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RESEARCH ARTICLE

Novel in-situ observations on the diel surface activity of the Romanian hamster, *Mesocricetus newtoni* (Rodentia, Cricetidae), during pup rearing

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Abstract

The Romanian hamster *Mesocricetus newtoni* is a threatened and cryptic species, with a distribution limited to North-eastern Bulgaria and South-eastern Romania (Dobruja region). Current literature does not provide sufficient data regarding diel activities and behavior of this species, especially under field conditions. In this context, one female *M. newtoni*, during the rearing period of her four pups, was monitored for ten days using camera traps. For each documented activity, the date, time, age of the individual, type of activity, and duration were recorded. In total, from the 26140 media files, 72968 seconds were recorded as active behaviors. Data analysis revealed that diurnal activity was predominant and documented for all monitored days; however, the animals spent more time per each activity during the night. The nocturnal activity was present but erratic, without significant patterns. No significant differences were observed in the median duration of activities of the adult compared to the immature individuals. Both the adult female and pups spent time exploring the burrow entrance, especially during the day, but immatures were more reserved to leave the burrow than the female. The female used four burrows for rearing the pups. During this time, food storage behaviors and transferring of immatures

between burrows, as well as the weaning of the pups were documented. This study demonstrates that *M. newtoni* exhibits significant diurnal activity, at least in certain ecological and physiological conditions.

Keywords
Mesocricetus newtoni, Romanian hamster, behavior, diurnal activity, field conditions, camera traps.

Introduction

All living organisms have evolved to show rhythmic changes in behavior and physiological processes with a 24-hour periodicity, generally synchronized with the ambient light-dark (LD) cycle (Weaver 1998, Gattermann et al. 2008). In mammals, this has been demonstrated to be regulated primarily by the suprachiasmatic nucleus complex (SCN) of the ventral hypothalamus (Klein and Moore 1991). Mammals can be categorized as nocturnal (active at night), diurnal (active during the day), crepuscular (active at dusk and dawn), or noncircadian (Smale et al. 2003; Roll et al. 2006). However, evidence suggests that for many species of mammals, the LD cycle may be secondary to various abiotic and biotic factors, such as interactions with conspecifics, predator activity, food availability, temperature, and humidity changes (Smale et al. 2003; Mistlberger and Skene 2004). In Rodents, phylogeny has been demonstrated to be a major indicator of circadian activity patterns, although a tendency towards a-rhythmic behavior, caused by physiological constraints and specialized habitat use has been observed (Roll et al. 2006).

The genus *Mesocricetus* is comprised of four species: *M. auratus, M. brandti, M. raddei* and *M. newtoni* (Wilson and Reeder 2005). The Romanian hamster *Mesocricetus newtoni* (Nehring, 1898) has a distribution limited to North-eastern Bulgaria and South-eastern Romania (Dobruja region) (Peshev et al. 2004; Yiğit et al. 2006). The preferred habitats of this species are agricultural fields of perennial plants or cereal, forest belts, and grassland (Murariu and Popescu 2001). Less often it can be seen in corn fields and field-protecting belts and is completely absent from arable fields (Marcheș 1964; Peshev et al. 2004).

Although it is considered a predominantly herbivorous species, feeding on roots, herbs, fruits and cereals, it is also known to consume invertebrates, small mammals and birds (Dombrowski 1907). Foraging, gathering, and storage behaviors have been associated with feeding in Romanian hamsters (Marcheș 1964). It is a solitary species, living mainly in simple burrows with a depth of around 30–180 cm. Males settle for a 70–80 cm depth in their burrows; however, females, starting with their second gestation, may dig a burrow of 180 cm. The burrows have walls padded with herbaceous vegetation and can have 2–5 almost vertical entrances, useful for rapid escape or as refuges for the pups (Marcheș 1964). Breeding starts in April–May and the gestation length is 16 days. One female may produce 2–3 liters per season, each of 2–10 pups, which are weaned at 3 weeks, but become independent only after 2–3 months (Marcheș 1964). The Romanian hamster has long been viewed as crepuscular

