# A plastic device fixed around trees can deter snakes from predating bird nest boxes

H. Navalpotro, D. Mazzoni, J. C. Senar

Navalpotro, H., Mazzoni, D., Senar, J. C., 2021. A plastic device fixed around trees can deter snakes from predating bird nest boxes. *Animal Biodiversity and Conservation*, 44.1: 103–108, Doi: https://doi.org/10.32800/abc.2021.44.0103

**Abstract**

*A plastic device fixed around trees can deter snakes from predating bird nest boxes.* Several devices have been designed to prevent predation in nest boxes by mammals and birds. Although snakes are one of the most common predators in cavity–nesters, they have always been difficult to deter. Here we tested a method originally designed to avoid predation by tree–climbing mammals. To prevent snakes from climbing trees and predating on nest boxes, we wrapped a transparent acetate sheet of 80 cm high around tree trunks below a sample of 40 nest boxes used by tits. The acetate sheets were secured with duct tape. The remaining nest boxes (N = 74) in the study area were left as controls. The predation rate in the experimental nest boxes was 20 % and 2 % in control boxes. This method can be useful to increase bird breeding success, improving both the effectiveness of resources to obtain scientific data and the breeding success of endangered species.

Key words: Nest protectors, Snake predation, Nesting success, Nest boxes, Mediterranean

**Resumen**

*Una lámina de plástico fijada alrededor de los árboles puede impedir que las serpientes ataquen las cajas nido de las aves.* Se han diseñado varios artilugios para impedir que los mamíferos y las aves ataquen las cajas nido. A pesar de que las serpientes son uno de los depredadores más comunes de las aves que anidan en cavidades, siempre han sido difíciles de evitar. En el presente artículo probamos un método originalmente concebido para evitar que los mamíferos trepen a los árboles. Para impedir que las serpientes trepen a los árboles y ataquen las cajas nido, utilizamos una lámina de acetato transparente de 80 cm de altura para envolver los troncos de los árboles en los que se ubicaba una muestra de cajas nido (N = 40) utilizadas por carboneros y herrerillos. Las demás cajas nido (N = 74) se dejaron como control. La tasa de depredación en los nidos de control fue del 20 % y solo del 2 % en las cajas nidos experimentales. El método puede ser útil para aumentar el éxito reproductivo de las aves y, por lo tanto, para aumentar la eficacia de los recursos dirigidos a obtener datos científicos, y el éxito reproductor de las especies en peligro de extinción.

Palabras clave: Protectores de nidos, Depredación por serpientes, Éxito de anidación, Cajas nido, Mediterráneo

*Received: 13 I 21; Conditional acceptance: 20 I 21; Final acceptance: 3 II 21*

*Helena Navalpotro, Daniele Mazzoni, Juan Carlos Senar, Museu de Ciències Naturals de Barcelona, Castell dels Tres Dragons, Parc Ciutadella, Passeig Picasso s/n., 08003 Barcelona, España (Spain).*

Corresponding author: J. C. Senar. E–mail: jcsenar@bcn.cat

ORCID ID: H. Navalpotro: 0000-0003-3730-8845; D. Mazzoni: 0000-0001-7342-4857;
J. C. Senar: 0000-0001-9955-3892

ISSN: 1578–665 X
eISSN: 2014–928 X

## Introduction

Cavity–nesting passerines are commonly used as research subjects in many ecological studies because they can be monitored using nest boxes. One of the main causes of reproductive failure in these species is nest predation (Nilsson, 1984; Møller, 1989; Cox*et* et al., 2013). The most common predators in nest boxes are usually mammals such as mustelids (Møller, 1989; Sorace et al., 2004; Suzuki, 2015), squirrels (Willson, Santo and Sieving, 2003), other birds (e.g. woodpecker) (Nilsson, 1984; Skwarska et al., 2009), and snakes (Weatherhead and Blouin–Demers, 2004; Weatherhead et al., 2010; Degregorio et al., 2015).

