

RESEARCH ARTICLE

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Towards a moss flora of Taif and its vicinities, Saudi Arabia. 2-Grimmiaceae

ABSTRACT:

Grimmiaceae in Saudi Arabia includes 8 species belonging to 2 genera namely; *Grimmia* Hedw. and *Schistidium* Bruch & Schimp. Grimmiaceae is reported here for the first time in Taif Province (Taif city and its vicinities) in Makkah region, Saudi Arabia. Three species viz.; *Grimmia orbicularis* Bruch ex Wilson, *G. pulvinata* (Hedw.) Sm. and *G. trichophylla* Grev. are recorded in the study area. This study raised the total number of fully identified mosses known from Taif Province to 29 taxa belonging to 9 families. The three recorded species are described and illustrated for the first time from Saudi Arabia with information on their habitats, floristic elements and distribution.

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INTRODUCTION:

One hundred and twenty two moss taxa are known from Saudi Arabia (Kürschner and Ochyra, 2014; Taha and Shabbara, 2019; Taha *et al.*, 2020); only 26 of them are recorded in Taif Province (Taif city and its vicinities) in Makkah region, belonging to eight families (Kürschner, 2000; Abou-Salama *et al.*, 2005). It is worth to mention that in the last decade several of taxonomic and nomenclatural changes have been made and many taxa were sunken within synonymy e.g. *Grimmia pulvinata* var. *pulvinata* (Hedw.) Sm. and *G. pulvinata* var. *africana* (Hedw.) Wilson included as a synonym to *G. pulvinata* (Hedw.) Sm. (Ros *et al.*, 2013), so the number of recorded taxa in Taif Province reduced to 26 taxa after Kürschner (2000) and Abou-Salama *et al.* (2005).

Kürschner (2000) recorded 23 moss taxa belong to seven families from Taif Province then Abou-Salama *et al.* (2005) added three taxa of an eighth family, namely Funariaceae. The 26 moss taxa are arranged alphabetically under their families as tabulated below (Table 1).

KEY WORDS:

Grimmiaceae, Makkah region, Moss flora, Saudi Arabia, Taif

Table 1. Shows the names of 26 moss taxa are recorded in Taif Province (Taif city and its vicinities) in Makkah region under their families.

Family	Taxon
Bartramiaceae	<i>Bartramia stricta</i> Brid.
Encalyptaceae	<i>Encalypta intermedia</i> Jur.
Fabroniaceae	<i>Fabronia abyssinica</i> Müll. Hal.
Fissidentaceae	<i>Fissidens crassipes</i> Wilson ex Bruch & Schimp. subsp. <i>crassipes</i> <i>F. crispus</i> Mont. <i>F. viridulus</i> (Sw.) Wahlenb.
Funariaceae	<i>Entosthodon attenuatus</i> (Dicks.) Bryhn, <i>E. muhlenbergii</i> (Turner) Fife <i>E. pulchellus</i> (H. Philib.) Brugués.
Leskeaceae	<i>Pseudoleskea plagiostoma</i> var. <i>attenuata</i> Müll. Hal.
Orthotrichaceae	<i>Orthotrichum diaphanum</i> Schrad. ex Brid.
Pottiaceae	<i>Aloina rigida</i> (Hedw.) Limpr. <i>Barbula bolleana</i> (Müll.Hal.) Broth. <i>Crossidium aberrans</i> Holz. & E. B. Bartram <i>C. crassinervium</i> (De Not.) Jur. <i>C. davidai</i> Catches. <i>C. squamiferum</i> (Viv.) Jur. var. <i>pottioideum</i> (De Not.) Mönk. <i>Didymodon acutus</i> (Brid.) K. Saito <i>D. australasiae</i> (Hook. & Grev.) R. H. Zander <i>D. rigidulus</i> Hedw. <i>Syntrichia fragilis</i> (Taylor) Ochyra <i>Timmia barbuloidea</i> (Brid.) Mönk. <i>Tortella squarrosa</i> (Brid.) Limpr. <i>Tortula atrovirens</i> (Sm.) Lindb. <i>T. inermis</i> (Brid.) Mont. <i>Weissia condensa</i> (Voit) Lindb.

The taxa of three Funariaceae, shown in the above table, are published by Abou-Salama *et al.* (2005) in the first paper of this series on mosses collected from Taif Province. The present work is the second, in this series, and is concerned with a ninth family namely Grimmiaceae.

This work aimed to study Grimmiaceae family in as many sites and habitats as possible in the study area and to provide new distribution data about its taxa. Moreover, it provides descriptions and illustrations of the studied taxa including regional variation for the first time from Saudi Arabia because their earlier records from this country by Kürschner (2000) and Kürschner and Frey (2011) did not include descriptions and/or illustrations of the studied taxa.

STUDY AREA AND MATERIAL:

Taif Province in Makkah region lies between 40° 00' – 42° 00' E and 20° 00' – 22° 00' N (Fig. 1), occupying about 321 km², in the northern end of El-Al-Sarawat Mountains at an altitude ca. 1700 m above sea level (a.s.l.); the height increases toward the west and the south to reach 2500 m (Abou-Salama *et al.*, 2005).