and nocturnal, along with other members of the genus *Mesocricetus* (Dombrowski 1907; Murariu and Popescu 2001; Gattermann et al. 2008). However, isolated reports of diurnal activity in *M. newtoni* have been recorded and challenge the existing knowledge (Popescu and Barbu 1964). Other studies provide data on the behavior and activity patterns of this species, but only on captive individuals housed in artificial or semi-natural conditions, concluding that it is predominantly nocturnal (Marcheș 1964; Simeonovska-Nikolova and Dekov 2013).

Quantitative population densities are not known, but are estimated to be decreasing due to agricultural intensification, therefore the species was assessed as "near threatened" (Coroiu and Vohralík 2008). Also, the species is protected under the Habitats Directive 92/43/EEC, under Annexes II and IV.

Taking into account that the data on the behavior and ecology of *M. newtoni* in the wild is scarce (Fritzsche et al. 2017), the aim of this study was to provide more insight into the diel surface activity and behavior of this secluded and insufficiently studied species. To contribute to filling this gap, surface activities were monitored using camera traps and later were analyzed and classified to establish if any temporal pattern could be discerned. Furthermore, this study provides new data regarding maternal behavior for *M. newtoni* in natural field conditions.

Methods

Study area

The research was conducted near Săcele village, Constanța county, Romania, over a period of 10 days, in two intervals: 06 May – 11 May and 15 May – 18 May 2017. The habitat was located in a steppe pasture with ruderal vegetation, adjacent to wheat crop fields, at 150 m altitude.

The study group consisted of a family of five animals: one adult female and four pups were observed and later monitored in the field under natural conditions (Fig. 1). At the beginning of the study, the pups were estimated to be 12–14 days old, considering size and appearance. Over the study period, four burrows were identified and monitored.

Field study

The recordings were made using a Reconyx PC850 Professional camera trap, programmed to take a sequence of five pictures, and multiple Ltl Acorn 6210 camera traps, programmed to take three pictures and a video of 20 seconds per sequence (Fig. 1). In total, 26140 media files were analyzed. The date, time, age of the individual and type of activity, with the start and end time, were noted. The types of observed activities were coded as: (1) exploring the burrow entrance; (2) completely outside the burrow; (3) away from the burrow (when the individual is at least at one length of its body away from the entrance); (4) returning to the burrow; (5) feeding; and (6) transfer of immatures.

Figure 1. Field study area during the monitoring of a female *M. newtoni* under natural conditions, using a Ltl Acorn 6210 camera trap.

Figure 2. Female *M. newtoni* observed transferring an immature pup from the burrow region.

The diurnal and nocturnal activity was differentiated considering sunrise and sunset times. These were verified using *https://www.timeanddate.com/* for Săcele village, Constanța county, Romania, for each day the animals were monitored.

Data analysis

Only complete activities were taken into consideration (with known start and end time) for data analysis; Activities that could not be determined as complete based on the media footage were excluded.

Statistical analyses and plotting were performed in RStudio (RStudio Team 2020) using the base package (for statistics) and the package *ggplot2* (Wickham H. 2009). The Wilcoxon test was used to explore differences between the median duration of diurnal or nocturnal activity and the median duration of activities performed by adult and immature individuals.

A two-way analysis of variance (ANOVA) was computed to identify whether there are differences between the time spent by adults and immatures exploring the burrow entrance during the day and during the night. The dependent variable (duration, in seconds) was log-transformed before being introduced into the analysis to ensure normality. Assumptions of homogeneity of variance were assessed visually using the residuals versus fits plot; normality of residuals was assessed visually and using the Shapiro-Wilk test. All analyses were performed at a confidence level of 95%.

