

Alicja Wolska¹, Michał Ciach^{1,*}

Amphibians and reptiles in bird nests and bird-excavated cavities: a mini review

¹ Department of Forest Biodiversity, Faculty of Forestry, University of Agriculture, al. 29
Listopada 46, 31-425 Kraków, Poland

* Corresponding author e-mail: michal.ciach@urk.edu.pl

Alicja Wolska ORCID 0009-0001-4209-2877

Michał Ciach ORCID 0000-0002-5619-9747

Key words: bird architecture, construction behaviour, ecological engineering, endotherm, ectotherm

Highlights:

- Amphibians and reptiles use bird-created structures worldwide
- Interactions involve diverse amphibians and reptiles and numerous bird species
- Nests, cavities or burrows provide shelter, hibernacula, breeding or foraging sites
- Use of bird-created structures by ectothermic tetrapods is likely underestimated
- Targeted surveys are needed to detect short-term, cryptic and seasonal interactions

Abstract: Bird nests and bird-excavated cavities provide suitable environments for egg incubation and nestling development. However, bird-created structures are also exploited by a wide range of organisms, including taxa that are phylogenetically distant from the avian constructors. While birds, mammals, and invertebrates are well documented as secondary users of nests and cavities, the occurrence of ectothermic tetrapods, i.e. amphibians and reptiles, in bird-created structures has received little attention. Here, we review published records of amphibians and reptiles using bird nests, cavities excavated or modified by birds, nest boxes, and bird burrows. Our review shows that bird-created structures serve as shelters, hibernacula, breeding or foraging sites, and resource-rich microhabitats for a diverse range of amphibians and reptiles. Although records of ectothermic tetrapods occupying bird-created structures remain relatively scarce, we identified representatives of multiple families associated with structures created by a range of bird species across most biogeographic realms. The limited number of available records may reflect either the infrequent and short-term nature of these interactions or methodological challenges associated with detecting herpetofauna in active or abandoned nests, burrows, and cavities. We suggest that the use of bird-created structures by ectothermic vertebrates is more widespread than currently documented, but targeted surveys and appropriate detection methods are needed to investigate this phenomenon.

1. Introduction

Nest building is associated with reproduction and influences incubation behaviour, nestling care and offspring performance (Deeming & Reynolds, 2015). Although the primary function of a bird nest is to provide a suitable site for egg incubation and nestling development, nest architecture is shaped by ecological pressures and, in some cases, by sexual selection, resulting in considerable variation in nest placement, construction type, size and

materials used (Mainwaring et al., 2014; Healy, 2022). Consequently, nest architecture ranges from shallow scrapes on the ground, used for several weeks of incubation, to large and complex structures that provide sites for nestling care and offspring development over subsequent breeding seasons (Collias & Collias, 1984; Hansell, 2000). As nest abundance is closely related to the abundance of breeding birds in a given area, bird-created structures constitute a substantial component of many ecosystems, with their density and diversity varying considerably among habitat types.

Bird nests, burrows and bird-excavated cavities are characterized by modified abiotic and biotic conditions (Mainwaring et al., 2014; Deeming et al., 2020). These structures may buffer fluctuations in ambient temperature and humidity, reduce exposure to predators and accumulate organic matter such as faeces, food remains, feathers and nestling carcasses (Hansell, 2000). This accumulation of bird-associated organic matter is particularly pronounced in breeding colonies, where large quantities of faecal material may accumulate in the vicinity of nests over successive breeding seasons (Goc et al., 2005). Consequently, nests and their immediate surroundings may constitute distinct microhabitats within the broader ecosystem.

Once constructed or excavated by birds, nests, burrows and cavities may become resources for other organisms, including phylogenetically distant taxa. Published studies of secondary users have focused primarily on birds (Martin & Eadie, 1999; Delhey, 2018) and, to a lesser extent, on mammals (Czeszczewik et al., 2008) and selected groups of invertebrates (López-Rull & Macías García, 2015). In contrast, the use of bird-created structures by ectothermic tetrapods, i.e. amphibians and reptiles, is often regarded as rare. Many amphibians and reptiles use arboreal microhabitats, particularly in tropical forests (Kays & Allison, 2001), although climbing behaviour has also been documented in temperate regions (Waldron & Humphries, 2005; Petrovan et al., 2022). Moreover, reptiles are common

predators of bird eggs and nestlings and may visit nests while foraging (Stake et al., 2005; Menezes & Marini, 2017).

Given the widespread occurrence of bird-created structures in the environment, interactions between ectothermic tetrapods and bird nests, burrows or bird-excavated cavities may be more frequent than currently documented. However, such interactions can easily be overlooked during ornithological fieldwork and the limited number of available records may reflect underreporting rather than the true rarity of the phenomenon. The aim of this study is to review the published evidence for the use of bird-created structures by herpetofauna. We synthesize information on the species involved in interactions between amphibians or reptiles and avian structures, the geographic locations of reported records and the types of structures used, which we classify according to their functional roles.

2. Methods

We conducted a literature search for records of amphibians and reptiles in bird nests, bird burrows, bird-excavated cavities and nest boxes. The search was limited to English-language literature indexed in the Web of Science and Scopus databases. We used combinations of keywords related to avian structures, i.e. nest, cavity, tree hole, nest box, burrow, and herpetofauna, i.e. amphibian, frog, toad, salamander, newt, reptile, lizard, snake, turtle. Reference lists of the retrieved papers were also screened to identify additional sources reporting relevant records. The common and scientific names of taxa identified in the retrieved papers were subsequently used as keywords in additional database searches. To assess whether the use of bird-created structures by amphibians and reptiles had also been documented outside the scientific literature, we searched publicly available online sources, including Google, YouTube, Facebook and Instagram, using the same combinations of

keywords. Unpublished observations identified through these online sources were not included in the review.

For each literature record, we extracted the type of avian structure used, the bird species involved (if reported), the herpetofauna species involved, the number of observations (if reported), the functional role of the bird-created structure for secondary users, i.e. shelter, hibernaculum, foraging site, breeding site or colony-associated microhabitat, and the geographic location. Studies describing the use of tree cavities formed solely through wood decomposition, i.e. saproxylogenic cavities, were excluded unless birds were confirmed to have modified or occupied them. Records from studies that surveyed a general pool of bird-excavated and decay-formed cavities were retained without assigning individual observations to a specific cavity type, because this information could not be determined from the published data. We excluded nest boxes constructed for non-avian taxa, e.g. those designed for arboreal rodents, unless birds were confirmed to have used them as nesting sites. We also included studies describing herpetofauna using colony-associated microhabitats, i.e. nutrient-enriched ground beneath nesting trees, where the link to bird-created structures was associated with the presence of resources in the vicinity of nesting birds.

In this review, we use the term “bird/avian nest/structure” to refer to physical structures built or modified by birds for reproductive purposes. We distinguish four categories of microhabitats potentially attractive to herpetofauna: (A) open or enclosed nests – cup-shaped or domed nests constructed above the ground in vegetation, on the ground or floating on the water surface; (B) tree cavities excavated or modified by birds and bird nest boxes; (C) burrows – underground tunnels created by burrow-nesting birds; and (D) breeding colonies – aggregations of nests and associated habitats where bird activity locally modifies the environment.

3. Results

3.1. Amphibians

To date, 21 published reports have documented the use of bird-created structures by at least 21 amphibians, including 19 anurans and two caudates (Table 1). Anurans have been recorded using a range of bird-created structures, including open and enclosed nests, woodpecker-excavated cavities, nest boxes and burrows, whereas caudates have been recorded only in open nests (Table 1). Although climbing behaviour and the use of decay-formed tree hollows have been reported in salamanders (Basile et al., 2017; Bringsøe, 2013; Piraccini et al., 2017; Sequeira et al., 2001; Waldron & Humphries, 2005), this group of amphibians has not been documented using bird-excavated cavities or bird nest boxes. Given that amphibians use arboreal or elevated microhabitats, particularly in environments associated with water bodies (Oschadleus, 2015; Hałupka & Czylok, 2021), and that arboreal nests of small mammals and nest boxes designed for rodents are already known to be used by amphibians (Forsman & Swingle, 2007; Petrovan et al., 2022), additional species may be expected to utilize structures created by birds.

