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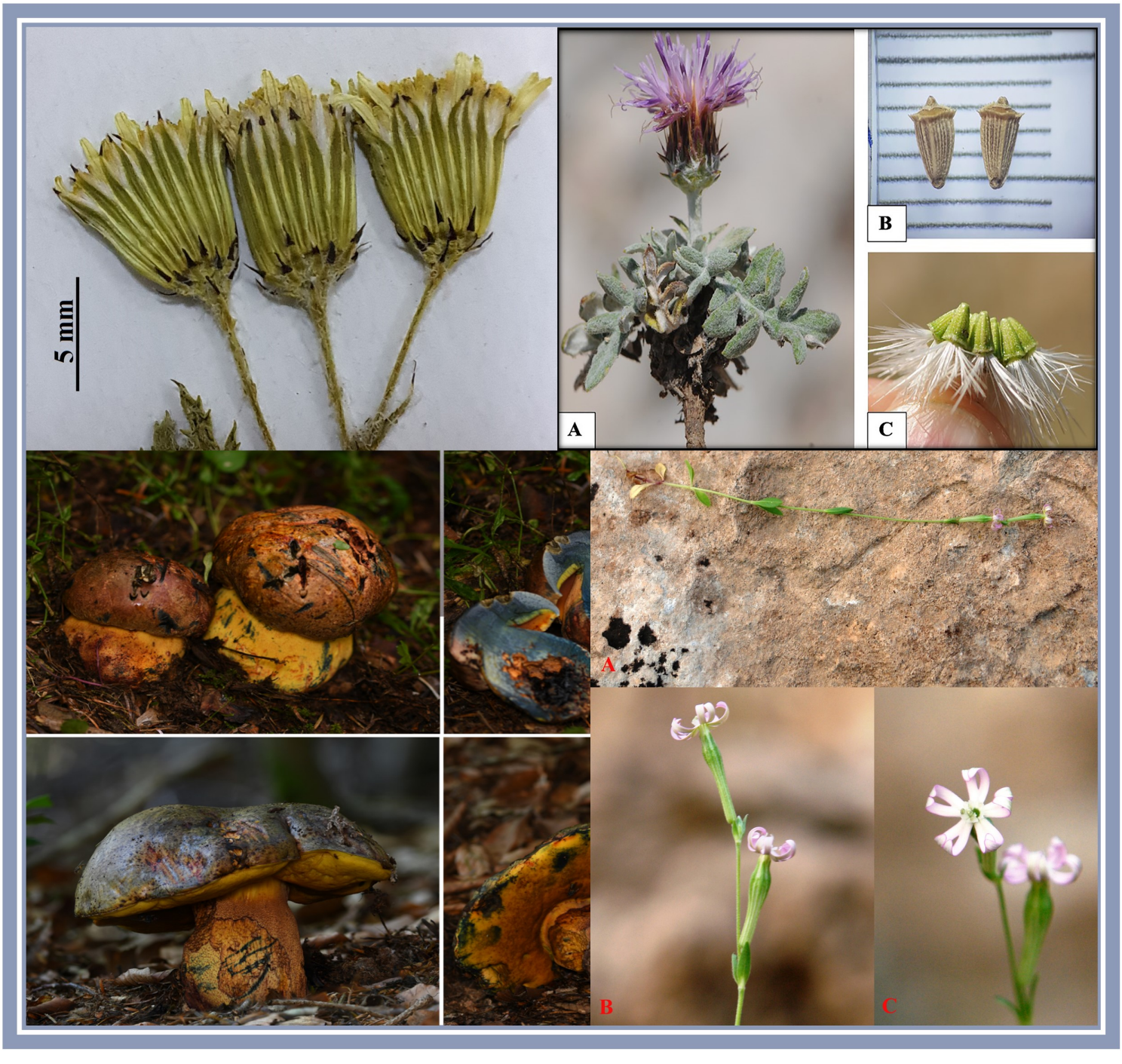

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Senecio x helwingii (Asteraceae), Türkiye Florası İçin Yeni Bir Melez Kaydı

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Özet

Kahramanmaraş Sütçü İmam Üniversitesi Karacasu Kampüsü ve Bolu Abant İzzet Baysal Üniversitesi Kampüsünden toplanan *Senecio x helwingii*, Türkiye florası için yeni bir melez kaydıdır. Melezin Türkiye'de var olduğunu gösteren, toplanmış örneğe dayanan herhangi bir yayına rastlanmamıştır. *Senecio vernalis* dilsi çiçekleri 5–10 mm boyundadır. *S. vulgaris* ise diskoit kapituluma sahiptir ve dilsi çiçekleri yoktur. *S. x helwingii* ata türler olan *S. vernalis* ve *S. vulgaris* ile birçok karakter bakımından benzerdir. Ancak dilsi çiçeklerinin 1–3 mm boyunda olması nedeniyle her iki türden de ayrılır. Ayrıca melezin akenleri kısırdır. Burada melezin incelenen örneklere dayalı betimlemesi, genel ve Türkiye dağılışı, taksonomisi ve bazı ekolojik tercihleri verilmiştir.

Anahtar kelimeler: Compositae, hibrit, taksonomi, Türkiye, *Senecio*, yeni kayıt

Senecio x helwingii (Asteraceae), A New Hybrid Record for the Flora of Türkiye

Abstract

Senecio x helwingii, collected from Kahramanmaraş Sütçü İmam University Karacasu Campus and Bolu Abant İzzet Baysal University Campus are a new hybrid record for the flora of Turkey. No literature showing the existence of the hybrid in Türkiye and that was based on a specimens collected was encountered. The ligulate flowers of *Senecio vernalis* are 5–10 mm long. *S. vulgaris* has a discoid capitulum and does not have ligulate flowers. *S. x helwingii* is similar to the parent species *S. vernalis* and *S. vulgaris* in many characters. However, it differs from both species because its ligulate flowers are 1–3 mm long. In addition, the achenes of the hybrid are sterile. Here, the description based on the examined specimens, the general and Türkiye distribution, taxonomy, and some ecological preferences of this hybrid were given.

Keywords: Compositae, hybrid, new record, *Senecio*, taxonomy, Türkiye

GİRİŞ

Dünya genelinde 1500'den fazla tür içeren *Senecio* L., Asteraceae familyasının Senecioneae oymağında bulunur (WFO, 2023; Pelser vd., 2007; Nordenstam vd., 2009). "Flora of Turkey and the East Aegean Islands" adlı eserde Türkiye'de *Senecio* cinsi 39 tür, 3 alt tür ve 6 varyete olmak üzere toplam 48 takson ile temsil edilir (Matthews, 1975). Cinse son yıllarda Tuz Gölü civarından ve Munzur Dağlarından (Tunceli) 2 yeni tür, Artvin, Ardahan ve Kars civarından 3 yeni kayıt olmak üzere toplam 5 takson daha eklenmiştir. Böylece cinsin Türkiye'deki toplam takson sayısı 53 olmuştur. Bu taksonlardan 21'i Türkiye için endemiktir ve cinsin endemizm oranı yaklaşık %40'tır (Vural vd., 2006; Budak vd., 2007; Hamzaoğlu & Çetin, 2016). Son yıllarda yapılan taksonomik

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çalışmalar sonucunda, Türkiye *Senecio* cinsi altında yer alan bazı türler *Adenostyles* Cass., *Tephroseris* (Rchb.) Rchb., *Jacobaea* Mill., *Iranecio* B.Nord., *Caucasalia* B.Nord. ve *Turanecio* Hamzaoğlu gibi cinslere aktarılmıştır (Jeffrey vd., 1977; Nordenstam & Rechinger, 1989; Jeffrey, 1992; Heller & Heyn, 1993; Schischkin, 1995; Nordenstam, 1997; 2007; Pelser vd., 2006; 2007; Hamzaoğlu vd., 2011).

Türkiye *Senecio* cinsinin revizyonu çalışmaları kapsamında 2008 yılında yapılan arazi çalışmaları esnasında Kahramanmaraş Sütçü İmam Üniversitesi Karacasu Kampüsünden bazı ilginç örnekler toplandı. İlk bakışta *Senecio vernalis* Waldst. & Kit. türünü andıran, ancak dilsi çiçekleri çok kısa olan örneklerden inceleme amacıyla yeterli miktarda alındı. Toplanan örnekler öncelikle Flora of Turkey and the East Aegean Islands adlı eserden yararlanarak teşhis edildi (Matthews, 1975). Teşhis sonucunda örneklere en yakın türlerin *Senecio vernalis* ve *Senecio vulgaris* L. olduğu, ancak bazı çiçek karakterleri bakımından farklılık gösterdiği anlaşıldı. Yapılan literatür taraması sonucunda örneklerin *Senecio vernalis* ve *S. vulgaris* türlerinin doğal melezi olan *Senecio x helwingii* Beger ex Hegi olduğu tespit edildi (Beger, 1928).

MATERYAL VE METOT

Bu çalışmanın materyalini, Kahramanmaraş Sütçü İmam Üniversitesi Karacasu Kampüsü ve Bolu Abant İzzet Baysal Üniversitesi Kampüsünden toplanan ve burada yeni kayıt olarak tanıtılan *Senecio x helwingii* melezine ait örnekler oluşturmaktadır. Toplanan örnekler, ilgili literatür ve herbaryum örnekleri ışığında değerlendirilmiştir (Beger, 1928; Matthews, 1975). Toplanan *Senecio x helwingii* örnekleri GAZI, ANK ve HUB herbaryumlarında muhafaza edilmektedir. Herbaryum kısaltmalarında Thiers (2020) takip edilmiştir. Takson ve yazar isimlerinin yazımında Plants of the World Online (POWO, 2023) temel alınmıştır. Betimlemede kullanılan Latince kelimelerin Türkçe karşılıkları yazılırken Resimli Türkiye Florası adlı eserden yararlanılmıştır (Güner vd. 2014). Örneklerin incelenmesinde Leica EZ4 stero mikroskop ve fotoğrafların çekiminde Samsung Galaxy A33 mobil telefon kullanılmıştır. Betimlemede verilen morfolojik karakterlere ait uzunluk değerleri, 0.5 mm hassasiyetli cetvelle belirlenmiştir.

SONUÇLAR VE TARTIŞMA

Senecio x helwingii Beger ex Hegi, Illustr. Fl. Mittel-Eur. 6(2): 795 (1928). (Şekil 1-2).

Protolog. [Almanya] Pflanzen ohne Strahlblüten (= f. Discoideus D.J.Christiansen) wurden bei Lüneburg 1924 beobachtet. Im Nordostdeutschen Flachland (namentlich Ost. und Westpreussen) nicht selten und bereits 1717 von Helwing bei Angerburg aufgefunden, neuerdings auch in Mittel. und Westdeutschland mehrfach beobachtet, so bei Löbejun nachst Halle (leg. Chuster), Soest (Westfalen, 1920 leg. Preuss), Oggersheim (Pfatz, leg. Fr. Zimmermann, 1907), Bahnhof Waghausel (Baden), Holesovice bei Prag.

Tip. Tespit edilemedi.

Betimleme. Bir yıllık otlar. Gövde basit veya üst kısımda dallanmış, dik veya eğik yükselici, 10–20 cm boyunda, seyrek flokkoz. Taban yapraklar saplı; saplar 0.5–1.5 cm uzunluğunda; aya tam veya 1–5-çift yan loblu lirat-pinnatisekt, dıştan oblong-eliptik veya ters mızraksı-ters yumurtamsı, 2–5 × 1–2 cm, her iki yüzü seyrek flokkoz; kenarı düzensiz testeremsi-dişli; ucu sivri; tabanı attenuat. Alt gövde yaprakları taban yapraklarına benzer; saplar 0.5–1 cm uzunluğunda; aya pinnatilobat veya pinnatisekt, 3–6-çift yan loblu. Üst gövde yaprakları tedricen küçülücü, sapsız; aya şeritsi-mızraksı, tabanda gövde-sarıcı ve kulakçıklı. Çiçek durumu bileşik korimbos, 2–10-kapitulalı, ± düz veya

testeremsi-dişli kenarlı şeritsi-mızraksı yapraklarla desteklenmiş. Pedunkuller 0.5–1.5 cm uzunluğunda, seyrek flokkoz. Kapitula radiat, tabanı seyrek flokkoz. Kalikular brakteler 10–15, 1.5–2.5 mm uzunluğunda, yeşilimsi, uca doğru çoğunlukla siyah. İnvolukrum 3–6 mm eninde; fillariler 20–21, şeritsi-mızraksı, 3–7 mm uzunluğunda, ± tüysüz veya seyrek flokkoz; ucu sivri ve genellikle siyah. Dilsi çiçekler 8–12, oblong, 1–3 × 1.5–2.3 mm. Tüpsü çiçekler 5-loblu, 50–80, 5–6 mm uzunluğunda. Akenler kısır, 1–2 mm uzunluğunda, yoğun tüylü. Pappus 5–6 mm uzunluğunda.

