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Entrapped in Olive-Harvesting Nets: A Case of a Grass Snake *Natrix natrix* from an Olive-Growing Greek Aegean Island

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Abstract: Despite a recent shift towards sustainable practices to support the conservation of traditional olive groves, little is known about their potential threats to herpetofauna species. On the island of Lesvos, one of the main olive-growing islands in the Mediterranean, olive cultivation often prioritizes the expeditious harvesting of olives with minimal or no supplementary intervention, resulting in their generally suboptimal management, a component of which also pertains to the olive nets that, in many cases, remain dispersed and unfurled throughout the groves. This particular practice affects the species living in the olive groves, making them more prone to risks related to their accidental trapping. In this study, we report the first case of a Grass snake being inadvertently trapped in an olive net laid out on an olive grove. The position of the snake under the net, within a folded tipping, made it difficult for it to escape, and it became increasingly entangled. Based on this incident, it is plausible to assume that similar cases may occur in areas where nets are used in olive groves, both in Greece and other olive-growing countries. Further systematic research is necessary to determine the extent of this issue.

Keywords: herpetofauna; reptiles; traditional olive groves; traditional practices; Lesvos

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Agriculture, a paramount human activity worldwide, bears a direct relationship with the natural environment and exerts a direct or indirect impact on biodiversity [1,2]. In particular, contemporary agricultural practices have been identified as a major threat to herpetofauna [3,4] as they affect a significant proportion of reptilian species on a global scale. In olive-cultivating regions such as the Mediterranean basin, the intensification of agriculture through the substitution of traditional olive orchards with olive monocultures [5] has resulted in an escalation and a more extensive utilization of chemical inputs, mechanization, tillage, and removal of natural vegetation, resulting in herpetofauna species' decline [6,7]. In recent years, the production of olive oil in the Mediterranean basin has undergone a transition towards sustainable practices as a means of preserving traditional olive groves and recognizing their crucial ecological role in terms of augmenting biodiversity [8] and furnishing a plethora of ecosystem services. Furthermore, the characteristics of traditional olive groves in conjunction with sustainable traditional practices have played a crucial role in maintaining viable fauna species populations [9,10]. However, despite the many positive attributes of traditional olive-harvesting practices, little is known regarding their potential threats to herpetofauna species.

In Greece, the traditional method of olive harvesting involves the manual use of long poles to detach the fruit from the tree, which is subsequently collected using expansive olive-harvesting nets. These nets are prevalent in many regions within Greece and other Mediterranean countries [11–15], where the terrain presents technical challenges, such as hilly or mountainous areas, positioned beneath the tree canopy to facilitate the natural fall of the fruit, in order to be collected in a more efficient manner (Figure 1). This method of collection offers several benefits, including ease of harvest, protection against soil-borne pathogens, and minimization of potential contact with pesticide residues or acidic soil conditions [16–19].

Figure 1. Olive-harvesting nets under the canopy of the olive trees, in a traditional olive grove on the island of Lesvos.

On the island of Lesvos, which is the third largest island of Greece and one of the primary regions for olive cultivation in the Mediterranean, the olive groves are primarily traditional in nature [20] and are situated in hilly, mountainous, and lowland areas. These groves comprise over 85% of the island's agricultural area and are estimated to have between eight and eleven million olive trees [21]. During the olive-fruit-harvesting period, which typically takes place between October and March, the olive nets are spread out and utilized throughout the duration of this period, all around the olive groves. Afterwards, the nets are cleaned, folded, and stored in warehouses, while some farmers leave them in designated areas within the groves (pers. obs.). However, in recent times, due to land abandonment, this traditional practice has undergone some modification. Nowadays, olive cultivation often prioritizes the expeditious harvesting of olives with minimal or no supplementary intervention, such as pruning or clearing fields of surface vegetation [20]. This results in their generally suboptimal management, a component of which also pertains to the olive nets that, in many cases, remain dispersed and unfurled throughout the grove or in various locations after the olive-harvesting period (Figure 2) (pers. obs.). This particular practice poses an increased risk of accidentally trapping the fauna species inhabiting these groves. Here, we document for the first time such a case: a Grass snake trapped in an olive net within a traditional olive grove.

In the ambit of a protracted investigation commencing in 2017 pertaining to the conservation of traditional olive orchards on the island [20], we embarked upon a field study of a traditional olive grove in the environs of Fteli, a coastal hamlet situated at the mouth of the Gulf of Gera, with the objective of assessing the vitality of the olive trees (Figure 3).

