

Circadian activity patterns of the Red fox (*Vulpes vulpes*) and the Stone marten (*Martes foina*) in agricultural landscape of Northwestern Bulgaria during autumn-winter period

ALEXANDER PETROV¹, KRASIMIR KIRILOV², DESISLAVA TINCHEVA²

¹University of Plovdiv "Paisii Hilendarski", Faculty of Biology, Department of Ecology and Environmental Conservation, 24 Tzar Assen Str., 4000 Plovdiv, Bulgaria

²Trakia University, Faculty of Agriculture, Department of Animal Production – Non-ruminants and Other Animals, Stara Zagora 6000, Bulgaria

Abstract. Our study was aimed to establish the circadian activity of the Red fox (*Vulpes vulpes*) and the Stone marten (*Martes foina*) in the protected area "Zlatiyata", situated in an agricultural landscape. The study was conducted from September 2021 to March 2022 using camera traps. It provides new data on the behavioral ecology of the target species contributing to the knowledge of their co-existence in croplands.

Key words: mesocarnivores, agricultural regions, camera traps.

Introduction

A large part of the mesopredators in Europe inhabit the same territory forming the so-called local carnivore guild (Dalerum *et al.* 2009). Food resources or territory competition may occur between them. Those relationships most often depend on a particular habitat (Gompper *et al.* 2016). Local resource availabilities, landscape structure and human presence influence carnivores' cohabitation (Seveque *et al.* 2020, Manlick & Pauli 2020).

The Red fox (*Vulpes vulpes*) and the Stone marten (*Martes foina*) are among the most common mesocarnivores in Bulgaria (Popov & Sedefchev 2003). Several studies on their circadian activity were conducted in different regions of Bulgaria (for Stara Planina Mts - Georgiev *et al.* 2015, Dudin & Georgiev 2015, Peeva 2016, for Western Rhodopes - Dudin 2017). No relevant study has been conducted for the agricultural region of Northwestern Bulgaria.

Material and Methods

The protected area "Zlatiyata" is located in Northwestern Bulgaria (Fig. 1.), in the Danubian Plain, close to the town of Kozloduy. It covers a plateau with open grasslands of steppe character and arable lands. In some places there are earth loess walls overgrown with low trees and shrubs, composed mainly of common hawthorn (*Crataegus monogyna*) and dog rose (*Rosa canina*). The invasive *Ailanthus* (*Ailanthus altissima*) is abundant on the earth walls of the plateau and around them. Scattered pastures, orchards, vineyards, wind protection belts, patches of broadleaved and riparian forests along The Ogosta River are also present in the area (Natura 2000).

Other carnivores that our cameras captured and cohabit with the studied species in the area are the European wild cat (*Felis silvestris*), the European badger (*Meles meles*) and the Golden jackal (*Canis aureus*).

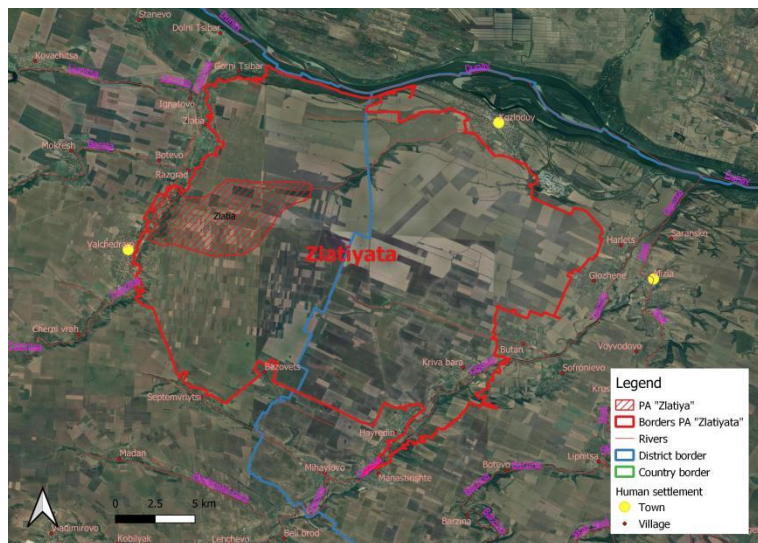


Fig. 1. Location of the protected area “Zlatiyata” in Northwestern Bulgaria.

