky 1993; Crozier & Schulte-Hostedde 2015). In the case of nesting birds, field research or disturbances due to human observers, such as ecotourists and birdwatchers, may lead to changes in nesting habitat, nest site availability and safety, increase exposure and stress, compromise the survival of chicks and adults, cause nest desertion, or modify predator behaviour and predation rates, all of which may affect nesting birds in ways that are negative, neutral, or even positive (Götmark 1992; Müllner et al. 2004; Weidinger 2008; Ibáñez-Álamo et al. 2012). The unscrupulous or insensitive behaviour of human observers, such as disturbing nest sites and nesting birds for the purpose of bird photography, which is unethical and detrimental to birds, has been criticized and conservationists have called for the adoption of better guidelines (Dattatri & Sreenivasan 2016; Podduwage 2016). The excessive use of call playback to attract birds has also been a matter of concern as there could be possible effects on bird breeding, stress, and survival, especially in the breeding season (Sen 2009; Kannan & Santharam 2015). Organisations concerned with birdwatching and bird conservation have provided guidelines for birdwatchers, including a code of behaviour (ABA 2012; RSPB 2019), and measures to minimise disturbance during nest observations (BTO 2019). Birdwatchers who are aware and sensitive to these concerns are more likely to change their behaviour to benefit birds (Weston et al. 2015).

Within India, professional ornithologists and birdwatchers continue to carry out field research and natural history observations on the nesting habits of many bird species to build our knowledge of nesting birds. There has been an increase in the number of natural history and anecdotal notes on nesting biology submitted to *Indian BIRDS* journal in the last few years (over 30 manuscripts since September 2015). The need for scientific and natural history journals to consider ethical aspects related to the research or observations they publish has been widely highlighted (Marsh & Eros 1999; Kannan & Santharam 2015; Costello et al. 2016). Most journals that publish research on animals now require that authors adhere to international standards and best practices, with due attention to ethical considerations in their work before it can be considered for publication (e.g., Animal Behaviour 2020). In India, as an increasing number of amateur birdwatchers, citizen scientists, students, and scientists carry out studies on bird nests, it is important to bring into consideration, from the planning stage through observation and publication, aspects such as: ethics, appropriateness and repeatability of the research methods, permits and training, and the trade-off between new information generated *versus* potential negative impacts on nesting birds. In this paper, we briefly outline the need for nesting biology studies, discuss how studies at bird nests may affect birds negatively or positively, and provide some guidelines and resources that may help researchers make decisions about when and how to study the nesting ecology of Indian birds.

Nesting biology studies

Some basic aspects of nesting biology have been described for a majority of the Indian bird species (Ali & Ripley 1983), but there is much to learn, particularly in relation to variation within and across species, and across different habitats and regions. Many aspects of bird reproductive ecology are similar across closely-related species (phylogenetically conserved) and have been described in the ornithological literature. For example, all woodpecker species around the world excavate cavity nests and all lapwings nest on the ground (del Hoyo et al. 1992), so observations that merely provide additional site or photographic records or descriptions of such woodpecker or lapwing nests may not add significantly to existing knowledge. On the other hand, studies that yield information on what kinds of trees a woodpecker species uses to nest in, say, urban parks *versus* forests, or on lapwings nesting on rooftops of buildings, may add interesting new knowledge and improve our understanding of how species adapt to different habitats.

In contrast to phylogenetically conserved traits, other aspects such as clutch size and incubation period may be highly variable across closely related species (Barve & Mason 2015). Moreover, while there are some well-known macroecological patterns in avian reproductive biology (such as the increase in clutch size with latitude, across bird species; Jetz et al. 2008), there are other aspects such as, variation in relation to elevation (Boyce et al. 2015), which are less well documented. Additional documentation and studies on these aspects will help build our corpus of knowledge on Indian birds and improve our understanding of the ecological correlates of breeding patterns.