Çiçeklenme: 3–5. Yol kenarları, yerleşim alanları, 550–850 m.

Habitat ve ekoloji. Kahramanmaraş Sütçü İmam Üniversitesi ve Bolu Abant İzzet Baysal Üniversitesi kampüslerinde tespit edilen popülasyonlara göre *Senecio x helwingii* yaklaşık olarak 550–850 metreler arasındaki antropojen alanları tercih etmektedir. Hibridin çiçeklenme dönemi Mart sonunda başlar ve Mayıs sonuna kadar devam eder. Kısır olduğundan akenler olgunlaşmaz. Kahramanmaraş Sütçü İmam Üniversitesi Karacasu Kampüsü popülasyonunda yapılan gözlemlere göre, melez ata türler olan *Senecio vernalis* ve *S. vulgaris* türlerinin bol olduğu alanlarda ortaya çıkmaktadır. Bu durum hibridin tespit edildiği dünyadaki diğer tüm popülasyonlarda da gözlenmiştir (Beger, 1928; Comes & Kadereit, 1990; Comes, 1994).

Şekil 1. *Senecio x helwingii* genel görünümü.

Taksonomik notlar

Melezin genel görünümü ata türler olan *Senecio vernalis* (dilsi çiçek 5–10 mm boyunda) ve *S. vulgaris*'e (dilsi çiçek yok) benzerdir. Ancak dilsi çiçeklerinin 1–3 mm boyunda olması nedeniyle her iki türden de ayrılır (Şekil 2). Ayrıca melezin akenleri kısırdır.

Şekil 2. *Senecio x helwingii* kapitulumlar.

Yayılış

Son bulgular ışığında *Senecio x helwingii* Avusturya, Danimarka, Almanya, Balkanlar, İsrail ve bu makalede verilen adreslere göre de Türkiye'de yayılış gösterir (Beger, 1928; Comes & Kadereit, 1990; Comes, 1994; POWO, 2023).

İncelenen örnekler

Senecio x helwingii. TÜRKİYE. **Bolu**: Bolu Abant İzzet Baysal Üniversitesi, kampüs içi, lojmanlara çıkan yol, [c. 850 m], 27.04.2004, *Gündüz* (Bolu Hb.!); **Kahramanmaraş**: Kahramanmaraş Sütçü İmam Üniversitesi, Karacasu Kampüsü, 555 m, 23.03.2008, *Hamzaoğlu 5034, Budak & Aksoy* (GAZI!; ANK!; HUB!).

TEŞEKKÜR

"Türkiye *Senecio* L. (Asteraceae) Türlerinin Taksonomisi" adlı proje (TBAG 106T240) kapsamında maddi destek sağlayan TÜBİTAK'a ve *Senecio x helwingii* örneklerinin toplanmasına katkı sağlayan Prof. Dr. Ahmet İlçim, Prof. Dr. Ahmet Aksoy ve Prof. Dr. Ümit Budak'a teşekkür ederim.

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KAYNAKLAR

Beger, H.K.E. (1928). [*Senecio helwingii* Beger ex Hegi]. In: Hegi, G. (Ed.). Illustrierte Flora von Mittel-Europa. Vol. 6, Ser. 2, J.F.Lehmanns Verlag, München, pp. 795.

Budak Ü., Hamzaoğlu E. & Aksoy A. (2007). A New Record for the Flora of Turkey: *Tephroseris cladobotrhys* (Ledeb.) Griseb. & Schenk (Senecioneae, Asteraceae). *Turkish Journal of Botany* 31(3): 265-268.

Comes, H.P. (1994). The Occurrence of *Senecio vulgaris* L. var. *vulgaris* and *S.* × *helwingii* Beger ex Hegi (*S. vulgaris* × *S. vernalis* Waldst. et Kit.) in Israel. Israel Journal of Plant Sciences 42: 105-113.

Comes, H.P. & Kadereit, J.W. (1990). Aspects of Hybridization between the Closely Related *Senecio vulgaris* L. and *Senecio vernalis* Waldst. & Kit. Flora 184: 381-388.

Hamzaoğlu, E., Budak, Ü. & Aksoy, A. (2011). A new genus, Turanecio, of the Asteraceae (tribe Senecioneae). *Turkish Journal of Botany* 35: 479-508.

Hamzoğlu, E. & Çatin, T. (2016). Contributions to the taxonomy and distribution of the genus *Turanecio* (Asteraceae, Senecioneae). *Biological Diversity and Conservation* 9(1): 76-81.

Heller, D. & Heyn, C.C. (1993). Conspectus Florae Orientalis – An annotated catalogue of the flora of the Middle East. Fascicle 8. Israel Academy of Sciences and Humanities, Jeruselam.

Jeffrey, C. (1992). The tribe Senecioneae (Compositae) in the Mascarerne Island with an annotated world check-list of the genera of the tribe Notes on Compositae: VI. *Kew Bulletin* 47(1): 49-109.

Jeffrey, C., Halliday, P., Wilmot-Dear, M. & Jones, S.W. (1977). Generic and sectional limits in Senecio (Compositae), I: Progress report. *Kew Bulletin* 32: 47-67.

Matthews, V.A. (1975). [*Senecio* L.]. In: Davis, P.H. (Ed.). Flora of Türkiye and the East Aegean Islands. Vol. 5, Edinburgh University Press, Edinburgh, pp. 80-97.

Nordenstam, B. (1989). [*Senecio* L. & Iranecio B.Nord.] In: Rechinger, K.H. (Ed.). Flora Iranica, Compositae VII. Vol. 164, Akademische Druck- u. Verlegsanstalt, Graz, Austria, pp. 53-95.

Nordenstam, B. (1997). *Caucasalia*, a new genus of the Asteraceae, Senecioneae. *Plant Systematic and Evolution* 206: 19-32.

Nordenstam, B. (2007). [Senecioneae]. In: Kadereit, J.W. & Jeffrey, C. (Eds.). The Families and Genera of Vascular Plants. Vol. VII, pp. 208-241.

Nordenstam, B., Pelser, P.B., Kadereit, J.W. & Watson, L.E. (2009). [Senecioneae]. In: Funk, V.A., Susanna, A., Stuessy, T.F. & Bayer, R.J. (Eds.). Systematics, Evolution, and Biogeography of Compositae. International Association for Plant Taxonomy, Vienna, pp. 503-525.

Pelser, P.B., Veldkamp, J.F. & Van der Meijden, R. (2006). New combinations in Jacobaea Mill. (Asteraceae/Senecioneae). Compositae Newsletter. 44: 1-11.

Pelser, P.B., Nordenstam, B., Kadereit, J.W. & Watson, L.E. (2007). An ITS phylogeny of tribe Senecioneae (Asteraceae) and a new delimitation of *Senecio* L. Taxon 56(4): 1077-1104.

POWO (2023). Plants of the World Online (POWO). *Senecio* × *helwingii* Beger ex Hegi. http://www.worldfloraonline.org/ [26.10.2023].

Schischkin, B.K. (1995). [*Senecio* L.] In: Schischkin, B.K., Bobrov, E.G. (Eds.). Flora of the U.S.S.R. Vol. 26, Bishen Singh Mahendra Pal Singh & Koeltz Scientific Books, Dehra Dun, pp. 801-908.

Vural, M., Duman, H, Aytaç, Z. & Adıgüzel, N. (2006). *Saponaria karapinarensis*, *Senecio salsuginea* and *Centaurea tuzgoluensis*, Three New Species from Central Anatolia Türkiye. *Belgium Journal of Botany* 139(2): 252-260.

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Research Article

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Reproductive Ecology and Viability Assessment of *Jurinea cadmea* Subspecies Distributed in Western Anatolia: Implications for Conservation and Biodiversity

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Abstract
In this study, the reproductive capacity of endemic *Jurinea cadmea* subspecies, *J. cadmea* subsp. *cadmea*, and *J. cadmea* subsp. *nifensis* was investigated, focusing on pollen, stigma, seed viability, and seed germination. Plant materials were collected from natural populations in Western Anatolia (Nif Mountain, Bozdağ, Babadağ and Muğla Oyuklu Mountain) between 2017 and 2020. The tests employed in this study included the MTT (2,5-diphenyl tetrazolium bromide-thiazolyl blue) test for pollen viability, the Peroxide test for stigma viability, the TTC (2,3,5-triphenyl tetrazolium chloride) test for seed viability, and seed germination tests under different conditions, with and without pre-treatment (wet-cold stratification). The study revealed high viability of mature pollen, stigma, and seeds, indicating successful reproductive capacity. Seed germination experiments showed that most populations exhibited high germination rates in light conditions. After 30 days of stratification, seeds showed very low germination in light and dark conditions, but after 60 days at 4°C, Nif Mountain, Bozdağ, and Muğla Mountain (short) populations exhibited germination rates above 80%. However, Babadağ population showed low seed germination in light and dark conditions. This study has significantly contributed to our understanding of the reproductive biology of both subspecies.
Keywords: *Jurinea cadmea* subspecies, endemic, Türkiye, reproductive capacity

Batı Anadolu'da Yayılış Gösteren *Jurinea cadmea* Alt Türlerinin Üreme Ekolojisi ve Canlılık Değerlendirmesi: Koruma ve Biyoçeşitlilik Üzerine Çıkarımlar

Özet
Bu çalışmada, endemik *Jurinea cadmea* alt türlerinin, *J. cadmea* subsp. *cadmea* ve *J. cadmea* subsp. *nifensis*'in, polen, stigma, tohum canlılığı ve tohum çimlenmesine odaklanarak üreme kapasitesi araştırıldı. Bitki materyali, 2017-2020 yılları arasında Batı Anadolu'daki doğal popülasyonlardan (Nif Dağı, Bozdağ, Babadağ ve Muğla Oyuklu Dağı) toplandı. Bu çalışmada kullanılan testler arasında polen canlılığı için MTT (2,5-difenil tetrazolyum bromür-tiyazolil mavi) testi, stigma canlılığı için peroksit testi, tohum canlılığı için TTC (2,3,5-trifenil tetrazolyum klorür) testi ve farklı koşullarda tohum çimlenmesi için ön işlem (stratifikasyon) ile ve ön işlem olmadan yapılan testler bulunmaktadır. Çalışma, olgun polen, stigma ve tohumların yüksek canlılığını ortaya koyarak başarılı üreme kapasitesini gösterdi. Tohum çimlenme deneyleri, çoğu populasyonun ışık koşullarında yüksek çimlenme oranları sergilediğini gösterdi. Tohumlar, 30 gün stratifikasyon sonrasında ışık ve karanlık koşullarda çok düşük çimlenme gösterirken, 60 gün boyunca 4°C'de tutulduktan sonra Nif, Bozdağ ve Muğla (kısa) populasyonları %80'in üzerinde çimlenme oranları sergiledi. Ancak, Babadağ populasyonu hem

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ışıkta hem de karanlıkta düşük tohum çimlenmesi gösterdi. Bu çalışma, her iki alt türün üreme biyolojisinin anlaşılmasına önemli bir katkı sağlamıştır.

Anahtar kelimeler: *Jurinea cadmea* alt türleri, endemik, Türkiye, üreme kapasitesi

INTRODUCTION

The Asteraceae family stands out as one of the largest flowering plant families, boasting approximately 1,620 genera and over 23,600 species, making it a prominent member of the plant kingdom (Stevens 2001). In Türkiye, the Asteraceae family ranks as the second-largest family, comprising 134 genera and a total of 1,209 species, with 447 being endemic, contributing to a remarkable 37% endemism (Özhatay & Kültür 2006; Doğan et al. 2011). As part of the Asteraceae family, the *Jurinea* Cass. genus plays a vital role in ecological systems and offers insights into plant adaptation across diverse regions. With an extensive distribution spanning Central Asia, Iran, Türkiye, and the Eastern Mediterranean, this genus encompasses around 180 species (Szukala et al. 2019). *Jurinea*'s endemism in Türkiye is noteworthy, constituting approximately 42.1% of the genus (Aksoy et al. 2018). Eight species are endemic to Türkiye, particularly in the Mediterranean and Irano-Turanian phytogeographic regions, representing 18 species in total (Danin & Davis 1975; Doğan et al. 2007; 2009; 2010). The prevalence and endemism of *Jurinea* species in Türkiye highlight the genus's significance in contributing to the country's biodiversity. Numerous endemics within the *Jurinea* genus are threatened due to anthropogenic factors like deforestation, destruction of steppe vegetation, and the conversion of semi-desert areas for agricultural and industrial purposes.