Results

In total, from the 26140 media files, 72968 seconds were recorded as active behaviors. A representative actogram for the activity pattern of the female *M. newtoni* and pups is shown in Fig. 3. Diurnal activity was predominant and documented for all monitored days, with peaks recorded between 7:00 AM – 11:30 AM and between 15:00 PM – 20:00 PM. However, a significant decrease in activity was observed between 14:00 and 20:00 PM, during the last three days of the study (16–18 May). The nocturnal activity was present but erratic, without significant patterns, and relatively absent for three nights (9–11 May).

Activity types, recorded for adults and immatures, categorized as diurnal and nocturnal, are shown in Fig. 4. The longest activities recorded were the periods spent away from the burrow, for both adults and immatures, during both daytime and night-time.

Daily activity and age-specific differences

There was a significant difference in the median duration of the activity of animals during the day and during the night (Wilcoxon test, $W = 142940$, $p = 0.0001887$), with more time spent per each activity during the night (Fig. 5). No significant difference was observed in the median duration of activity of the adult and the immature individuals (Wilcoxon test, $W = 180089$, p-value = 0.497) (Fig. 6).

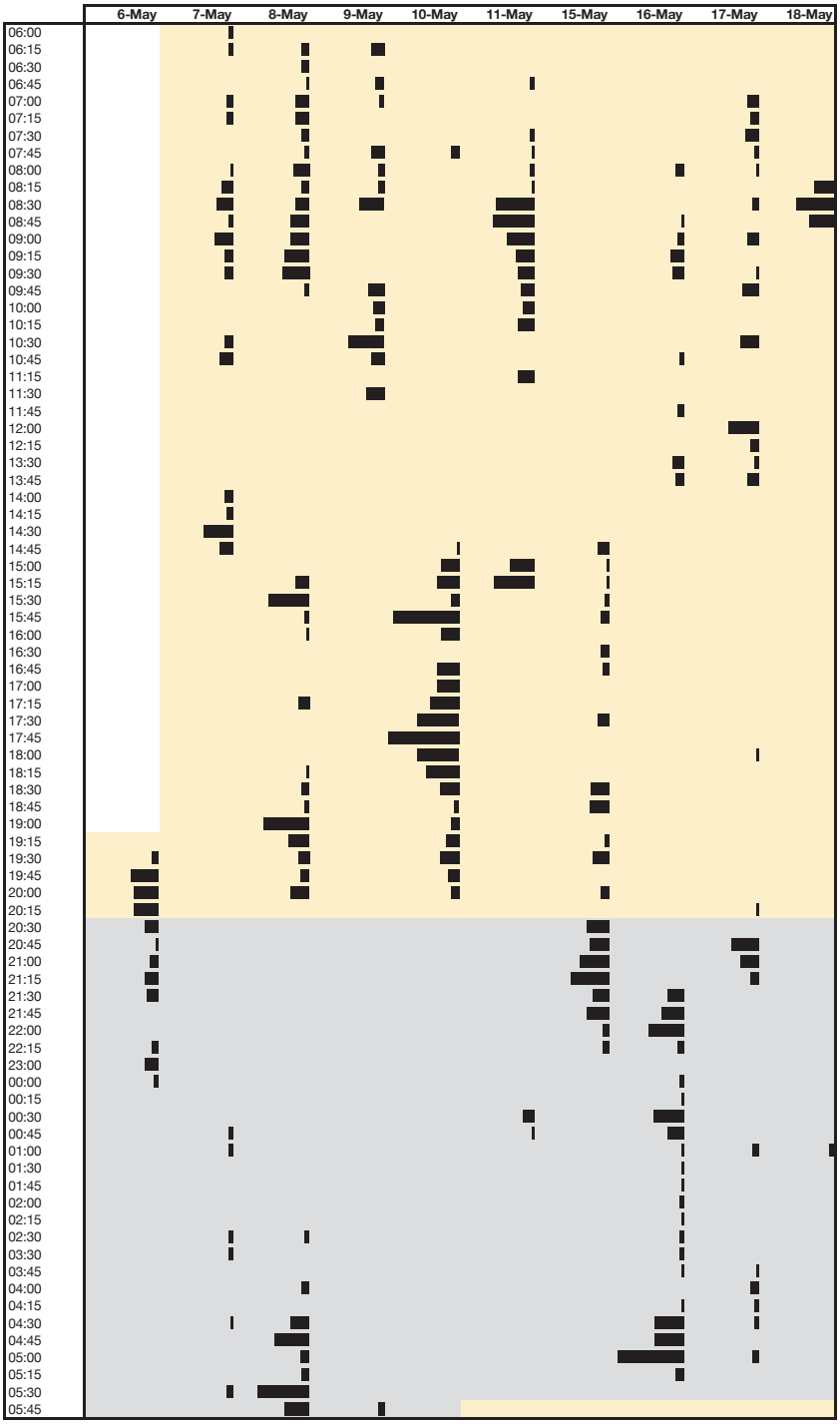

