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Unusual Activity Patterns in Anuran and Urodela Species During the Hibernation Period

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Abstract

Hibernation is an important strategy that allows amphibian species to survive in cold weather conditions by minimizing their metabolic activities. This study reports unusual activity patterns of 7 different amphibian species across Türkiye. The findings, based on 16 different observation data, reveal that these species exhibit different behaviors during the winter period, a time when they are typically inactive. During the observations, it was found that soil and air temperatures are related to the timing of the species, activities. The data suggests that the movement of these species during this period could be triggered by local temperature increases or other environmental variables. Notably, some species were observed to surface or become active in response to short-term temperature increases. This phenomenon is important for studying the effects of global climate change on amphibian species. However, the ecological consequences of these behaviors, such as their impact on energy expenditure and predation risk, have not yet been fully understood. The findings of this study aim to contribute to the understanding of the ecological and environmental impacts of unusual activity during the hibernation period. Furthermore, they provide valuable insights into the ecology of amphibian species in Türkiye, offering important clues for conservation biology.

Key Words: Winter activity, amphibian ecology, unusual activity, soil temperature, climate change

Hibernasyon Dönemindeki Anura ve Urodela Türlerinde Olağandışı Aktivite Örüntüleri

Öz

Hibernasyon, amfibi türlerinin soğuk hava koşullarında metabolik aktivitelerini en aza indirerek hayatta kalmalarını sağlayan önemli bir stratejidir. Bu çalışma, Türkiye genelinde 7 farklı amfibi türünün alışılmadık aktivite örüntülerini rapor etmektedir. 16 farklı gözlem verisine dayanan bulgular, genellikle hareketsiz oldukları kış döneminde bu türlerin farklı davranışlar sergilediğini ortaya koymaktadır. Gözlemler sırasında, türlerin aktivitelerinin zamanlaması ile toprak ve hava sıcaklıklarının ilişkili olduğu tespit edilmiştir. Veriler, bu dönemdeki hareketlerin yerel sıcaklık artışları veya diğer çevresel değişkenler tarafından tetiklenebileceğini göstermektedir. Özellikle, bazı türlerin kısa süreli sıcaklık artışlarına yanıt olarak yüzeye çıktığı veya aktif hale geldiği gözlemlenmiştir. Bu olgu, küresel iklim değişikliğinin amfibi türleri üzerindeki etkilerinin incelenmesi açısından önem taşımaktadır. Ancak, bu davranışların enerji harcaması ve avlanma riski üzerindeki ekolojik sonuçları henüz tam olarak anlaşılmamıştır. Çalışmanın bulguları, hibernasyon dönemindeki alışılmadık aktivitelerin ekolojik ve çevresel etkilerinin anlaşılmasına katkı sağlamayı hedeflemektedir. Ayrıca, Türkiye'deki amfibi türlerinin ekolojisine dair değerli bilgiler sunarak koruma biyolojisi açısından önemli ipuçları sağlamaktadır.

Anahtar Kelimeler: Kış aktivitesi, amfibi ekolojisi, olağandışı aktivite, toprak sıcaklığı, iklim değişimi

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1. INTRODUCTION

Global climate change has caused a steady rise in global temperatures, significantly disrupting ecosystems worldwide (Iturra-Cid et al. 2014; López-Alcaide et al. 2011; Root et al. 2003). Amphibians, as ectothermic animals, are especially vulnerable to these changes because their physiological processes and behaviors are closely tied to environmental temperatures (Altunışık 2019; Schmidt et al. 2024a). In temperate regions, many amphibians enter hibernation during winter to survive harsh conditions (Kurnaz and Şahin 2021).

Hibernation is an adaptive strategy that involves a dramatic reduction in metabolic activity, allowing animals to conserve energy when food is scarce, and temperatures are low. During this state, amphibians lower their body temperature, respiration, and heart rate, enabling them to endure prolonged dormancy until favorable conditions return (Podhajský and Gvoždík 2016). However, recent fluctuations in temperature have altered these dynamics. Some amphibians now reach their thermal optima earlier than expected, resulting in premature activation of metabolic processes and leading to unexpected winter activity (Kurnaz and Şahin 2021).