On the 9 March 2020, at 14:02 h, during our field expedition, we detected an ensnared Grass snake *Natrix natrix* (Linnaeus, 1758) (Squamata: Colubridae) (39°0′1.131′′ N, 26°32′8.867′′ E) caught in a plastic net on the ground of a traditional olive grove that had been recently harvested, at an altitude of 20.6 m a.s.l. (Figure 4). The conditions were characterized by a light overcast sky with a mean temperature of 16 °C. We handled the snake very carefully in order to extricate it from the net and then we released it in its natural environment at a short distance from the olive grove. Upon release, the snake demonstrated signs of robustness and rapidly disappeared into the bushy vegetation.

Figure 2. Dispersed olive nets in different locations within a traditional olive grove on the island of Lesvos. The dearth of management is apparent both from the presence of the abandoned olive nets and from the unpruned olive trees.

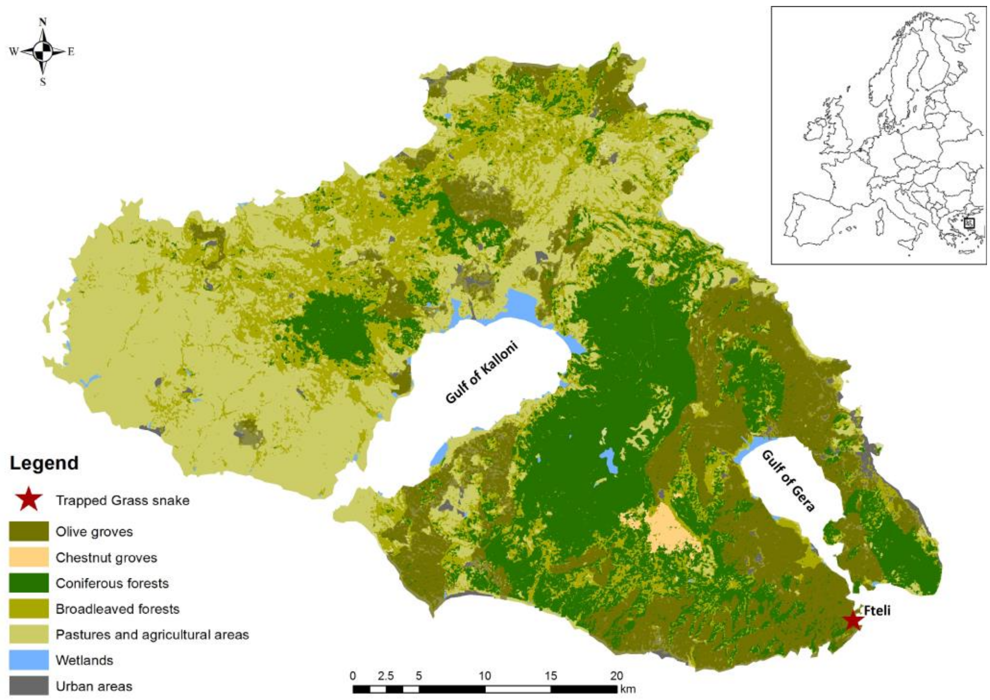

Figure 3. Distribution map concerning the main land cover types of the island of Lesvos along with the locality of the trapped Grass snake.

Figure 4. Photographic documentation, from the island of Lesvos, Greece, of a Grass snake ensnared within a plastic olive-harvesting net within a traditional olive grove: (**a**) the ensnared snake in proximity to an olive-tree cavity, and (**b**) the ensnared snake relocating from its initial position in an effort to extricate itself.

The Grass snake, *Natrix natrix*, is a nonvenomous reptile that can be encountered in both aquatic and terrestrial ecosystems. It is primarily a terrestrial species that inhabits freshwater environments, taking refuge in thickets, dense herbaceous vegetation, and hiding places such as fallen tree trunks, rocks, stones, and debris, as well as anthropogenic structures such as bridges, stone walls, ruins, old buildings, and dams [22,23] (pers. obs.). Additionally, it has been observed to ascend woody vegetation while foraging [24]. This species is ubiquitous in the vicinity of all types of freshwater bodies, and can also be found in orchards, gardens, and woodland edges. Its distribution is widespread across mainland Greece as well as in many islands [23,25]. The presence of the Grass snake is well documented on the island of Lesvos, where it is prevalent in various localities [23,26] (pers. obs.).

In our case, it is likely that the Grass snake became ensnared in the net placed on the ground while it was in the process of locomotion or foraging. The position of the snake beneath the net, within a folded tipping, appeared to have hindered its ability to extricate itself, leading to its further entanglement during its attempts to escape. To the extent of our knowledge, this is the first report of a snake trapped in olive-harvesting nets.