3.1.1. Shelters

Resting amphibians have been found in a range of bird-created structures, including open and enclosed nests, woodpecker-excavated cavities, nest boxes and bird burrows. At least 11 anurans have been documented in open and enclosed nests (Table 1). Among enclosed nests, those constructed by weavers have repeatedly been reported as shelters for frogs in Africa (Wilson, 1948; Kielgast & Lötters, 2009; Oschadleus, 2015). Enclosed nests of the fairy martin *Petrochelidon ariel* have been reported as shelters for at least three tree frog species in Australia (Schulz, 1998). The European tree frog *Hyla arborea* has been observed occupying open nests of the Eurasian reed warbler *Acrocephalus scirpaceus*, with at least one

case in which the presence of a frog likely contributed to egg cooling and nest failure (Hałupka & Czylok, 2021). Other reports have described anurans in abandoned passerine nests (Table 1), including those of the common blackbird *Turdus merula* (Petrovan et al., 2022) and the Eurasian chaffinch *Fringilla coelebs* (Schmidt & Smith, 1953). Anurans have also been found in floating nests of waterbirds, including the Eurasian coot *Fulica atra*, great crested grebe *Podiceps cristatus*, western grebe *Aechmophorus occidentalis* and Clark's grebe *Aechmophorus clarkii*. Floating nests of waterbirds and their surroundings may also be used by tadpoles, as these microhabitats host invertebrates that may serve as food for amphibian larvae (Hayes et al., 2018; Ceylan et al., 2021). Bird burrows, i.e. breeding sites excavated by rainbow bee-eaters *Merops ornatus*, have been used by cane toad *Rhinella marina* as shelters and foraging sites (Boland, 2004).

3.1.2. Breeding sites

Two amphibian species have been documented reproducing in bird-created structures (Table 1). The abandoned nests of the blue-billed malimbe *Malimbus nitens* contained remnants of nests constructed by the African foam-nest tree frog *Chiromantis rufescens* (Kielgast & Lötters, 2009), whereas eggs of the La Estrella salamander *Nototriton picadoi* have been recorded in the nest of an unidentified hummingbird (McCranie & Wilson, 1992). Bird nests located above the ground may protect eggs and tadpoles from predators and unfavourable abiotic conditions, similar to the conditions provided by phytotelmata used by amphibians for reproduction (Lehtinen et al., 2004).

3.1.3. Hibernacula

Floating nests of the Eurasian coot have been used as hibernacula by the smooth newt *Lissotriton vulgaris* (Van Der Goot et al., 2022). The European spadefoot toad *Pelobates*

fuscus and the natterjack toad *Epidalea calamita* have been reported to hibernate in the burrows of sand martin *Riparia riparia* (Wells, 2007).

3.1.4. Cavities and nest boxes

Woodpecker-excavated cavities and bird nest boxes have been documented as shelters for five anurans (Table 1). In one case, a common toad *Bufo bufo* was found in a cavity formed through wood decomposition that contained a nest of a great tit *Parus major* (Störr, 2003). Frogs and toads have also been reported inside nest boxes designed for non-avian species, i.e. for the hazel dormouse *Muscardinus avellanarius* (Petrovan et al., 2022).

3.1.5. Environment modified by bird colonies

Five amphibians have been recorded in the vicinity of nesting colonies of metallic starling *Aplonis metallica*, apparently exploiting the abundance of prey (Natusch et al., 2016). Breeding colonies concentrate nutrients and organic matter through the accumulation of faeces, food remains and nest debris, which may alter soil properties, vegetation structure and invertebrate communities (Goc et al., 2005). Amphibians may therefore benefit from bird nesting activity through increased prey availability or other habitat modifications. A similar resource-mediated effect has been documented in the green toad *Bufotes viridis*, for which greater availability of invertebrate prey was associated with the local accumulation of fallen fleshy fruits (Kaczmarek et al., 2019).

3.2. Reptiles

Although some reptiles are predators of bird eggs and nestlings (Weatherhead & Blouin-Demers, 2004; DeGregorio et al., 2014; DeGregorio et al., 2015; Menezes & Marini, 2017), non-predatory use of bird-created structures has also been documented (Table 2). In

some cases, reptiles use avian structures as shelters or foraging sites, while a few records suggest more complex commensal or mutualistic associations. The 26 published reports documented at least 49 reptiles using bird-created structures, including lizards, snakes, turtles, crocodilians and tuatara (Table 2).

3.2.1. Shelters

At least 19 reptiles have been recorded using open nests, enclosed nests and burrows as shelters (Table 2). For example, western pond turtles *Actinemys marmorata*, pond sliders *Trachemys scripta* and terrestrial garter snakes *Thamnophis elegans* have been observed basking on floating grebe nests (Hayes et al., 2018). Enclosed nests of the fairy martin have also been used by at least seven reptile species (Schulz, 1998). Seabird burrows provide another example, with blue-lipped sea krait *Laticauda laticaudata* and New Caledonian sea krait *Laticauda saintgironsi* recorded in burrows excavated by wedge-tailed shearwater *Ardeanna pacifica* (Lane & Shine, 2011).

3.2.2. Cohabitation

Reptile use of bird-created structures may involve more complex interactions, including cohabitation with nesting birds and the exploitation of prey resources associated with bird breeding activity (Table 2). An example of reptile–bird cohabitation is the association between the tuatara *Sphenodon punctatus* and the burrow-nesting fairy prion *Pachyptila turtur*, in which the reptile uses the burrow as a shelter and feeds largely on ground-dwelling invertebrates attracted by faeces and food remains deposited by birds (Corkery et al., 2015). Another example of cohabitation and the use of nests as foraging sites involves blind snakes: the Texas blind snake *Rena dulcis* has been found within nests of the elf owl *Micrathene whitneyi* and the eastern screech owl *Megascops asio* (Gehlbach &

Baldrige, 1987; Bucher, 1988), while the worm snake *Xerotyphlops vermicularis* has been recorded in nests of the Eurasian scops owl *Otus scops* (Göçer et al., 2025). Although it remains unclear whether the snakes were transported to the nests by owls as potential prey or entered the nests intentionally, these snakes feed on invertebrates and may potentially reduce ectoparasite loads, thereby indirectly benefiting the birds (Gehlbach & Baldrige, 1987; Bucher, 1988; Göçer et al., 2025).

3.2.3. Cavities and nest boxes

At least 18 reptiles have been reported using woodpecker- or barbet-excavated cavities and bird nest boxes, primarily as shelters (Table 2). Observations from other arboreal microhabitats, including nest boxes designed for non-avian taxa (Fokidis & Risch, 2005) and decay-formed cavities (Patel et al., 2021), suggest that reptiles may use bird-created cavities more frequently than currently documented (Warakai et al., 2013). In tropical regions, reptiles use arboreal microhabitats not only for shelter but also as hibernacula and breeding sites (Ellinger et al., 2001; Chiesari et al., 2003; Bryant et al., 2012). Studies from Australia, where primary cavity excavators are scarce and most cavities are formed through decay processes, show that many lizards and snakes use tree hollows for shelter, thermoregulation, and reproduction (Webb & Shine, 1997; Gibbons & Lindenmayer, 2002; Fitzgerald et al., 2010).

3.2.4. Environment modified by bird colonies

The immediate vicinity of metallic starling nesting colonies has been used by 12 reptiles, apparently attracted by modified habitat conditions or increased food availability (Natusch et al., 2016). Colony-associated interactions are also exemplified by the association between the American alligator *Alligator mississippiensis* and colonial waterbirds (Ciconiiformes and Pelecaniformes). In this system, birds nesting above alligator-inhabited

waters gain protection from mammalian predators, whereas alligators benefit from scavenging dead nestlings and other bird-derived prey and remains (Nell & Frederick, 2015; Nell et al., 2016; Gabel et al., 2019, 2021). In both cases, reptiles do not use the nests directly but apparently recognize and exploit resources generated by the activity of breeding birds.