Reports of such unusual behaviors include foraging, movement, and even mating during periods traditionally associated with dormancy. Examples of species displaying these behaviors include *Bufo bufo* (Altunışık and Kara 2021), *Bufotes viridis* (Altunışık 2019), and *Ommatotriton ophryticus* (Bülbül and Koç 2020). These phenomena provide essential insights into the impact of climate change on amphibian species, particularly in regions like Türkiye, which hosts a rich diversity of amphibians.

The present study aims to examine the unusual winter activities of 7 different amphibian species distributed in Türkiye and to evaluate the potential ecological and conservation effects of these behaviors in the context of global climate change.

2. MATERIAL AND METHOD

2.1. Study Area

Türkiye is a transcontinental peninsula connecting Europe and Asia, bordered by the Black Sea to the north, the Mediterranean Sea to the south, and the Aegean Sea to the west. Its diverse climate varies across regions. Coastal areas experience a Mediterranean climate, characterized by hot, dry summers and mild, rainy winters. In contrast, interior regions exhibit a continental climate, with hot summers and cold winters (Şensoy et al. 2008). These geographical and climatic variations make Türkiye an ideal location for studying amphibian ecology.

2.2. Data Collection

In this study, amphibian observations from various regions of Türkiye were analyzed. Data were collected through field surveys but also through detailed searches on social media platforms such as Facebook, Instagram, iNaturalist, and Twitter between November 2020 and March 2021. Additional information was sourced from the open Facebook group "Türkiye Wildlife Association" and personal social media networks. Contributors shared photographs of amphibians, and whenever possible, GPS coordinates were obtained. Information was considered by authors as herpetology experts, only if it was supported with digital images of a quality sufficient for species identification (Figure 1). In cases where GPS data were unavailable, approximate locations were determined through interviews with contributors, ensuring an accuracy of ±0.5 km. Environmental data, including air temperature, soil temperature, cloud cover, and humidity, were retrieved from the website soiltemperature.app (accessed on January 15, 2025).

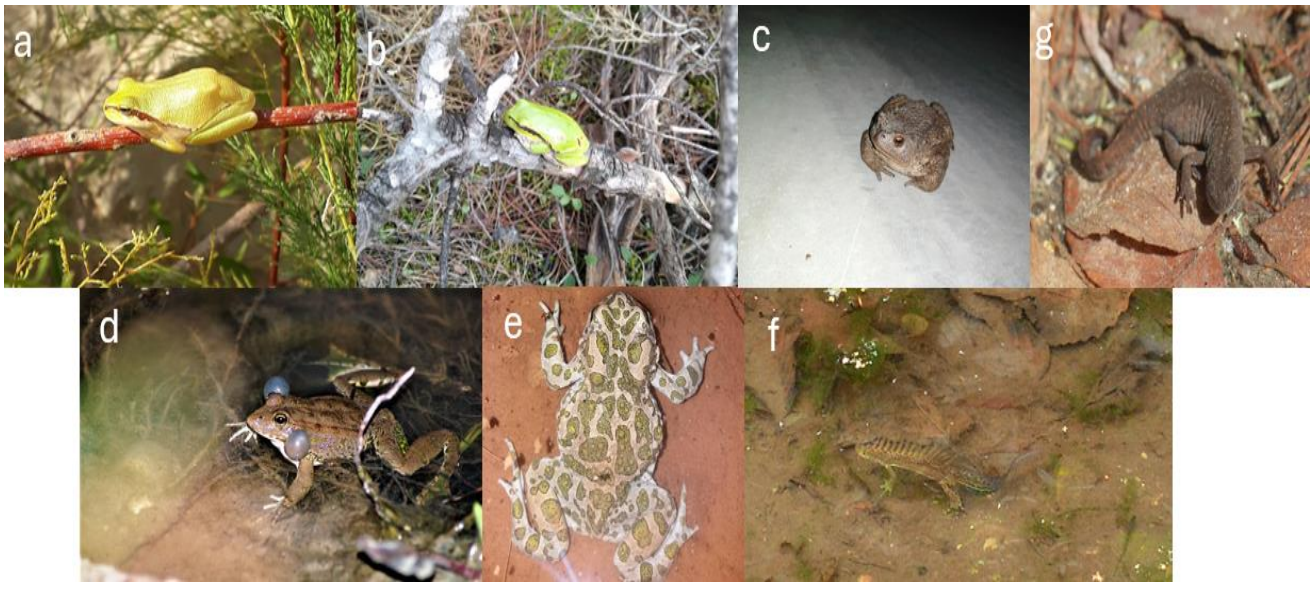

Figure 1. Photographs of some observed species. a. *Hyla savignyi* b. *Hyla orientalis* c. *Bufo bufo* d. *Pelophylax ridibundus* e. *Bufotes viridis* f. *Ommatotriton ophryticus* g. *Triturus anatolicus.*