Aspects of the reproductive biology of individual birds (e.g., nest placement, clutch size, and reproductive success) may be influenced by a variety of proximate mechanisms such as, social system (Barve et al. 2019), population density (Dhondt et al. 1992), food availability (Aranzamendi et al. 2019), predator density (Fontaine & Martin 2006), body condition (Crossin et al. 2017), habitat alteration, such as due to logging (Srinivasan et al. 2015), environmental fluctuations (Pinaud & Weimerskirch 2002), and environmental pollution (Marzluff 2001). Research on the breeding biology of birds has provided empirical evidence for many ecological and evolutionary theories and may also illuminate how bird life history attributes relate to their vulnerability to extinction and their conservation needs (Birkhead et al. 2014; Xiao et al. 2017). Nest monitoring studies have been instrumental in revealing important insights in natural selection (Grant & Grant 2019), intra- and inter-specific ecological interactions (Samplonius & Both 2019), population ecology (Clutton-Brock & Sheldon 2010), social behaviour (Koenig et al. 2016), and conservation actions (Rane & Datta 2015). However, despite its significance for ecology, evolutionary biology, and conservation science, the nesting ecology of many birds, especially tropical forest species, is poorly known (Xiao et al. 2017). For Indian birds, gaps in knowledge vary from no information on the nesting ecology of some species (e.g., Marsh Babbler *Pellorneum palustre,* Black-headed Shrike-Babbler *Pteruthius rufiventer,* and Ward's Trogon *Harpactes wardi*), to a dearth of information on the spatial and temporal variation in nest placement, clutch size, phenology, provisioning of nest inmates, and fledging success for many widespread species (Padmanabhan & Yom-Tov 2000). Lastly, the effects of environmental and ecological factors such as habitat degradation, predator density, or nest site availability, on the reproductive ecology of most species remain virtually unknown.

Effects of nest studies on birds: need for care, caution, and ethical guidelines

While there are significant opportunities to study the nesting biology of birds, there are also concerns on how observations may impinge on the birds themselves. It is therefore important that concerns for the welfare of birds, and the best practices that address these concerns, are kept in the forefront as one embarks on bird nesting studies. In an early review, Götmark (1992) highlighted a number of potential effects of observer-related disturbance on birds including increased exposure to predation and extreme temperatures, effects on nest-site selection and breeding density, and altered behaviour of parents and young. Götmark (1992) particularly highlighted negative effects on nesting birds due to increase in nest predation. This prompted many observers and researchers to take care to minimise disturbance and harm to nesting birds by using appropriate field methods and less intrusive methods. Since Götmark's 1992 paper, there have been numerous studies on the nesting ecology of birds, including many that specifically compared the nesting success of birds under close, or regular, observation with that of nests that were not similarly observed. However, a recent review of this literature, analysing data from 18 experimental studies involving 25 bird species from six avian orders, came to a contrasting conclusion (Ibáñez-Álamo et al. 2012). Ibáñez-Álamo et al. (2012) found that researcher activities did not generally affect the incidence of nest predation and, surprisingly, nest survival of passerines increased weakly with researcher activities. They also found significant positive effects of researcher activity on nest survival for species breeding on coastal areas and for species

nesting on the ground. While their patterns were inconsistent among avian orders and are based on a limited set of species, they highlight that careful observation (carried out using proper protocols) has the potential to increase our knowledge of nesting ecology without harming the birds being observed.

New technology is also increasingly being deployed to study birds at nests through photography or videography (Franzreb & Hanula 1995; Boom & Fuller 2003; Margalida et al. 2006; Robinson et al. 2015), such as by using remote cameras mounted near nests, specially designed video cameras, unmanned aerial vehicles (drones), and remote-operated vehicles (rovers). It is known that disruptive and intrusive nest photography or videography by unscrupulous observers can harm birds and should be strictly avoided (Podduwage 2016; Dattatri & Sreenivasan 2016). However, cameras, drones, and rovers deployed with proper care, to minimise disturbance to birds, can be valuable assets in bird research (e.g., Palkar 2016; Mori et al. 2017). The use of such technology in bird studies is relatively new to India. Species such as the White-bellied Sea-eagle *Haliaeetus leucogaster* (Bhau Katdare, *verbally*, dated 15 December 2013), Brown Fish Owl *Ketupa zeylonensis* (Vyas et al. 2013), White-rumped Vulture *Gyps benghalensis,* Indian Vulture *G. indicus* (Prakash et al. 2012; Pande et al. 2015), Indian Pitta *Pitta brachyura* (Solanki et al. 2018), Indian Grey Hornbill *Ocyceros birostris* (Gadikar 2017; Kasambe 2020), and Malabar Pied Hornbill *Anthracoceros coronatus* (Mandar Sawant, *verbally*, dated 15 December 2013) are some notable examples. So far, closed-circuit television (CCTV) cameras, web cameras with television or computer monitors, digital single-lens reflex (DSLR) cameras, and infra-red cameras with motion sensors have been used in these studies.