5. Discussion

Our review shows that bird nests, burrows and bird-excavated cavities are used by a range of ectothermic tetrapods across most biogeographical realms as shelters, hibernacula, breeding sites and foraging microhabitats. Specific thermal and humidity conditions are important for the activity and survival of ectotherms (Hertz et al., 1993; Taylor et al., 2021), and open nests located above water, as well as floating nests, may facilitate thermoregulation. Concealment within the interior of these structures may reduce exposure to predators and buffer extreme temperatures and unfavourable weather conditions (Schwarzkopf & Alford, 1996; Lelièvre et al., 2010; Yu et al., 2022); enclosed nests, cavities, nest boxes and burrows may therefore function as shelters. Hibernating herpetofauna also depends on microhabitats that buffer fluctuations in ambient conditions (Ultsch, 2006), and burrows and other insulated bird-created structures may be used during cold or dry seasons. Bird nests and nesting colonies also accumulate organic material, which may support invertebrate communities, increase local food availability, influence trophic interactions, and provide foraging opportunities for amphibians and reptiles (Caseiro-Silva et al., 2023; Levesque-Beaudin et al., 2023; Maziarz et al., 2026). However, the relationship between herpetofauna and bird-created structures remains poorly documented compared with the use of such structures by avian and mammalian secondary users (Cockle et al., 2011; Martin, 2015; Delhey, 2018).

The use of bird-created structures by ectothermic vertebrates is consistent with the broader concept of ecological engineering, whereby organisms modify the environment and

thereby alter habitat conditions and resource availability for other species (Hastings et al., 2007). Termite mounds (Moreira et al., 2009), ant nests (Kronauer & Pierce, 2011), mammal burrows (Kotliar et al., 1999), reptile burrows (Jackson & Milstrey, 1989), and reptile nests (Pierini et al., 2025), all of which are used by other species, demonstrate that animal-built structures can function as microhabitats for organisms other than their constructors. Mammals also construct persistent nests and burrows that may be secondarily occupied by herpetofauna (Forsman & Swingle, 2007; Connior & Guenther, 2008), extending this pattern beyond avian structures. Ecosystem engineers generally have positive effects on species richness (Romero et al., 2015), and these effects may extend beyond the direct activity of the engineer, influencing other organisms across broader spatial and temporal scales (Hastings et al., 2007). Therefore, the ecological role of structures built by birds for reproduction may extend beyond their original function, providing resources and microhabitats for ectothermic vertebrates.

Although most published records involve abandoned nests or observations made outside the breeding season, several studies have documented amphibians and reptiles occupying active nests or occurring in the vicinity of breeding colonies. Consequently, the effects of herpetofauna on birds may vary depending on the timing of nest use and the species involved. In active nests, amphibians and reptiles may negatively affect breeding success, as reported for the European tree frog occupying nests of the Eurasian reed warbler, where the frog's presence likely contributed to egg cooling and nest failure (Hałupka & Czylok, 2021). Conversely, some interactions may be neutral or potentially beneficial to birds and may represent examples of commensalism or mutualism, depending on the effects of reptile presence on the birds. For example, blind snakes feeding on arthropods in owl nests may reduce ectoparasite loads (Bucher, 1988; Göçer et al., 2025). At the colony scale, reptiles may also influence avian breeding success indirectly, as American alligators beneath breeding colonies provide anti-predator benefits to nesting birds while exploiting fallen nestlings and

other bird-derived organic material (Nell & Frederick, 2015; Nell et al., 2016; Gabel et al., 2019, 2021). The co-occurrence of birds and reptiles at nesting sites may also have a long evolutionary history, as Late Cretaceous fossils suggest that birds, crocodylomorphs and gekkotan squamates may have nested in close association at the same locality (Fernández et al., 2019).

Amphibian and reptile species richness is higher in the tropics than in temperate and boreal climatic zones (Azevedo Calderon & Guerino, 2011; Pincheira-Donoso et al., 2013). Therefore, interactions between herpetofauna and bird-created structures may be more common in tropical regions, particularly where amphibians and reptiles frequently use arboreal microhabitats (Kays & Allison, 2001). The limited number of published records from tropical forests may reflect methodological constraints, as forest canopies are difficult to access and arboreal amphibians and reptiles are often challenging to survey (Barker & Pinard, 2001; Kays & Allison, 2001). In addition, biodiversity research is geographically biased towards temperate and boreal regions, whereas countries located in the tropics remain relatively understudied despite their high biodiversity (Titley et al., 2017). Consequently, records from tropical regions compiled in our study should be interpreted as documented examples of a potentially broader but poorly sampled set of interactions. Records from temperate climatic zones, i.e. relatively well-studied regions, indicate that bird-created structures may be used more frequently by herpetofauna as shelters, breeding sites or foraging sites.

Tree cavities are widely recognised as important structures for forest biodiversity, providing shelter, nesting and roosting sites for numerous vertebrates (Cockle et al., 2011; Remm & Lõhmus, 2011). Primary cavity excavators, such as woodpeckers, create cavities that are subsequently used by multiple secondary cavity users, particularly birds and mammals, and can therefore influence cavity-dependent communities (Martin et al., 2004;

Cockle et al., 2011). As amphibians and reptiles use a variety of microhabitats that enhance moisture retention, predator avoidance, thermoregulation and overwintering opportunities (Hertz et al., 1993; Schwarzkopf & Alford, 1996; Taylor et al., 2021), bird-created structures may represent additional microhabitats of importance to these groups of ectothermic tetrapods. From a conservation perspective, bird-created structures should be viewed not only as resources for avian and mammalian secondary users but also as potential habitat components for amphibians and reptiles. Therefore, management actions that reduce the availability of old tree cavities and old bird nests, or that limit populations of cavity excavators and nest constructors may affect a broader range of vertebrates, including ectothermic taxa, and potentially contribute to declines in overall biodiversity.

Our dataset should be considered a conservative minimum estimate of the true diversity and frequency of interactions between herpetofauna and bird-created structures. As many amphibians and reptiles are secretive, nocturnal or seasonally active, their detection can be challenging. Most records of amphibians and reptiles in nests or cavities originate from incidental observations made during studies focusing on avian breeding ecology. Moreover, inspections of bird-created structures outside the breeding season are not routinely conducted, further limiting the detection of such associations. Therefore, the absence of records for species known to climb or use elevated microhabitats may reflect the design and timing of current studies rather than the actual absence of such behaviour. In addition, the use of nests by amphibians and reptiles may leave few or no detectable traces, severely limiting the potential for indirect detection. Camera trapping (Gregory et al., 2014; Cotsell & Vernes, 2016) and environmental DNA sampling (Newton et al., 2022; Kronenberger et al., 2025) of nests and cavities, together with more systematic surveys of unoccupied and abandoned nests and cavities during the non-breeding season, could increase the number of documented records of herpetofauna in bird-created structures. Additional records may exist in journals

published in national languages that are not indexed in major bibliographic databases, while some observations remain unpublished but are nevertheless available through publicly accessible online sources (Fig. 1).

Our review shows that bird-created structures serve as shelters, hibernacula, breeding sites and resource-rich microhabitats for amphibians and reptiles. Although records of ectothermic vertebrates in bird-created structures remain relatively scarce, our review identified representatives of multiple herpetofauna families and a range of bird species involved in such interactions across most biogeographical realms. The consequences of nest or cavity use for both ectothermic tetrapods and birds remain largely unexplored and further studies are needed to determine the actual frequency and ecological significance of these interactions. Given the global threat of extinction faced by many herpetofauna species, particularly amphibians (Houlahan et al., 2000; Stuart et al., 2004), as well as significant regional declines and increasing homogenization of bird populations (Şekercioğlu et al., 2004; Clavel et al., 2011; Rosenberg et al., 2019), the frequency of these interactions may decline over time and some may disappear before they are documented. Recognizing the ecological relationship between bird nests and cavities and herpetofauna may also contribute to the effective conservation of the microhabitats provided by birds.

Funding declaration

This research was funded by the National Science Centre, Poland (No. 2021/41/B/NZ8/03456).

Authorship contribution statement

Alicja Wolska: Data curation, Formal analysis, Investigation, Methodology, Writing - original draft, Writing - review & editing; **Michał Ciach:** Conceptualization, Funding acquisition, Investigation, Methodology, Supervision, Writing - original draft, Writing - review & editing.

Ethical statement

The study was performed in accordance with Polish law.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

All the data used in this study is presented in tables.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors did not use Generative AI and AI-assisted tools.