Several devices have been designed to deter predation in nest boxes by mammals and birds (Yamaguchi et al., 2005; Bailey and Bonter, 2017; Stojanovic et al., 2019). However, avoiding predation by snakes is more challenging due to their ease in hanging and entering through tubes or other structures. For nest boxes hanging from a branch, a cone–shaped piece of plastic put on the box can sometimes be effective (Bailey and Bonter, 2017). When the nest boxes are placed on a metal pole, a stovepipe baffle or cone baffle placed on the metal structure has also shown to prevent climbing snakes from reaching the box (Bailey and Bonter, 2017). However, when nest boxes are located on the tree trunk and near the ground, no simple device seems available.

Keo et al. (2009) fixed a plastic device around the tree from the tree base to a height of 1.5 m to prevent mammals from climbing the trunk and reaching the nest box. They authors observed that breeding success increased and suggested that the method could also be useful to prevent snake predation. However, no quantitative data were presented on the effectiveness of the method to specifically deter snakes. The aim of this paper was to test the effectiveness of the Keo et al.'s method (2009) to avoid nest box predation by snakes. To prevent snake climbing and consequent predation we covered tree trunks below a sample of nest boxes with a transparent acetate sheet of 80 cm in height. This sheet was attached to the trunk with duct tape. The other trees in the study area were left as controls.

The experiment was carried out in a Mediterranean forest near the city of Barcelona, where two snake species may typically be responsible for bird nest predation: Montpellier snakes (*Malpolon monspessulanus*) (Gutiérrez, 1994; Feriche et al., 2008) and ladder snakes (*Zamenis scalaris*) (Pleguezuelos et al., 2007). In our study area, both species have been reported to predate great tit and blue tit nestlings (*Parus major* and *Cyanistes caeruleus*) (fig. 1). Our results showed this device was highly effective in preventing predation by snakes, but the findings also identified additional points that should be taken into account.

## Material and methods

The study was carried out in the field station of 'Can Catà' within the Parc Natural de Collserola (Cerdanyola, Barcelona, NE of the Iberian Peninsula,


Fig. 1. Graphic documentation on the two snake species typically predating on tit nests in our study area while we were recording tit nest attendance. On the left, we have an adult male Montpellier snake predating on a great tit chick after capturing it in the nest. On the right, we have an adult ladder snake entering the nest box, which it later predated.

*Fig. 1. Documentación gráfica de las dos especies de serpiente que atacaron con más frecuencia los nidos de carboneros y herrerillos en nuestra zona de estudio mientras grabábamos la presencia de aves en los nidos. A la izquierda, tenemos un adulto de culebra bastarda o de Montpellier depredando a un pollo de carbonero común tras capturarlo en el nido. A la derecha, tenemos un adulto de culebra de escalera entrando en la caja nido que posteriormente atacó.*

45º 27' N, 20º 8' E). The area is situated at the bottom of a valley of sclerophyllous forest dominated by holm oaks (*Quercus ilex*, 67 %) and, to a lesser extent, oaks (*Quercus cerrioides*, 17 %) and aleppo pines (*Pinus halepensis*, 16 %), with a highly developed understory. Aleppo pine was the predominant species on most of the hills (54 %), surrounded by shrubs and oak species (holm oaks: 31 %, oaks: 14 %). The altitude of the area ranges from 80 to 225 m above sea level. Additional information about the study area is given in Navalpotro et al. (2016). The 'Can Catà' field station has 183 titmice nest boxes distributed throughout an area of 80 ha. The size of the nest boxes is 21 cm x 32 cm with an entrance hole diameter of 30 mm. To minimize damage by woodpeckers, the wooden nest boxes are 3 cm thick. Nest boxes also include a cylindrical PVC tube of 10 cm in length and 5 cm (in diameter) designed to protect the entrance from mammal predators (such as mustelids or genets). Nest boxes are located directly on the trunks of the trees approximately 1.30 m above ground level, and at least 25 m apart from each other.