Taif has a hot desert climate (Köppen's climate classification in Rubel and Kottek, 2011), with hot summers and mild winters. Temperatures are not as extreme in summer

as for lower-lying regions of Saudi Arabia. It is much cooler in Taif during the summertime than it is in other parts of Saudi Arabia. Precipitation is low, but all months see some rain, with more rain in spring and late autumn than in other seasons (NOAA, 2013). Available climatic data from Taif meteorological station (National Meteorology and Environment Center Surface, 2016) show that the means of temperatures are between 20 to 32°C in summer and between 8 to 20°C in winter but it sometimes falls to 4°C, the average of annual rainfall is about 180 mm, relative humidity in January reaches 61% while in June it is 25%.

One thousand three hundred and fifty (1350) moss samples were collected by Usama Abou-Salama from August 1999 to April 2003 from Taif Province covering various seasons and habitats; all these moss samples were placed in CAIA (Herbarium of Botany department in Ain Shams University at Cairo). Out of these (1350 moss samples) 23 samples belonged to Grimmiaceae family.

The 23 Grimmiaceae samples have been collected through six field visits in August/2001, April/2002 and February/2003 from 8 sites, situated in two main areas of Taif Province: **A.** Al-Shafa (7 sites) is about 30 km southwest of Taif city (Abou-Salama *et al.*, 2005) and **B.** Al-Hada (one site) is about 20 km northwest of Taif city (Abou-Salama *et al.*, 2005) as follows (Fig. 1):

A. Al-Shafa: is about 30 km southwest of Taif city (Abou-Salama *et al.*, 2005), at 21°04' N and 40°18' E, 1500 - 2500 m a.s.l., the climate is temperate tends to cool in summer and very cold in winter. The studied samples were collected from 7 sites at Al-Shafa area: sites no. 1 & 2: Gebel Daka, site no. 3: small Wadi parallel to Wadi Al-Shafa, site no. 4: Wadi Khomas, site no. 5: Wadi on the extension of Wadi Al-Malek, site no. 6: Wadi Samah., site no. 7: Wadi Al-Sharaf.

B. Al-Hada: is about 20 km northwest of Taif city (Abou-Salama *et al.*, 2005), at 21°22' N and 40°17' E, up to ca. 2000 m a.s.l., urban area located on the western edge of the heights of the Hijaz Mountains and directly overlooking the plains of the Province of Tihama and thus enjoys a temperate climate and characteristic mountain nature. Site no. 8: Wadi from Al-Hada road before police station.