7. References

- Azevedo Calderon, L. de, & Guerino, R. (2011). Anuran Amphibians: A Huge and Threatened Factory of a Variety of Active Peptides with Potential Nanobiotechnological Applications in the Face of Amphibian Decline. *Changing Diversity in Changing Environment*. <https://doi.org/10.5772/25106>
- Barker, M. G., & Pinard, M. A. (2001). Forest canopy research: Sampling problems, and some solutions. *Plant Ecology*, 153, 1–2. <https://doi.org/10.1023/A:1017584130692>
- Basile, M., Romano, A., Costa, A., Posillico, M., Roger, D. S., Crisci, A., Raimondi, R., Altea, T., Garfi, V., Santopuoli, G., Marchetti, M., Salvidio, S., De Cinti, B., & Matteucci, G. (2017). Seasonality and microhabitat selection in a forest-dwelling salamander. *Science of Nature*, 104, 9–10. <https://doi.org/10.1007/S00114-017-1500-6>
- Boland, C. R. J. (2004). Introduced cane toads *Bufo marinus* are active nest predators and competitors of rainbow bee-eaters *Merops ornatus*: Observational and experimental evidence. *Biological Conservation*, 120(1). <https://doi.org/10.1016/j.biocon.2004.01.025>
- Borgo, J. S., Conover, M. R., Berryman, J. H., Conner, L. M., & Jones, J. W. (2009). Nest Boxes Reduce Flying Squirrel Use of Red-Cockaded Woodpecker Cavities. *Wildlife Society Bulletin*, 34(1), 171–176. [https://doi.org/10.2193/0091-7648\(2006\)34\[171:NBRFSU\]2.0.CO;2](https://doi.org/10.2193/0091-7648(2006)34[171:NBRFSU]2.0.CO;2)
- Bringsøe, H. (2013). Height-seeking habits of the Smooth Newt, *Lissotriton vulgaris* – a neglected behavioural trait. *Mertensiella*, 19, 131–138.
- Bryant, G. L., Dundas, S. J., & Fleming, P. A. (2012). Tree hollows are of conservation importance for a Near-Threatened python species. *Journal of Zoology*, 286(1), 81–92. <https://doi.org/10.1111/j.1469-7998.2011.00852.x>
- Bucher, E. H. (1988). Do birds use biological control against nest parasites? *Parasitology Today*, 4(1), 1–3. [https://doi.org/10.1016/0169-4758\(88\)90045-2](https://doi.org/10.1016/0169-4758(88)90045-2)
- Buckley, E.E. & Maritz, B. (2026), Community- and species-level responses of reptiles to an avian ecosystem engineer. *Journal of Zoology*, 328, 203–209. <https://doi.org/10.1111/jzo.70087>

- Caseiro-Silva, F., Faria, F. A., Barreto, C. T., Fernandez, C. N., & Bugoni, L. (2023). Colonial waterbirds provide persistent subsidies to swamp forests along an estuarine island food chain. *Oecologia*, 202(1). <https://doi.org/10.1007/s00442-023-05377-y>
- Ceylan, M., Çetinkaya, O., & Kvist, S. (2021). Function of the waterfowl nests as reproduction and living areas for leeches (Annelida: Hirudinea). *Animal Reproduction Science*, 232. <https://doi.org/10.1016/j.anireprosci.2021.106816>
- Chiesari, L., Gordo, M., & Hödl, W. (2003). Treeholes as Calling, Breeding, and Developmental Sites for the Amazonian Canopy Frog. *Copeia*, 2003(2).
- Clavel, J., Julliard, R., & Devictor, V. (2011). Worldwide decline of specialist species: Toward a global functional homogenization? *Frontiers in Ecology and the Environment*, 9(4). <https://doi.org/10.1890/080216>
- Cockle, K. L., Martin, K., & Wesolowski, T. (2011). Woodpeckers, decay, and the future of cavity-nesting vertebrate communities worldwide. *Frontiers in Ecology and the Environment*, 9(7), 377–382. <https://doi.org/10.1890/110013>
- Collias, N. E., & Collias, E. C. (1984). *Nest Building and Bird Behavior*. Princeton University Press.
- Conner, R. N., Rudolph, D. C., Saenz, D., & Schaefer, R. R. (1997). Species Using Red-Cockaded Woodpecker Cavities in Eastern Texas. *Faculty Publications*.
- Conner, R. N., Saenz, Daniel., & Rudolph, D. C. (1995). Fauna using nest boxes in four timber types in eastern Texas. *Bulletin of the Texas Ornithological Society*, 28(1), 101–102.
- Connior, M., & Guenther, I. (2008). Amphibian, reptile, and small mammal associates of Ozark pocket gopher habitat in Izard County, Arkansas. *Journal of the Arkansas Academy of Science*, 62(1), 45–51.
- Corkery, I., Bell, B. D., & Nelson, N. J. (2015). Is the breeding behaviour of nesting seabirds influenced by the presence of a predatory reptile - The tuatara? *Journal of the Royal Society of New Zealand*, 45(1), 21–30. <https://doi.org/10.1080/03036758.2014.999690>
- Cotsell, N., & Vernes, K. (2016). Camera traps in the canopy: Surveying wildlife at tree hollow entrances. *Pacific Conservation Biology*, 22(1), 48–60. <https://doi.org/10.1071/PC15030>
- Czeszczewik, D., Walankiewicz, W., & Stańska, M. (2008). Small mammals in nests of cavity-nesting birds: Why should ornithologists study rodents? *Canadian Journal of Zoology*, 86(4), 286–293. <https://doi.org/10.1139/Z07-139>
- Deeming, D. C., Dickinson, A. M., Broughton, R. E., Locke, E., Gray, L. A., Bennett, S. L., Gilchrist, R., Muniz, S., Goodman, A. M., & Biddle, L. E. (2020). Factors Affecting Thermal Insulation of Songbird Nests as Measured Using Temperature Loggers. *Physiological and Biochemical Zoology*, 93(6). <https://doi.org/10.1086/711959>
- Deeming, D. C., & Reynolds, S. J. (2015). *Nests, Eggs, and Incubation: New ideas about avian reproduction*. Oxford University Press.
- DeGregorio, B. A., Chiavacci, S. J., Weatherhead, P. J., Willson, J. D., Benson, T. J., & Sperry, J. H. (2014). Snake predation on North American bird nests: Culprits, patterns and future directions. *Journal of Avian Biology*, 45(4). <https://doi.org/10.1111/jav.00364>
- DeGregorio, B. A., Sperry, J. H., Ward, M. P., & Weatherhead, P. J. (2015). Wait Until Dark? Daily Activity Patterns and Nest Predation by Snakes. *Ethology*, 121: 1225–1234. <https://doi.org/10.1111/eth.12435>
- Delhey, K. (2018). Nest webs beyond woodpeckers. *Ecology*, 99(4), 985–988. <https://doi.org/10.2307/26625554>
- Ellinger, N., Schlatter, G., Jerome, N., & Hödl, W. (2001). Habitat use and activity patterns of the neotropical arboreal lizard *Tropidurus (= Uracentron) azureus wernerii* (Tropiduridae). *Journal of Herpetology*, 35(3). <https://doi.org/10.2307/1565957>