3. RESULTS

We recorded 16 observations across seven amphibian species, including five Anura (frogs) and two Urodela (salamanders). Species distributions and observation data are summarized below (Figure 2). Two observations have been recorded of *Hyla savignyi.* The first observation was made on 8/10/2020in Eğil/Diyarbakır (38.199, 40.117). In this observation, the air temperature (Ta) was measured at 8.4°C, while the substrate temperature (Ts) was 11.9°C. The second observation took place on 04/02/2021 in Tekeli/Mersin (36.1339, 33.1286). The air temperature (Ta) was recorded at 16.9°C, and the substrate temperature (Ts) was 18.8°C. This is the first report of winter activity for this species.

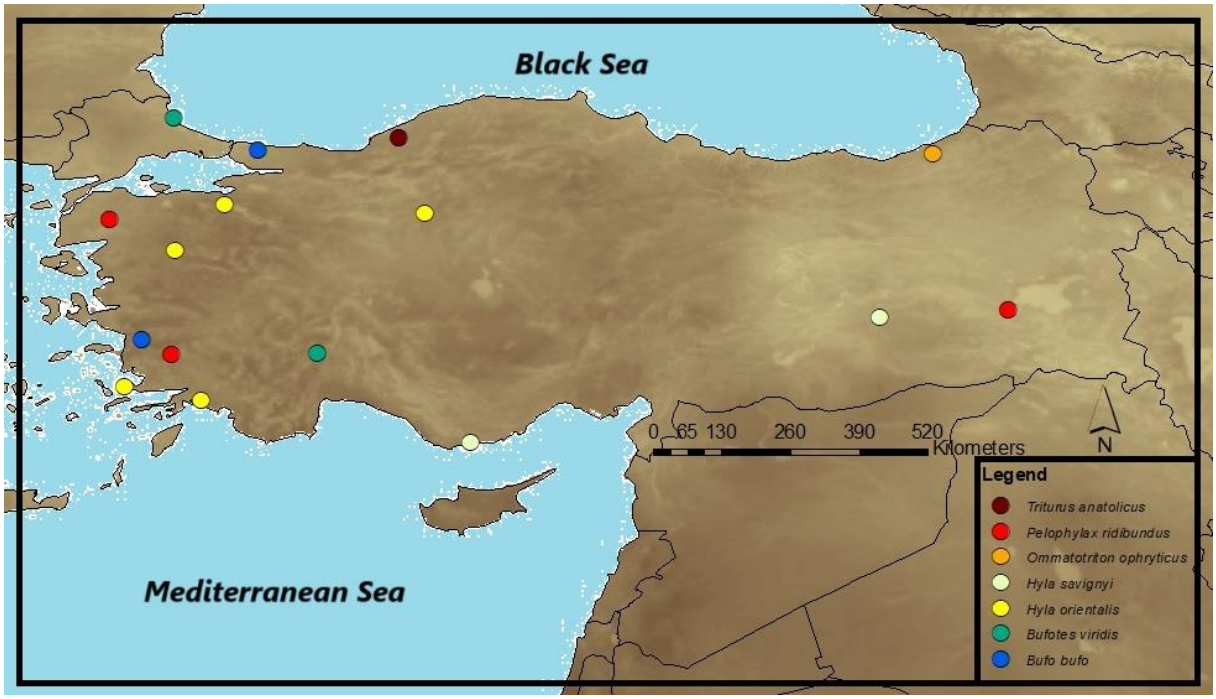

Figure 2. The spatial distribution of observations across Turkey is illustrated, with each species uniquely represented by a distinct color for clarity and differentiation.