The breeding biology of White-bellied Sea-eagles was studied using CCTV units in 2000 (Bhau Katdare, *verbally*, dated 15 December 2013). Since then, CCTV technology has also been used to study Oriental Dwarf Kingfisher *Ceyx erithaca* nests (Palkar et al. 2009). Vyas et al. (2013) used infra-red video camera traps to reveal the nesting behaviour of the nocturnal Brown Fish Owl. Similar studies have been done for the Indian Grey Hornbill (Gadikar 2017, Kasambe 2020) and the Indian Pitta (Solanki et al. 2018).

There is little information, or experimental studies, on how cameras affect nesting birds, particularly for tropical and forest bird species. For a small set of temperate bird species in North America, Richardson et al. (2009) reviewed studies and concluded that on average, the use of camera equipment may reduce nest predation rates, but the differences they observed varied according to region, study duration, and vegetation type, and were not always significant. They cautioned that researchers using camera surveillance to monitor nests must be aware that the equipment may affect rates of predation and possibly bias data collected on predator identity. Similarly, Ibáñez-Álamo et al. (2012) suggested that nest predators may be more sensitive to the human observer-related disturbance, implying the need for caution in interpreting studies of predation at nests as well as the need for research on effects of observer-disturbance on nest predators. Recent research on the use of drones and rovers to study nesting birds such as gulls, ducks, waders, and penguins has highlighted that such technology can potentially be deployed in ways that cause less disturbance to nesting birds than direct observations that involve handling birds or imply greater proximity of human observers to nests (Sardà-Palomera et al. 2012; Le Maho et al. 2014; Vas et al. 2015). As research on this aspect is still nascent and the effects of the use of such technology on a majority of bird species, particularly forest birds, remains unknown, it is better to take a precautionary approach and maintain high standards of care, ethics, and sensitivity while deploying these methods to study nesting birds.

Questions to ask before one begins a nesting study

Given the above context and the need for studies of nesting biology as well as the need for care in how such studies are conducted, we would like to suggest a set of questions that one could answer prior to launching such studies. These questions are not meant to be comprehensive, nor do they address all possible issues that may arise in the context of studies of any particular species. The researchers or observers should ideally adopt a practice of critical and continuous self-questioning and sensitivity to understand and address the various issues related to their study species. The questions we provide here are more in the nature of broad guidelines for observers to help identify relevant information and adopt best practices in preparation for studying birds at their nests.

Questions

1. Have I made a comprehensive review of the available literature on the species to assess what additional contributions my research will add to existing information?

Although limited in comparison to the information available for European or North American birds, there is much information that can be found on many Indian bird species. An essential starting point in any research is a survey of the available literature on the species or question. Ali & Ripley (1983) is, to this day, the most comprehensive resource on Indian ornithology and may be a 'go-to' resource for most species. This publication comprehensively collates data from various important sources such as Hume (1873, 1874, 1875), and Baker (1895, 1896), and the series on nidification of Indian birds by Lamba (e.g., Lamba 1963). Most academic papers published on Indian birds, over the last thirty years, are also available in online repositories and can be searched using appropriate keywords on academic literature search engines like Google Scholar (**http://scholar.google.com**), or the Searchable Ornithological Research Archive, SORA (**https://sora.unm.edu/**). A comprehensive bibliography of scientific literature on Indian avifauna can also be found at **http://www.southasiaornith.in/** (Pittie 2019). Less than 10% of Indian bird species are endemic to the country (Jathar & Rahmani 2007); species more widely distributed may have been studied in other range countries. Therefore, it is also important to refer to more global databases such as the *Handbook to the Birds of the World* Series (del Hoyo et al. 1992), Ebird.org (Sullivan et al. 2014), AviBase (Lepage et al. 2014), the *IUCN Red List* (IUCN 2017), and other sources for information, including regions outside India where the species may have been already studied. Gaps in knowledge about a species, and the justification for its study, should be decided only after completing a thorough literature review. A good literature review on the species of interest may highlight that your observations are significant as they represent a breeding record for the species in a new region, habitat, or elevation. It may reveal an unknown nest placement type, or nest