- Fernández, M. S., Wang, X., Vremir, M., Laurent, C., Naish, D., Kaiser, G., & Dyke, G. (2019). A mixed vertebrate eggshell assemblage from the Transylvanian Late Cretaceous. *Scientific Reports*, 9(1). <https://doi.org/10.1038/s41598-018-36305-3>
- Fitzgerald, M., Lazell, B., & Shine, R. (2010). Ecology and conservation of the Pale-headed Snake (*Hoplocephalus bitorquatus*, Elapidae). *Australian Zoologist*, 35(2), 283–290. <https://doi.org/10.7882/AZ.2010.017>
- Fokidis, H. B., & Risch, T. S. (2005). The use of nest boxes to sample arboreal vertebrates. *Southeastern Naturalist*, 4(3), 447–458. [https://doi.org/10.1656/1528-7092\(2005\)004\[0447:TUONBT\]2.0.CO;2](https://doi.org/10.1656/1528-7092(2005)004[0447:TUONBT]2.0.CO;2)
- Forsman, E. D., & Swingle, J. K. (2007). Use of arboreal nests of tree voles (*Arborimus* spp.) by amphibians. *Herpetological Conservation and Biology*, 2(2).
- Gabel, W., Frederick, P., & Zabala, J. (2019). Nestling carcasses from colonially breeding wading birds: patterns of access and energetic relevance for a vertebrate scavenger community. *Scientific Reports*, 9(1). <https://doi.org/10.1038/s41598-019-50986-4>
- Gabel, W., Frederick, P., & Zabala, J. (2021). Alligator presence influences colony site selection of long-legged wading birds through large scale facilitative nest protector relationship. *Scientific Reports*, 11(1). <https://doi.org/10.1038/s41598-020-80185-5>
- Gehlbach, F. R., & Baldrige, R. S. (1987). Live blind snakes (*Leptotyphlops dulcis*) in eastern screech owl (*Otus asio*) nests: a novel commensalism. *Oecologia*, 71(4). <https://doi.org/10.1007/BF00379297>
- Gibbons, P., & Lindenmayer, D. (2002). Tree Hollows and Wildlife Conservation in Australia. CSIRO publishing. <https://doi.org/10.1071/9780643090033>
- Goc, M., Iliszko, L., & Stempniewicz, L. (2005). The largest European colony of the great cormorant on the Vistula Spit (N Poland) - an impact on the forest ecosystem. *Ecological Questions*, 6.
- Goçer, E., Johnson, D. H., Bilgin, C. C., & Vrezec, A. (2025). Association of nesting *Otus scops* (Eurasian Scops Owl) with *Xerotyphlops vermicularis* (worm snake) in Türkiye. *Ornithology*. <https://doi.org/10.1093/ornithology/ukaf054>
- Gregory, T., Carrasco Rueda, F., Deichmann, J., Kolowski, J., & Alonso, A. (2014). Arboreal camera trapping: Taking a proven method to new heights. *Methods in Ecology and Evolution*, 5(5). <https://doi.org/10.1111/2041-210X.12177>
- Halupka, L., & Czylok, A. (2021). The European Tree Frog *Hyla arborea* as a probable reason for nest failure in the Eurasian Reed Warbler *Acrocephalus scirpaceus*. *Ornithol Science*, 20. <http://www.wbrc.org.uk/WorcRecd/>
- Hansell, M. (2000). Bird Nests and Construction Behaviour. Cambridge University Press.
- Hastings, A., Byers, J.E., Crooks, J.A., Cuddington, K., Jones, C.G., Lambrinos, J.G., Talley, T.S. & Wilson, W.G. (2007). Ecosystem engineering in space and time. *Ecology Letters*, 10: 153–164. <https://doi.org/10.1111/j.1461-0248.2006.00997.x>
- Hayes, F. E., Turner, D. G., McIntosh, B. J., Weidemann, D. E., Zimmerly, N. D., Peralta, M. B., Stoppelmoor, D. B., & Hellie, M. E. (2018). Floating bird nests provide resources for wildlife: ecological roles of vertebrates using *Aechmophorus* grebe nests at Clear Lake, California. *Wetlands Ecology and Management*, 26(6). <https://doi.org/10.1007/s11273-018-9631-x>
- Healy, S. D. (2022). Nests and nest building in birds. *Current Biology*, 32(20). <https://doi.org/10.1016/j.cub.2022.06.078>
- Hernández, A. (1992). *Lacerta schreiberi* using a *Lanius collurio* nest as a sleeping site. *Amphibia-Reptilia*, 13(1), 79–80. <https://doi.org/10.1163/156853892X00265>
- Hertz, P. E., Huey, R. B., & Stevenson, R. D. (1993). Evaluating temperature regulation by field-active ectotherms: The fallacy of the inappropriate question. *American Naturalist*, 142(5). <https://doi.org/10.1086/285573>

- Houlahan, J. E., Fiday, C. S., Schmidt, B. R., Meyer, A. H., & Kuzmin, S. L. (2000). Quantitative evidence for global amphibian population declines. *Nature*, 404(6779). <https://doi.org/10.1038/35008052>
- Hussain, I., Abbasi, S., Mirza, S. N., Anwar, M., Rais, M., & Mahmood, T. (2013). Tree cavities and associated vertebrate fauna in a coniferous forest of Dhirkot, Azad Jammu and Kashmir part of Pakistan. *Turkish Journal of Zoology*, 37(5), 647–658. <https://doi.org/10.3906/zoo-1209-32>
- Jackson, D. R., & Milstrey, E. G. (1989). The fauna of gopher tortoise burrows. 86–98.
- Kaczmarek, M., Tryjanowski, P., & Kubicka, A. M. (2019). Urban plums and toads: Do fleshy fruits affect the post-metamorphic growth of amphibians? *PeerJ*, 2019(1). <https://doi.org/10.7717/peerj.6337>
- Kays, R., & Allison, A. (2001). Arboreal tropical forest vertebrates: Current knowledge and research trends. *Plant Ecology*, 153(1–2). <https://doi.org/10.1023/A:1017585622940>
- Kielgast, J., & Lötters, S. (2009). Forest weaverbird nests utilized by foam-nest frogs (*Rhacophoridae: Chiromantis*) in Central Africa. *Salamandra*, 45(3), 170–171.
- Kotliar, N. B., Baker, B. W., Whicker, A. D., & Plumb, G. (1999). A critical review of assumptions about the prairie dog as a keystone species. *Environmental Management*, 24(2). <https://doi.org/10.1007/s002679900225>
- Kronauer, D. J. C., & Pierce, N. E. (2011). Myrmecophiles. *Current Biology*, 21(6). <https://doi.org/10.1016/j.cub.2011.01.050>
- Kronenberg, J. A., Zarri, E. C., Noson, A., & Wilcox, T. M. (2025). Metabarcoding Close to Home: Songbird Nests as eDNA Aggregators for Trophic Ecology and Biodiversity Studies. *Ecology and Evolution*, 15(10). <https://doi.org/10.1002/ece3.72164>
- Lane, A. M., & Shine, R. (2011). When seasnake meets seabird: Ecosystem engineering, facilitation and competition. *Austral Ecology*, 36(5). <https://doi.org/10.1111/j.1442-9993.2010.02185.x>
- Lehtinen, R. M., Lannoo, M. J., & Wassersu, R. J. (2004). Phytotelm-breeding anurans: past, present and future research. *Miscellaneous Publications, Museum of Zoology, University of Michigan*, 193, 1–9.
- Lelièvre, H., Blouin-Demers, G., Bonnet, X., & Lourdais, O. (2010). Thermal benefits of artificial shelters in snakes: A radiotelemetric study of two sympatric colubrids. *Journal of Thermal Biology*, 35(7). <https://doi.org/10.1016/j.jtherbio.2010.06.011>
- Levesque-Beaudin, V., Steinke, D., Böcker, M., & Thalinger, B. (2023). Unravelling bird nest arthropod community structure using metabarcoding. *Metabarcoding and Metagenomics*, 7. <https://doi.org/10.3897/mbmg.7.103279>
- Lowney, A. M., & Thomson, R. L. (2022). Ecological engineering across a spatial gradient: sociable weaver colonies facilitate animal associations with increasing environmental harshness. *Journal of Animal Ecology*, 91, 1385–1399. doi:10.1111/1365-2656.13688
- López-Rull, I., & Macías García, C. (2015). Control of invertebrate occupants of nests. *Nests, Eggs, and Incubation*. Oxford University Press, Oxford, 82–96.
- Maclean, G. L. (1973). The Sociable Weaver, Part 4: Predators, Parasites and Symbionts. *Ostrich*, 44(3–4), 241–253. <https://doi.org/10.1080/00306525.1973.9639161>
- Mainwaring, M. C., Hartley, I. R., Lambrechts, M. M., & Deeming, D. C. (2014). The design and function of birds' nests. *Ecology and Evolution*, 4(20), 3909–3928. <https://doi.org/10.1002/ece3.1054>
- Manikandan, P., & Balasubramanian, P. (2018). Sequential Use of Tree Cavities by Birds and Nest Web in a Riparian Forest in Southwest India. *Acta Ornithologica*, 53(1). <https://doi.org/10.3161/00016454AO2018.53.1.005>