Figure 3. Actogram showing the activity patterns of the female *M. newtoni* and four pups, during the total monitoring time (yellow - daytime; gray - nighttime).

Both adults and immatures spent time exploring the burrow entrance, especially during the day. The two-way ANOVA showed a significant difference between the average time spent exploring the burrow entrance by the adult and the immatures ($F = 4.249$, $p = 0.048$) and between the average time spent exploring the burrow entrance during the day and during the night ($F = 4.421$, $p = 0.036$). More time is being spent on this activity during the day and the immatures were more reserved than the adult (Fig. 7).

Pup-rearing related behaviors

The female was observed using a total of four burrows. The minimum distance between the entrances was 8.8 meters, while the maximum was 24.9 meters, with a mean of 13.3 meters. The female exhibited food storage behaviors prior to the transfer of immatures to other burrows. During the study, the female transferred the pups a total number of eight times, showing a tendency to exhibit this behavior during the day (seven times during the day and once during the night) (Fig. 2). During the last seven days of the monitoring period, the female was observed refusing to breastfeed the pups, but continued transferring them to other burrows.

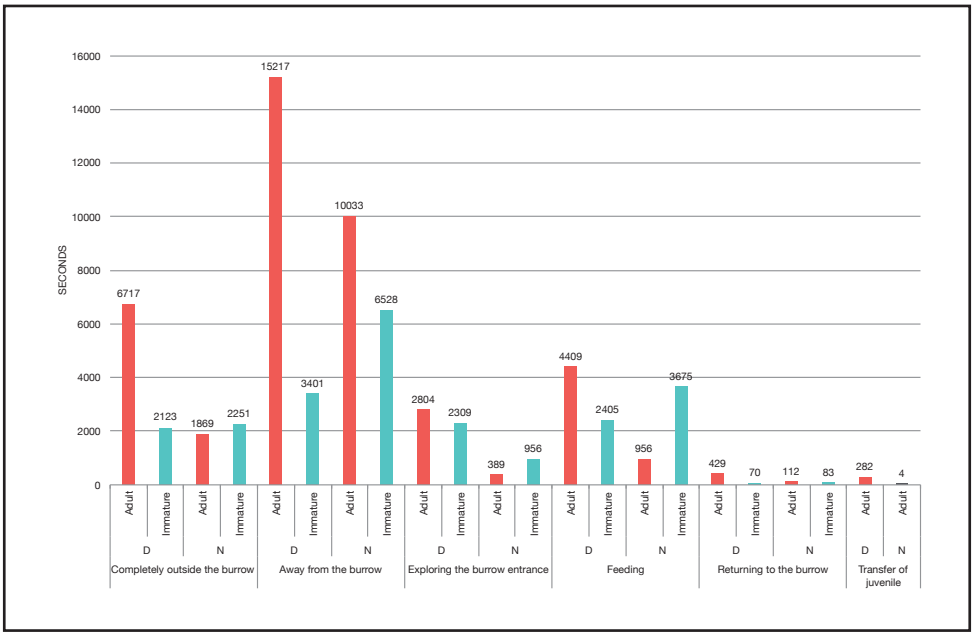

Figure 4. Types of activities recorded (in seconds), categorized by the time of day and age of the animals (D - daytime; N - nighttime).