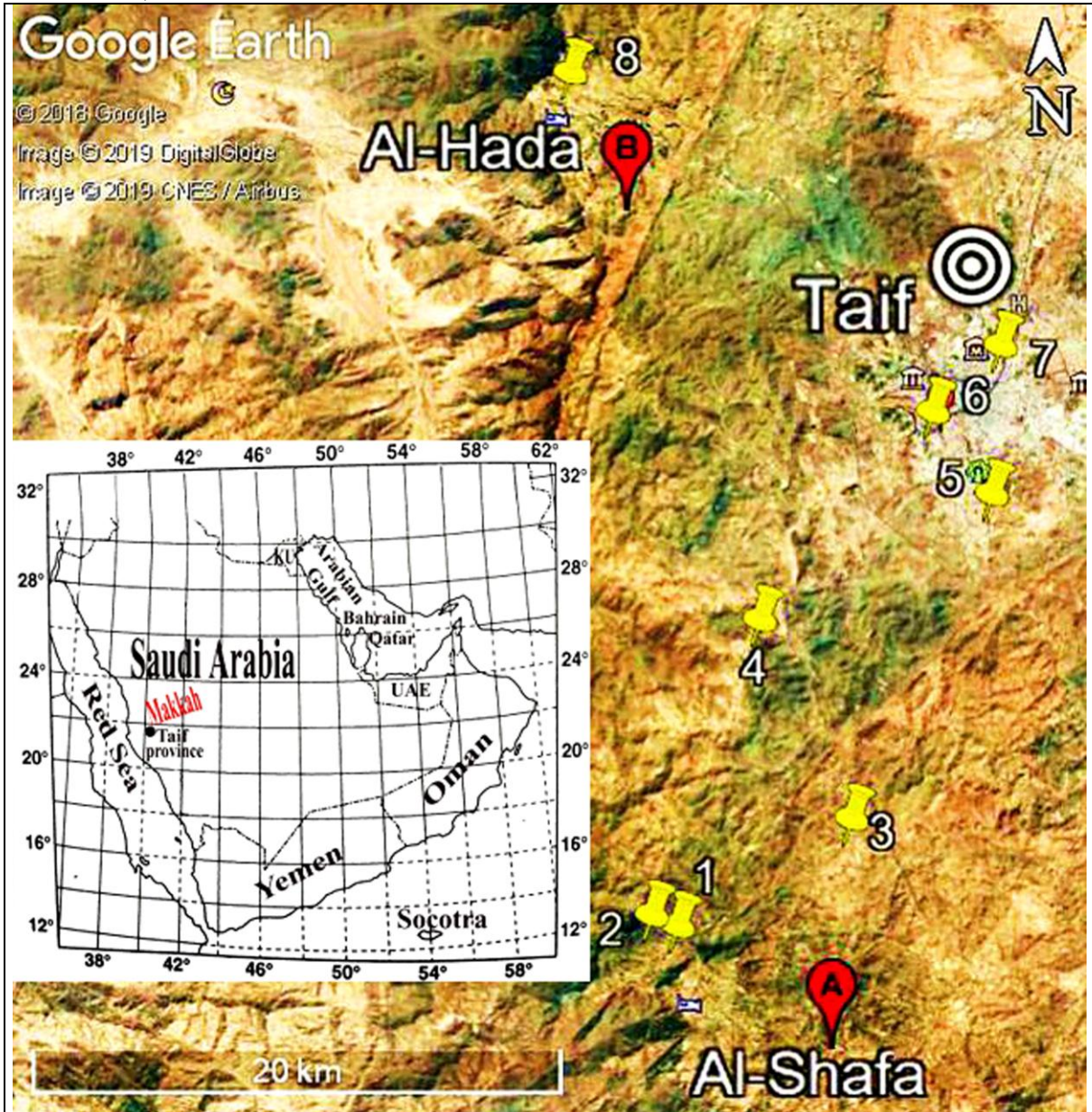


Fig. 1. Map showing sites of collections in two main study areas of Taif province; A. Al-Shafa and B. Al-Hada; 1 & 2. Gebel Daka, 3. Small Wadi parallel to Wadi Al-Shafa, 4. Wadi Khomas, 5. Wadi on the extension of Wadi Al-Malek, 6. Wadi Samah, 7. Wadi Al-Sharaf behind Gebel Daka, 8. Wadi from Al-Hada road before police station (<https://earth.google.com>).

RESULTS:

The examination of the 23 Grimmiaceae samples resulted in the recognition of 3 species viz.; *Grimmia orbicularis*, *G. pulvinata* and *G. trichophylla*. Among these samples 12 are pure and the rest (11 samples) are mixed

with members of other four moss families (i.e. Pottiaceae, Encalyptaceae, Bartramiaceae, Bryaceae) and/or with Hepatics. The latter family represents a new record to the study area.

It is worth to mention that, all the three Grimmiaceae species recorded here were

already known from other regions in Saudi Arabia but are recorded for the first time from Makkah region. So, this study increases the number of identified mosses known from Makkah region to 29 taxa.

Grimmiaceae in Saudi Arabia includes 8 species belonging to 2 genera (*Grimmia* Hedw. and *Schistidium* Bruch & Schimp.) Kürschner and Frey (2011). Grimmiaceae is mainly found in the South Western part of the country, where 6 out of the 8 species were recorded in Asir region (Kürschner, 2000; see Fig. 2), 3 species recorded in Middle Western part of Makkah region (at this work in Taif Province; see Fig. 2), 2 species recorded in North Western part of Saudi Arabia in Tabuk and Ha'il (Kürschner, 2000; see Fig. 2); one of the last two species was recorded in South, Middle and North Western part of Saudi Arabia (Kürschner, 2000) and one species namely: *Grimmia tergestina* is recorded from Saudi Arabia by Muñoz and Pando (2000) without precise locality.

Regarding frequency of occurrence; *Grimmia pulvinata* was found in 15 samples while *G. orbicularis* in 5 samples and *G. trichophylla* in 3 samples. *Grimmia pulvinata*

was only found carrying sporophytes (in 9 out of the 15 samples).

The three recorded *Grimmia* species are described and illustrated here and provided with key, sites, habitats, dates of collection, herbarium numbers, floristic elements (Kürschner, 2008), distribution in Saudi Arabia, Arabian Peninsula countries and in the world (Ros *et al.*, 1999; Kürschner, 2000; Ignatov *et al.*, 2006; O'Shea, 2006; Kürschner and Frey, 2011; Ros *et al.*, 2013) and discussion (about diagnostic characters, habitats, altitude and comparisons with the most related taxa based on available literatures).

All the three studied taxa are widely distributed in the world (for explanations of phytogeographical regions abbreviations of mosses in the world referred to in this paper (Van der Wijk *et al.*, 1959); in northern, tropical and warm temperate Europe, Africa, the Americas, Asia, Australia and elsewhere; with slight differences in their distribution (Ros *et al.*, 1999; Maier, 2002a; Casas *et al.*, 2006; Ignatov *et al.*, 2006; Lüth, 2006; O'Shea, 2006; Kürschner and Frey, 2011; Ros *et al.*, 2013; Porley, 2016).