A total of 3 camera traps (BolyGuard BG590-K2 and Keep Guard Cam KG690NV) were set up on trees along wild animal paths. The devices were angled at 45-90 degrees to the trails depending on the size of the target species. The operation mode of the cameras was to take 3 consecutive photos with 5 minutes delay. The images of a particular species separated by thirty-minute interval were treated as an independent observation (one event). The studied period lasted from September 1, 2021 to February 28, 2022. No baits or lures were used, compared to other studies (Dudin & Georgiev 2015; Dudin 2017).

Results and Discussion

The earliest activity of the Red fox during the day was detected at 17:59 and of the stone marten - at 18:33. Both species (Fig. 2) demonstrated nocturnal bimodal activity. The first peak was at 22:00-00:00 and the second one - between 04:00 and 06:00 (Fig. 3).



Fig. 2. Stone marten, *Martes foina* (left) and Red fox, *Vulpes vulpes* (right) captured in protected area “Zlatiyata”, Northwestern Bulgaria.

The share of photos with recorded crepuscular activity was 7.9% for the fox and 9% for the Stone marten. Our results are similar with that of other authors investigating activity patterns of the same species in Bulgaria (Dudin & Georgiev 2015, Georgiev *et al.* 2015, Peeva 2016, Dudin 2017). Nocturnal but unimodal activity for both species was described by Tsunoda *et al.* (2020) for Central Bulgaria.

We noticed small inconsistencies expressed with daily activity in agricultural regions of Southern Bulgaria (Georgiev *et al.* 2015) and high mountain regions (Petrov *et al.* 2016).

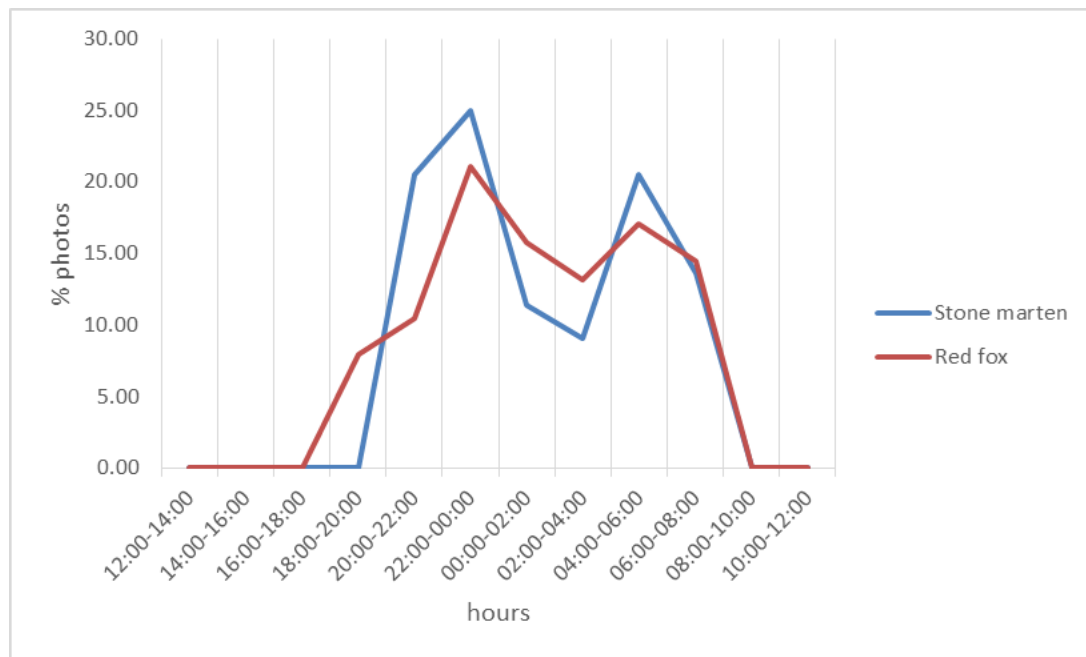


Fig. 3. Stone marten (*Martes foina*) and Red fox (*Vulpes vulpes*) daily activity patterns in protected area "Zlatiyata", Northwestern Bulgaria.

