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GRIMMIA UNICOLOR HOOK. (GRIMMIACEAE), A NEW MOSS RECORD FROM THE HYRCANIAN FORESTS, IRAN

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Abstract
The Hyrcanian humid and temperate area, located in the Euro-Siberian region, is one of Iran's richest ecosystems and showcases a remarkable diversity of mosses across its sites and habitats. In particular, the Mazichal region in Kelardasht, located in the northern parts of the Middle Alborz Mountains, exhibits a unique moss flora. During a field study on moss flora of the area, we discovered a species from the genus *Grimmia* Hedw., which further research identified as *Grimmia unicolor* Hook. This finding establishes a new record for the moss flora of Iran, accompanied by a description of its botanical and ecological characteristics.

Keywords: Acrocarpos mosses; bryophytes; *Grimmia unicolor*; Mazichal; terricolous

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گونه *Grimmia unicolor* Hook. (Grimmiaceae)، گزارش خزه جدید برای جنگل‌های هیرکانی ایران

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لارس هدناس: بخش گیاه‌شناسی، موزه تاریخ طبیعی سوئد، استکهلم، سوئد.

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چکیده: منطقه مرطوب و معتدل هیرکانی، یکی از غنی‌ترین اکوسیستم‌های ایران واقع در منطقه اروپا–سیبری، تنوع قابل توجهی از خزه‌ها را در مکان‌ها و زیستگاه‌های خود به نمایش می‌گذارد. به ویژه، منطقه مازیچال در کلاردشت واقع در بخش‌های شمالی رشته کوه البرز میانی، دارای فلور خزه‌ای منحصر به فردی است. طی یک مطالعه میدانی روی فلور خزه‌ای منطقه، گونه‌ای از جنس *Grimmia* Hedw. جمع‌آوری گردید که براساس مطالعات تکمیلی به عنوان گونه *Grimmia unicolor* Hook. شناسایی شد.

این گزارش، نخستین رکورد حضور این گونه در فلور خزه‌ای ایران را ارائه می‌دهد و ویژگی‌های ریخت‌شناسی و بوم‌شناختی آن را تشریح می‌کند.

INTRODUCTION

The Grimmiaceae is a family of mosses (*Bryophyta*, *Grimmiales*) that includes 14 genera depending on the source used, and numerous species *Grimmia* is the largest genus within the family (Muñoz, 1998; Streiff, 2005), comprising 122 species (www.gbif.org), and represents a large group of primarily rock-inhabiting mosses widely distributed across the world (Delgadillo Moya 2015; Glime 2007; Cambay & al. 2025). Members of this genus are acrocarpous, the majority of which are saxicolous, xerothermophilous, and acidophilous (Streiff 2005; Delgadillo Moya 2015) well-adapted to withstand extreme environmental conditions, such as intense sunlight, temperature fluctuations, and prolonged dryness. *Grimmia* was named in honor of the German physician and botanist Johann Friedrich Carl Grimm (Greven 2003), and was formally recognized by Hedwig in 1801. According to the most recent checklist of the Iranian bryoflora, 15 species of this genus have been reported from Iran (Kürschner & Frey, 2011). However, based on the updated checklist by H. Zare, currently in press, the number of identified species has increased to 18. In the present study, *Grimmia unicolor* is introduced as a new record for the bryoflora of Iran. It typically forms dense or occasionally loose cushions (Hastings & Greven, 2007) on rocky substrates in habitats with consistent or intermittent moisture resulting from surface drainage. It is capable of colonizing a wide variety of rock types, including calcareous substrates, and demonstrates a high level of tolerance to acidic to circumneutral pH conditions (Hastings & Greven, 2007). This species is most frequently encountered at mid-elevations, particularly under forest canopy cover. It is readily identifiable by its glossy dark green to nearly black pigmentation and its rounded, slightly cucullate leaf apices (Miller & Hastings, 2013). According to the most recent IUCN Red List (www.iucnredlist.org) assessment, *G. unicolor* is classified as a species of Least Concern (LC), a category assigned to species that have been evaluated and found to be at minimum risk of extinction under current conditions.