type for the species, or highlight behavioural differences such as the presence of non-parent "helpers" at the nest. In many cases, literature reviews reveal that some observations are not novel. Undertaking such studies may not be worthwhile, particularly if they are associated with some level of disturbance to birds. Focussing your observations on the novelty of your finding may also streamline your research methods and the effort involved in data collection.

However, the novelty of an observation or the validity of a particular academic question may not be the only criterion to decide on whether a nest observation study should be undertaken. Long-term nest monitoring is increasingly critical for biodiversity conservation, and to identify trends, changes, and threats that may be affecting the breeding of a species. For example, long-term studies are being carried out on five hornbill species in Arunachal Pradesh, India, since 1997, led by one of us (AD). While these species had already been studied in Thailand, and at least one species in southern India earlier (Kannan & James 1997; Poonswad et al. 2005), nothing was known of their breeding biology from north-eastern India. Studies involving nest observations were carried out to document hornbill breeding biology in Arunachal Pradesh (Datta 2001; Datta & Rawat 2004). One could argue that the incremental knowledge, or the small differences one sees between sites or regions, does not warrant more studies, but there is a need for, and value in, studies of the same species in different sites or across its range as they may reveal interesting differences that yield new ecological insights. They also provide a more comprehensive knowledge of the biology of a species across its range: for instance, we know from these studies that the breeding season of hornbills is different across these three regions, possibly due to differences in climate and phenology (fruit availability). Additionally, long-term studies are important for conservation: determining changing threats to species status in specific areas, and trends in breeding activity or timing in relation to ecological variables such as food availability and climate. For example, the peak ripe fruit availability in north-eastern India occurs in the middle of the breeding season, while in Thailand it peaks after chicks fledge. Two sites in Thailand have had arguably the longest-running hornbill projects in Asia, studying the breeding of several sympatric hornbill species (Poonswad et al. 2005). These long-term studies in Thailand and India have yielded insights into the interspecific competition for nest sites between hornbill species, nest turnover and re-use/longevity of nest trees, variation in timing of breeding, nesting success, and duration. Long-term monitoring has shown the shortage of nest sites and resulted in repair of limiting nest cavities along with nest box provisioning (Poonswad et al. 2005; Datta et al. unpubl. data). Pioneering efforts in Thailand on hornbill research and conservation with the help of communities outside Protected Areas have now been replicated in India in the Western Ghats (Bachan et al. 2011), north-east India (Datta et al. 2012; Rane & Datta 2015), Malaysia (Yeap 2019), and the Philippines (Alabado et al. 2009).

Another example of research involving hornbills is the study of Indian Grey Hornbills by an amateur ornithologist in Indore city for 12 years. It has revealing unusual breeding sites (Gadikar 2017), and changes in their breeding pattern and timing thanks to the long-term observations of nests (A. Gadikar, unpubl. data). For the last two to three years, it has been noted that the Indian Grey Hornbill is initiating nesting 15 days earlier than in the past (A. Gadikar, unpubl. data). In north-eastern India, the median nest entry date of Great and Wreathed Hornbills was 29 days earlier than what was recorded in the previous 16 years (A. Datta, unpubl. data). A third example is of a study of nesting colonies of the Finn's Weaver (*Ploceus megarhynchus*), over a period of 21 years, which helped in monitoring the population decline at a landscape level, as well suggesting a revision of the IUCN status of the species from Vulnerable to Critically Endangered or Endangered (Bhargava 2017).