However, the unintentional entrapment of reptiles by various human-discarded items [27–29] or as bycatch in traps that are intended for other faunal species [30,31], and within anthropogenic structures [32–35], has been well documented on numerous occasions. In particular, trapping by agricultural and gardening items and equipment has also been observed [36–39], with one such case being reported in the context of olive cultivation [40].

In light of this incident, we posit that analogous incidents may transpire in regions where nets are employed in olive groves, both within Greece and in other olive-growing countries. In Greece, olive groves occupy an area of approximately 8870 km^2, while approximately 106,500 km^2 are dedicated to olive cultivation worldwide [41]. Consequently, it is possible that many other species of snakes, lizards, or even turtles may be imperiled by the unintentional entrapment resulting from this practice. A more systematic study of this issue across other countries would be necessary to fully gauge the magnitude of this problem. In parallel, trapping reptilian species in nets not only poses a threat to their survival but also creates potential risks to human health, especially in regions where venomous snakes, such as vipers, are prevalent. Unrolling the nets can expose workers to danger, resulting in snake bites and subsequent health complications. Therefore, it is crucial to raise awareness of these potential risks and implement proper safety measures to prevent harm to both workers and wildlife. To ensure the safety of all parties involved, it is strongly recommended that the removal of trapped snakes be carried out by expert snake handlers. On the island of Lesvos, where the venomous Ottoman viper is present [23] (pers. obs.), farmers and workers should not attempt to handle trapped snakes but should seek assistance from experienced professionals who possess the necessary skills and knowledge to handle these creatures safely.

An imperative initial step would be for olive growers to scrupulously inspect their nets prior to laying them on the ground and promptly extricate any animals ensnared within them. When the olive harvesting concludes, they should retrieve the nets and store them in a manner that precludes their contact with snakes or other faunal species. Additionally, our case highlights the vulnerability of reptiles to entrapment in nets; thus, at the end of their useful lifespan, the nets should be disposed of in an appropriate manner. Inorganic agricultural waste, which can amount to hundreds of tons, should not be discarded indiscriminately or improperly, as it has been observed in several instances [12,14,42–44] (pers. obs.). When their use is no longer viable, arrangements should be made for their collection in safe locations, and a suitable management system must be established to avoid contact with wildlife. The development and implementation of conservation measures, such as the proper management and maintenance of olive nets, may prove to be crucial in mitigating their negative effects on these species.

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References

1. Perrings, C.; Halkos, G. Agriculture and the threat to biodiversity in sub-saharan africa. *Environ. Res. Lett.* **2015**, *10*, 95015. [CrossRef]
2. De Oliveira, M.M.; Morato, R.G.; Jorge, R.S.P.; de Paula, R.C. Agricultural activities and threat to fauna in Brazil: An analysis of the Red Book of Endangered Brazilian Fauna. *Pap. Avulsos Zool.* **2021**, *61*, e20216193. [CrossRef]
3. Todd, B.; Willson, J.; Gibbons, J. The Global Status of Reptiles and Causes of Their Decline. In *Ecotoxicology of Amphibians and Reptiles*, 2nd ed.; CRC Press: Boca Raton, FL, USA, 2010; pp. 47–67.
4. Böhm, M.; Collen, B.; Baillie, J.E.M.; Bowles, P.; Chanson, J.; Cox, N.; Hammerson, G.; Hoffmann, M.; Livingstone, S.R.; Ram, M.; et al. The conservation status of the world's reptiles. *Biol. Conserv.* **2013**, *157*, 372–385. [CrossRef]
5. Benton, T.G.; Vickery, J.A.; Wilson, J.D. Farmland biodiversity: Is habitat heterogeneity the key? *Trends Ecol. Evol.* **2003**, *18*, 182–188. [CrossRef]