Jurinea cadmea Boiss. is an endemic plant species, meaning it is native and restricted to a specific geographic region. Distinctive morphological features, such as the absence or rarity of a stem and the presence of scabrous pappus, set *Jurinea cadmea* apart from other species within the *Jurinea* genus (Danin & Davis 1975; Doğan et al. 2010). *J. cadmea*, a species with two subspecies, which are *J. cadmea* subsp. *cadmea* and *J. cadmea* subsp. *nifensis* Yıldırım & Şenol, holds ecological significance in Türkiye and Greece. While *J. cadmea* subsp. *cadmea* is distributed across Türkiye and Greece, *J. cadmea* subsp. *nifensis* is confined to a small range on Nif Mountain in Izmir, Türkiye, making it a local endemic taxon. According to Doğan (2012), *J. cadmea* subsp. *nifensis* was not accepted as a valid taxon and was considered synonymous under *J. cadmea*. However, as a result of a comprehensive revision study carried out by us on *J. cadmea*, which has not yet been published, *J. cadmea* subsp. *nifensis* distinctly separated from *J. cadmea* subsp *cadmea* both morphologically and molecularly. Thus, *J. cadmea* subsp. *nifensis* is treated as a valid taxon in this article. According to the Türkiye Plants Red Data Book, Ekim et al. (2000) suggested a potentially vulnerable (VU) categorization for *J. cadmea*. The impact of human activities has led to the critical endangerment (CR) classification for *J. cadmea* subsp. *nifensis* (Yıldırım & Şenol 2010) and the vulnerable (VU) classification for *J. cadmea* subsp. *cadmea* on the IUCN Red List. The critical endangerment of *J. cadmea* subsp. *nifensis* and the vulnerability of *J. cadmea* subsp. *cadmea* underlines the need for immediate action and a unified approach to protecting these valuable plant species. The unique morphological features and limited geographical ranges of *J. cadmea* subspecies highlight the urgency of conservation efforts.

Research on *Jurinea cadmea* has been limited, primarily focusing on morphological, molecular, cytological, and palynological studies. This study aims to enhance our understanding of the life cycles of the two taxa within *J. cadmea*, providing clarity on their taxonomic statuses.

Understanding the biological potential of *J. cadmea* subpopulations is crucial for effective conservation strategies. The study of pollen, stigma, seed viability, and seed germination is considered the only way to preserve the genetic diversity of populations. This becomes especially important in rare and endemic species and for species at risk of extinction. Understanding the germination abilities of these taxa is emphasized as crucial for their conservation and the continuity of generations. Species like *J. cadmea* may exhibit specific germination strategies adapted to local conditions, allowing them to respond to environmental changes and ensure their survival. Knowledge of pollen and stigma viability contributes to understanding reproductive barriers within and between *J. cadmea* populations. This information is crucial for addressing challenges related to gene flow and maintaining genetic diversity. Environmental factors such as temperature, humidity, and pollinator's presence can impact pollen and stigma viability in *J. cadmea* species. Studies on how these factors affect reproductive success are vital for conservation and cultivation efforts. Knowledge of seed germination is a critical event that shapes the life cycle of plants like *J. cadmea*, influencing population dynamics, genetic continuity, and the overall health of ecosystems. Understanding the germination requirements of *J. species* is crucial for reintroducing them into their native habitats and restoring ecosystems.

The findings of this research are expected to enhance knowledge regarding the reproductive characteristics of *Jurinea cadmea*, including pollen, stigma, seed viability, and seed germination. The comprehensive insights gained will not only contribute to the scientific understanding of this species but will also serve as a foundational resource for informed conservation efforts, ensuring the preservation of biological diversity in the country.

MATERIAL AND METHOD

Material

Plant materials for both *Jurinea cadmea* subspecies were collected during the vegetation seasons of 2017-2020 from natural populations in the following regions of Western Anatolia: Izmir / Nif Mountain, Izmir / Bozdağ, Denizli / Babadağ, and Muğla / Oyuklu Mountain (Table 1, Figure 1). Sampling was conducted during the flowering period (May-July) and the fruiting period (June-October) to encompass the entire vegetation cycle of *J. cadmea*. Plant materials, including flowers, were collected during the flowering period to capture the reproductive stage, while achenes and other reproductive structures were collected during the fruiting period to represent the later stages of the vegetation cycle.

Seed morphology of *Jurinea cadmea* subsp. *cadmea*

Achenes are light brown, tetragonal, longitudinally striped, and crowned, 3.06-6.10 × 1.06-2.66 mm. The pappus is scabrous, dirty white, 8.34-15.18 mm, generally with 2-5 hairs longer than the others. When mature, the pappus does not emerge from the achene. Flowering time is May-June (population in Muğla), July-October (population in Bozdağ), and August-October (population in Babadağ). Achene maturity is June (population in Muğla), August-October (population in Bozdağ), and September-October (population in Babadağ, Figure 2).

The research areas in Bozdağ, Babadağ, and Muğla Oyuklu Mountain are characterized by rocks of silica origin, such as schist and gneiss. Notably, the population of *Jurinea cadmea* in Muğla was first recorded in 2019, and the study related to this population represents the first research conducted on it. In the populations of *J. cadmea* in Babadağ and Muğla Oyuklu Mountain,

two forms have been identified: a short-stemmed form - s (with capitula on short peduncles up to 6.55 cm) and a long-stemmed form - l (with capitula on long peduncles up to 29 cm) (Figure 3). This variation in forms suggests a possible transitional form between *J. cadmea* and *J. mollis* species.

Table 1. The locations of studied populations of *J. cadmea* subspecies in Türkiye.

Location	***Subspecies***	***Coordinates***	***Altitude (m)***
İzmir / Nif Mountain	*Jurinea cadmea* subsp. *nifensis*	38;23;22.7280 N - 27;21;24.437999 E 38;23;3.32399 N - 27;21;18.929999E	1457 1441
İzmir / Bozdağ	*Jurinea cadmea* subsp. *cadmea*	36;31;46.64999 N - 29;11;2.172000 E 38,19;20.07899 N - 28;6;14.491999 E 38;19;26.95199 N - 28;6;0.0660000 E 38;19;10.16399 N - 28;6;41.831999 E	1924 2160 2125 2054
Denizli / Babadağ	*Jurinea cadmea* subsp. *cadmea*	37;42;9.761999 N - 28;59;27.77400 E 37;41;44.60999 N - 28;59;25.04399 E 37;41;36.00000 N - 28;59;29.04600 E 37;42;8.945999 N - 28;59;31.54200 E	2039 1895 1831 2012
Muğla / Oyuklu Mountain	*Jurinea cadmea* subsp. *cadmea*	37;16;14.95800 N - 28;26;36.37200 E 37;16;16.64999 N - 28;26;30.72599 E 37;16;15.26399 N - 28;26;30.31799 E	1601 1636 1624

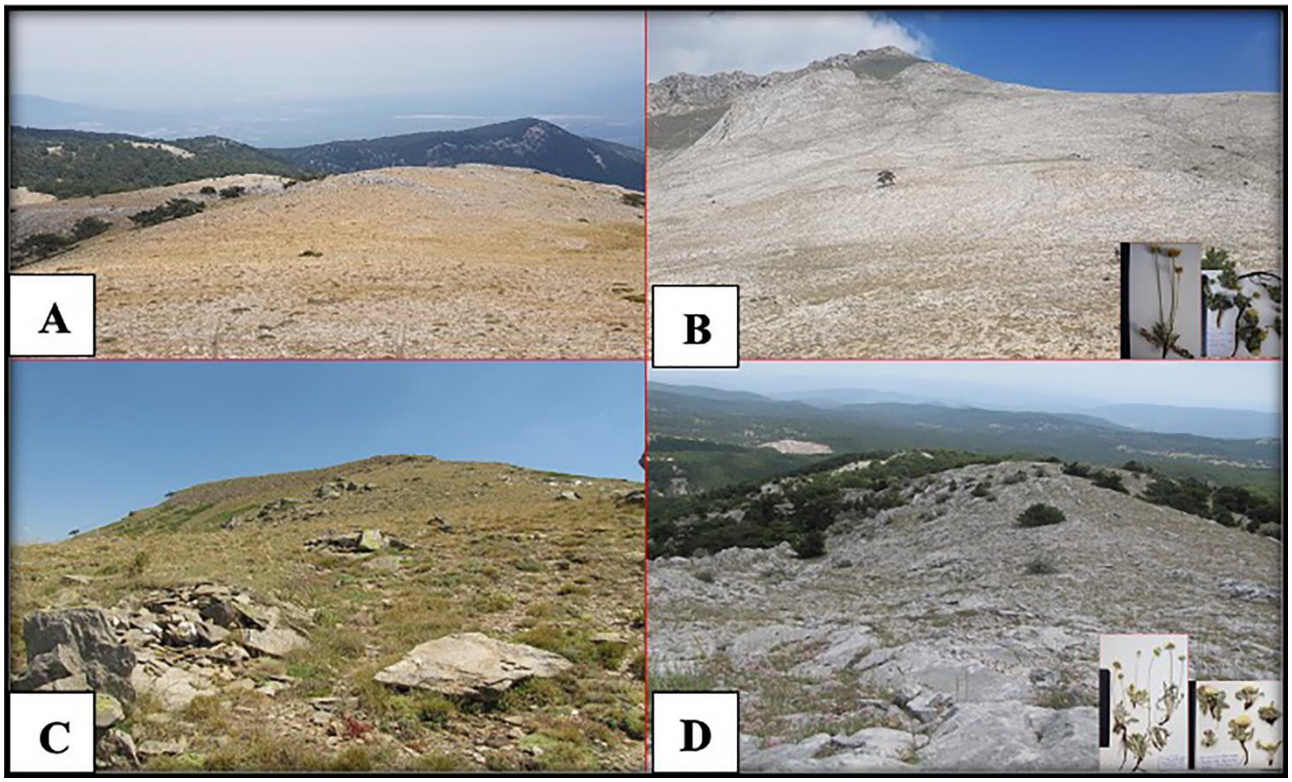

Figure 1. Studied populations of *Jurinea cadmea* subspecies (photos by Aida Tuğ). A) İzmir / Nif Mountain – *J. cadmea* subsp. *nifensis*; B) Denizli / Babadağ – *J. cadmea* subsp. *cadmea*; C) İzmir / Bozdağ – *J. cadmea* subsp. *cadmea*; D) Muğla / Oyuklu Mountain – *J. cadmea* subsp. *cadmea.*

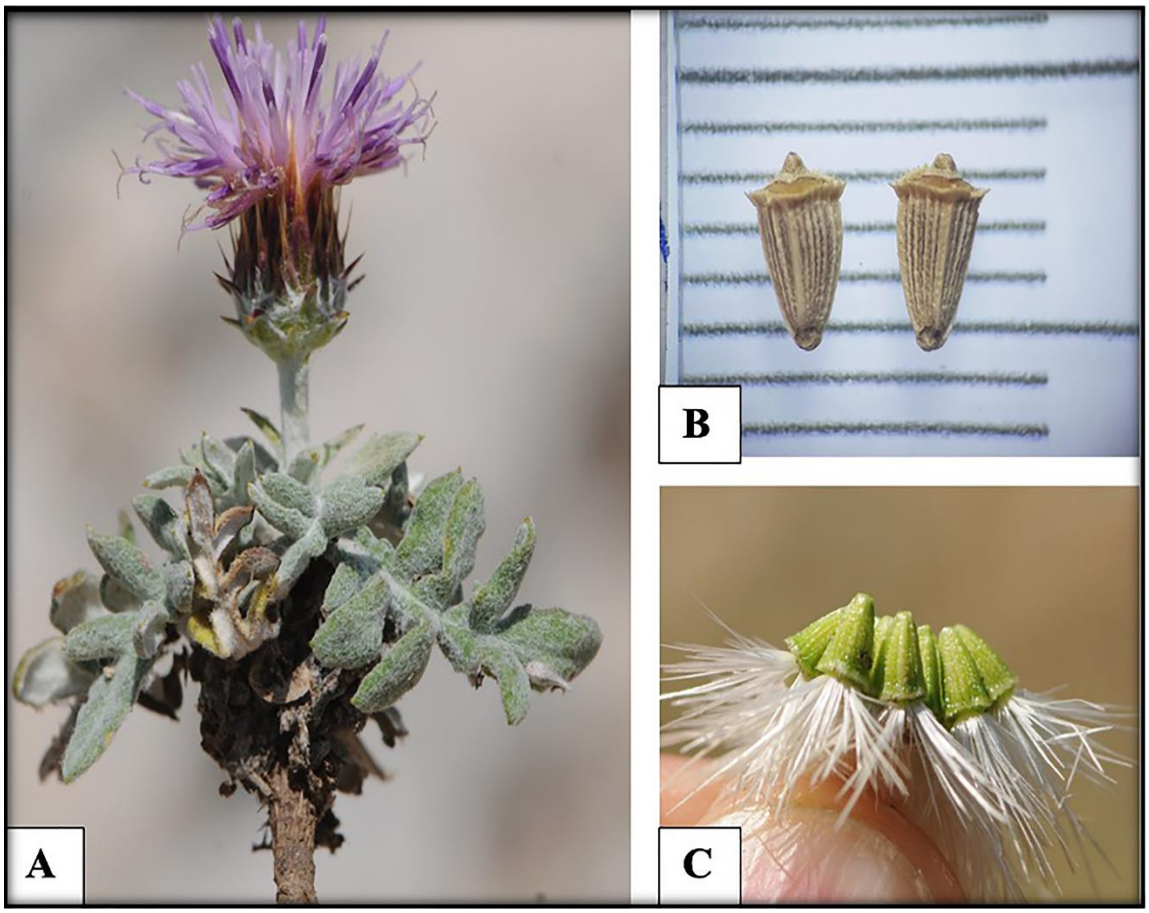

Figure 2. *Jurinea cadmea* subsp. *cadmea.* A) Plant's general appearance; B-C) Achenes.