The predator exclusion method to increase the breeding success of our studied species was applied during the spring of 2018. A transparent plastic (acetate sheet) 0.8 m in height and 1 mm thick was attached with duct tape around the trunk. After clearing the branches and bushes in a circle of 1 m radius around the tree, we placed the plastic belt below the nest box to prevent snakes from climbing up (see fig. 2). We randomly protected a sample of the occupied nest boxes (n = 40) for use as experimental boxes. The remaining occupied nest boxes (n = 74) were used as controls. The experimental nest boxes were spread throughout the study area to avoid altitude and other environmental collateral effects related to location. The device was installed on the trunk of the 40 trees as soon as we detected egg laying to prevent predation on eggs or incubating females.

All nest boxes were monitored 2–3 times a week for laying date, hatching date, number of eggs, number of chicks, and other observations. We checked chicks and broken or missing eggs for signs of predation. Normally, snake predation is characterized by an intact nest with missing chicks or eggs because the snake ingests the prey without damaging the nest, while mammals normally disrupt the whole nest (Kibler, 1969; Christman and Dhondt, 1997; Chen et al., 2020). Nest boxes were also videotaped from inside the box to record parental investment (see Pagani–Núñez and Senar (2013) for details). This further allowed us to confirm the main nest predators in the study area (fig. 1).

Great tit and blue tit reproduction started on March 31st (first egg laid) and ended on July 10th 2018 (last fledged chick). The plastic was removed once the breeding season ended.

Statistical analyses were carried out using a log–linear analysis of frequency tables which allows to test for the interaction between more than two categorical variables (Agresti, 2019). Factors used were species (great tit vs blue tit), outcome (fledged or predated), and treatment (experimental or control).


Fig. 2. Predator–exclusion plastic sheet (marked with white arrow) used to prevent access by snakes to nest boxes attached to tree trunks. The plastic was fixed with duct tape around the trunk, generally in the upper part. Photo by J. C. Senar.

*Fig. 2. Cinturón de plástico contra depredadores utilizado para impedir el acceso de las serpientes a las cajas nido instaladas en árboles. El plástico se fijó alrededor del tronco con cinta adhesiva, generalmente en la parte superior. Fotografía de J. C. Senar.*

## Results

We video–recorded 13 instances of successful nest predation in our nest boxes (2013–2020), eight by Montpellier snakes and five by ladder snakes. We also recorded some attempts by genets *Genetta genetta*, stone martens *Martes foina* and jays *Garrulus glandarius*, but none of these were successful.

Results showed a significant difference between the outcome of nest boxes with plastic and those without plastic ($\chi^2$ = 6.54, $p$ = 0.01, table 1). There was only one predation event in the nest boxes with protective plastic (experimental), but 15 nest boxes in the control group were predated. Twenty percent of the nest boxes without plastic were predated whereas only two percent of protected nests were predated

Table 1. Results of a log–linear analysis testing for partial associations between the variable species (great tit vs. blue tit), outcome (fledged or predated), and treatment (experimental or control). Only interactions between outcome and treatment are significant.

*Tabla 1. Resultados de un análisis log–lineal para establecer asociaciones parciales entre la variable de la especie (carbonero común o herrerillo común), el resultado (pollos emplumados o depredados) y el tratamiento (experimental o control). Solo son significativas las interacciones entre el resultado y el tratamiento.*

| | df | $\chi^2$ | *p* |
|---|---|---|---|
| Species x outcome | 1 | 0.17 | 0.68 |
| Species x treatment | 1 | 0.15 | 0.70 |
| Outcome x treatment | 1 | 6.54 | 0.01 |
| Sp x out x treat | 1 | 0.04 | 0.84 |

Table 2. Contingency table relating treatment (plastic and control) and outcome (fledged and predated) of both species. Expected frequencies are shown in parentheses.

*Tabla 2. Tabla de contingencia en la que se relaciona el tratamiento (plástico y control) y el resultado (pollo emplumado y depredado) de ambas especies. Frecuencias esperadas entre paréntesis.*

| | Plastic | Control |
|---|---|---|
| Fledged | 39 (34) | 59 (64) |
| Predated | 1 (6) | 15 (10) |

(table 2). There was no significant three–way interaction, indicating that predation did not vary according to tit species in any of the treatments ($\chi^2$ = 0.04, $p$ = 0.84, table 1).