2. What do I want to study and how generalizable are my results given my sample size (number of nests being observed)?

Given the vulnerability of nesting individuals, studying nesting biology requires understanding the trade-offs between any new information a study may generate and the disturbance it may cause for the birds in question. For example, when nothing is known about the reproductive ecology of a species, careful and continuous observation and monitoring of a single nest may provide valuable new information. However, for species whose basic biology is well known, information on an additional one, or a few nests, may not be of sufficient scientific rigour to add new or useful knowledge, while carrying the risk of such a study being intrusive and potentially deleterious for the birds. Similarly, if the motive is to study the effect of an ecological mechanism, a robust sample size is required to reach ecological conclusions with adequate statistical support and significance. Take for instance a familiar species, the Baya Weaver *Ploceus philippinus*, for which basic aspects of nesting and breeding have been described by multiple earlier observers (Ali 1931; Ambedkar 1964; Crook 1964; Davis 1971). Nevertheless, many ecological and behavioural aspects of their breeding—for instance, the influence of nest height, location, or orientation of nest-openings on reproductive success—remained unknown or inconclusive. To answer such questions, Quader (2003, 2006) studied a sample of 1,445 nests of the Baya Weaver using both observations and experimental manipulations (sample size of nests for specific comparisons and hypotheses testing ranged from 9 to 864 nests). Such careful studies with adequate sample size, appropriate methods, and experimental manipulations may be necessary to answer behavioural-ecological and evolutionary questions, but on occasion even these may be insufficient, as Quader (2006) observed:

> "...Behavioural ecologists and evolutionary biologists are often hesitant to carry out extreme manipulations. Nevertheless, such manipulations may be necessary to reveal certain natural and sexual selection pressures that would otherwise be hidden from scrutiny. If manipulating nest traits is impossible, large sample sizes and careful analyses will often be required (but might still not be sufficient) to detect selection on nest attributes."

Having clear objectives when studying breeding birds is critical to ensure that the nesting individuals are not disturbed unnecessarily. Hence, observers should avoid 'fishing expeditions' where data is collected first, and then the study is designed around it to be described in a manuscript form. To make your research comparable to others, and reliable enough to add new knowledge to the literature on the species, it is important to have clear *a priori* objectives, assess what sample sizes you plan to

get or are feasible, and use appropriate methods of observation, analysis, and inference.

In certain cases, nest monitoring is done for species conservation, to ensure nesting individuals are not hunted or that their nest sites are not disturbed, to ensure nesting success. It is especially important in such scenarios that researchers or field staff are trained to cause minimal disturbance during their monitoring visits.

3. Am I using the right research methods and those that are least intrusive for the purpose?

It is important to choose a research methodology that is (1) repeatable, (2) reliable and appropriate for the question or objective of the study, (3) provides the most information while minimizing the impact on the nesting birds, and (4) ensures the welfare and safety of birds and researchers. An exhaustive review of the best methods to study birds, particularly at their nests, is beyond the scope of this manuscript. Besides textbooks and handbooks on bird biology (e.g., Lovette & Fitzpatrick 2016), a number of handbooks of techniques and research methods are available, which can be consulted as starting points (Ralph et al. 1993; Sutherland et al. 2004; Ferguson-Lees et al. 2011).

Several 'public' protocols have been published to involve citizen scientists in amassing information on the nesting ecology of common birds across huge spatial scales, such as over the whole of North America (Neighborhood NestWatch: https://nationalzoo.si.edu/migratory-birds/neighborhood-nestwatch). Online certification programs have also been established to provide guidelines for nest monitoring (The Cornell Lab of Ornithology's NestWatch, https://nestwatch.org/). Such programs strongly discourage unethical practices such as clearing of vegetation around the nest, repeated visits to the nest, and playing bird song near the nest as such methods alter the natural behaviour of birds and thus render the research unreliable and not comparable to other studies.

4. What is the legal status of the bird species, and do I have the required permits and experience to carry out the observations?