Five observations have been recorded of *Hyla orientalis.* The first observation was made on 26/10/2020 in Ekincik/Muğla (36.8358, 28.5892). During this observation, the air temperature (Ta) was 17.9°C, and the substrate temperature (Ts) was measured at 18.8°C. The second observation occurred on 01/11/2020 in Dağyenice/Bursa (40.1568, 28.9612). At the time of this observation, the air temperature (Ta) was 13.7°C, and the substrate temperature (Ts) was 15.2°C. The third observation was recorded on 09/11/2020 in Bigadiç/Balıkesir (39.449, 28.301). The air temperature (Ta) was 15.5°C, while the substrate temperature (Ts) was 18.4°C. The fourth observation took place on 09/11/2020 in İlyasbeyköy/Kastamonu (42.0103, 33.3624). During this observation, the air temperature (Ta) was 14.1°C, and the substrate temperature (Ts) was measured at 16.6°C. The fifth observation occurred on 27/12/2020 in Karayaka Village/Muğla (29.296, 38.031). In this observation, the air temperature (Ta) was 15.7°C, and the substrate temperature (Ts) was 16.8°C. This is the first report of winter activity for this species.

Two observations have been recorded for *Bufo bufo*. The first observation took place on 14/11/2020 in Ulupelit/İstanbul (41.0861, 29.5251). During this observation, the air temperature (Ta) was measured at 11.7°C, and the substrate temperature (Ts) was 12.2°C. The second observation occurred on 27/01/2021 in Kızılcapınar/Aydın (37.8828, 27.5501). During this observation, the air temperature (Ta) was 16.2°C, and the substrate temperature (Ts) was recorded at 17.7°C.

Three observations have been recorded for *Pelophylax ridibundus*. The first observation took place on 13/11/2020 in Çine/Aydın (37.614, 28.037). During this observation, the air temperature (Ta) was measured at 14.7°C, and the substrate temperature (Ts) was 16.8°C. The second observation occurred on 04/12/2020 in Kokarsu/Bitlis (38.381, 42.2593). The air temperature (Ta) was recorded at 4.1°C, which is the lowest air temperature observed among our other surveys. The substrate temperature (Ts) was measured at 7.7°C. The last observation for this species took place on 02/01/2021 in Ozancık/Çanakkale (39.9161, 27.0119). The air temperature (Ta) was 12.2°C, and the substrate temperature (Ts) was also 13.9°C. This is the first report of winter activity for this species.

A total of two observations have been made for *Bufotes viridis* . The first observation took place on 22/10/2020 in Kıyıköy/Kırklareli (41.6534, 28.0625). During this observation, the air temperature (Ta) was measured at 13.7°C, and the substrate temperature (Ts) was 15.6°C. The second observation occurred on 23/10/2020 in

Ağlasun/Burdur (37.623, 30.619). The air temperature (Ta) was recorded at 9.1°C, and the substrate temperature (Ts) was 11.3°C.

One observation has been made for *Ommatotriton ophryticus*. This observation took place on 01/02/2021 in Yolkıyı/Rize (41.0219, 40.9711). During the observation, the air temperature (Ta) was 5.3°C, and the substrate temperature (Ts) was measured at 5.7°C. Additionally, this substrate temperature is recorded as the lowest temperature value among the observations conducted.

One observation has been made for *Triturus anatolicus*. The observation took place on 08/12/2020 in Kabaca/Zonguldak (41.5291, 31.9894). During this observation, the air temperature (Ta) was measured at 5.9°C, and the substrate temperature (Ts) was recorded as 8.1°C. Additionally, this observation marks the first report of winter activity for this species.

4. DISCUSSION AND CONCLUSION

Global climate change is undoubtedly having a harmful effect on amphibians, with rising air temperatures being the primary factor influencing their early emergence from hibernation or failure to enter hibernation altogether. Many studies suggest that this phenomenon is a direct result of the increasing annual temperature averages driven by global climate change (Altunışık 2019; Bülbül and Koç 2020). Research conducted in Türkiye also shows that air temperatures are exceeding seasonal norms (Altunışık and Kara 2021; Kurnaz and Şahin 2021). According to reports from the Turkish State Meteorological Service (mgm.gov.tr ; accessed on 2 April 2025), positive temperature anomalies have been recorded since the 2000s. Specifically, during the period covered by our study (the winter of 2020-2021), the temperatures ranked as the third and fourth warmest years in Türkiye's history. In 2021, the average temperature was 14.9°C, 1°C higher than the 13.9°C average for the 1991-2020 period. Notably, winter temperatures, which averaged 3.6°C between 1981-2010, rose to 6.2°C during the 2020-2021 winter. This clearly illustrates that winter temperatures were significantly above seasonal averages. Furthermore, when examining the annual temperature map of 2021, it is evident that temperatures at our observation sites align with the higher temperature averages.