MATERIALS AND METHODS

Moss samples were collected from Mazandaran Province (Kelardasht, Mazichal) of Iran, with geographical coordinates of longitude 51° 02′ 59.43″, latitude 36° 31′ 44.75″, at an altitude of 2400 m a.s.l. during fieldwork conducted in June 2020 (Fig. 1). Mosses were carefully removed from rock surfaces, stored in paper envelopes, and labeled. Fresh samples of moss stems and leaves were initially selected and soaked in distilled water for an appropriate duration to rehydrate and soften the tissues, thereby facilitating easier dissection. Using a stereomicroscope, leaves were carefully separated from the stems, and transverse sections were prepared from both organs. The dissected materials were examined under a compound light microscope at varying magnifications to assess cellular morphology. Particular attention was paid to the shape and arrangement of cells in different parts of the leaf, including marginal areas and specialized structures. For accurate species identification, each specimen was compared with reliable floristic references, including Ignatov & Ignatova (2003), Smith (2004), and Nyholm (1975), and diagnostic features were verified using identification keys provided by Kürschner & Frey (2020). For confirmation, selected specimens were sent to the Swedish Museum of Natural History in Stockholm, where Lars Hedenäs confirmed their identification as *Grimmia unicolor*, a species not previously recorded in the moss flora of Iran. The confirmed specimen is deposited in the Herbarium of the Nowshahr Botanical Garden (NBGH), under voucher number 2356.

RESULTS AND DISCUSSION

Grimmia unicolor exhibits significant morphological similarity to *G. atrata* Hornsch., which is not native to Iran, particularly in leaf shape and growth form in saxicolous habitats. Both species commonly form dark-colored cushions on rocks and possess muticous leaves with a somewhat cucullate apex. These similarities can lead to confusion during field identification, especially when sterile specimens are collected under dry conditions. However, there are important anatomical differences that help to distinguish the two. In leaf cross-section, the lamina of *G. unicolor* is mostly unistratose, becoming bistratose only at the margins and apex, whereas *G. atrata* typically has a multistratose upper lamina. Additionally, *G. atrata* has distinctly bistratose, often hyaline alar cells, a feature absent in *G. unicolor*. Therefore, despite their superficial resemblance, careful examination of microscopic features, especially leaf anatomy and cell structure, is essential for accurate identification of these two species. *G. unicolor* remains within the genus *Grimmia* with relatively stable identification, whereas *G. atrata* has been moved to the genus *Streptocolea* by Ochyra & Bednarek-Ochyra (2004) due to its unique structural features, including the leftward torsion of the vaginula, systylious

capsules, distinct convex auricles, and a characteristic annulus composed of a single row of paradental cells at the insertion of the peristome, which together differentiate it from other species of *Grimmia*, although it can still be confused with *G. unicolor* due to morphological similarities. Some of these distinguishing characters are summarized in the comparison table below (Maier 2002; Greven 2003) (Table 1).