Another basic question to ask is whether there are specific permits and expertise (or training) that you require before you embark on a study of nesting birds. Within India, if your observations are being carried out in any wildlife reserve (Wildlife Sanctuary, National Park, Tiger Reserve, or Community or Conservation Reserves), according to the Wild Life (Protection) Act, 1972, you will need to apply for and secure relevant entry and research permits from the Chief Wildlife Warden of the State where the reserve is located. If the study site is located in a Reserved Forest or Protected Forest, permits from the respective wing of the Forest Department will need to be obtained. Note that it is not just permits from government authorities that may be required. If your work is on private or community land, you will need to inform and secure permits from the corresponding owners or community institutions (such as Village Council or Panchayat) before working in the area.

The legal status and conservation status of the study species also matters. This includes the international status under the *IUCN Red List of Threatened Species* (www.iucnredlist.org), and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (henceforth, CITES; www.cites.org), and the national status under the Wild Life (Protection) Act, 1972. Birdwatchers and researchers should adopt procedures of due care when studying species that are Critically Endangered, Endangered, Vulnerable, or Near Threatened (Rahmani 2012). CITES regulates trade in live birds and specimens (including parts of a bird such as feathers, eggs, or bones) with prohibitions or strict regulations for species listed in Appendices I to III.

Under India's Wild Life (Protection) Act, 1972, endangered species are listed in Schedule I, while other protected species or taxonomic groups are listed in Schedules II to IV (WLPA 1972). Under this Act, the capture or handling of birds, even for the purpose of research, is categorised under 'hunting', which is generally prohibited under Section 9. However, under Section 12, birds can be 'hunted' (meaning captured/collected) under a special permit from the Chief Wildlife Warden for the purposes of education, research, or collection of specimens for recognised zoos and museums. Permission shall be granted to foreigners or non-resident Indians or institutions owned by foreigners or non-resident Indians only if the project has been sanctioned, and permission issued by the Government of India, Ministry of Environment, Forests and Climate Change (henceforth, MoEFCC), Ministry of External Affairs, Ministry of Home, and by the National Biodiversity Authority, as referred to in Section 3 of the Biological Diversity Act, 2002. In case of research that involves the capture, and handling of, or the collection of biological samples from any species listed in Schedule I, the award of approval would lie with the Director (Wildlife Preservation), Government of India (Additional Director General (Wildlife) and Director, Wildlife & Preservation, MoEFCC). In all cases, the proposal should be submitted to the Chief Wildlife Warden, and a copy to the Additional Director General (Wildlife), MoEFCC, Government of India. For studies requiring the capture and handling of bird species in Tiger Reserves, a no-objection letter is also required from the National Tiger Conservation Authority.

In the specific case of observations of birds at nests, another legal aspect applies. In India's Wildlife (Protection) Act, 1972, the definition of 'hunting' under Section 2(16-c) of the Act states that 'hunting' includes "injuring or destroying or taking any part of the body of any such animal, *or in the case of wild birds or reptiles, damaging the eggs of such birds or reptiles, or disturbing the eggs or nests of such birds or reptiles*" (emphasis ours). Damaging or disturbing the eggs or nests of birds can thus be construed as 'hunting' under the Act and therefore liable for prosecution. Because of these legal provisions, it is very important that nest observers and researchers obtain required legal permits and exert due care in how they conduct their work.

Besides the required legal permits, observers may need to gain necessary training and experience in nest and bird observations and research techniques. This is particularly important for studies that involve (a) the capture and handling of birds by mist-netting and ringing, morphometric measurements, radio-telemetry, and geo-locator tagging studies, (b) experimental protocols and manipulation such as collection of blood or regurgitates, plumage alteration, nest modification, and egg or nestling experiments. Many institutions train birdwatchers and ornithologists in best practices and standard research methodologies (e.g., observation of animals, taking blood samples, mist-netting, bird ringing) and observers who plan to use these methods should seek out appropriate training and develop their credentials and expertise.

The Bombay Natural History Society undertakes bird ringing and trapping courses (www.bnhsenvis.nic.in) under the Green Skill Development Programme of MoEFCC, Govt. of India. In most cases, besides hands-on training and practice, researchers may have to pass a test following the training and may be provided certificates upon its successful completion. When writing reports or manuscripts based on observations and studies, it is important to indicate, in appropriate places, the following details: legal permits obtained, community consent, and training experience or expertise in capture and handling or experimental protocols used in the study.