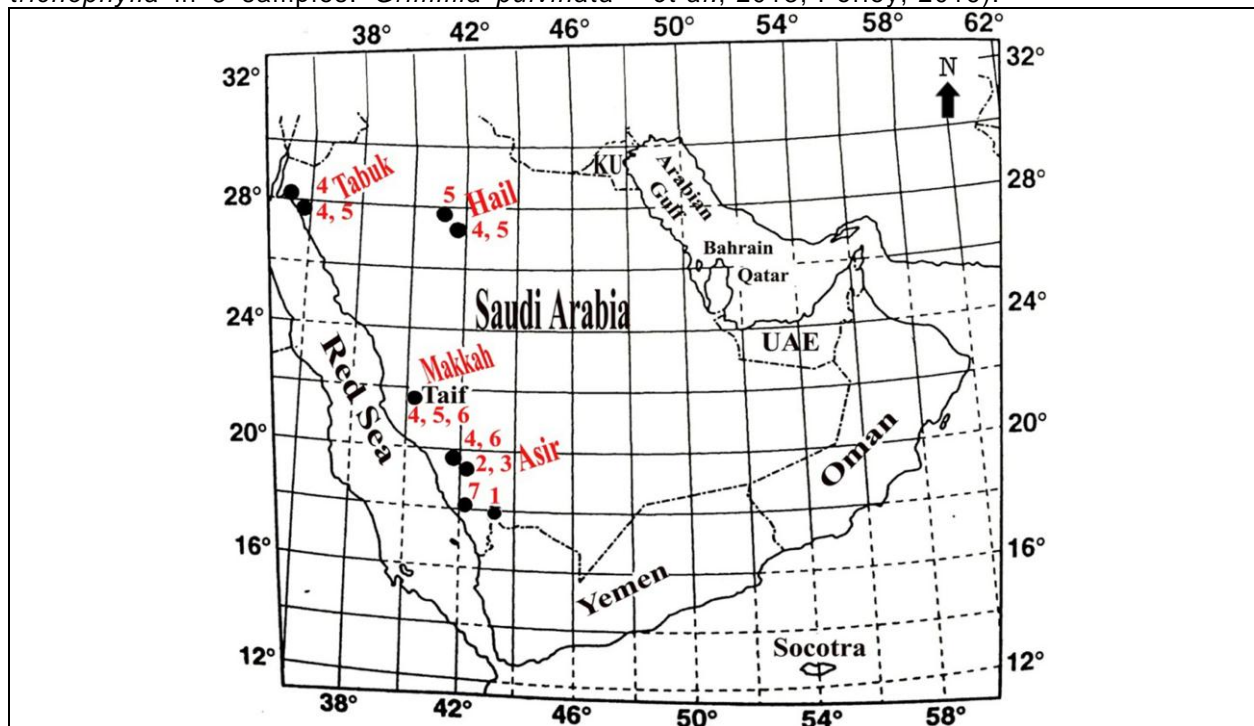


Fig. 2. Map showing distribution of Grimmiaceae species in Saudi Arabia & location of Taif province in Makkah region (After Kürschner 2000); 1. *Grimmia anodon*, 2. *G. laevigata*, 3. *G. lisae*, 4. *G. orbicularis*, 5. *G. pulvinata*, 6. *G. trichophylla*, 7. *Schistidium crassipilum*, UAE. United Arab Emirate, KU. Kuwait.

Key and Descriptions:

- 1 Leaf margins uni-stratose.....***Grimmia orbicularis***
 1 Leaf margins bi-stratose.....2
 2 Hair point more than 1/2 length of leaf, gemmae absent.....***G. pulvinata***

- 2 Hair point usually less than 1/4 length of leaf or mucous or absent; gemmae present.....***G. trichophylla***

1. *Grimmia orbicularis* Bruch ex Wilson: Plate I (Figs. 1-15)

Plants monoicous, yellowish brown above, reddish brown below, up to 9 mm high. Stem usually branched sometimes unbranched, central strand present or decayed,

sclerodermis well developed (3 - 4 layers). Leaves imbricate when dry, erect-patent to open spreading, keeled when moist, oblong lingulate to oblong lanceolate, 1.3 - 1.5 mm long (exclusive hair point), 0.3 - 0.5 mm wide; hair points hyaline, often slightly denticulate or smooth, vary in length up to 1.2 mm long at upper leaves, sometimes very short or without hair point toward lower leaves; apex obtuse; margins recurved except at distal tip and base, uni-stratose; upper lamina cells usually quadrate, sub-quadrate or irregular, firm-walled, more or less sinuose, 10 - 12.5 (15) μm , become longer and distinctly sinuose at mid-leaf, 7.5 - 10 x 15 - 20 μm ; basal lamina cells quadrate to more or less short rectangular, or elongate (near costa), smooth or sinuose, thick walled, (7.5) 10 - 15 x 20 - 40 μm . Perichaetial leaf up to 1.8 mm long (exclusive hair point), hair point long about 2.5 mm long; perigonal leaf shorter than perichaetial one, about 1.2 mm long

(exclusive hair point), hair point usually short about 0.4 mm.

In terms of frequency, *Grimmia orbicularis* is in the second rank after *Grimmia pulvinata* and in the third rank after the two other studied species in terms of distribution.

Samples examined: Makkah region, South Taif city, Al- Shafa, Wadi Samah (Fig. 1, site no. 6); 21°15` N, 40°24` E; 1710 m a.s.l.; on land exposed to sunlight, on rocks of vertical and inclined land; 25/8/2001; leg. Usama Abou-Salama 2122aU, 2127U, 2128aU, 2129U, 2130U (CAIA).

Floristic element: Circum-Mediterranean.

Distribution in Saudi Arabia (Fig. 2): Asir, Tabuk and Hail regions.

Distribution in the Arabian Peninsula: Saudi Arabia, Oman.

Distribution in the World: Afr. 1, 4, Am. 1, 2, 6; As. 2, 3, 5; Austr. 1, 2; Eur.