- Martin, K. (2015). Nest webs and woodpecker ecological services: the role of woodpeckers in tree cavity-using wildlife communities in North America. *Denisia, Zugleich Kataloge Des Oberösterreichischen Landesmuseums*, 36(164), 77–86.
- Martin, K., Aitken, K. E. H., & Wiebe, K. L. (2004). Nest sites and nest webs for cavity-nesting communities in interior British Columbia, Canada: Nest characteristics and niche partitioning. *Condor*, 106(1), 5–19. <https://doi.org/10.1650/7482>
- Martin, K., & Eadie, J. M. (1999). Nest webs: A community-wide approach to the management and conservation of cavity-nesting forest birds. *Forest Ecology and Management*, 115(2-3), 243-257.
- Maziarz, M., Broughton, R. K., Foster, C. W., Leśniewska, M., Mazur, M. A., Rutkowski, T., Trigos-Peral, G., Witek, M., & Hebda, G. (2026). Bird nests support a diverse, dynamic and distinctive macroarthropod community on the forest floor. *Insect Conservation and Diversity*.
- McComb, W. C., & Noble, R. E. (1981). Herpetofaunal use of natural tree cavities and nest boxes. *Wildlife Society Bulletin*, 9(4), 261–267.
- McCranie, J. R., & Wilson, L. D. (1992). Life history notes. *Nototriton barbouri* (NCN): reproduction. *Herpetological Review*, 23, 115–116.
- Menezes, J. C. T., & Marini, M. Â. (2017). Predators of bird nests in the Neotropics: a review. *Journal of Field Ornithology*, 88(2), 99–114. <https://doi.org/10.1111/JOFO.12203>
- Moreira, L. A., Fenolio, D. B., Silva, H. L. R., & da Silva, N. J. (2009). A preliminary list of the herpetofauna from termite mounds of the Cerrado in the Upper Tocantins river valley. *Papeis Avulsos de Zoologia*, 49(15). <https://doi.org/10.1590/s0031-10492009001500001>
- Natusch, D. J. D., Lyons, J. A., Brown, G., & Shine, R. (2016). Communally Nesting Migratory Birds Create Ecological Hot-Spots in Tropical Australia. *PLoS One*, 11(10), e0162651. <https://doi.org/10.1371/JOURNAL.PONE.0162651>
- Nell, L. A., & Frederick, P. C. (2015). Fallen Nestlings and Regurgitant as Mechanisms of Nutrient Transfer from Nesting Wading Birds to Crocodilians. *Wetlands*, 35(4), 723–732. <https://doi.org/10.1007/s13157-015-0664-0>
- Nell, L. A., Frederick, P. C., Mazzotti, F. J., Vliet, K. A., & Brandt, L. A. (2016). Presence of breeding birds improves body condition for a crocodilian nest protector. *PLoS One*, 11(3). <https://doi.org/10.1371/journal.pone.0149572>
- Newton, J. P., Bateman, P. W., Heydenrych, M. J., Mousavi-Derazmahalleh, M., & Nevill, P. (2022). Home is where the hollow is: Revealing vertebrate tree hollow user biodiversity with eDNA metabarcoding. *Environmental DNA*, 4(5). <https://doi.org/10.1002/edn3.313>
- Oschadleus, D. (2015). Weaver nests as a resting site for frogs. *Herpetology Notes*, 8, 129–131. <https://www.researchgate.net/publication/286620893>
- Patel, B., Sivaraman, S., & Balakrishanan, P. (2021). Use of tree cavities by Indian vertebrates: status of research, knowledge gaps and future conservation perspectives. *Current Science*, 121(4).
- Petrovan, S. O., Al-Fulaij, N., Christie, A., & Andrews, H. (2022). Why link diverse citizen science surveys? Widespread arboreal habits of a terrestrial amphibian revealed by mammalian tree surveys in Britain. *PloS One*, 17(7), e0265156. <https://doi.org/10.1371/JOURNAL.PONE.0265156>
- Pierini, S. E., Simoncini, M. S., Larriera, A., Frutos, A. E., & Piña, C. I. (2025). Are caiman nests microhabitats? Assessing their ecological role across different levels of anthropogenic disturbance. *Proceedings of the Royal Society B: Biological Sciences*, 292(2052).
- Pincheira-Donoso, D., Bauer, A. M., Meiri, S., & Uetz, P. (2013). Global Taxonomic Diversity of Living Reptiles. *PLoS One*, 8(3). <https://doi.org/10.1371/journal.pone.0059741>

- Piraccini, R., Cammarano, M., Costa, A., Basile, M., Posillico, M., Boitani, L., Bascietto, M., Matteucci, G., De Cinti, B., & Romano, A. (2017). Habitat trees and salamanders: Conservation and management implications in temperate forests. *Forest Ecology and Management*, 384, 17–25. <https://doi.org/10.1016/j.foreco.2016.10.048>
- Remm, J., & Löhmus, A. (2011). Tree cavities in forests - The broad distribution pattern of a keystone structure for biodiversity. *Forest Ecology and Management*, 262(4), 579–585. <https://doi.org/10.1016/j.foreco.2011.04.028>
- Romero, G. Q., Gonçalves-Souza, T., Vieira, C., & Koricheva, J. (2015). Ecosystem engineering effects on species diversity across ecosystems: A Meta-analysis. *Biological Reviews*, 90(3). <https://doi.org/10.1111/brv.12138>
- Rosenberg, K. V., Dokter, A. M., Blancher, P. J., Sauer, J. R., Smith, A. C., Smith, P. A., Stanton, J. C., Panjabi, A., Helt, L., Parr, M., & Marra, P. P. (2019). Decline of the North American avifauna. *Science*, 366(6461). <https://doi.org/10.1126/science.aaw1313>
- Rymer, T. L., Thomson, R. L., & Whiting, M. J. (2014). At home with the birds: Kalahari tree skinks associate with sociable weaver nests despite African pygmy falcon presence. *Austral Ecology*, 39(7), 839–847. <https://doi.org/10.1111/aec.12152>
- Sarà, M., Milazzo, A., Falletta, W., & Bellia, E. (2005). Exploitation competition between hole-nesters (*Musccardinus avellanarius*, Mammalia and *Parus caeruleus*, Aves) in Mediterranean woodlands. *Journal of Zoology*, 265(4), 347–357. <https://doi.org/10.1017/S095283690500645X>
- Schmidt, K. P., & Smith, M. (1953). The British Amphibians and Reptiles. *Copeia*, 1953(1). <https://doi.org/10.2307/1440264>
- Schulz, M. (1998). Bats and other fauna in disused Fairy Martin *Hirundo ariel* nests. *Emu*, 98(3). <https://doi.org/10.1071/MU98026>
- Schwarzkopf, L., & Alford, R. A. (1996). Desiccation and Shelter-Site Use in a Tropical Amphibian: Comparing Toads with Physical Models. *Functional Ecology*, 10(2). <https://doi.org/10.2307/2389843>
- Sequeira, F., Gonçalves, H., Faria, M. M., Meneses, V., & Arntzen, J. W. (2001). Habitat-structural and meteorological parameters influencing the activity and local distribution of the golden-striped salamander, *Chioglossa lusitanica*. *Herpetological Journal*, 11(3), 85–90.
- Smith, M. (1951). The British Amphibians and Reptiles. Collins, London, XIV.
- Stake, M. M., Thompson, F. R., Faaborg, J., & Burhans, D. E. (2005). Patterns of Snake Predation at Songbird Nests in Missouri and Texas. *Journal of Herpetology*, 39(2), 215–222.
- Störr, R. (2003). Die Baumkröte. *Jahresschrift Für Feldherpetologie Und Ichthyofaunistik Sachsen*, 7(169).
- Stuart, S. N., Chanson, J. S., Cox, N. A., Young, B. E., Rodrigues, A. S. L., Fischman, D. L., & Waller, R. W. (2004). Status and trends of amphibian declines and extinctions worldwide. *Science*, 306(5702). <https://doi.org/10.1126/science.1103538>
- Şekercioğlu, Ç. H., Daily, G. C., & Ehrlich, P. R. (2004). Ecosystem consequences of bird declines. *Proceedings of the National Academy of Sciences of the United States of America*, 101(52). <https://doi.org/10.1073/pnas.0408049101>
- Taylor, E. N., Diele-Viegas, L. M., Gangloff, E. J., Hall, J. M., Halpern, B., Massey, M. D., Rödder, D., Rollinson, N., Spears, S., Sun, B. jun, & Telemeco, R. S. (2021). The thermal ecology and physiology of reptiles and amphibians: A user's guide. *Journal of Experimental Zoology Part A: Ecological and Integrative Physiology*, 335(1). <https://doi.org/10.1002/jez.2396>