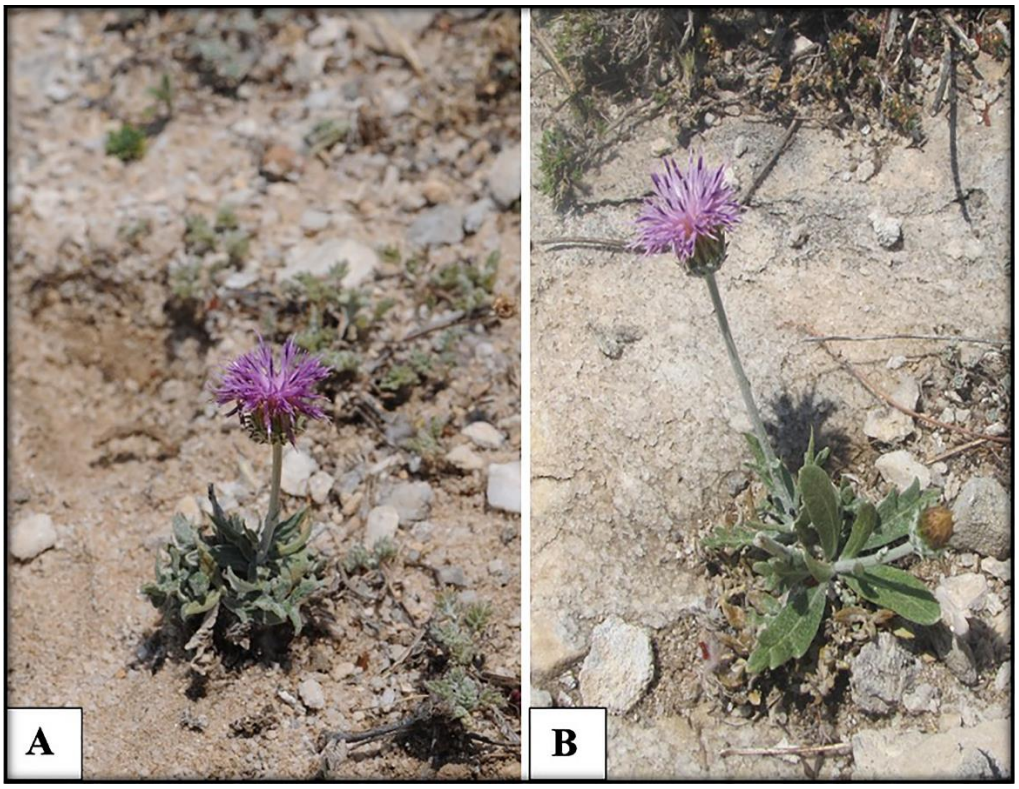

Figure 3. *Jurinea cadmea* subsp. *cadmea.* A) short form; B) long form.

Seed morphology of Jurinea cadmea* subsp. *nifensis

The achenes are tetrahedral, 4-5 × 1.5-2 mm, not glandular hairy, lightly lined, longitudinally striped light brown and transversely striped dark brown, naked. The pappus is 10-17 mm long, whitish, and scabrous. Mature pappus does not persist on the achene (Figure 4). This subspecies was described by Yıldırım and Şenol (2010) based on specimens from Nif Mountain in Izmir. It is distributed on calcareous soils at elevations between 1400-1500 m in the Nif Mountain within the boundaries of the Kemalpaşa district of Izmir. It has a restricted distribution in high elevations and open subalpine regions. Due to anthropogenic pressures, this subspecies is classified as critically endangered according to the IUCN Red List.

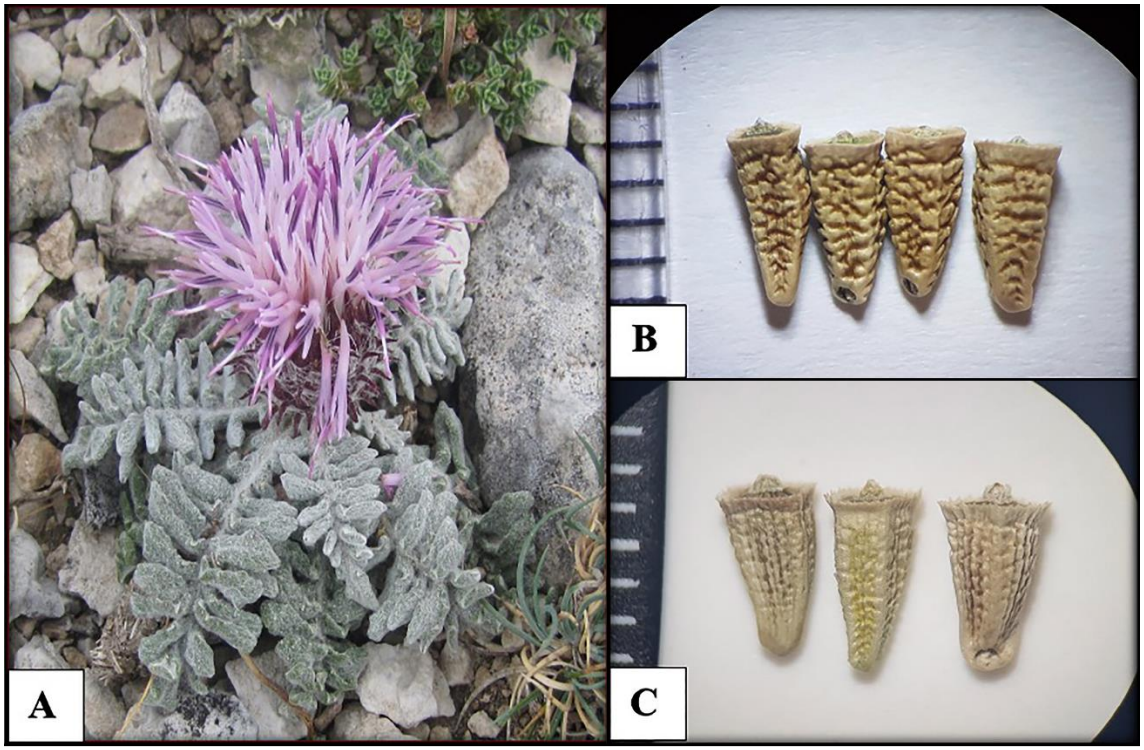

Figure 4. *Jurinea cadmea* subsp. *nifensis.* A) Plant's general appearance, B-C) Achenes.

Methods

Pollen viability analyses

To assess the pollen viability of the target taxa, *Jurinea cadmea* subsp. *cadmea* and *J. cadmea* subsp. *nifensis*, we employed a 5% sucrose solution in the MTT (2,5-diphenyl tetrazolium bromide-thiazolyl blue) test (Rodriguez-Riano & Dafni 2000; Zeng-Yu et al. 2004; Dafni 2007). Given the occurrence of secondary pollen presentation in *J. cadmea*, fresh pollen grains were randomly collected both before the presentation (pre-anthesis) and during the anthesis stage (Figure 5). A total of 108 samples from fresh buds and flowers (36 plants) of both subspecies underwent the MTT test for pollen viability analysis. Using fine tweezers, pollen grains were transferred onto glass slides, and 1-2 drops of the MTT solution were added. Pollen grains, with a minimum of 300 grains per preparation field, were counted. The viability percentage for each phase was calculated by dividing the number of colored pollen grains by the total number of pollen grains in the field of view and multiplying by 100. In the MTT test, live pollen grains exhibiting a dark purple or black color

change due to the presence of the dehydrogenase enzyme in the mitochondria were distinguished from non-viable or damaged pollen, which did not undergo any color change.

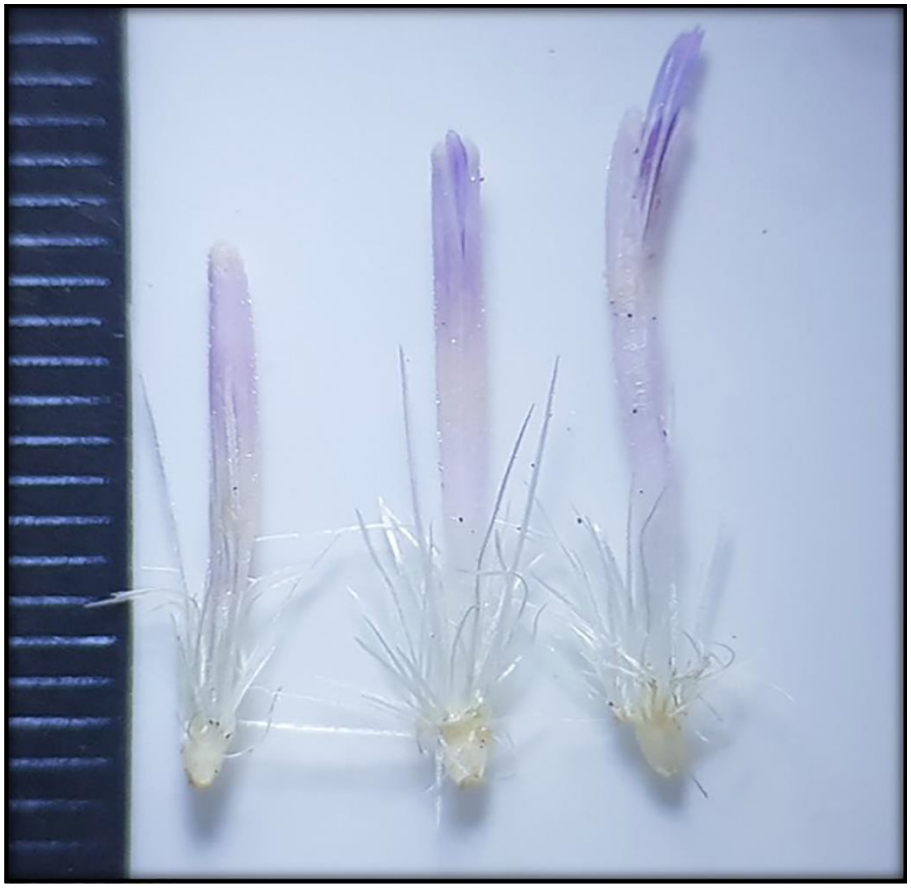

Figure 5. *Jurinea cadmea* flowers in pre-anthesis and anthesis phases.

Stigma viability analyses

We employed the Peroxide test to evaluate the stigma viability in the studied subspecies of *Jurinea cadmea* (Dafni & Firmage 2000). This test is designed to detect the presence of hydrogen peroxide in tissues. When hydrogen peroxide is present, the enzyme induces a color change to dark orange. The test kit includes a color scale indicating peroxide concentrations in the 10-5000 ppm range. Fresh flowers after secondary pollen presentation, just before fruiting, were utilized for analyzing stigma viability. A total of 108 stigmas, obtained from samples collected from 36 individuals, were included in this study. The procedure involved adding one or two drops of the Peroxide test solution to the isolated stigma on a glass slide. After waiting 1-4 minutes for the enzyme to activate, the color of the tissue was compared to the Peroxide test scale values to determine the viability of the stigma. Compared to the Peroxide test scale, the tissue's color change enabled the determination of stigma viability.

Seed viability test

A total of 180 mature achenes were collected from four populations of each of the two subspecies, each with two replicates. The potential seed viability was assessed using the TTC test. Seeds were soaked between moistened filter papers for 24 hours. Subsequently, they were soaked in a 1% TTC solution for one day. Viability levels were determined by observing color changes. The tetrazolium

solution is initially colorless but turns red when it comes into contact with hydrogen produced by enzymes during the respiration process (reduction process). Live embryos turn red, while partially stained or unstained embryos are considered non-viable.