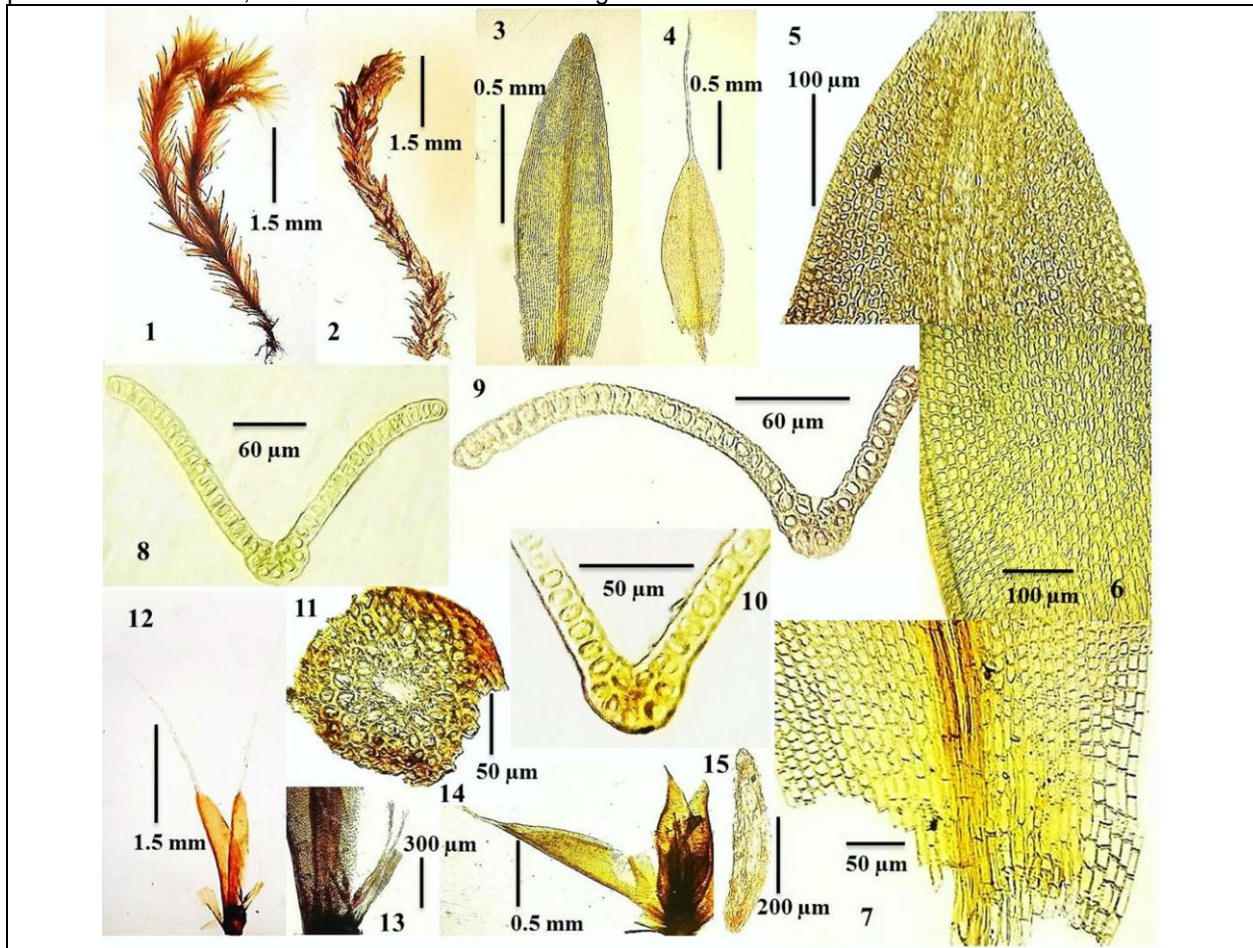


Plate I (Figs. 1 - 15): *Grimmia orbicularis* Bruch ex Wilson: Fig. 1. Wet plant; Fig. 2. Dry plant; Figs. 3 & 4. Different leaves; Fig. 5. Upper part of leaf; Fig. 6. Middle cells showing sinuose walls; Fig. 7. Basal part of leaf; Fig. 8. Leaf section at upper part; Fig. 9. Leaf section at middle part; Fig. 10. Magnified costa section at mid-leaf; Fig. 11. Stem section; Fig. 12. Perichaetial leaves with archegonia; Fig. 13. Archegonia; Fig. 14. Perigonal leaves with antheridia; Fig. 15. Antheridium.

2. *Grimmia pulvinata* (Hedw.) Sm.: Plate II (Figs. 1-20)

Plants monoicous, yellowish brown below, yellowish green to dark green above, up to 9 mm high. Stem usually branched

sometimes un-branched, central strand present, sclerodermis well developed. Leaves imbricate when dry, erect-patent to open spreading when moist, keeled above, oblong lanceolate to oblong lingulate, 1.8 - 3.7 mm long (including hair point), 0.4 - 0.6

mm wide; hair points hyaline, usually more than 3/4 to equal leaf length, rarely longer than leaf length; 0.5 - 2.1 mm long, often more or less denticulate; apex obtuse to blunt acute; margins usually recurved except at distal tip and base, 2 - 3 stratose; upper lamina cells usually rounded to quadrate, or irregular, often smooth, become sinuose toward middle cells, firm-walled, sometimes partly bi-stratose, (5) 7 - 10 x (5) 7 - 10 μ m; basal lamina cells quadrate to short rectangular at margins become elongate to long rectangular near costa, smooth not sinuose, thin or slightly thick walled, 10 - 15 μ m x 20 - 35 (40) μ m. Perichaetial leaf about 1.8 mm long (exclusive hair point), hair point long about 2 mm long; perigonal leaf highly differ from stem and perichaetial leaves; 1 - 1.3 mm long (exclusive hair point), hair point usually short about 0.5 mm. Seta twisted when dry, more or less curved when moist, rounded in section, sclerodermis highly developed 1 - 3 layers, central strand ill-developed; capsules wrinkled plicate, strongly ribbed when dry, inclined ellipsoid to inclined obloid, 0.7 - 1.4 mm long (exclusive lid), stomata present; lid rostrate, about 0.5 mm long; peristome teeth cribose (numerous perforations), 275 - 300 μ m long; annulus deciduous, 2 - 3 layer of cells; spores rounded, granulose, thick exine, (7) 10 - 12 μ m in diameter.