The Red fox and the Stone marten demonstrate bimodal nocturnal activity during autumn-winter season in the agricultural landscape of Northwest Bulgaria.

Acknowledgements. The study is a part of the project MU21-BF-016 "Seasonal and diurnal activity of the red fox (*Vulpes vulpes* L.) and the stone marten (*Martes foina* Erxl.) in the protected area "Maritsa - Parvomay" (Upper Thracian lowland) and protected area "Zlatiyata" (Northwest Danube Plain)" Under the program "Young Scientists" of the University of Plovdiv "Paisii Hilendarski".

References

- Dalerum, F., Cameron, E., Kunkel, K. & Somers, M. (2009) Diversity and depletions in continental carnivore guilds: implications for prioritizing global carnivore conservation. *Biology Letters*, 5(1): 35-38.
- Dudin, G. & Georgiev, D. (2015) On the daily activity of the stone marten (*Martes foina* Erxl.) in forest habitats in Bulgaria. *Journal of BioScience and Biotechnology*, SE/ONLINE: 239-240.
- Dudin, G. (2017) On the daily activity of the Red Fox (*Vulpes vulpes*) in two village areas of Bulgaria: a case study. *ZooNotes*, 115: 1-4.
- Gompper, M., Lesmeister, D., Ray, J., Malcolm, J., Kays, R. & Reed, A. (2016) Differential habitat use or intraguild interactions: What structures a carnivore community? *PLOS ONE*, 11(1): e0146055.

- Ilemin, Y. & Gürkan, B. (2010) Status and activity patterns of the Caracal, *Caracal caracal* (Schreber, 1776), in Datca and Bozdurun Peninsulas, Southwestern Turkey. *Zoology in the Middle East*, 50(1): 3-10.
- Jaeger, M., Hauque, E., Sultana, P. & Bruggers, R. (2007) Daytime cover, diet and space-use of golden jackals (*Canis aureus*) in agro ecosystems of Bangladesh. *USDA National Wildlife Research Center – Staff Publications*, 71(1/2): 1-10.
- Manlick, P. & Pauli, J. (2020) Human disturbance increases trophic niche overlap in terrestrial carnivore communities. *Proceedings of the National Academy of Sciences*, 117(43): 26842-26848.
- Peeva, S. (2016) Influence of the atropogenic factor on the nutrient spectrum of the protein (*Martes foina*, Erxl. 1777) and the emergence of the conflict "Man - wild animal", *Dissertation*, 147 pp.
- Petrov, P., Popova, E. & Zlatanova, D. (2016) Niche Partitioning among the Red Fox *Vulpes vulpes* (L.), Stone Marten *Martes foina* (Erxleben) and Pine Marten *Martes martes* (L.) in Two Mountains in Bulgaria. *Acta Zoologica Bulgarica*, 68(3): 375-390.
- Racheva, V., Zlatanova, D., Peshev, D. & Markova, E. (2012) Camera traps recorded use of sett sites by badgers (*Meles meles* L., Mammalia) in different habitats. *Acta zoologica bulgarica*, 64(2): 145-150.
- Roemer, G, Gompper, M. & Van Valkenburgh, B. (2009) The Ecological Role of the Mammalian Mesocarnivore. *BioScience*, 59(2): 165-173.
- Servin, J., Rau, J., Delibes, M. (1991) Activity pattern of the red fox *Vulpes vulpes* in Donana, SW Spain. *Acta Theriologica*, 36(3-4): 369-373.
- Seveque, A., Gentle, L., Lopez-Bao, J., Yarnell, R. & Uzal, A. (2020) Human disturbance has contrasting effects on niche partitioning within carnivore communities. *Biological Reviews*, 95: 1689-1705.
- Tsunoda, H., Newman, C., Peeva, S., Raichev, E., Buesching, C. D. & Kaneko, Y. (2020) Spatio-temporal partitioning facilitates mesocarnivore sympatry in the Stara Planina Mountains, Bulgaria. *Zoology*, 141: 125801.
- Zalewski, A. (2000) Factors affecting the duration of activity by pine martens (*Martes martes*) in the Białowieża National Park, Poland. *Journal of Zoology*, 251(4): 439-447.