## Discussion

The results of this study indicate that wrapping the tree trunk with acetate sheeting decreased snake predation by preventing snakes from climbing up to nest boxes. The case in which we failed to deter snake predation was because the tree with the nest box was very close to another tree, so that the snake could have climbed this adjacent tree and then jumped to the nest box on the nearby tree. This also happened twice in 2020; using a camera trap, we videotaped how a Montpellier snake jumped from a neighboring tree to the nest box in an adjacent tree (see supplementary material). This observation suggests plastic sheeting should also be placed around nearby trees if it is suspected snakes could climb these to reach the nest box. In 2020, when we were videotaping parental effort with cameras located within the nest boxes (see e.g. Pagani–Núñez and Senar, 2014), we also recorded three occasions on which the snakes used the cable that connected the camera placed inside the nest box with the battery located at the base of the tree to climb up to the nest box. This indicates that any structure close to the tree trunk should also be covered with the plastic.

All the instances we video recorded of predation in our nest boxes were by Montpellier and ladder snakes (fig. 1). This not only confirms that the cylindrical tube at the entrance to the nest box was effective to protect the box from mammalian and bird predators, but also confirms that these two snake species were responsible for the predation instances recorded in our area. The horseshoe snake *Hemorrhois hippocrepis* is also a common nest predator in Spain (Suárez et al., 1993), but although it was once recorded in the Collserola mountains (Cano et al., 2013), and hence it should appear in our area according to atlas data (Pleguezuelos and Feriche, 2002), it has never been recorded by Collserola Park biologists (F. Llimona, pers. comm.) and we have never recorded it in Can Catà field station.

Snakes are one of the main nestling predators in any habitats (Weatherhead and Blouin–Demers, 2004). Predation by snakes in any given locality increases with time, since it has been observed that snakes have long–term spatial memory (Miller, 2002). In a scenario of climate warming, these reptiles will likely increase their above–ground foraging (Le Galliard et al., 2013; Capula et al., 2016). Consequently, in Mediterranean areas, where climate warming is predicted to have a higher impact (Gao and Giorgi, 2008), snake predation will have an increasing impact on cavity–nesters. Any tactics to deter snake predation may therefore be increasingly demanded. These methods can be useful to avoid nest failures, and thus, increase the effectiveness of resources to obtain scientific data and to increase breeding success on endangered species (Keo et al., 2009). We therefore strongly encourage researchers to try the proposed methods in different habitats with significant populations of bird–nest predators to test the generality of the method.

## Acknowledgements

We are grateful to the Associate Editor of *Animal Biodiversity and Conservation* and two anonymous referees for their useful comments to improve the manuscript. This work was supported by funds from The Ministry of Economy and Competitiveness (MINECO), Spanish Research Council to JCS (CGL-

2016-79568-C3-3-P). We thank the late Leopoldo Gil and his family, for their constant support of our work, and for allowing us to sample birds in the Can Catà forest area. We also thank Lluïsa Arroyo, Marta Olivé, Mónica Navarro and Francesc Uribe for their help in the field and to Carolyn Newey for improving the English.

## References

Agresti, A., 2019. *An introduction to categorical data analysis*. John Wiley and Sons, Hoboken NJ.

Bailey, R. L., Bonter, D. N., 2017. Predator guards on nest boxes improve nesting success of birds. *Wildlife Society Bulletin*, 41: 434–441, Doi: 10.1002/wsb.801

Cano, J. M., Martínez–Silvestre, A., Soler, J., 2013. Patrón de coloración atípico en *Hemorrhois hippocreppis*. *Boletín de la Asociación Herpetológica Española,* 24: 5–6.