Diagnostic characters for *Grimmia pulvinata* are plants hoary cushions; capsules wrinkled plicate, strongly ribbed when dry, inclined ellipsoid to inclined obloid; lid rostrate; lamina uni-stratose and on both sides some rows of marginal cells 2 - 3 stratose. In addition, the author noted that

prominent costa is a conspicuous character in all examined samples.

Samples examined: Samples are collected from two main areas in Makkah region as given below, all leg. Usama Abou-Salama and Kept at CAIA:

1. Al-Shafa area (South Taif city), at four sites in list that follows:

-Wadi Khomas (Fig. 1, site no. 4); 21°11` N, 40°20` E; 1809 m a.s.l.; rocks crevices; 23/8/2001; 2087bU.

-Small Wadi parallel to Wadi Al- Shafa (Fig. 1, site no. 3); 21°07` N, 40°21` E; 2056 m a.s.l.; on land and between rocks; 11/4/2002; 2246U, 2259a, 2260-2263U, 2264bU, 2265U.

-Gebel Daka (Fig. 1, site no. 1); 21°06` N, 40°16` E; 2033 m a.s.l.; between rocks and in crevices; 11/4/2002; 2282bU, 2289U, 2290aU.

-Wadi Al-sharaf behind Gebel Daka (Fig. 1, site no. 7); 21°16` N, 40°25` E; 1675 m a.s.l.; between and below rocks; 7/2/2003; 2491aU, 2503U.

2. Al-Hada (West Taif city), Wadi from Al-Hada road before police station (Fig. 1, site no. 8); 21°20` N, 40°21` E; 1812 m a.s.l.; on vertical faces of rocks; 18/4/2002; 2303U.

Floristic element: Sub-cosmopolitan.

Distribution in Saudi Arabia (Fig. 2): Tabuk and Ha'il regions.

Distribution in the Arabian Peninsula: Saudi Arabia.

Distribution in the World: Afr. 1, 2, 4, Am. 1-6; As. 1, 2, 3, 5; Austr. 1, 2; Eur.; Oc.