The rising substrate temperatures and reaching thermal optimum levels accelerate metabolic processes in organisms, causing them to emerge from hibernation earlier (Kurnaz and Şahin 2021). It has been observed that temperatures above 4°C lead to an increase in the metabolic rate of amphibians, resulting in higher energy consumption. Consequently, warmer winter days may deplete amphibians' energy reserves more quickly, exhausting them faster than expected. This depletion weakens their immune systems, making survival more difficult, and negatively impacts reproductive success by reducing egg and sperm production (Schmidt et al. 2024b). In terms of reproduction, studies have shown that the length of daylight is even more important than temperature (Reading 1998).

Additionally, the scarcity of insects, which serve as a vital food source for amphibians during winter, combined with extended activity periods, will exacerbate the negative effects on these species (Kurnaz and Şahin 2021). If amphibians emerge earlier than usual, when food resources are limited, adult amphibians may perish before they have the opportunity to reproduce, posing a severe threat to their populations.

In conclusion, these observations not only document the unusual behaviors of these species but also lay the groundwork for more extensive research. Long-term monitoring of the effects of climate change is essential to understanding the future survival prospects of amphibians.

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REFERENCES

Altunışık A, Kara Y (2021). Unusual winter activity of *Bufo bufo* (Anura: Bufonidae). Turkish Journal of Biodiversity, 4(2): 105-107.

Altunışık A (2019). A case study on earlier activation of the variable toad, *Bufotes variabilis* (Pallas, 1769). Biological Diversity and Conservation, 12(2): 38-40.

Bülbül U, Koç H (2020). The unusual winter activity and negative effects of pollution on breeding of *Ommatotriton ophryticus* (Berthold, 1846) in Turkey. Sinop Üniversitesi Fen Bilimleri Dergisi, 5(1): 77-83.

General Directorate of Meteorology (2025). https://www.mgm.gov.tr/. Accessed date: 10/01/2025.

Iturra-Cid M, Vidal M, Labra A, Ortiz JC (2014). Winter thermal ecology of *Pleurodema thaul* (Amphibia: Leptodactylidae). Gayana, 78(1): 25-30.

Kurnaz M, Şahin MK (2021). Unusual winter activity observations of two newt species (*Ommatotriton ophryticus & Triturus ivanbureschi*) from the Anatolian Peninsula. Uluslararası Tarım ve Yaban Hayatı Bilimleri Dergisi, 7(2): 337-342.

López-Alcaide S, Macip-Ríos R (2011). Effects of climate change in amphibians and reptiles. Biodiversity Loss in a Changing Planet, (2011): 163-184.

Podhajský L, & Gvoždík L (2016). Variation in winter metabolic reduction between sympatric amphibians. Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology, 201: 110-114.

Reading CJ (1998). The effect of winter temperatures on the timing of breeding activity in the common toad *Bufo bufo*. Oecologia, 117: 469-475.

Root TL, Price JT, Hall KR, Schneider SH, Rosenzweig C, Pounds JA (2003). Fingerprints of global warming on wild animals and plants. Nature, 421: 57-60.

Schmidt R, Zummach C, Sinai N, Sabino-Pinto J, Künzel S, Dausmann KH, Ruthsatz K (2024b). Physiological responses to a changing winter climate in an early spring-breeding amphibian. Ecology and Evolution, 14(7): e70042.

Schmidt R, Zummach C, Sinai N, Sabino-Pinto J, Künzel S, Dausmann KH, Ruthsatz K (2024a). Between a Warm Winter and a Cold Spell: Physiological Responses to Changing Winter Climate in Amphibians. bioRxiv, 2024(01): 1-30.

Şensoy S, Demircan M, Ulupinar Y, Balta I (2008). Climate of turkey. Turkish state meteorological service, 401: 1-13.

Soil Temperature App (2025) https://soiltemperature.app/. Accessed date: 10/02/2025.