Discussion

Although existing data consider *M. newtoni* as a nocturnal or crepuscular species, with one previous reference of daytime activity (Popescu and Barbu 1964), this study shows that under certain ecological and physiological conditions, some individuals are predominantly diurnal. Simeonovska-Nikolova and Dekov (2013) found that under laboratory conditions, *M. newtoni* is active mainly during the dark, with two peaks of activity: between 03.00 and 07.00 and between 19.00 and 22.00. Similar differences in activity patterns between hamsters observed in artificial versus natural conditions can be detected in other *Mesocricetus* species. For example, *M. auratus* and *M. raddei* both exhibited diurnal behavior under natural conditions and nocturnal behavior under laboratory conditions (Gattermann et al. 2008; Fritzsche et al. 2017). In our study, the animals were observed to be more active during the day. In *M. auratus* and *M. raddei*, similar patterns have been hypothesized to be adaptations for nocturnal predatory avoidance (Gattermann et al. 2008; Larimer et al. 2011; Fritzsche et al. 2017). From existing data, the predators of *M. newtoni* are mostly nocturnal species: *Mustela eversmanii, Bubo bubo, Asio otus, Meles meles* (Hamar and Șutova 1963; Popescu and Sin 1966, 1968; Schnapp 1971).

The animals spent more time per activity during the night. The shorter duration of daytime activities can be explained by heat stress avoidance during high-temperature periods (Gattermann et al. 2008; Simeonovska-Nikolova and Dekov 2013). Considering that some diurnal predators have also been recorded: *Buteo buteo, Buteo lagopus* (Ausländer S. 1957; Popescu 1977), this could also demonstrate that the

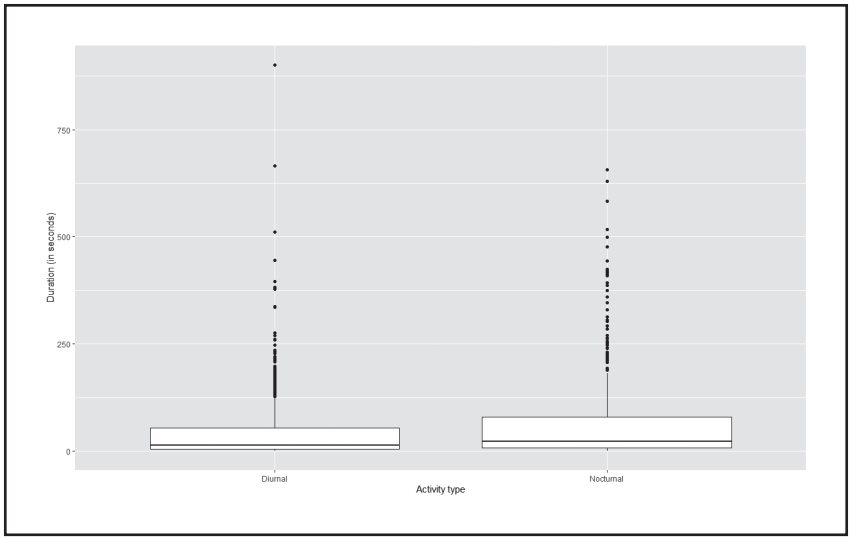

Figure 5. Duration of the activities (in seconds) performed by the animals during the day and during the night.