- Titley, M. A., Snaddon, J. L., & Turner, E. C. (2017). Scientific research on animal biodiversity is systematically biased towards vertebrates and temperate regions. *PLoS One*, 12(12). <https://doi.org/10.1371/journal.pone.0189577>
- Ultsch, G. R. (2006). The ecology of overwintering among turtles: Where turtles overwinter and its consequences. *Biological Reviews of the Cambridge Philosophical Society*, 81(3). <https://doi.org/10.1017/S1464793106007032>
- Van Der Goot, A., De Visser, M., & Hiemstra, A. F. (2022). Smooth newts *Lissotriton vulgaris* observed hibernating in a waterfowl nest. *Herpetological Bulletin*, 162, 41–42. <https://doi.org/10.33256/hb162.4142>
- Waldron, J. L., & Humphries, W. J. (2005). Arboreal Habitat Use by the Green Salamander, *Aneides aeneus*, in South Carolina. *Journal of Herpetology*, 39(3), 486–492. <https://doi.org/10.1670/228-04A.1>
- Walters, E. L., & Kneitel, J. M. (2004). Use of water-filled red-cockaded woodpecker cavities by other organisms. *Red-cockaded woodpecker: road to recovery*. Hancock House Publishers, WA, pp 492–498.
- Wambsganß, R. (2004). Laubfrösche (*Hyla arborea*) nutzen Vogelnistkästen als Tageshabitat. *Fauna und Flora in Rheinland-Pfalz*, 10(2), 709–710.
- Warakai, D., Okena, D. S., Igag, P., Opiang, M., & Mack, A. L. (2013). Tree cavity-using wildlife and the potential of artificial nest boxes for wildlife management in New Guinea. *Journal-Tropical Conservation Science*, 6(6)
- Weatherhead, P. J., & Blouin-Demers, G. (2004). Understanding avian nest predation: Why ornithologists should study snakes. *Journal of Avian Biology*, 35(3), 185–190. <https://doi.org/10.1111/j.0908-8857.2004.03336.x>
- Webb, J. K., & Shine, R. (1997). Out on a limb: Conservation implications of tree-hollow use by a threatened snake species (*Hoplocephalus bungaroides*: Serpentes, Elapidae). *Biological Conservation*, 81(1–2), 21–33. [https://doi.org/10.1016/S0006-3207\(96\)00160-7](https://doi.org/10.1016/S0006-3207(96)00160-7)
- Wells, K. D. (2007). *The Ecology and Behavior of Amphibians*. University of Chicago Press.
- Wilson, C. E. (1948). Birds Causing Crop Damage in the Sudan. *Sudan Notes and Records*, 29, 161–172.
- Yu, X., Wu, N. C., Ge, L., Li, L., Zhang, Z., & Lei, J. (2022). Artificial shelters provide suitable thermal habitat for a cold-blooded animal. *Scientific Reports*, 12(1). <https://doi.org/10.1038/s41598-022-09950-y>



Fig. 1. Examples of amphibians and reptiles using bird-created structures documented in photographs obtained from publicly accessible online sources: (A) American toad *Anaxyrus americanus* in a bird nest of an unidentified species, Warkworth, Ontario, Canada, 18 July 2024; photograph by Nikki Fotheringham (@greenmoxie); (B) southern toad *Anaxyrus terrestris* in a bird nest of an unidentified species, Naples, Florida, USA, 27 August 2023; video still by David Graham; (C) American toad in a bird nest of an unidentified species that had fallen to the ground, Carleton Place, Ontario, Canada, 16 June 2018; photograph by Rebecca Wilson; (D) presumed pond slider *Trachemys scripta* (non-native species) in a mute swan *Cygnus olor* nest, Amelung Pond, Chorzów, Poland, April 2025; photograph by Andrzej Skowronek; (E) unidentified water frog *Pelophylax* sp. in a sand martin *Riparia riparia* burrow, Wizna, Narew River, Poland, August 2024; video still by Zenon Borawski; (F) unidentified tree frog *Dryophytes* sp. in a nest box occupied by an eastern bluebird *Sialia sialis*, Santee National Wildlife Refuge, Summerton, South Carolina, USA, June 2024; photograph by Bailey Slice Parker.

Table 1. Records of amphibian use of bird-created structures, including structure type, associated bird species, amphibian species, number of observations, functional role, geographic location and source. NA – not reported.

Structure type	Associated bird species	Amphibian species	Number of observations	Functional role	Location	Source
Open nest	Eurasian reed-warbler <i>Acrocephalus scirpaceus</i>	European tree frog <i>Hyla arborea</i>	single nest with clutch and several nests after fledging or nest failure	shelter	Poland	Halupka & Czylok, 2021
Open nest	Eurasian chaffinch <i>Fringilla coelebs</i>	common toad <i>Bufo bufo</i>	1	presumably shelter	Great Britain	Smith, 1951
	unidentified abandoned nest		1			
Open nest	common blackbird <i>Turdus merula</i>	common toad <i>Bufo bufo</i>	1	presumably shelter	Great Britain	Petrovan et al., 2022
Open nest	unidentified hummingbird	La Estrella salamander <i>Nototriton picadoi</i>	1	breeding site	Honduras	McCranie & Wilson, 1992
Floating nest	western grebe <i>Aechmophorus occidentalis</i>	American bullfrog <i>Lithobates catesbeianus</i>	NA	shelter	USA (California)	Hayes et al., 2018
	Clark's grebe <i>Aechmophorus clarkii</i>					
Floating nest	common coot <i>Fulica atra</i>	smooth newt <i>Lissotriton vulgaris</i>	several	hibernaculum	Netherlands	Van Der Goot et al., 2022
Floating nest	common coot <i>Fulica atra</i>	unidentified frog	NA	presumably shelter	Turkey	Ceylan et al., 2021
	great crested grebe <i>Podiceps cristatus</i>					
Enclosed nest	grey-capped social weaver <i>Pseudonigrita arnaudi</i>	unidentified frog	3	presumably shelter	Sudan	Wilson, 1948
Enclosed nest	southern masked weaver <i>Ploceus velatus</i>	marbled reed frog <i>Hyperolius marmoratus taeniatus</i>	1	shelter	South Africa	Oschadleus, 2015
	eastern golden weaver <i>Ploceus subaureus</i>	marbled reed frog <i>Hyperolius marmoratus marmoratus</i>	7			
	thick-billed weaver <i>Amblyospiza albifrons</i>	Fornasini's spiny reed frog <i>Afrixalus fornasinii</i>	4			
		Natal banana frog <i>Afrixalus spinifrons</i>	1			
Enclosed nest	blue-billed malimbe <i>Malimbus nitens</i>	African foam-nest tree frog <i>Chiromantis rufescens</i>	remains of 2 foam-nest	breeding site	Democratic Republic of Congo	Kielgast & Lötters, 2009
Enclosed nest	fairy martin <i>Petrochelidon ariel</i>	red-eyed tree frog <i>Litoria rothii</i>	15	shelter	Australia	Schulz, 1998
		emerald-spotted tree frog <i>Litoria peronii</i>	8			
		Australian green tree frog <i>Litoria caerulea</i>	3			
Nesting colony	metallic starling <i>Aplonis metallica</i>	cane toad <i>Rhinella marina</i>	4168	colony-associated resource use	Australia (Queensland)	Natusch et al., 2016
		white-lipped tree frog <i>Litoria infrafrenata</i>	71			
		northern banjo frog <i>Limnodynastes terraereginae</i>	12			
		marbled frog <i>Limnodynastes convexiusculus</i>	7			
		green tree frog <i>Litoria caerulea</i>	5			
Bird nest box	unknown	unidentified tree frog <i>Dryophytes</i> sp.	14	presumably shelter	USA (Texas)	Conner et. al., 1995
Bird nest box (one with tit nest)	unidentified tit	European tree frog <i>Hyla arborea</i>	4	presumably shelter	Germany	Wambsganß, 2004
Cavity (excavated)	red-cockaded woodpecker <i>Leuconotopicus borealis</i>	gray tree frog <i>Dryophytes versicolor</i> or Cope's tree frog <i>Dryophytes chrysoscelis</i>	5	presumably shelter	USA (Texas)	Conner et al., 1997
Cavity (excavated water-filled)	red-cockaded woodpecker <i>Leuconotopicus borealis</i>	squirrel tree frog <i>Dryophytes squirellus</i>	NA	presumably shelter	USA (Florida)	Walters & Kneitel, 2004
Cavity (decay-formed with bird nest)	great tit <i>Parus major</i>	common toad <i>Bufo bufo</i>	1	presumably shelter	Germany	Störr, 2003
Bird nest box	unknown	squirrel tree frog <i>Dryophytes squirellus</i>	26	presumably shelter	USA (Louisiana)	McComb & Noble, 1981
Cavity (excavated and decay-formed)		green tree frog <i>Dryophytes cinereus</i>	26			
		gray tree frog <i>Dryophytes versicolor</i> or Cope's tree frog <i>Dryophytes chrysoscelis</i>	147			
		unidentified tree frog <i>Dryophytes</i> sp.	NA			
Cavity (excavated)	red-cockaded woodpecker <i>Leuconotopicus borealis</i>	unidentified tree frog <i>Dryophytes</i> sp.	cavity: 17	presumably shelter	USA (Georgia)	Borgo et al., 2009
Bird nest box			nest box: 1			
Burrow	sand martin <i>Riparia riparia</i>	European spadefoot toad <i>Pelobates fuscus</i>	several	hibernaculum	Europe	Wells, 2007
		natterjack toad <i>Epidalea calamita</i>				
Burrow	rainbow bee-eater <i>Merops ornatus</i>	cane toad <i>Rhinella marina</i>	several	shelter and foraging	Australia	Boland, 2004

Table 2. Records of reptile use of bird-created structures, including structure type, associated bird species, reptile species, number of observations, functional role, geographic location and source. NA – not reported.