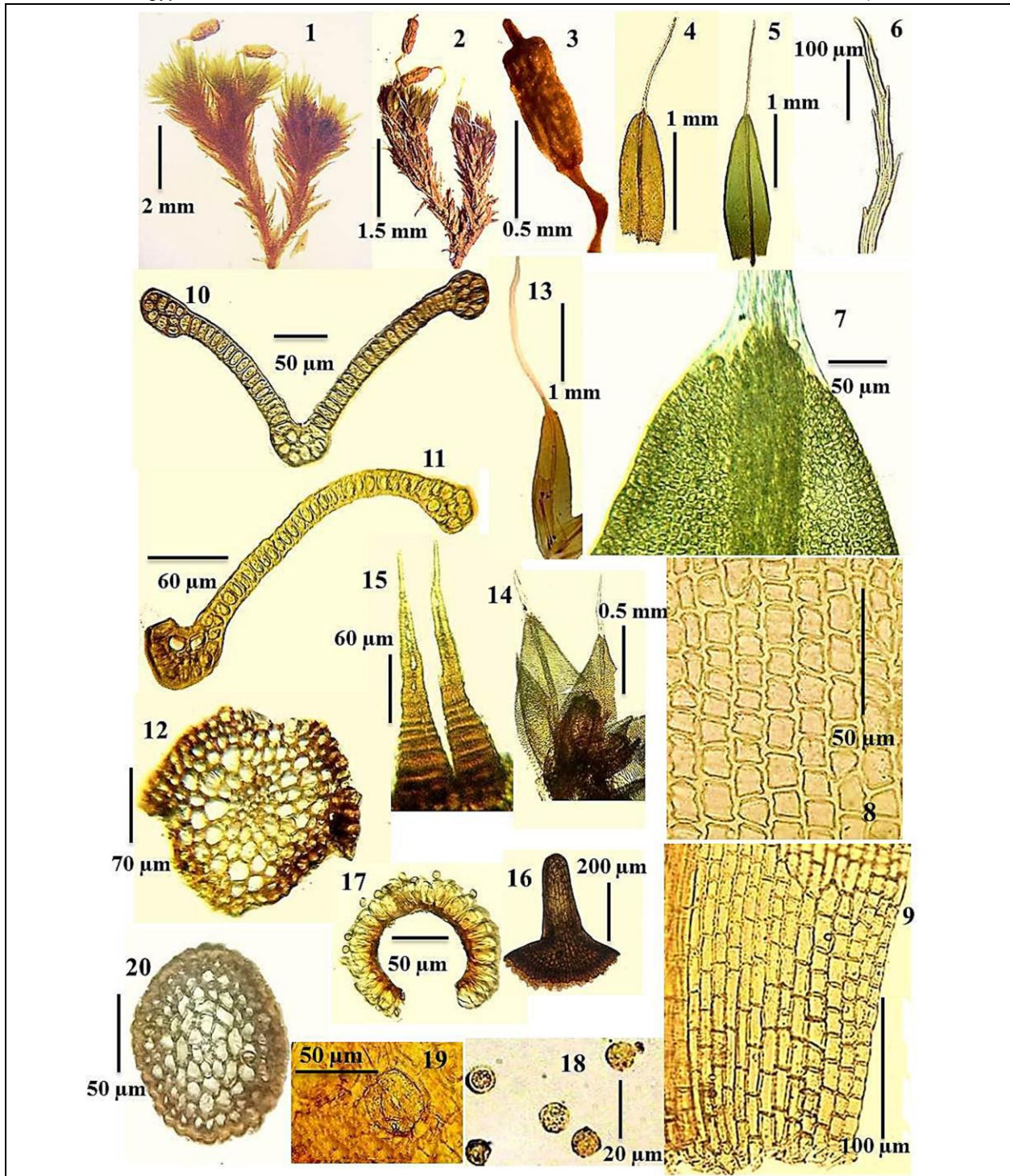


Plate II (Figs. 1 - 20): *Grimmia pulvinata* (Hedw.) Sm.: Fig. 1. Wet plant; Fig. 2. Dry plant; Fig. 3. Capsule when dry showing wrinkled plicate shape; Figs. 4 & 5. Different leaves; Fig. 6. Denticulate hair point; Fig. 7. Upper part of leaf; Fig. 8. Middle cells showing sinuose walls; Fig. 9. Basal part of leaf; Fig. 10. Leaf section at upper part; Fig. 11. Leaf section at middle part; Fig. 12. Stem section; Fig. 13. Perichaetial leaf with archegonia; Fig. 14. Perigonial Leaves with antheridia; Fig. 15. Peristome teeth; Fig. 16. Lid; Fig. 17. Annulus; Fig. 18. Spores; Fig. 19. Surface view of capsule membrane showing a stoma; Fig. 20. Seta section.

3. *Grimmia trichophylla* Grev.: Plate III (Figs. 1-21)

Plants dioicous, yellowish green above, reddish brown to yellowish brown below, up to 10 mm high. Stem often branched, central strand slightly differentiated, sclerodermis highly developed. Leaves imbricate contorted when dry, erect-patent to open spreading,

sometimes slightly curved, more or less strongly keeled when moist, lanceolate, oblong lanceolate, linear-lanceolate with ovate base, 0.9 - 1.4 mm long (exclusive hair point), 0.2 - 0.4 mm wide; hair points at upper leaves hyaline, up to 0.6 mm long; costa at mid and lower leaves often very short excurrent or percurrent, prominent at back, 2 guides at mid-section become 4 guides at

base-section arranged in 2 layers, the inner one consists of 1 or sometimes 2 large cells; apex acute to acuminate; margins usually recurved, bi-stratose; upper lamina cells rounded or irregular, sometimes quadrate, thick-walled, slightly sinuose, or smooth, 7.5 - 10 μm wide, 5 - 7.5 μm long, partly bi-stratose, become larger and distinctly sinuose at mid-leaf, 5 - 10 x 7.5 - 12.5 μm ; basal lamina cells quadrate, smooth at margins, elongate, more or less sinuose toward costa, thick walled, 5 - 7.5 x 10 - 35 μm . Vegetative propagules present, multicellular, vary in shape; globose, club-shaped, ellipsoid, at axil of leaves or on dorsal side of leaves. Male plant, perigonal leaves very short up to 0.8 mm long, antheridia on lateral branches about 0.5 mm long, cluster of multicellular filamentous paraphysis were found on tip of branches.

Samples examined: Samples are collected from Makkah region, South Taif city, Al-Shafa, from two sites as given below, all leg. Usama Abou-Salama and Kept at CAIA:

-Wadi on the extension of Wadi Al-Malek (Fig. 1, site no. 5); 21°13` N, 40°25` E; 1700 m a.s.l.; between rocks of a vertical substrate; 22/8/2001; 2050aU, 2056bU.

-Gebel Daka (Fig. 1, site no. 2); 21°05` N, 40°17` E; 2388 m a.s.l.; between rocks; 11/4/2002; 2278aU.

Floristic Element: Sub-cosmopolitan.

Distribution in Saudi Arabia (Fig. 2): Asir region.

Distribution in the Arabian Peninsula: Saudi Arabia.

Distribution in the World: Afr. 1, 2, 4, Am. 1, 2, 4, 5, 6; As. 2, 4, 5; Austr. 1, 2; Eur.; Oc.