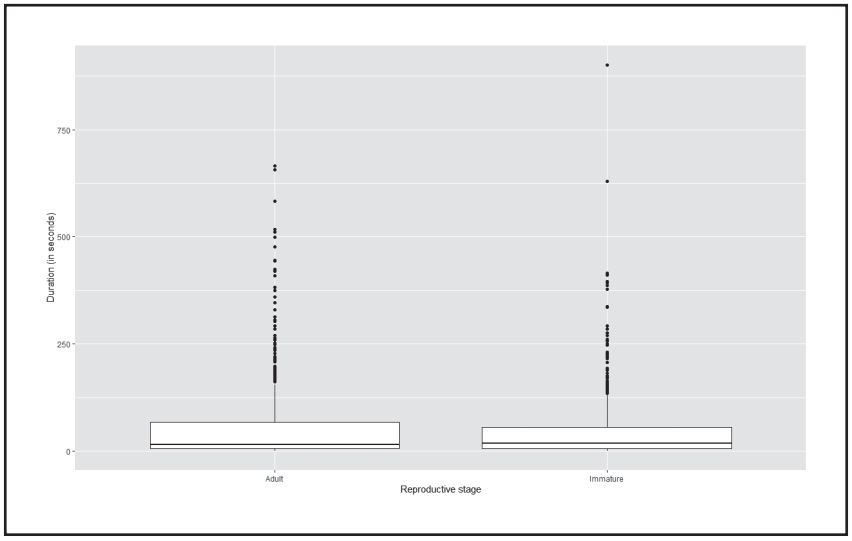

Figure 6. Duration of the activities (in seconds) performed by adult and the immature individuals.

significantly longer time spent exploring the burrow entrance during the day could be another adaptation to predator avoidance. This hypothesis is supported by the fact that immatures were shown to be significantly more reserved to leave the burrow than adults, probably due to less experience in risk assessment.

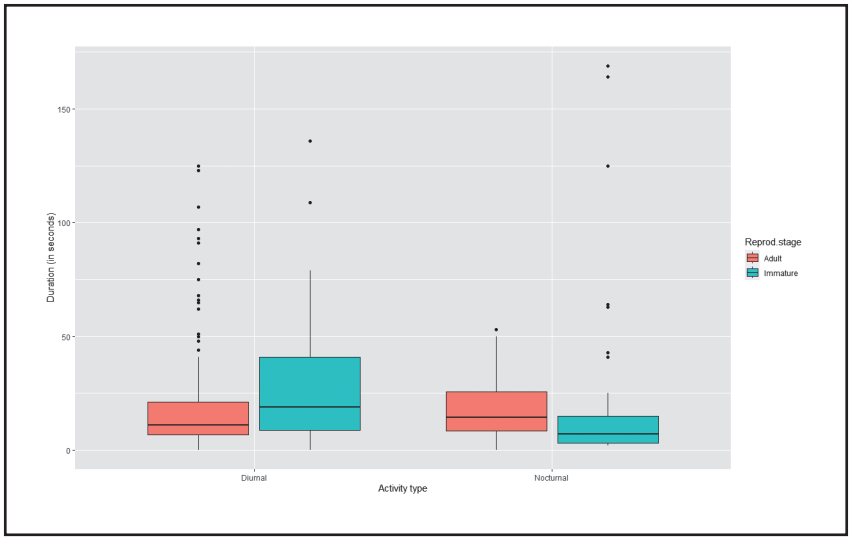

Figure 7. Time spent (in seconds) by adults and immatures exploring the burrow entrance during the day and at night.

Another possible strategy for predator avoidance and/or food availability could be seen during the period of the study when the female exhibited food storage behaviors prior to the transfer of immatures to other burrows. This could be explained by the possible depletion of the food source in the proximity of the active burrow, thus motivating the change of location, in order to spend the shortest amount of time in search of food above ground. This strategy could also be used to avoid predators.