Structure type	Associated bird species	Reptile species	Number of observations	Functional role	Location	Source
Open nest	red-backed shrike <i>Lanius collurio</i>	Iberian emerald lizard <i>Lacerta schreiberi</i>	10	shelter	Spain	Hernández, 1992
Floating nest	common coot <i>Fulica atra</i>	unidentified water snake	NA	presumably shelter	Turkey	Ceylan et al., 2021
Floating nest	great crested grebe <i>Podiceps cristatus</i>					
	western grebe <i>Aechmophorus occidentalis</i>	western pond turtle <i>Actinemys marmorata</i>	NA	shelter	USA (California)	Hayes et al., 2018
	Clark’s grebe <i>Aechmophorus clarkii</i>	pond slider <i>Trachemys scripta</i>	NA			
Enclosed nest	sociable weaver <i>Philetairus socius</i>	terrestrial garter snake <i>Thamnophis elegans</i>	NA			
		African striped skink <i>Trachylepis striata</i>	several	presumably shelter and/or foraging site	South Africa	Maclean, 1973
		Turner's thick-toed gecko <i>Chondrodactylus bibronii</i>				
		unidentified skink				
		unidentified gecko				
Enclosed nest	sociable weaver <i>Philetairus socius</i>	Kalahari tree skink <i>Trachylepis spilogaster</i>	several	shelter	South Africa	Rymer et al., 2014
Enclosed nest	sociable weaver <i>Philetairus socius</i>	Kalahari tree skink <i>Trachylepis spilogaster</i>	several	shelter and foraging site	South Africa	Buckley & Marits, 2026
		Cape thick-toed gecko <i>Pachydactylus capensis</i>				
Enclosed nest	sociable weaver <i>Philetairus socius</i>	Kalahari tree skink <i>Trachylepis spilogaster</i>	several	shelter and foraging site	South Africa	Lowney & Thomson, 2022
		variegated skink <i>Trachylepis variegata</i>				
Enclosed nest	fairy martin <i>Petrochelidon ariel</i>	dubious dtella <i>Gehyra dubia</i>	24	shelter	Australia	Schulz, 1998
		robust velvet gecko <i>Oedura robusta</i>	3			
		northern spotted rock dtella <i>Gehyra nana</i>	2			
		Australian water dragon <i>Intellagama lesueurii</i>	4			
		striped snake-eyed skink <i>Cryptoblepharus virgatus</i>	1			
		Bynoe’s gecko <i>Heteronotia binoei</i>	2			
		marbled velvet gecko <i>Oedura marmorata</i>	1			
Nesting colony	metallic starling <i>Aplonis metallica</i>	brown tree snake <i>Boiga irregularis</i>	639	colony-associated resource use	Australia (Queensland)	Natusch et al., 2016
		amethystine python <i>Morelia amethystina</i>	375			
		slaty grey snake <i>Stegonotus cucullatus</i>	228			
		water python <i>Liasis fuscus</i>	18			
		tree dtella <i>Gehyra dubia</i>	10			
		giant tree gecko <i>Pseudothecadactylus australis</i>	8			
		brown headed snake <i>Furina tristis</i>	9			
		blue-tailed monitor <i>Varanus doreanus</i>	3			
		black-headed python <i>Aspidites melanocephalus</i>	1			
		spotted python <i>Antaresia maculosa</i>	1			
		carpet python <i>Morelia spilota</i>	1			
		blind snake <i>Anilius polygrammicus</i>	1			
Nesting colony	colonial-nesting waterbirds (Ciconiiformes and Pelecaniformes)	American alligator <i>Alligator mississippiensis</i>	several	colony-associated resource use/predator deterrence	USA (North Carolina and Florida)	Gabel et al., 2019, 2021; Nell et al., 2016; Nell & Frederick, 2015
Bird nest box	unknown	broad-headed skink <i>Plestiodon laticeps</i>	1	presumably shelter	USA (Texas)	Conner et. al., 1995
		western rat snake <i>Pantherophis obsoletus</i>	2			
Bird nest box	unknown	Italian wall lizard <i>Podarcis sicula</i>	several	presumably shelter	Italy	Sarà et al., 2005
		Sicilian wall lizard <i>Podarcis waglerianus</i>				
		common wall gecko <i>Tarentola mauritanica</i>				
Bird nest box	elf owl <i>Micrathene whitneyi</i>	Texas blind snake <i>Rena dulcis</i>	several	foraging site	North America	Bucher, 1988; Gehlbach & Baldrige, 1987
	eastern screech owl <i>Megascops asio</i>					
Bird nest box	Eurasian scops owl <i>Otus scops</i>	worm snake <i>Xerotyphlops vermicularis</i>	48	foraging site	Turkey	Göçer et al., 2025

Table 2. (continued)

Structure type	Associated bird species	Reptile species	Number of observations	Functional role	Location	Source
Bird nest box	unknown	western rat snake <i>Pantherophis obsoletus</i>	38	presumably shelter	USA (Louisiana)	McComb & Noble, 1981
Cavity (excavated and decay-formed)		rough green snake <i>Opheodrys aestivus</i>	1			
		green anole <i>Anolis carolinensis</i>	NA			
		five-lined skink <i>Plestiodon fasciatus</i>	NA			
		southeastern five-lined skink <i>Plestiodon inexpectatus</i>	NA			
		broad-headed skink <i>Plestiodon laticeps</i>	9			
Cavity (excavated)	red-cockaded woodpecker <i>Leuconotopicus borealis</i>	corn snake <i>Pantherophis guttatus</i>	cavity: 3	presumably shelter	USA (Georgia)	Borgo et al., 2009
Bird nest box		western rat snake <i>Pantherophis obsoletus</i>	nest box: 2			
Cavity (excavated)	red-cockaded woodpecker <i>Leuconotopicus borealis</i>	broad-headed skink <i>Plestiodon laticeps</i>	1	presumably shelter	USA (Texas)	Conner et al., 1997
Cavity (excavated water-filled)	red-cockaded woodpecker <i>Leuconotopicus borealis</i>	western rat snake <i>Pantherophis obsoletus</i> or corn snake <i>Pantherophis guttatus</i>	NA	presumably shelter	USA (Florida)	Walters & Kneitel, 2004
Cavity (excavated and decay-formed)	unknown	Kashmir cliff racer <i>Platyceps rhodorachis</i>	1	presumably shelter	Pakistan	Hussain et al., 2013
		common cat snake <i>Boiga trigonata</i>	2			
		spotted barn gecko <i>Hemidactylus brookii</i>	3			
		Kumaon mountain lizard <i>Japalura kumaonensis</i>	2			
		monitor lizard <i>Varanus benghalensis</i>	6			
Cavity (excavated and decay-formed)	unknown	Oriental rat snake <i>Ptyas mucosa</i>	4	shelter	India	Manikandan & Balasubramanian, 2018
		garden lizard <i>Calotes versicolor</i>	3			
		tuatara <i>Sphenodon punctatus</i>	NA			
		blue-lipped sea krait <i>Laticauda laticaudata</i>	4			
Burrow	fairy prion <i>Pachyptila turtur</i>	New Caledonian sea krait <i>Laticauda saintgironsi</i>	5	shelter /co-habitation	New Zealand	Corkery et al., 2015
Burrow	wedge-tailed shearwater <i>Ardenna pacifica</i>	blue-lipped sea krait <i>Laticauda laticaudata</i>	4	shelter	Australia	Lane & Shine, 2011
			5			