Capula, M., Rugiero, L., Capizzi, D., Franco, D., Milana, G., Luiselli, L., 2016. Long–term, climate–change–related shifts in feeding frequencies of a Mediterranean snake population. *Ecological Research*, 31: 49–55, Doi: 10.1007/s11284-015-1312-0

Chen, P., Chen, T., Liu, B., Zhang, M., Lu, C., Chen, Y., 2020. Snakes are the principal nest predators of the threatened reed parrotbill in a coastal wetland of eastern China. *Global Ecology and Conservation,* 23: e01055, Doi: 10.1016/j.gecco.2020.e01055

Christman, B. J., Dhondt, A. A., 1997. Nest Predation in Black–Capped Chickadees: How Safe Are Cavity Nests? *The Auk*, 114(4): 769–773, Doi: 10.2307/4089299

Cox, W. A., Thompson, F. R., Reidy, J. L., 2013. The effects of temperature on nest predation by mammals, birds, and snakes. *The Auk*, 130(4): 784–790, Doi: 10.1525/auk.2013.13033

Degregorio, B. A., Westervelt, J. D., Weatherhead, P. J., Sperry, J. H., 2015. Indirect effect of climate change: Shifts in ratsnake behavior alter intensity and timing of avian nest predation. *Ecological Modelling*, 312: 239–246, Doi: 10.1016/j.ecolmodel.2015.05.031

Feriche, M., Pleguezuelos, J. M., Santos, X., 2008. Reproductive Ecology of the Montpellier Snake, *Malpolon monspessulanus* (Colubridae) and Comparison with Other Sympatric Colubrids in the Iberian Penisula. *Copela*, 2008(2): 279–285.

Gao, X., Giorgi, F., 2008. Increased aridity in the Mediterranean region under greenhouse gas forcing estimated from high resolution simulations with a regional climate model. *Global and Planetary Change,* 62(3–4): 195–209, Doi: 10.1016/j.gloplacha.2008.02.002

Gutiérrez, R., 1994. Predació de niu de Mallerenga Carbonera per serp verd (*Malpolon monspessulanus*). *Butlletí del Grup Català d'Anellament*, 11(1): 69–70.

Keo, O., Collar, N. J., Sutherland, W. J., 2009. Nest protectors provide a cost–effective means of increasing breeding success in Giant Ibis *Thaumatibis gigantea*. *Bird Conservation International*, 19(1): 77–82, Doi: 10.1017/S0959270908008319

Kibler, L. F., 1969. The Establishment and Maintenance of a Bluebird Nest–Box Project. A Review and Commentary. *Bird Banding*, 40(2): 114–129.

Le Galliard, J. F., Massot, M., Baron, J.–P., Clobert, J., 2013. Ecological effects of climate change on European reptiles. In: *Wildlife Conservation in a Changing Climate*: 179–202 (J. F. Brodie, E. S. Post, D. F. Doak, Eds.). The University of Chicago Press, Chicago.

Miller, K. E., 2002. Nesting Success of the Great crested Flycatcher in Nest Boxes and in the Tree Cavities: Are Nest Boxes Safer From Nest Predation? *The Wilson Bulletin*, 114(2): 179–185. JSTOR: https://www.jstor.org/stable/4164439

Møller, A. P., 1989. Parasites, Predators and Nest Boxes: Facts and Artefacts in Nest Box Studies of Birds? *Oikos*, 56(3): 421–423, Doi: 10.2307/3565628

Navalpotro, H., Pagani–Núñez, E., Hernández–Gómez, S., Senar, J. C., 2016. Comparing prey composition and prey size delivered to nestlings by great tits, *Parus major*, and blue tits, *Cyanistes caeruleus*, in a Mediterranean sclerophyllous mixed forest. *Animal Biodiversity and Conservation,* 39(1): 129–139, Doi: 10.32800/abc.2016.39.0129

Nilsson, S. G., 1984. The Evolution of Nest–Site Selection among Hole–Nesting Birds: The Importance of Nest Predation and Competition. *Ornis Scandinavica*, 15(3): 167–175, Doi: 10.2307/3675958

Pagani–Núñez, E., Senar, J. C., 2013. One hour of sampling is enough: Great Tit *Parus major* parents feed their nestlings consistently across time. *Acta Ornithologica*, 48(2): 194–200, Doi: 10.3161/000164513X678847

– 2014. Are colorful males of great tits Parus major better parents? Parental investment is a matter of quality. *Acta Oecologica*, 55: 23–28, Doi: 10.1016/j.actao.2013.11.001

Pleguezuelos, J. M., Feriche, M., 2002. *Coluber hippocrepis*. In: *Atlas y Libro Rojo de los Anfibios y Reptiles de España,* 2nd edition: 266–268 (J. M. Pleguezuelos, R. Márquez, M. Lizana, Eds.). Dirección General de Conservación de la Naturaleza–Asociación Herpetologica Española, Madrid.