Seed germination tests

To determine seed germination, achenes were collected at full maturity, cleaned, and stored in a dark place at room temperature until the experiments were conducted. A total of 720 achenes were used for germination trials, encompassing all four populations. Before the experiment, achenes were immersed in a 5% sodium hypochlorite solution for 1 minute to prevent mold formation. For the stratification method, achenes were placed between two layers of filter paper in an 8 cm petri dish and moistened with distilled water to maintain moist and dark conditions. The dishes were then wrapped in aluminum foil and kept in the refrigerator at 4°C for 30 and 60 days (two groups consisting of 40 achenes each per working population). Two groups with 20 achenes each from each population were used for control. For the room temperature germination method, achenes were arranged between two layers of filter paper in an 8 cm petri dish and kept in both bright and dark environments at room temperature. Distilled water was added during the experiment to keep the filter paper moist. Every 3-4 days, germinated achenes were removed from the petri dish. Seeds were considered germinated if they were the same length or longer than the achene. These seed germination methods provide insights into the reproductive success and potential of *J. cadmea* subspecies, contributing valuable information for further research and conservation initiatives. The experiment was set up as follows: **Control group (room temperature)**: two repetitions with 20 seeds each were placed between moistened filter papers in a petri dish. a) Kept at room temperature in a bright environment for 30 days. b) Kept at room temperature in a dark environment for 30 days. **Stratification group (cold-wett treatment)**: two repetitions with 40 seeds each were placed between moistened filter papers in a petri dish for stratification. a) After 30 days at +4°C, transferred to 20°C and kept in both bright and dark environments for an additional 30 days. b) After 60 days at +4°C, transferred to 20°C and kept in a bright environment for an additional period. In both the control and stratification groups, the petri dishes were regularly checked to maintain the moisture of the filter papers. Every 3-4 days, germinated seeds were removed from the dishes for assessment. The experiment aimed to observe the germination responses of *J. cadmea* subspecies seeds under different conditions, including room temperature and stratification.

RESULTS AND DISCUSSION

The pollen viability and stigma activity for *Jurinea cadmea* subsp. *nifensis* were observed to be approximately 74.18% before presentation in the male phase and 52.13% during presentation. The Bozdağ population showed an average pollen viability of 76.60% before presentation in the male phase and 53.13% during presentation. The Babadağ population (short form) exhibited a pre-presentation pollen viability of 89.39% and a pollen presentation viability of 79.39%. In the long-form Babadağ population, the pre-presentation pollen viability was 82.28%, and it was 65.23% during the presentation. In all studied populations, it was observed that all stigmas were active in the female phase (Figures 6 and 7). Pollen viability and stigma activity tests were not conducted for the Muğla Oyuklu Mountain populations in this study.

Based on the staining intensity with the tetrazolium solution, live seeds are stained red, while partially stained or unstained seeds are considered non-viable (Figure 8). Using the tetrazolium test, it was determined that the majority of seeds in all studied populations were viable (Figure 9).

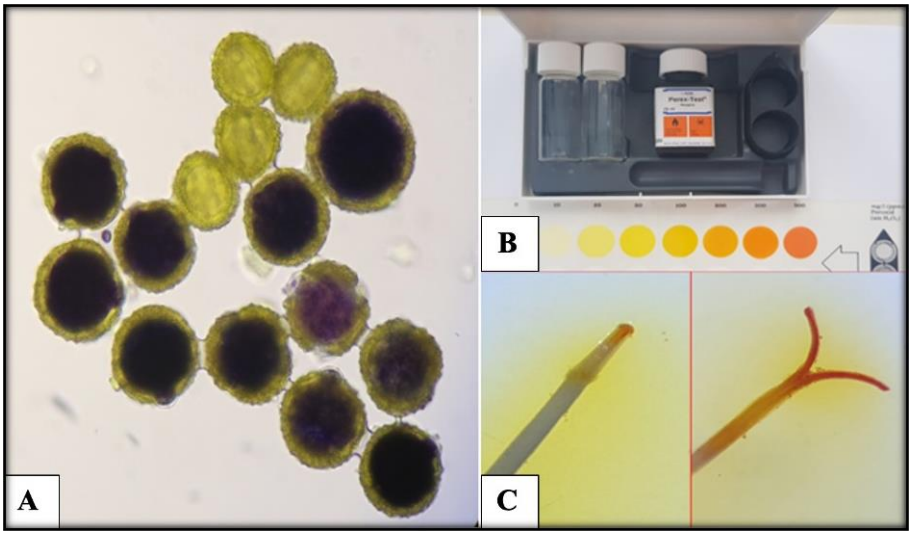

Figure 6. Pollen and stigma viability. A) Live (purple dark) and death (yellow) pollen grains; B) Peroxide test scale for determination of stigma viability; C) Viable stigmas.

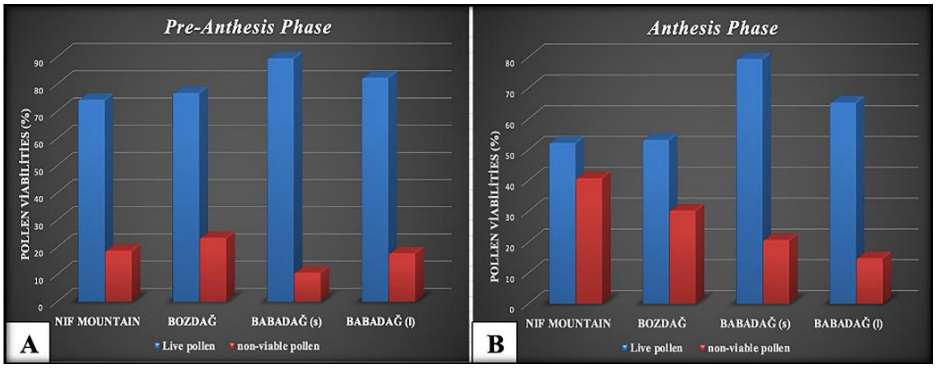

Figure 7. Pollen viability test. A) Pre-anthesis phase; B) Anthesis phase.

Figure 8. Non-viable seed (-); viable seed (+).

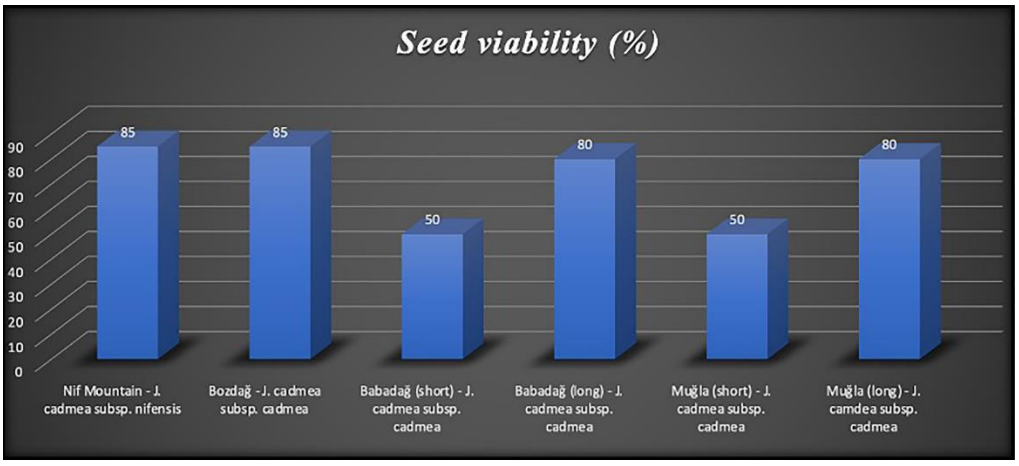

Figure 9. Seed viability in *Jurinea cadmea* subspecies showed by populations.

When seeds were examined for germination without pre-treatment (control) in a lighted area, most populations in the study exhibited high germination rates. An exception was observed in the Muğla Oyuklu Mountain short population and Babadağ short population, where the germination percentage was slightly lower than in other examined populations. The germination percentage was 25% in the Muğla Oyuklu Mountain short population and 65% in the Babadağ short population. For most populations studied, the minimum time for germination to start ranged between 5 to 7 days. Seeds from the Nif Mountain population showed 100% germination on the seventh day of the experiment. In the other studied populations, seeds reached maximum germination between 14 to 18 days after the initiation of the experiment (Figure 10).

When seeds were examined for germination in the dark without pre-treatment (control), seeds obtained from the Nif Mountain and Bozdağ populations showed germination rates exceeding 60%. In other studied populations, germination ranged between 10% and 40%. While the minimum germination time in the dark was 3 to 5 days for the Nif Mountain and Babadağ populations, it ranged from 10 to 12 days for seeds from the Bozdağ and Muğla Oyuklu Mountain populations. Seeds obtained from the Nif Mountain population reached maximum germination (85%) in the dark after 18 days of initiating the experiment. Seeds obtained from the Bozdağ and Babadağ populations reached maximum germination after 20 and 26 days, respectively, from the initiation of the experiment in the dark. Regardless of light conditions, seeds from the Muğla Oyuklu Mountain population showed low germination without pre-treatment (Figure 10).

To determine whether the stratification process influenced the germination of *Jurinea cadmea* subspecies seeds and to what extent seeds from the studied populations were subjected to stratification after pre-treatment (control). For this purpose, the seeds were kept in the refrigerator at 4°C for 30 and 60 days. After 30 days of stratification at 4°C, the *J. cadmea* subspecies seeds were divided into two groups and kept at room temperature in light and dark conditions. Germination of seeds was monitored and recorded daily, and the experiment was stopped after 30 days when no further changes in germination were observed. The seeds of the *J. cadmea* subspecies showed very low germination in light and dark conditions after 30 days of the stratification process (Figure 10). The seeds obtained from the Nif Mountain and Muğla Oyuklu Mountain populations did not germinate. Seeds from the Bozdağ population showed slightly better germination in the dark (15%) compared to the illuminated place (5%). On the other hand, seeds from the Babadağ population

exhibited better germination in the illuminated place (25% for the short form and 45% for the long form) compared to the dark place (15% for the short form and 40% for the long form).

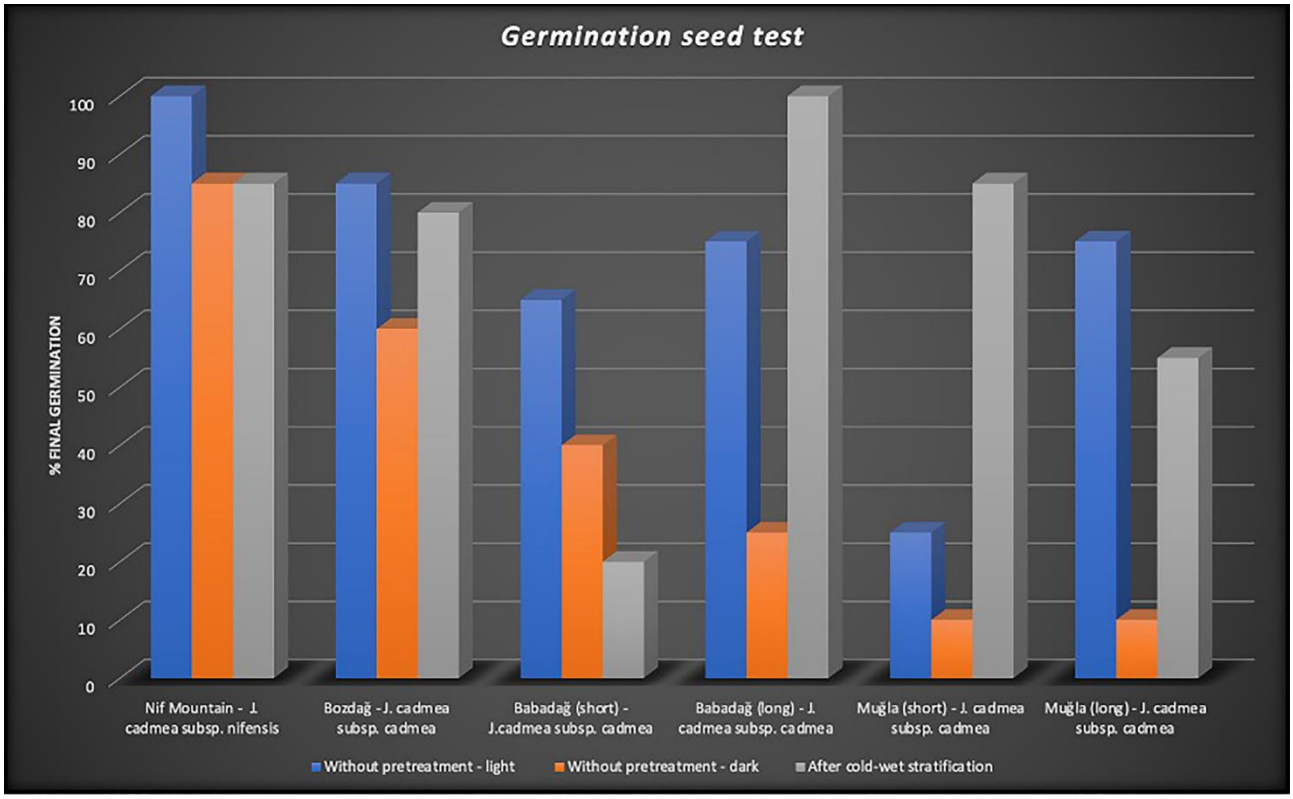

Figure 10. Germination seed test by populations and by treatments.

After 60 days of seed stratification at 4ºC, the germination percentage of seeds in most studied populations was above 60%. Specifically, the germination percentage for the Nif Mountain population was 85%, Bozdağ was 80%, Babadağ (short form) was 15%, Babadağ (long form) was 55%, Muğla Oyuklu Mountain (short form) was 85%, and Muğla Oyuklu Mountain (long form) was 55% (Figure 10).