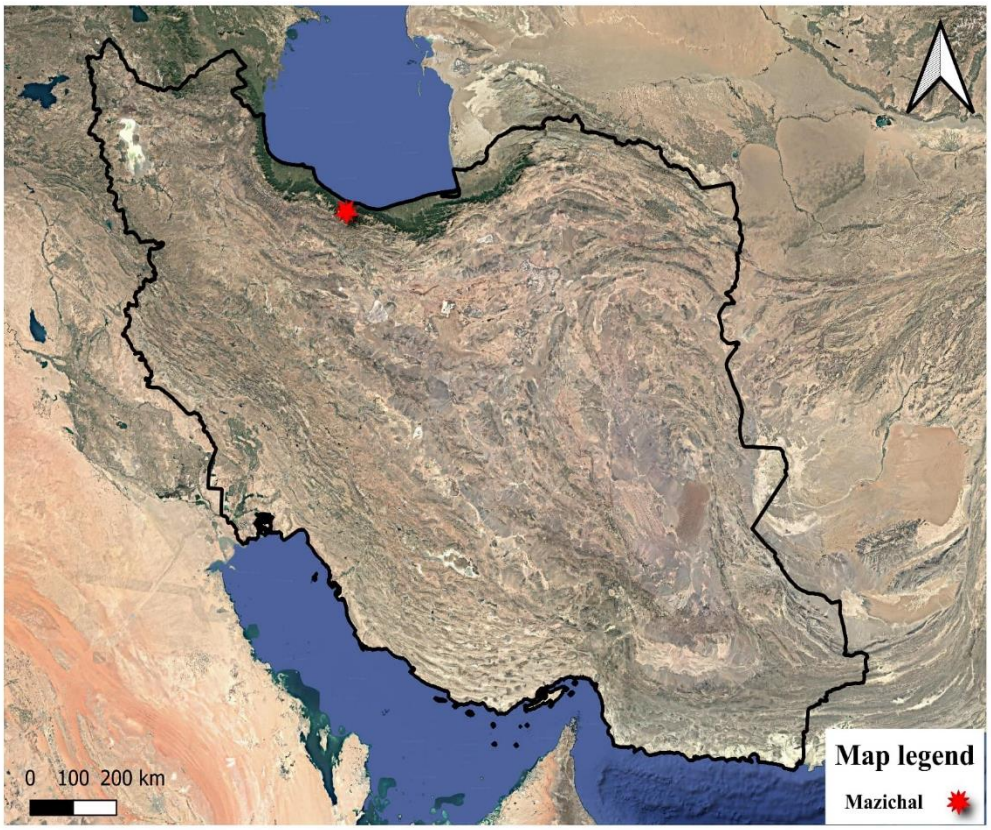

Fig. 1. Map showing the sampling sites of *Grimmia unicolor* in Mazandaran province, Iran.

Table 1. Morphological differences between *Grimmia unicolor* and *Grimmia atrata* (Modified from: Greven 2003; Maier 2002).

Characteristic	***G. unicolor***	***G. atrata***
Cushion color	Dark green to grayish green	Dark green to black
Leaf shape	Lanceolate to ovate, often with a cucullate apex	Lingulate-lanceolate, muticous, sometimes cucullate
Leaf apex	Broadly obtuse, often cucullate	Narrowly obtuse, occasionally cucullate
Lamina structure	Multistratose in the upper half	Mostly unistratose, bistratose at the margin and apex
Alar cells	Not differentiated, unistratose	Differentiated, bistratose, often hyaline
Leaf cells	Small and rounded with smooth walls	Square with relatively clearly warty cell walls
Unique feature	Multistratose lamina in upper leaves	Vaginula twisted to the left (unique in mosses)

***Grimmia unicolor* Hook**. (Grimmiaceae)

Plants dioicous, typically forming compact to somewhat loose tufts or mats, dark green to blackish or reddish-brown, generally reaching 2–5 cm height. Stems approximately 1.5–4 (–5) cm in length. Leaves erect-spreading, lanceolate, concave, with broad and

sheathing base, without hair-point, 1.5–2.5 mm long and 0.5–0.7 mm wide, with an erect-spreading orientation and a sheathing base, leaf margins consistently inrolled; lamina typically 2–3 cells thick distally, increasing to 4 layers along the margins, may occasionally be 2–4-stratose throughout; costa narrow at the base, becoming broader but less distinct in the upper part. Distal laminal cells are rounded, thick-walled, and 2–3-stratose, with a width of about 6–7 µm; medial cells are rounded to nearly square, also thick-walled. Basal cells near the costa and margins are short-rectangular, straight, with thickened lateral walls and are pale yellow to hyaline, sometimes elongated and translucent along the margins (Fig. 2). Perichaetial leaves enlarged. Capsule was not observed in the specimen.

Examined specimen: Mazandaran, Kelardasht, Mazichal, 2400 m. Zare 2365 (NBGH).

Habitat: The specimen was collected on a stone substrate.