Pleguezuelos, J. M., Fernández–Cardenete, J. R., Honrubia, S., Feriche, M., Villafranca, C., 2007. Correlates between morphology, diet and foraging mode in the Ladder Snake *Rhinechis scalaris*. *Contributions to Zoology,* 76(3): 179–186.

Skwarska, J. A., Kaliñski, A., Wawrzyniak, J., Banbura, J., 2009. Opportunity makes a predator: Great Spotted Woodpecker predation on Tit broods depends on nest box design. *Ornis Fennica,* 86(3): 109–112.

Sorace, A., Petrassi, F., Consiglio, C., 2004. Long–distance relocation of nestboxes reduces nest predation by Pine Marten *Martes martes*. *Bird Study,* 51(2): 119–124, Doi: 10.1080/00063650409461343

Stojanovic, D., Eyles, S., Cook, H., Alves, F., Webb, M., Heinsohn, R., 2019. Photosensitive automated doors to exclude small nocturnal predators from

nest boxes. *Animal Conservation*, 22: 297–301, Doi: 10.1111/acv.12471

Suárez, F., Yanes, M., Herranz, J. & Manrique, J., 1993. Nature reserves and the conservation of Iberian shrubsteppe passerines: The paradox of nest predation. *Biological Conservation*, 64: 77–81, Doi: 10.1016/0006-3207(93)90385-E

Suzuki, T. N., 2015. Assessment of predation risk through referential communication in incubating birds. *Scientific Reports,* 5: 10239, Doi: 10.1038/srep10239

Weatherhead, P. J., Blouin–Demers, G., 2004. Understanding avian nest predation: why ornithologists should study snakes. *Journal of Avian Biology,* 35(3): 185–190. JSTOR: http://www.jstor.org/stable/3677428

Weatherhead, P. J., Carfagno, G. L. F., Sperry, J. H., Brawn, J. D., Robinson, S. K., 2010. Linking snake behavior to nest predation in a Midwestern bird community. *Ecological Applications*, 20(1): 234–241. JSTOR: https://www.jstor.org/stable/27797801

Willson, M. F., Santo, T. L. D., Sieving, K. E., 2003. Red squirrels and predation risk to bird nests in northern forests. *Canadian Journal of Zoology*, 81(7): 1202–1208, Doi: 10.1139/z03-096

Yamaguchi, N., Kawano, K. M., Yamaguchi, Y. & Saito, T. (2005). Small protection plates against marten predation on nest boxes. *Applied Entomology and Zoology*, 40(4): 575–577, Doi: 10.1303/aez.2005.575

## Supplementary material

Video. The two trees, one of which contains a nest box, were protected with a plastic around the trunk to prevent snakes from climbing it and preying on the great tit chicks inside the nest box. However, the Montpellier snake managed to climb the other nearby tree, and leaning on the photo trap box, it tried to jump over the nest box. The recording does not show us how exactly it managed to get to the nest box, but finally it is clear that it reached it and preyed on the chicks it contained. At the end of the recording, it is observed how the snake hanged down and when it came down from the nest box it avoided touching the plastic that covered the trunk.

Vídeo. Los dos árboles, uno de los cuales contiene una caja nido, se protegieron con un plástico alrededor del tronco para evitar que las serpientes pudieran trepar por él y depredar a los pollos de carbonero común que había dentro de la caja nido. Sin embargo, la serpiente de Montpellier consiguió trepar por el otro árbol cercano y, apoyándose en la caja de foto trampeo, intentó saltar sobre la caja nido. En la grabación no se observa exactamente cómo consiguió llegar hasta la caja nido, pero queda claro que al final lo logró y depredó a los pollos que contenía. Al término de la grabación, se observa que la serpiente se descolgó y que, al bajar de la caja nido, evitó tocar el plástico que cubría el tronco.

https://youtu.be/4RQbXNaQ6IU