5. Does my work conform to international standards and guidelines for the ethical conduct of research?

An additional, and overarching, aspect that is very important in bird nesting biology research, is ethics. Even if an observer has chosen appropriate objectives and observation methods, secured relevant legal permits, and acquired any relevant training or experience, there may be ethical considerations that apply. For instance, an observer may choose to carry out experimental manipulation of nests or use call-playback experiments to study aspects of breeding behaviour. The repeated manipulation of nests, or call-playbacks within the territories of nesting birds may, however, negatively affect birds if they become stressed, or are forced to expend extra energy, or take time away from other activities to respond to playback (Harris & Haskell 2013; Kannan & Santharam 2015). Ethical considerations may then dictate restrictions on the use of such methods or identify limited use such as a single manipulation or playback experiment per pair per breeding season (Sen 2009; Sibley 2011).

Most bird research, and long-term studies around the world follow international standards and methods as well as institutionally-approved ethical guidelines for research. Although such guidelines may be available, studies that involve potential harm or disturbance to birds would generally require to be considered on a case-by-case basis by relevant Institutional Review Boards or Research Ethics Committees. Institutions such as the Nature Conservation Foundation (henceforth, NCF), Ashoka Trust for Research in Ecology and the Environment, Indian Institute of Science Education and Research, National Centre for Biological Science, Bombay Natural History Society (henceforth, BNHS), and others have ethics committees that screen research proposals before the work is carried out. In BNHS, the Research Subcommittee reviews all prerequisites for projects that involve conservation breeding, bird handling, and bird ringing, including aspects such as permissions, necessary compliance, and training of people involved. The institutions also sensitise and train researchers in broad aspects of research ethics, and in the specific application of ethical considerations to research that may involve animal or human subjects, experiments, or manipulations. Institutional ethics guidelines are based on the synthesis of a large and growing body of global research on the effect of scientific research on animals, researchers, and human subjects who may be involved in the work. The NCF research ethics guidelines, for instance, take a 4Rs approach to ethical research (NCF Research Ethics Committee 2015), stating that: Researchers in NCF will carry out their research on animals, plants, and habitats, with care, compassion, and concern, by adopting methods and approaches that will, to the extent possible:

- **Replace** animal subjects by other alternatives when available and appropriate (e.g., including choice of non-invasive sample collection, modelling studies, etc.).
- **Reduce** the number of animals, specimens, or research samples (e.g., using improved techniques, existing specimens or data, and optimising experimental/study design).
- **Refine** methods to minimise harm and suffering, and advance animal welfare (e.g., by modifying capture and handling techniques, methods to minimise disturbance).
- **Refuse** to carry out research that violates fundamental ethical considerations (e.g., inhumane and unethical treatment of animals, use of force on local communities).

Above all else, if adhered to closely, ethical research practices ensure that both researchers and research subjects remain unharmed and endure the least amount of stress during the research period. Thus, it is important for researchers at an institution that neither have such committees nor requires compliance with institutional ethics guidelines, or amateur ornithologists who are not associated with research institutions, to take the time to read up on research ethics and guidelines (such as those listed in Table 1) and apply them to their work. This will help ascertain, and ensure, that as far as possible their observations do not unwittingly disturb or harm their research subjects.

When observers report their research or submit manuscripts for publication, their manuscript should detail, in the Methods section, how ethical issues were considered and how the adopted methods were modified or refined to address them. Authors should include a statement about what ethical guidelines were followed, citing relevant publications or documents such as general institutional guidelines or specific internationally accepted protocols or guidelines for the kind of work undertaken. While some researchers insert a line in the Acknowledgements section of their paper, that the work was carried out with ethics approval, some journals carry a separate section, 'Ethics statement', after Acknowledgements, for authors to provide such a statement, or information on ethical aspects.

Concluding comments

Indian ornithology and bird conservation face the dual challenges of widespread habitat loss and associated population declines of many Indian bird species along with a lack of understanding of even the basic biology and life history of many of these species. Data on the breeding biology of bird species are fundamental not only for academic research in behavioural ecology or evolutionary biology, but also to understand the impacts on birds of environmental changes from the local scale (e.g., pollution, habitat alteration) to regional (e.g., habitat fragmentation), and global scales (e.g., climate change). There is a need for studying the breeding and nesting biology of birds for a better understanding of their ecology, behaviour, and conservation needs. There is also, simultaneously, a need to carry out observations in a manner that is sensitive to the welfare of the birds because breeding birds are often vulnerable to disturbances associated with human observers. This dual need is the inspiration behind this manuscript.