Later, the seeds were left in a lighted place at room temperature, and changes in germination were monitored. The experiment was terminated because there was no change in germination after the third day. The germinated seeds were recounted, and the percentages were determined. While the germination percentages of seeds from the Nif Mountain, Bozdağ, and Muğla Oyuklu Mountain populations remained unchanged, the germination percentage of seeds from the Babadağ population increased after three days. For the short individuals, the germination percentage became 20% (an increase of 15% from before), and for the long individuals, it became 100% (a rise of 55% from before).

This study examined the reproductive capacity of two subspecies of *Jurinea cadmea* (pollen, stigma, seed viability, and seed germination) to determine some fundamental features of their reproductive biology. Seed production is closely related to pollen and stigma viability (Dafni & Firmage 2000; Wilcock & Neiland 2002; Hu 2005), and it is known to facilitate the successful realization of reproductive capacity, an essential prerequisite for maintaining the population size (Wang et al. 2012). The study explored seed germination by subjecting the seeds of the studied subspecies to a cold-wet folding pretreatment, aiming to assess the impact of the stratification

process on germination. High viability for both pollen and stigma (above 70% for individuals from Nif Mountain and Bozdağ populations, and above 80% for individuals from Babadağ population), and high seed viability (above 85% for individuals from Nif Mountain and Bozdağ populations, above 80% for individuals from Babadağ-short, above 50% for individuals from Babadağ-long, above 80% for individuals from Muğla Oyuklu Mountain -short, above 50% for individuals from Muğla Oyuklu Mountain-long) indicate that the reproductive capacity was successfully achieved in both *J. cadmea* subspecies. Most seeds from the studied *J. cadmea* subspecies showed high germination without pretreatment (above 65% in most populations). Maximum germination percentage (100%) was observed in the first seven days for seeds obtained from Nif Mountain population (*J. cadmea* subsp. *nifensis*), while for the other *J. cadmea* subsp. *cadmea* populations, maximum germination was observed 14 to 18 days after the experiment was set up. The faster and maximum germination of *J. cadmea* subsp. *nifensis* seeds may be attributed to the absence of glandular hairs on the seed surface and potentially thinner seed coat. These reasons should be approached with caution until additional analyses are conducted on the germination of seeds of the *J. cadmea* subspecies. Muğla Oyuklu Mountain population seeds (25%) showed lower germination without pretreatment compared to the other studied populations, and the lower germination in these populations is thought to be due to the short waiting period (7 months) after seed collection. Seeds of other populations were collected and left to wait for more than 12 months. According to Urbanska and Schütz (1986) and Körner (1999), alpine plants may not germinate in the current season and enter a dormancy process to avoid low winter temperatures and be ready to germinate early in spring. The dormancy process terminates the embryo's development, removing physical constraints in the seed coat through alternate freezing and thawing. After 30 and 60 days of stratification pretreatment, seed germination significantly decreased in all studied populations, indicating a negative impact of the stratification process on the germination of *J. cadmea* subspecies. Our results partly overlap with the findings of Giménez-Benavides et al. (2005), who studied the germination of 20 Mediterranean species from higher altitudes. In most studied subspecies, high seed germination was found without any pretreatment. Larger seeds did not germinate after the stratification process in this study, while *Biscutella laevigata* L. subsp. *gredensis* (Guinea) Malag. and *Senecio pyrenaicus* L. subsp. *carpetanus* (Willk.) Rivas Mart. lost their viability during the stratification process.

This study aimed to understand better the life cycles of the two subspecies of *Jurinea cadmea*, namely *J. cadmea subsp. cadmea* and *J. cadmea* subsp. *nifensis*, by examining reproductive biology features such as pollen, stigma, seed viability, and seed germination. Both subspecies exhibited high viability rates and successful reproductive capacity, indicating the importance of maintaining population size and capacity. This study has contributed significantly to understanding the reproductive biology of both subspecies, laying a foundation for future research endeavors that delve deeper into the intricacies of the *J. cadmea* subspecies' variability and taxonomic status. Successful seed germination ensures the continuity of the species. It allows for the transmission of genetic information from one generation to the next, facilitating the persistence of *J. cadmea* in its natural habitat. Understanding this interconnectedness provides insights into the plant's reproductive strategies, environment adaptation, and potential challenges it may face in maintaining viable populations. Conservation efforts should consider these aspects to promote the overall reproductive success and sustainability of *J. cadmea* in its native habitats.

However, further research is needed to understand these two subspecies, intra-population and inter-population relationships, further research is needed, encompassing genetic, effects of phytohormones, climatic, phytosociological, taxonomic, pedological, and other variability factors. Such studies could provide more detailed insights into the variability and taxonomic status of the *Jurinea cadmea* subspecies.

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AUTHOR CONTRIBUTION STATEMENT

In this study; the authors made the study idea and design, data collection, analysis and interpretation of the results, and drafting of the article.

REFERENCES

Aksoy, N., Ataşlar, E. & Keskin, B.C. (2018). Morphological and molecular data reveal a new species of *Jurinea* (*Asteraceae)* from Western Black Sea Region, Turkey. Phytologia Balcanica 24(3): 351-359.

Dafni, A. & Firmage, D. (2000). Pollen viability and longevity: practical, ecological, and evolutionary implications. Plant Syst Evol 222(1-4): p.113-132. DOI: https://doi.org/10.1007/BF00984098.

Dafni, A. (2007). Manual of Pollination Ecology: Field Methods, (Text book) Laboratory of Pollination Ecology. Institute of Evolution University of Haifa.

Danin, A. & Davis, P.H. (1975). [*Jurinea* Cass.] In: Davis P.H. (Ed.). *Flora of Turkey and the East Aegean Islands*. Vol. 5. Edinnurgh University Press, Edinburgh.

Doğan, B., Duran, A. & Hakkı, E.E. (2007). Phylogenetic relationship analysis of *Jurinea* Cass. (Asteraceae) species from Turkey as revealed by Inter-Simple Sequence Repeat Amplification. *Ann Bot Fennici* 44(5): 353-358.

Doğan, B., Duran, A. & Hakkı, E.E. (2009). Numerical analyses of wild *Jurinea* spp. (Asteraceae) in Turkey. *Bangladesh J Bot* 38(1): 47-53. DOI: https://doi.org/10.3329/bjb.v38i1.5118.

Doğan, B., Hakki, E.E. & Duran, A. (2010). A phylogenetic analysis of *Jurinea* (Compositae) species from Turkey based on ITS sequence data. *African J Biotechnol* 9(12): 1741-1745. DOI: https://doi.org/10.5897/AJB10.1525.

Doğan, B., Duran, A., Martin, E. & Hakki, E.E. (2011). Karyotype analyses of the species of the genus *Jurinea* Cass. (Compositae) in Turkey. Afr J Biotechnol 10(5): 722-729. DOI: https://doi.org/10.5897/AJB10.907

Doğan, B. (2012). [*Jurinea* Cass.] In: Güner, A., Aslan, S., Ekim, T., Vural, M. & Babaç, M.T. (Eds.) *Türkiye Bitkileri Listesi (Damarlı Bitkiler)*. Nezahat Gökyiğit Botanik Bahçesi ve Flora Araştırmaları Derneği Yayını, İstanbul, pp. 176–177.

Ekim, T., Koyuncu, M., Vural, M., Duman, H., Aytaç, Z. & Adıgüzel, N. (2000). *Türkiye Bitkileri Kırmızı Kitabı*. Yüzüncü Yıl Üniversitesi ve Türkiye Tabiatını Koruma Derneği, Ankara.

Giménez-Benavides, L., Escudero, A. & Péez-García, F. (2005). Seed germination of high mountain Mediterranean species: altitudinal, interpopulation and interannual variability. *Ecol Res* 20(4): 433-444. DOI: https://doi.org/10.1007/s11284-005-0059-4.

Hu, S.Y. (2005). *Reproductive Biology of Angiosperms*. High Education Press, Beijing, China.

Körner, C. (1999). *Alpine Plant Life*. DOI: https://doi.org/10.1007/978-3-642-98018-3.

Özhatay, N. & Kültür, Ş. (2006). Check-list of additional taxa to the supplement Flora of Turkey III. *Turk J Bot* 30(4): 281-316.

Rodriguez-Riano, T. & Dafni, A. (2000). A new procedure to asses pollen viability. *Sex Plant Reprod* 12: 241-244. DOI: https://doi.org/10.1007/s004970050008.

Stevens, P.F. (2001). *Angiosperm Phylogeny Website*. Version 12, July 2012 [and More or Less Continuously Updated Since]. http://www.mobot.org/MOBOT/research/APweb/ [02.01. 2023].

Szukala, A., Korotkova, N., Gruenstaeudl, M., Sennikov, A. N., Lazkov, G. A., Litvinskaya, S. A., Gabrielian, E., Borsch & T. von Raab-Straube, E. (2019). Phylogeny of the eurasian genus *Jurinea* (Asteraceae: Cardueae): Support for a monophyletic genus concept and a first hypothesis on overall species relationships. *Taxon* 68(1): 112-131. DOI: https://doi.org/10.1002/tax.12027.

Urbanska, K.M. & Schütz, M. (1986). Reproduction by seed in alpine plants and revegetation research above timberline. *Botanica Helvetica* 96(1): 43-60.

Wang, Y.L., Guan, Z.Y., Chen, F.D., Fang, W.M. & Teng, N.J. (2012). Pollen viability, pistil receptivity, and embryo development in hybridization of *Nelumbo nucifera* Gaertn. *The Scientific World Journal*, Article ID 678706. DOI: https://doi.org/10.1100/2012/678706.

Wilcock, C. & Neiland, R. (2002). Pollination failure in plants: why it happens and when it matters. *Trends in Plant Science* 7(6): 270-277.

Yıldırım, H. & Şenol, G. S. (2010). A new taxon for *Jurinea* from West Turkey. *OT Sistematik Botanik Dergisi* 17(1): 1-8.

Zeng-Yu, W., Yaxin, G., Scott, M. & Spangenberg, G. (2004). Viability and longevity of pollen from transgenic and non-transgenic tall fescue (*Festuca arundinacea*) (Poaceae) plants. *Am J Bot* 91(4): 523-530. DOI: https://doi.org/10.3732/ajb.91.4.523.

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First Record of *Imperator torosus* for the Mycobiota of Türkiye

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Abstract
Imperator torosus (Fr.) Assyov, Bellanger, Bertéa, Courtec., Koller, Loizides, G. Marques, J.A. Muñoz, Oppicelli, D. Puddu, F. Rich. & P.-A. Moreau (Boletaceae) was reported as new record for the mycobiota of Türkiye, based on the identification of the samples collected from Gerede and Mudurnu districts of Bolu province. This species is the second member of the genus *Imperator* Koller, Assyov, Bellanger, Bertéa, Loizides, G. Marques, P.-A. Moreau, J.A. Muñoz, Oppicelli, D. Puddu & F. Rich. in Türkiye. A brief description of the Turkish collections is provided together with the photographs, related to its macro and micromorphologies.
Keywords: Biodiversity, Boletales, new record, Türkiye

Imperator torosus'un Türkiye Mikobiyotası İçin İlk Kaydı

Özet
Imperator torosus (Fr.) Assyov, Bellanger, Bertéa, Courtec., Koller, Loizides, G. Marques, J.A. Muñoz, Oppicelli, D. Puddu, F. Rich. & P.-A. Moreau (Boletaceae) Bolu'un Gerede ve Mudurnu ilçelerinden toplanan örneklerin teşhisine bağlı olarak, Türkiye mikobiyotası için yeni kayıt olarak rapor edilmiştir. Bu tür *Imperator* Koller, Assyov, Bellanger, Bertéa, Loizides, G. Marques, P.-A. Moreau, J.A. Muñoz, Oppicelli, D. Puddu & F. Rich. cinsinin Türkiye'deki ikinci üyesidir. Türün kısa bir betimlemesi, makro ve mikromorfolojisine ilişkin fotoğraflarıyla birlikte verilmiştir.
Anahtar kelimeler: Biyoçeşitlilik, Boletales, yeni kayıt, Türkiye

INTRODUCTION

Imperator Koller, Assyov, Bellanger, Bertéa, Loizides, G. Marques, P.-A. Moreau, J.A. Muñoz, Oppicelli, D. Puddu & F. Rich. is a boleteoid genus situated within the order Boletales. It was initially delimineated by Assyov et al. (2015) based on recent molecular studies related to Boletaceae (Nuhn et al. 2013; Wu et al. 2014). Members of this genus are predominantly characterized by a reticulate stipe ranging in color from yellow to reddish-orange, exhibiting a dark purplish-red staining from the base as they mature. Additionally, a distinctive blue to blackish discoloration occurs on the pileus surface upon tactile contact, accompanied by an intense blueing reaction in the context when incised (Breitenbach & Kränzlin 1991; Hills 1997; Assyov 2013).