6. Carpio, A.J.; Oteros, J.; Tortosa, F.S.; Guerrero-Casado, J. Land use and biodiversity patterns of the herpetofauna: The role of olive groves. *Acta Oecologica* **2016**, *70*, 103–111. [CrossRef]
7. Carpio, A.J.; Castro, J.; Mingo, V.; Tortosa, F.S. Herbaceous cover enhances the squamate reptile community in woody crops. *J. Nat. Conserv.* **2017**, *37*, 31–38. [CrossRef]
8. Fleskens, L.; Duarte, F.; Eicher, I. A conceptual framework for the assessment of multiple functions of agro-ecosystems: A case study of Trás-os-Montes olive groves. *J. Rural Stud.* **2009**, *25*, 141–155. [CrossRef]
9. Henle, K.; Alard, D.; Clitherow, J.; Cobb, P.; Firbank, L.; Kull, T.; McCracken, D.; Moritz, R.F.A.; Niemelä, J.; Rebane, M.; et al. Identifying and managing the conflicts between agriculture and biodiversity conservation in Europe-A review. *Agric. Ecosyst. Environ.* **2008**, *124*, 60–71. [CrossRef]
10. Plieninger, T.; Bieling, C. Resilience-based perspectives to guiding high-nature-value farmland through socioeconomic change. *Ecol. Soc.* **2013**, *18*, 20. [CrossRef]
11. Kiritsakis, A.; Markakis, P. Effect of olive collection regime on olive oil quality. *J. Sci. Food Agric.* **1984**, *35*, 677–678. [CrossRef]
12. Hiskakis, M.; Briassoulis, D.; Babou, E.; Liantzas, K. Agricultural Plastic Waste Mapping in Greece. *Acta Hortic.* **2008**, *801*, 351–358. [CrossRef]
13. Briassoulis, D.; Babou, E.; Hiskakis, M.; Scarascia, G.; Picuno, P.; Guarde, D.; Dejean, C. Review, mapping and analysis of the agricultural plastic waste generation and consolidation in Europe. *Waste Manag. Res. J. Sustain. Circ. Econ.* **2013**, *31*, 1262–1278. [CrossRef]
14. Blanco, I.; Loisi, R.V.; Sica, C.; Schettini, E.; Vox, G. Agricultural plastic waste mapping using GIS. A case study in Italy. *Resour. Conserv. Recycl.* **2018**, *137*, 229–242. [CrossRef]
15. Plasquy, E.; Sola-Guiraldo, R.R.; Florido, M.d.C.; García, J.M.; Blanco-Roldán, G. Evaluation of a manual olive fruit harvester for small producers. *Res. Agric. Eng.* **2019**, *65*, 105–111. [CrossRef]
16. García, J.M.; Yousfi, K. The postharvest of mill olives. *Grasas Aceites* **2006**, *57*, 16–24. [CrossRef]
17. Guardia-Rubio, M.; Ayora-Cañada, M.J.; Ruiz-Medina, A. Effect of Washing on Pesticide Residues in Olives. *J. Food Sci.* **2007**, *72*, C139–C143. [CrossRef]
18. Ouaouich, A.; Chimi, H. *Guide du Producteur de L'huile D'olive. Organisation des Nations Unies Pour le Développement Industriel*; Organisation des Nations Unies Pour le Développement Industriel: Vienne, Austria, 2007; 36p.
19. Mele, M.A.; Islam, M.Z.; Kang, H.-M.; Giuffre, A.M. Pre-and post-harvest factors and their impact on oil composition and quality of olive fruit. *Emir. J. Food Agric.* **2018**, *30*, 592. [CrossRef]
20. Zevgolis, Y.G.; Kamatsos, E.; Akriotis, T.; Dimitrakopoulos, P.G.; Troumbis, A.Y. Estimating Productivity, Detecting Biotic Disturbances, and Assessing the Health State of Traditional Olive Groves, Using Nondestructive Phenotypic Techniques. *Sustainability* **2022**, *14*, 391. [CrossRef]
21. Kizos, T.; Dalaka, A.; Petanidou, T. Farmers' attitudes and landscape change: Evidence from the abandonment of terraced cultivations on Lesvos, Greece. *Agric. Human Values* **2010**, *27*, 199–212. [CrossRef]
22. Madsen, T. Movements, Home Range Size and Habitat Use of Radio-Tracked Grass Snakes (*Natrix natrix*) in Southern Sweden. *Copeia* **1984**, *1984*, 707. [CrossRef]
23. Valakos, E.; Pafilis, P.; Lymberakis, P.; Maragou, P.; Sotiropoulos, K.; Foufopoulos, J. *The Amphibians and Reptiles of Greece*; Edition Chimaira: Frankfurt am Main, Germany, 2008; ISBN 9783899734614.
24. Kaczmarski, M. Arboreal foraging and ambush by grass snakes *Natrix natrix* on European treefrogs Hyla arborea. *Herpetol. Bull.* **2020**, *154*, 39–40. [CrossRef]
25. Reading, C.; Jofré, G. Habitat selection and range size of grass snakes *Natrix natrix* in an agricultural landscape in southern England. *Amphibia-Reptilia* **2009**, *30*, 379–388. [CrossRef]
26. Pafilis, P.; Maragou, P. *Atlas of Amphibian and Reptiles of Greece*; Broken Hill Publishers Ltd.: Nicosia, Cyprus, 2020; ISBN 978-9925-588-03-9.
27. Miranda, J.P.; de Matos, R.F.; Araújo, R.C.S.; Scarpa, F.M.; Rocha, C.F.D. Entanglement in plastic debris by Boa constrictor (Serpentes: Boidae) in the state of Maranhão, Northeastern Brazil. *Herpetol. Notes* **2013**, *6*, 103–104.
28. Blettler, M.C.M.; Mitchell, C. Dangerous traps: Macroplastic encounters affecting freshwater and terrestrial wildlife. *Sci. Total Environ.* **2021**, *798*, 149317. [CrossRef] [PubMed]
29. Zdunek, P.; Kolenda, K. The threat of discarded food and drinks containers to monitor lizards. *Herpetol. Bull.* **2022**, *161*, 28–30. [CrossRef]
30. Crane, M.; Oliver, K.; Silva, I.; Aksornneam, A.; Artchawakom, T.; Strine, C.T. A report of a Malayan Krait snake Bungarus candidus mortality as by-catch in a local fish trap from Nakhon Ratchasima, Thailand. *Trop. Conserv. Sci.* **2016**, *9*, 313–320. [CrossRef]
31. Christopoulos, A.; Vlachopoulos, K.; Christopoulos, I. The herpetofauna of drained Lake Karla (Thessaly, Greece): Distribution and threats. *Herpetol. Notes* **2021**, *14*, 1385–1405.
32. Woinarski, J.C.Z.; Armstrong, M.; Brennan, K.; Connors, G.; Milne, D.; Mckenzie, G.; Edwards, K. A different fauna?: Captures of vertebrates in a pipeline trench, compared with conventional survey techniques; and a consideration of mortality patterns in a pipeline trench. *Aust. Zool.* **2000**, *31*, 421–431. [CrossRef]