Observers must ensure that they are well informed and aware of any potential detrimental aspects of making observations on birds, particularly at their nests, and implement measures to

Table 1. Resources, birdwatching codes, guidelines, and research ethics

Publisher (accession date)	Title	Website URL
American Birding Association, 2012 (accessed 06 Dec 2019)	Code of Birding Ethics	https://www.aba.org/aba-code-of-birding-ethics/
BirdLife Australia (accessed 22 Apr 2020)	Ethical Birding Guidelines	http://www.birdlife.org.au/documents/POL-Ethical-Birding-Guidelines.pdf
BirdLife Photography (accessed 22 Apr 2020)	BirdLife Photography Policy for Nesting Bird Photography and the use of Call Playback to Observe and/or Photograph Native Birds - Code of Ethics	https://www.birdlifephotography.org.au/index.php/about-us/our-policies
British Trust for Ornithology, UK (accessed 06 Dec 2019)	Legislation and good practice	https://www.bto.org/sites/default/files/u15/downloads/publications/legislation_and_good_practice.pdf
British Trust for Ornithology, UK (accessed 22 Nov 2019)	Nest Record Scheme (NRS) Code of Conduct	https://www.bto.org/our-science/projects/nrs/coc
Conservation India (accessed 22 Apr 2020)	Stop! Don't Shoot Like that – A Guide to Ethical Wildlife Photography	https://www.conservationindia.org/resources/ethics
Illinois Institute of Technology, USA (accessed 22 Apr 2020)	Ethics Education Library	https://ethics.iit.edu/eelibrary/
Mindful Birding (accessed 06 Dec 2019)	The Complete List of Ethical Birding Guidelines	http://mindfulbirding.org/images/mindful/pdfs/complete.pdf
NCF Research Ethics Committee, 2015 (accessed 19 Jan 2019)	NCF Wildlife Research Ethics Guidelines (Version 1, Feb 2015). Nature Conservation Foundation, Mysore	https://www.ncf-india.org/publications/ncf-wildlife-research-ethics-guidelines
Royal Society for the Protection of Birds, UK (accessed 22 Apr 2020)	The birdwatchers code	https://www.rspb.org.uk/birds-and-wildlife/wildlife-guides/birdwatching/the-birdwatchers-code/
Sen, S.K., 2009 (accessed 06 Dec 2019)	Birdcall playback ethics and science: what do we know about it?	http://www.kolkatabirds.com/callplayback.html
Sibley, D.A., 2011 (accessed 06 Dec 2019)	The proper use of playback in birding.	http://www.sibleyguides.com/2011/04/the-proper-use-of-playback-in-birding/

avoid, or minimise, disturbance for scientific, legal, and ethical reasons. Additionally, observers must balance the potential gains in new knowledge against possible harm to birds, with adequate preparation, choice of proper research methods, and justification, before embarking on such studies. We have outlined points to consider before studying the nesting biology of birds that will ensure their well-being, and likely increase the scope, reliability, and utility of the study. We fully understand that researchers will have to weigh trade-offs over the five questions outlined in this manuscript, when designing their own study. Such trade-offs and considerations are common in virtually all research, so it is important to be aware of them and to give them due attention during your research, from planning to execution to publication. We hope this article serves as a springboard for further discussion and the evolution of best practice protocols and guidelines for the study of Indian birds. We also hope that it enables further research and observations on birds that builds our knowledge of Indian birds in a manner that places the welfare of the birds at the forefront.

Acknowledgements

We thank the editors of *Indian BIRDS* for inviting us to write this manuscript. We thank Ragupathy Kannan and Divya Mudappa for useful discussions. TRSR thanks the Science and Engineering Research Board, India, for supporting (SERB grant EMR/2016/007968) the long-term bird community dynamics project.

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