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Index Fungorum (2024) lists four members of this genus, *Imperator luteocupreus* (Bertéa & Estadès) Assyov, Bellanger, Bertéa, Courtec., Koller, Loizides, G. Marques, J.A. Muñoz, Oppicelli, D. Puddu, F. Rich. & P.-A. Moreau, *I. rhodopurpureus* (Smotl.) Assyov, Bellanger, Bertéa, Courtec., Koller, Loizides, G. Marques, J.A. Muñoz, Oppicelli, D. Puddu, F. Rich. & P.-A. Moreau, *I. torosus* (Fr.) Assyov, Bellanger, Bertéa, Courtec., Koller, Loizides, G. Marques, J.A. Muñoz, Oppicelli, D. Puddu, F. Rich. & P.-A. Moreau and *I. xanthocyaneus* (Ramain) Klofac, among which *I. torosus* is the type species of the genus.

Imperator rhodopurpureus is the only member of the genus that has been reported from Türkiye (Sesli et al. 2020). The current checklist (Sesli et al. 2020) and the most recent contributing studies (Akçay et al. 2022; Allı 2022; Polat & Keleş 2022; Acar & Dizkırıcı 2023; Yeşilyurt et al. 2023) on Turkish mycobiota indicate that any other member of the genus *Imperator* haven't been reported from Türkiye before. Here, we introduce *I. torosus* as a new record for the mycobiota of Türkiye.

MATERIAL AND METHOD

Basidiocarps of *Imperator torosus* were collected from Gerede and Mudurnu districts of Bolu province in 2023 during routine field surveys. Fruit bodies at different development stages were photographed in their natural habitat, and necessary notes were taken related to their ecological and other descriptive characteristics. Subsequently, the samples were transferred to the fungarium in paper boxes and dried in a climate-controlled room. Microscopic investigations were carried out on the sections obtained from dried material, and conducted under a Leica DM 2500 trinocular light microscope, and photographs related to micromorphology were taken by a Relab Sony imx 8.3 mp usb 3.0 camera. The samples were identified by comparing the accumulated descriptive data with the existing literature (Breitenbach & Kränzlin 1991; Hills 1997; Assyov 2013; Bertolini & Simonini 2013). The specimens are kept at Biology Department, Kamil Özdağ Science Faculty, Karamanoğlu Mehmetbey University.

RESULTS AND DISCUSSION

Basidiomycota R.T.Moore

Boletaceae Chevall.

Imperator torosus (Fr.) Assyov, Bellanger, Bertéa, Courtec., Koller, Loizides, G. Marques, J.A. Muñoz, Oppicelli, D. Puddu, F. Rich. & P.-A. Moreau (Figures 1-2).

Synonyms. [*Boletus appendiculatus* subsp. *torosus* (Fr.) Konrad, *Boletus torosus* Fr., *Boletus torosus* var. *gallicus* Romagn., *Boletus torosus* var. *xanthus* Cetto, *Boletus torosus* var. *xanthus* Cetto, *Dictyopus torosus* (Fr.) Quél., *Suillellus torosus* (Fr.) Blanco-Dios, *Suillus torosus* (Fr.) Kuntze, *Tubiporus torosus* (Fr.) Imler].

Macroscopic and microscopic features

Pileus 70-160 mm in diameter, globose to almost spherical when young, then hemispherical, convex to flattish at maturity. Surface smooth to somewhat velvety at first, later slightly tuberculate and with some slight linear depressions, finely appressed tomentose suedelike to somewhat glabrous at maturity, reddish brown with yellowish tint when young, later wineceous to dark olive-brown, immediately bluing strongly when touched or bruised (Fig. 1). Margin slightly incurved for a long time. Flesh thick, firm, yellowish to pale yellow, immediately turning to blue. Taste mild, odor

fruity. Pores round and small, bright to sulphur-yellow when young, orange-yellow to pale orange, especially towards the stipe, at maturity, immediately bluing when touched. Tubes up to 20 mm, yellow, bluing when cut, tube mouths pale orange. Stipe 60-120 × 40-70 mm, bulbous when young, bulbous-ventricose to clavate at maturity, brownish yellow to sulphur yellow when young, pale yellow to pale brownish yellow at maturity, covered with a reddish-brown reticulation, immediately bluing strongly when touched or bruised. Basidia 39-47 × 9-14 µm, clavate, generally four-spored, without a basal clamp. Cheilocystidia 35-50 × 6-8 µm, narrowly fusiform, pleurocystidia slightly shorter but similar to cheilocystidia. Basidiospores 12-15.5 × 5-6.7 µm, ellipsoid to somewhat fusiform, thick walled, some with small drops (Figure 2).

Figure 1. *B*asidiocarps of *Imperator torosus*.

Imperator torosus was reported to grow either solitarily or gregariously in calcareous soils within hardwood forests, often in association with deciduous trees such as *Carpinus* L., *Fagus* L., and particularly various species of *Quercus* L. The fruiting period occurs from spring through late summer (Alessio 1985; Breitenbach & Kränzlin 1991; Hills 1997; Assyov 2013).

Imperator torosus is added as a new record for Turkish Mycobiota. This species is the second member of the genus *Imperator* in Türkiye. In general, the characteristics of the sample are in agreement with Breitenbach and Kränzlin (1991), Hills (1997) and Assyov (2013).

Imperator torosus somewhat resembles *Cyanoboletus poikilochromus* (Pöder, Cetto & Zuccher.) M. Carbone, D. Puddu & P. Alvarado, but smaller fruit body, somewhat cylindrical stipe, and the lighter colours of younger fruit bodies of *C. poikilochromus* differs it from *I. torosus. Imperator torosus* is sometimes confused with *I. luteocupreus*, but the latter species is well separated by uniformly vivid red color of the pores even in young basidiocarps, while in *I. torosus* pores are mainly yellow (Assyov 2005).

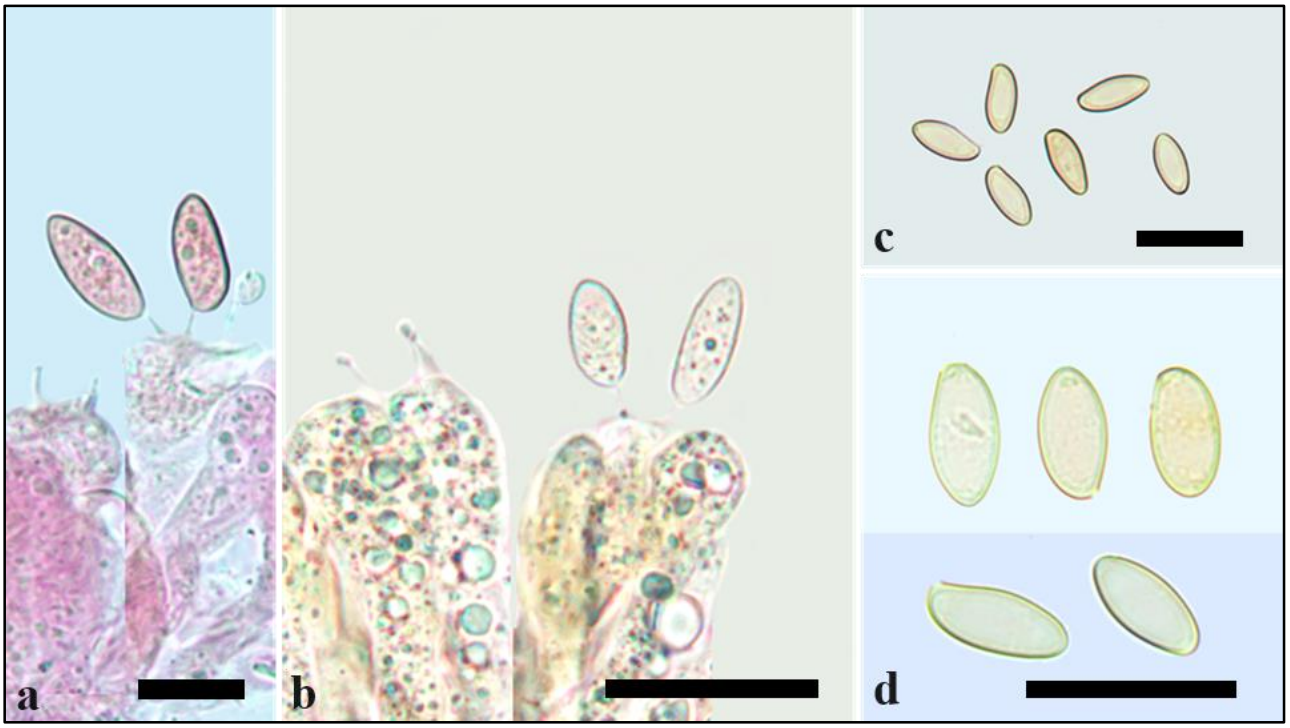

Figure 2. Basidia and basidiospores (a,b) and basidiospores (c,d) of *Imperator torosus* (bars: a- 10 µm, b-d- 20 µm) (a- in Congo Red, b-d- in water).

Specimen examined

***Imperator torosus*.** Türkiye. Bolu: Gerede, Hacı Veli High Plateau, on soil under *Abies* Mill. sp., 40.817990N, 32.184118E, 1400 m, 12.08.2023, *Y.Karaduman 30*; Mudurnu, Sinekli High Plateau, on soil under *Fagus* L. sp., 40.630760N, 31.287723E, 1450 m, 13.08.2023, *A.Gürzoglu 10*.

AUTHOR CONTRIBUTION STATEMENT

In this study; the study idea and design, data collection, analysis and interpretation of the results, and drafting of the article were made by the authors.

REFERENCES

Acar, İ. & Dizkırıcı, A. (2023). *Agaricus micromegethus*, a new record for Turkish Mycobiota. *Anatolian Journal of Botany* 7(2): 128–130.

Akçay, M.E., Dengiz, Y. & Kesici, S. (2022). *Coprotus* Korf & Kimbr.: A new coprophilous genus record for the mycobiota of Turkiye. *Anatolian Journal of Botany* 6(2): 75–77.

Alessio, C.L. (1985). *Boletus* Dill. ex. L. *Fungi Europaei* (in Italian). Vol. 2. Saronno, Italy: Biella Giovanna.

Allı, H. (2022). Muğla Sıtkı Koçman Üniversitesi Kampüsünde Yetişen Makromantarlar. *Mantar Dergisi* 13(2): 96–104.

Assyov, B. (2005). New and rare Bulgarian boletes. *Mycologia Balcanica* 2: 75–81.

Assyov, B. (2013). "*Boletus torosus*". https://boletales.com/genera/boletus/b-torosus/ [15.02.2024].

Assyov, B., Bellanger, J.M., Bertéa, P., Courtecuisse, R., Koller, G., Loizides, M., Marques, G., Muñoz, J.A., Oppicelli, N., Puddu, D., Richard, F. & Moreau, P.A. (2015). Nomenclatural novelties. Index Fungorum (243).

Bertolini, V. & Simonini, G. (2013). Problemi nomenclaturali inerenti alla Famiglia Boletaceae I. Tipificazioni: *Boletus torosus, Boletus rhodopurpureus* e B. emilei. *Rivista di Micologia* 2: 117–134.

Breitenbach, J. & Kränzlin, F. (1991). *Fungi of Switzerland*, Vol. 3. Lucerne: Verlag Mykologia.

Hills, A. (1997). Notes on British species of the *Boletus torosus* complex. *Mycologist* 11(4): 159–164.

Index Fungorum (2024). http://www.indexfungorum.org/Names/Names.asp. [15.01.2024].

Nuhn, M,E., Binder, M., Taylor, A.F., Halling, R.E. & Hibbett, D.S. (2013). Phylogenetic overview of the Boletineae. *Fungal Biology* 117(7–8): 479–511.

Polat, T. & Keleş, A. (2022). Macrofungal biodiversity of Kop Mount (Bayburt-Erzurum). *Anatolian Journal of Botany* 6(2): 109–114.

Sesli, E., Asan, A., Selçuk, F. (eds), Abacı Günyar, Ö., Akata, I., Akgül, H., Aktaş, S., Alkan, S., Allı, H., Aydoğdu, H., Berikten, D., Demirel, K., Demirel, R., Doğan, H.H., Erdoğdu, M., Ergül, C.C., Eroğlu, G., Giray, G., Halikî Uztan, A., Kabaktepe, Ş., Kadaifçiler, D., Kalyoncu, F., Karaltı, İ., Kaşık, G., Kaya, A., Keleş, A., Kırbağ, S., Kıvanç, M., Ocak, İ., Ökten, S., Özkale, E., Öztürk, C., Sevindik, M., Şen, B., Şen, İ., Türkekul, İ., Ulukapı, M., Uzun, Ya., Uzun, Yu. & Yoltaş, A. (2020). *Türkiye Mantarları Listesi*. Ali Nihat Gökyiğit Vakfı Yayını. İstanbul.

Wu, G., Feng, B., Xu, J., Zhu, X.T., Li, Y.C., Zeng, N.K., Hosen, M.I. & Yang, Z.L. (2014). Molecular phylogenetic analyses redefine seven major clades and reveal 22 new generic clades in the fungal family Boletaceae. *Fungal Diversity* 69(1): 93–115.