33. Doody, J.S.; West, P.; Stapley, J.; Welsh, M.; Tucker, A.; Guarino, E.; Pauza, M.; Bishop, N.; Head, M.; Dennis, S.; et al. Fauna by-catch in pipeline trenches: Conservation, animal ethics, and current practices in Australia. *Aust. Zool.* **2003**, *32*, 410–419. [CrossRef]
34. Manning, G.J. Uta stansburiana (Side-Blotched Lizard) mortality. *Herpetol. Rev.* **2007**, *38*, 465.
35. García-Cardenete, L.; Pleguezuelos, J.M.; Brito, J.C.; Jiménez-Cazalla, F.; Pérez-García, M.T.; Santos, X. Water cisterns as death traps for amphibians and reptiles in arid environments. *Environ. Conserv.* **2014**, *41*, 341–349. [CrossRef]
36. Stuart, J.N.; Watson, M.L.; Brown, T.L.; Eustice, C. Plastic netting: An entanglement hazard to snakes and other wildlife. *Herpetol. Rev.* **2001**, *32*, 162–164.
37. Brown, J.D.; Sleeman, J.M. Morbidity and mortality of reptiles admitted to the wildlife center of Virginia, 1991 to 2000. *J. Wildl. Dis.* **2002**, *38*, 699–705. [CrossRef]
38. Kapfer, J.; Paloski, R. On the threat to snakes of mesh deployed for erosion control and wildlife exclusion. *Herpetol. Conserv. Biol.* **2011**, *6*, 1–9.
39. Šmíd, J. Greenhouse netting as an effective trap for lizards in the Gran Canaria Island. *Herpetol. Notes* **2012**, *5*, 63.
40. Christopoulos, A.; Pafilis, P. An agricultural practice as a direct threat to the snake-eyed skink Ablepharus kitaibelii (Bibron & Bory de Saint-Vincent, 1833) in central Greece. *Herpetozoa* **2021**, *34*, 9–12. [CrossRef]
41. European Commission. *EU Olive Oil Farms Report*; European Commission: Brussels, Belgium, 2012.
42. Scarascia-Mugnozza, G.; Sica, C.; Picuno, P. The Optimisation of the Management of Agricultural Plastic Waste in Italy Using a Geographical Information System. In *ISHS Acta Horticulturae 801: International Symposium on High Technology for Greenhouse System Management: Greensys2007*; ISHS: Leuven, Belgium, 2007; pp. 219–226.
43. Vox, G.; Loisi, R.V.; Blanco, I.; Mugnozza, G.S.; Schettini, E. Mapping of Agriculture Plastic Waste. *Agric. Agric. Sci. Procedia* **2016**, *8*, 583–591. [CrossRef]
44. Lanorte, A.; De Santis, F.; Nolè, G.; Blanco, I.; Loisi, R.V.; Schettini, E.; Vox, G. Agricultural plastic waste spatial estimation by Landsat 8 satellite images. *Comput. Electron. Agric.* **2017**, *141*, 35–45. [CrossRef]