Nonetheless, our study was conducted primarily on one female *M. newtoni* which was monitored during the final week of her lactation and pup weaning period. This data suggests that family groups have a tendency for noncircadian behavior during the last part of development and weaning of the pups. Differences in foraging behavior have also been observed in *M. auratus* during lactation, as females need to restore their adipose tissue reserves while also sustaining lactation (Wade et al. 1986). Therefore, due to high energy demands, lactating females exposed themselves to more risks than non-lactating females and spent significantly more time foraging (Larimer et al. 2011). Comparable behaviors may be characteristic also of *M. newtoni*, so more studies are necessary to assess the general activity patterns of the species. Camera traps can be an efficient tool for monitoring small mammals because they can provide more data than the traditional use of traps (De Bondi et al. 2010; White et al. 2017; McCleery et al. 2022). These do not constrain the user to the problem of bycatch and can produce diverse data over a longer period. Despite these advantages, camera traps also have some limitations. During this study, camera sensitivity was considered an issue, because it produced a lot of false triggers or did not trigger when the animal's movements were too fast. Another disadvantage was the restricted angle of the cameras, which could not capture movements outside the field of vision. Therefore, the activity noted as "away from the burrow" cannot be distinguished from other possible activities.

Conclusion

To conclude, this study demonstrates that *M. newtoni* exhibits significant diurnal activity, at least in certain ecological and physiological conditions, which should be taken into consideration when monitoring this endangered and cryptic species. Moreover, behavioral data for pup-rearing and weaning periods was documented for the first time under natural conditions for this species.

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References

Ausländer D, Hellwing S (1957) Observations écologiques sur les petits Mammifères des écrans forestiers de protection de "Valul Traian": Références spéciales concernant leur dynamique. Travaux du Muséum d'Histoire Naturelle "Grigore Antipa" 1: 111–139. [in French]

De Bondi N, White JG, Stevens M, Cooke R (2010) A comparison of the effectiveness of camera trapping and live trapping for sampling terrestrial small-mammal communities. Wildlife Research 37: 456–465. https://doi.org/10.1071/WR10046

Coroiu I, Vohralík V (2008) *Mesocricetus newtoni*. The IUCN Red List of Threatened Species. Accessed on 02.05.2023. https://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T13221A3421872.en.

Dombrowski RR (1907) *Mesocricetus newtoni*, Nehring: Monographische studie. Buletinul Societății de Științe din București-România/Bulletin de la Société des Sciences de Bucarest-Roumanie 16: 94–101. [in German]

Fritzsche P, Chunkov MM, Ushakova M V., Omarov KZ, Weinert D, Surov A V. (2017) Diurnal surface activity of the Ciscaucasian hamster (*Mesocricetus raddei*) in the field. Mammalian Biology 85: 1–5. https://doi.org/10.1016/j.mambio.2017.02.002

Gattermann R, Johnston RE, Yigit N, Fritzsche P, Larimer S, Özkurt S, Neumann K, Song Z, Colak E, Johnston J, McPhee ME (2008) Golden hamsters are nocturnal in captivity but diurnal in nature. Biology Letters 4: 253–255. https://doi.org/10.1098/rsbl.2008.0066

Hamar M, Șutova M (1963) Studiul ecologic al rozătoarelor (Glires) din Bărăgan și Dobrogea. Analele Secției de Protecția Plantelor, Institutul Central de Protecția Plantelor I. [in Romanian]

Klein DC, Moore RY (1991) In: Suprachiasmatic Nucleus: The Mind's Clock. 125–143.

Larimer SC, Fritzsche P, Song Z, Johnston J, Neumann K, Gattermann R, McPhee ME, Johnston RE (2011) Foraging behavior of golden hamsters (*Mesocricetus auratus*) in the wild. Journal of Ethology 29: 275–283. https://doi.org/10.1007/s10164-010-0255-8

Marcheș G (1964) Contribuţii la studiul taxonomic, biologic, ecologic şi de creştere în captivitate a grivanului sau hamsterului dobrogean (*Mesocricetus newtoni* Nehring), un nou animal de experienţă. Studii şi Cercetări de Igienă şi Sănătate Publică. Bucureşti: 185–215. [in Romanian]

McCleery R, Monadjem A, Conner LM, Austin JD, Taylor PJ (2022) Methods for ecological research on terrestrial small mammals. JHU Press, 368 pp.