Geographical distribution: North, West, and Central Europe, Pyrenees, Caucasus, North America, Eurasia, Turkey, Africa, Norway, Pyrenees, Sweden, Finland, Russia, Kazakhstan, Turkmenistan (Nyholm, 1975), and Iran.

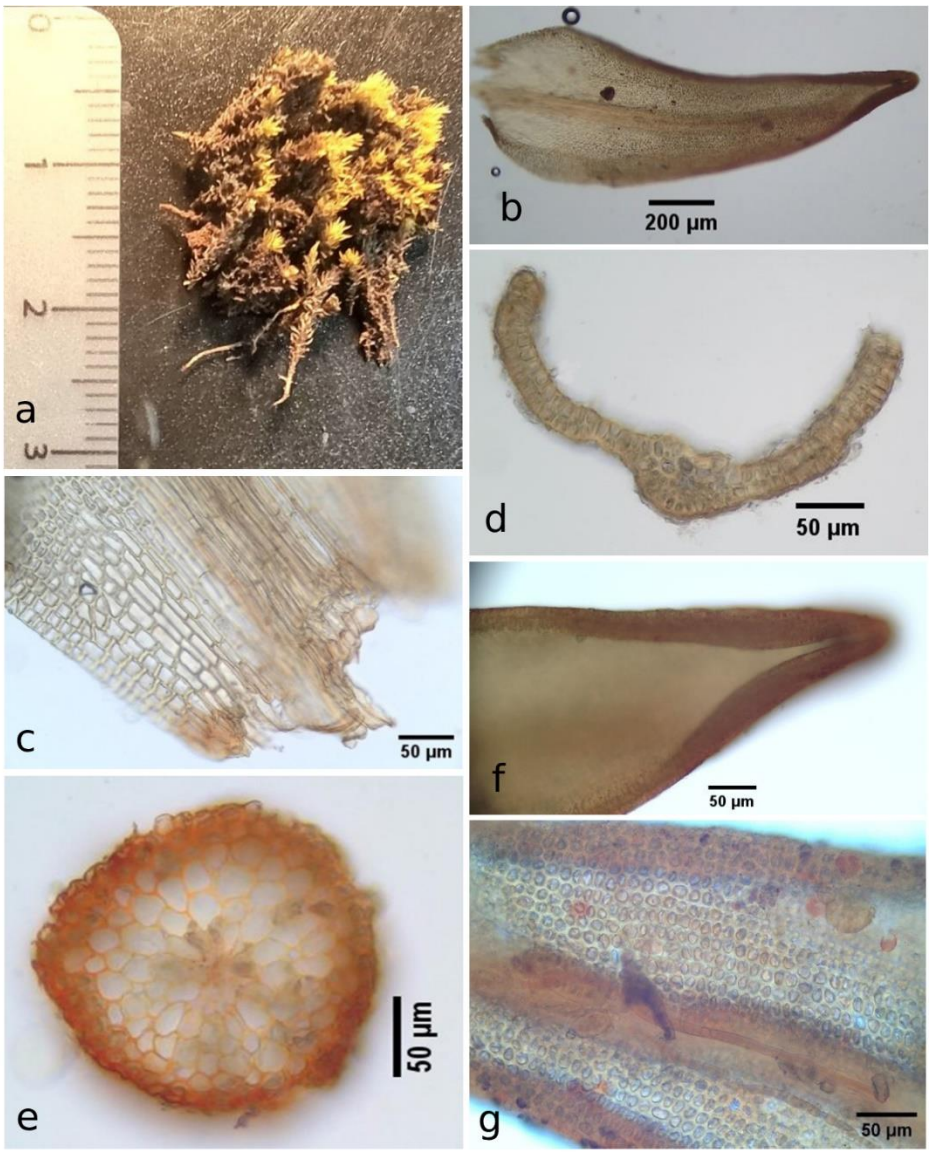

Fig. 2. *Grimmia unicolor*. a, habit; b, leaves; c, cellular arrangement of leaf base; d, cross-section of the leaves; e, cross-section of the stem; f, leaf apex; g, leaf cells.

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