Yeşilyurt, F., Uzun, Y. & Kaya, A. (2023). *Pseudoboletus parasiticus* (Bull.) Šutara, a New Record for Turkish Mycobiota. *Biological Diversity and Conservation* 16(1): 70–74.

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Research Article

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New Record for the Flora of Türkiye: *Silene vivianii* subsp. *viscida* (Caryophyllaceae)

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Abstract

Silene vivianii subsp. *viscida* (Caryophyllaceae), given as a new record for flora of Türkiye. The specimens were collected from Cizre (Şırnak) of Southeastern Anatolia. While this taxon has been known from North Africa, Egypt, Southern Palestine, Iran and Iraq until now, a record has been given from Türkiye for the first time. Detailed morphological picture, its photographs in its natural distribution area and the updated map of the distribution area are presented in the study.

Keywords: New record, *Silene vivianii*, Şırnak, Türkiye

Türkiye Florası için Yeni Kayıt: *Silene vivianii* subsp. *viscida* (Caryophyllaceae)

Özet

Silene vivianii subsp. *viscida* (Caryophyllaceae) Türkiye florası için yeni bir kayıt olarak verildi. Örnekler Güneydoğu Anadolu'da, Cizre (Şırnak)'den toplanmıştır. Bu takson şimdiye kadar Kuzey Afrika, Mısır, Güney Filistin, İran ve Irak'tan bilinmekte iken, bu defa Türkiye'den ilk kaydı verilmiştir. Çalışmada ayrıntılı morfolojik resim, doğal yayılış alanındaki fotoğrafları ve yayılış alanının güncellenmiş haritası sunulmuştur.

Anahtar kelimeler: Yeni kayıt, *Silene vivianii*, Şırnak, Türkiye

INTRODUCTION

Silene L. (Caryophylloideae) is one of the largest genera of flowering plants including about 700 species (Melzheimer, 1980; Morton, 2005). The flora of Türkiye consists of approximately 182 *Silene* taxa belonging to 31 sections (Coode & Cullen, 1967; Davis et al., 1988; Tan & Vural, 2000; Budak et al., 2018; Yıldız, 2012; Yıldız et al., 2017; Aydın et al., 2014; Aytaç et al., 2015; Güner & Duman, 2016; Fırat & Yıldız, 2016a; 2016b; Özbek & Uzunhisarcıklı, 2019).

MATERIAL AND METHOD

During floristic surveys in Gabar Mountain (Cizre, Şırnak) in April 2014 and June 2015, unidentified specimens from genus *Silene* were collected and therefore the author of the study decided to analyze the morphological characters of the species (Figure 1). Other specimens were subsequently collected and examined for diagnosis using a wide range of literature (Coode & Cullen, 1967; Davis et al., 1988; Boulos, 1995; Tan & Vural, 2000; Yıldız, 2012). As a result of this effort and with the light of new characters observed, the specimens were identified as *Silene vivianii*

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Steud. subsp. *viscida* (Boiss.). Boulos is a new record for the flora of Türkiye. Specimens of the *Silene vivianii* subsp. *viscida* were hold in the personal herbarium of the author (Herb. Fırat).

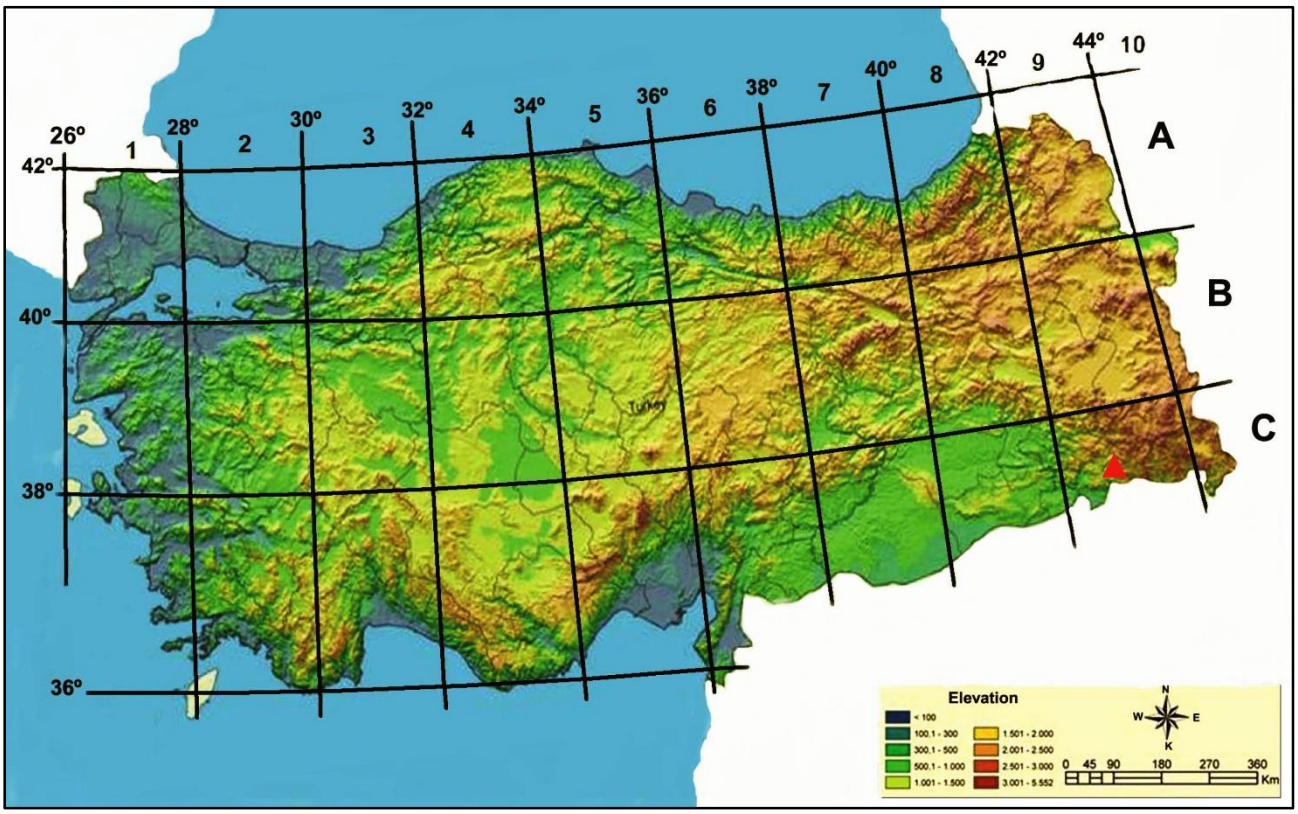

Figure 1. Distribution map of *Silene vivianii* subsp. *viscida* (▲) in Türkiye.

RESULTS AND DISCUSSION

***Silene vivianii* Steud. subsp. *viscida* (Boiss.) Boulos** (Figure 2-4)

Syn. *Silene setacea* Viv. var. ***viscida*** Boiss., Fl. Orient. 1: 594 (1867).

Plants scabrous with very short and sparse papillae and glandular hairs. Leaves linear- lanceolate, partly folded lengthwise, partly plane. In its outer appearance it approaches *Silene vivianii* which a simple, appressed indumentum.

Description. Annual, minutely appressed-puberulent to pubescent, not viscid, 10-30 cm. Stems ascending to erect, simple or branched especially at base. Leaves narrowly linear to setaceous, plicate, densely or sparingly pubescent. Cymes simple, monochasial. Bracts short, subequal. Pedicels mostly shorter than bracts. Calyx 1.2-1.5 cm, tubular, later club-shaped, umbilicate at base, pubescent or puberulent, more or less green-nerved; teeth about 3 mm, oblong-lanceolate, more or less acute, white-margined, ciliate. Petals white to whitish-pink; claw somewhat exserted; limb 2-partite into widely diverging linear lobes, dark-veined beneath; coronal scales small, obtuse. Capsule ovoid, about as long as hairy carpophore. Seeds 0.5-1 mm, reniform, rugulose, with ear-shaped depression and obtusely grooved back.

Habitat. Accumulated soil on stony rocky areas, 400-500 m.

Phenology. Flowering from March to May and fruiting from April to June.

Distribution in Türkiye. Cizre, Şırnak Province

General distribution. North Africa, Egypt, Southern Palestine, Iran, Iraq, and Türkiye

New locality. Türkiye: **C9** Şırnak: Cizre district, foothills of the Gabar mountain, 410 m a.s.l., 1 May 2014, *M.Fırat 30514* (in flower); *ibid*., 17 June 2015, *M.Fırat 32507* (in fruit).

Figure 2. A-B. habitat of *Silene vivianii* subsp. *viscida* (Gabar mountain) in Şırnak.

Figure 3. *Silene vivianii* subsp. *viscida*. A. habit, B-C. flower (in Türkiye), (*M.Fırat 30514*).

Figure 4. *Silene vivianii* subsp. *viscida*. A. immature capsule (*M.Fırat 30514*), B. ripe capsule (in Türkiye) (*M.Fırat 32507*).

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AUTHOR CONTRIBUTION STATEMENT

In this study; the study idea and design, data collection, analysis and interpretation of the results, and drafting of the article were made by Mehmet Fırat.

REFERENCES

Aydın, Z., Ertekin, A.S., Långström, E. & Oxelman, B. (2014). A new section of *Silene* Caryophyllaceae) including a new species from South Anatolia, Turkey. *Phytotaxa* 178(2): 98–112. https://doi.org/10.11646/phytotaxa.178.2.2.

Aytaç, Z., Kandemir, A. & Fişne, A. (2015). *Silene kemahensis* (Caryophyllaceae): A new species from Erzincan (Turkey). *Bağbahçe Bilim Dergisi* 2: 37-42.

Boulos, L. (1995). *Flora of Egypt: A Checklist*. Al-Hadara Publishing, Cairo.

Budak, Ü., Koç, M. & Hamzaoğlu, E. (2018). *Silene goksuensis* (Caryophyllaceae), a new species from south Turkey. *Phytotaxa* 345: 170-174. https://doi.org/10.11646/phytotaxa.345.2.9.

Coode, M.J.E. & Cullen, J. (1967). [*Silene* L.] In: Davis, P.H. (ed.), *Flora of Turkey and the East Aegean Islands*. Vol. 2, Edinburgh Univ Press., Edinburgh, pp. 179-242.

Davis, P.H., Mill, R.R. & Tan, Kit. (1988). [*Silene* L.] In: Davis, P.H., Mill, R.R. & Tan, K. (eds.), *Flora of Turkey and the East Aegean Islands*. Vol. 10. Edinburgh Univ Press., Edinburgh, Edinburgh, pp. 76-81.

Fırat, M. & Yıldız, K. (2016a). *Silene miksensis* (Caryophyllaceae), a new species from eastern Anatolia. *Phytotaxa* 273: 283–292. https://doi.org/10.11646/phytotaxa.273.4.4.

Fırat, M. & Yıldız, K. (2016b). *Silene konuralpii* (Sect. Spergulifoliae, Caryophyllaceae), a new species from eastern Anatolia. *Phytotaxa* 288: 214-226.

Güner, E.D. & Duman, H. (2016). A new species from Turkey, *Silene bilgilii* (Caryophyllaceae). *Phytotaxa* 246(4): 293-299. https://doi.org/10.11646/phytotaxa. 246.4.5.

Melzheimer, V. (1980). Revision einiger balkanischer Arten von *Silene* Sect. *Inflatae* (Caryophyllaceae). *Botanische Jahrbücher fuer Systematik* 10: 153-190.

Morton, J.K. (2005). *Silene* L. In: Flora of North America Editorial committee (Eds.) Flora of North America North of Mexico, vol. 5. Oxford University Press, New York & Oxford, pp. 166-214.

Özbek, M.U. & Uzunhisarcıklı, M.E. (2019). A new species of *Silene* (Caryophyllaceae) from Turkey. *Phytotaxa* 397(1): 74-82. https://doi.org/10.11646/phytotaxa.397.1.7.

Tan, K. & Vural, M. (2000) [Silene L.] In: Güner, A., Özhatay, N., Ekim, T. & Başer, K.H.C. (eds.), *Flora of Turkey and the East Aegean Islands*. vol. 11 (Suppl. II). Edinburgh University Press, Edinburgh, pp. 50-53.

Yıldız, K. (2012). [*Silene* L.] In: Guner, A., Aslan, S., Ekim, T., Vural, M. & Babaç, M.T. (Eds.) *Türkiye Bitkileri Listesi (Damarlı Bitkiler)*. Nezahat Gökyiğit Botanik Bahçesi & Flora araştırma derneği, İstanbul, pp. 354-365. [in Turkish].

Yıldız, K., Çırpıcı, A., Dadandı, M.Y. & Fırat, M. (2017). *Silene nemrutensis* (Caryophyllaceae), a new species from south-eastern Anatolia. *Phytotaxa* 292: 189-195. https://doi.org/10.11646/phytotaxa.292.2.6.