Mistlberger RE, Skene DJ (2004) Social influences on mammalian circadian rhythms: Animal and human studies. Biological Reviews of the Cambridge Philosophical Society 79: 533–556. https://doi.org/10.1017/S1464793103006353

Murariu D, Popescu A (2001) Fauna României Vol. 16: Mammalia, Fasc. 2: Rodentia. Editura Academiei Române, București, 208 pp. [in Romanian]

Peshev T, Peshev D, Popov V (2004) Fauna Bulgarica, Mammalia. 27th ed. Editio Academica "Marin Drinov", 632 pp. [in Bulgarian]

Popescu A (1977) Date privind hrana de vară a şoricarului comun (*Buteo buteo buteo* L.). Studii și Cercetări de Biologie, Seria Zoologie 29(1): 99–102. [in Romanian]

Popescu A, Barbu P (1964) Contribuţii la studiul sistematicii şi dinamicii mamiferelor mici din împrejurimea Măcinului. Studii şi Cercetări de Biologie. Seria Zoologie 16(4): 351–361. [in Romanian]

Popescu A, Sin G (1966) Despre cuibăritul şi hrana bufniţei (*Bubo bubo bubo* L.) în Dobrogea de Nord. Ocrotirea Naturii şi a Mediului Înconjurător 10(2): 217–222. [in Romanian]

Popescu A, Sin G (1968) Le terrier et la nourriture du blaireau (*Meles meles* L.) dans les conditions de la steppe de Dobroudja. Travaux du Muséum d'Histoire Naturelle "Grigore Antipa" 8: 1003–1012. [in French]

Roll U, Dayan T, Kronfeld-Schor N (2006) On the role of phylogeny in determining activity patterns of rodents. Evolutionary Ecology 20: 479–490. https://doi.org/10.1007/s10682-006-0015-y

RStudio Team (2020) RStudio: Integrated Development for R. RStudio.

Schnapp B (1971) The Fauna of Micromammals from Valul lui Traian (Dobroudja) in the years 1958–1962, according to *Asio otus* (L.) pellets. Travaux du Muséum d'Histoire Naturelle "Grigore Antipa" 11: 493–510.

Simeonovska-Nikolova D, Dekov O (2013) Some aspects of the behavior and defensive vocalization of the Romanian hamster, *Mesocricetus newtoni*. Acta Zoologica Bulgarica 65: 461–468.

Smale L, Lee T, Nunez AA (2003) Mammalian diurnality: Some facts and gaps. Journal of Biological Rhythms 18: 356–366. https://doi.org/10.1177/0748730403256651

Wade GN, Jennings G, Trayhurn P (1986) Energy balance and brown adipose tissue thermogenesis during pregnancy in Syrian hamsters. https://journals.physiology.org/doi/epdf/10.1152/ajpregu.1986.250.5.R845

Weaver DR (1998) The Suprachiasmatic Nucleus: A 25-Year Retrospective. Journal of Biological Rhythms 13: 100–112. https://doi.org/10.1177/074873098128999952

White JD, Bronner GN, Midgley JJ (2017) Camera-Trapping and Seed-Labelling Reveals Widespread Granivory and Scatter-Hoarding of Nuts by Rodents in the Fynbos Biome. African Zoology 52: 31–41. https://doi.org/10.1080/15627020.2017.1292861

Wickham H (2009) ggplot2: Elegant Graphics for Data Analysis.: 10–1007.

Wilson DE, Reeder DM (2005) Mammal species of the world: a taxonomic and geographic reference. Vol. 1. JHU Press, 2005. 3rd ed. Baltimore, 1008 pp.

Yiğit N, Çolak E, Gattermann R, Neumann K, Özkurt Ş, Gharkheloo MM, Fritzsche P, Çolak R (2006) Morphological and biometrical comparisons of mesocricetus Nehring, 1898 (Mammalia: Rodentia) species distributed in the palaearctic region. Turkish Journal of Zoology 30: 291–299.

*** https://www.timeanddate.com/