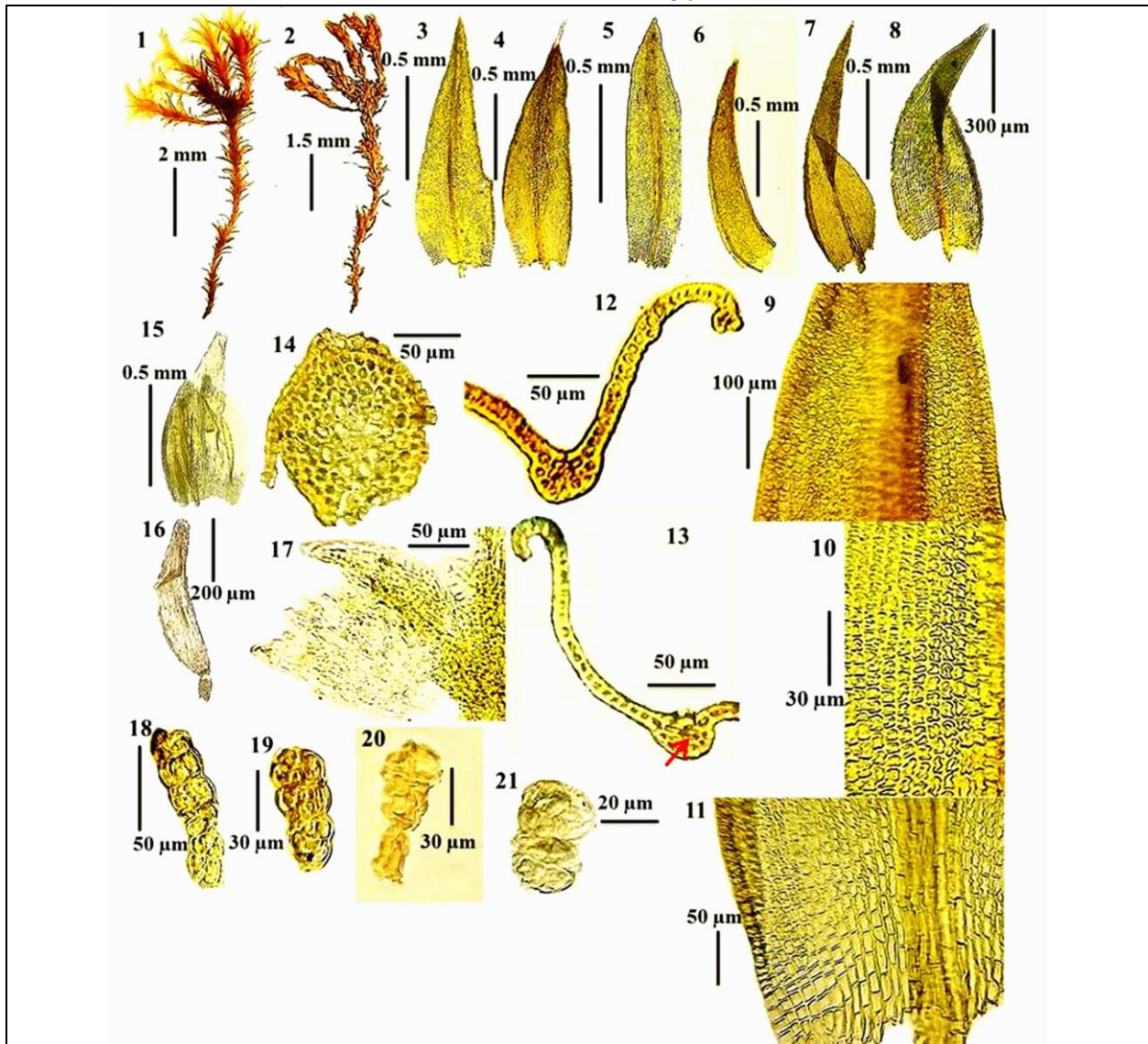


Plate III (Figs. 1 – 21): *Grimmia trichophylla* Grev.: Fig. 1. Wet plant; Fig. 2. Dry plant; Figs 3 – 8. Different leaves; Fig. 9. Upper part of leaf; Fig. 10. Middle cells showing sinuose walls; Fig. 11. Basal part of leaf; Fig. 12. Leaf section at mid-leaf; Fig. 13. Leaf section at base showing 4 guides arranged in 2 layers, the inner one consists of one large cell; Fig. 14. Stem section; Fig. 15. Perigonal leaf; Fig. 16. Antheridium; Fig. 17. Cluster of hyaline paraphysis; Figs. 18 – 21. Different shapes of gemmae.

DISCUSSION:

Grimmia (Grimmiaceae) is a large genus of mosses and found on all continents, includes 51 accepted species (Maier, 2010). Out of the 51 species, only seven (viz.; *Grimmia anodon* Bruch & Schimp., *G. laevigata* (Brid.) Brid., *G. lisae* De Not., *G. orbicularis* Bruch ex Wilson, *G. pulvinata* (Hedw.) Sm., *G. tergestina* Tomm. ex Bruch & Schimp. and *G. trichophylla* Grev.) were recorded in Arabian Peninsula countries. Although all the 7 *Grimmia* species are represented in Saudi Arabia yet they represent a small percentage of the moss flora of this country (7 out of 122 mosses).

Grimmia orbicularis may be confused with *G. pulvinata*, as both species form comparable hemispherical cushions and sometimes grow in the same habitat and altitude. However, they differ markedly in both of morphologic and anatomic characters of the gametophyte. *Grimmia orbicularis* has short- to long-rectangular marginal basal cells, with thick nodulose lateral walls toward costa and 1-stratose margins. Moreover, during examination the samples of *G. orbicularis* it was noted that the leaves are fragile while *G. pulvinata* has quadrate to short-rectangular marginal basal cells, with thin-walled, smooth near costa, 2-stratose margins and the leaves are not fragile.

The studied *Grimmia trichophylla* leaves are more or less short than those described by Kürschner and Frey (2011), and this may be attributed to the regional variation especially that, this species has broad range of leaves length in different Southwest Asian regions. In this regard, Flora of North America Editorial Committee (2007) mentioned that *Grimmia trichophylla* may occur with small, short leaves and reduced awns, or even with muticus leaves in damp and shaded habitats, just as in dry unfavorable habitats at high altitudes.

Grimmia trichophylla is considered a problematic species (has many phenotypes, numerous subspecies and varieties) and looks like three other species (*Grimmia dissimulata* E. Maier, *G. lisae* De Not., *G. meridionalis* (Müll. Hal.) E. Maier) which were considered as varieties to it and/or synonyms to each other. Maier (2002b) published detailed descriptions of the main differences between the four confused species, provided by figures. She referred to that costa cross section is the best character for differentiation between the four species. *G. lisae* was the most different species and can easily be distinguish by very distinctive squarrose leaves when moist and the costa cross section at leaf base has 6 guide cells. The remaining three species were closely related in dry and moist state of leaves; moreover, in the costa cross section at leaf base has 4 guide

cells. But in *G. trichophylla* arranged in 2 layers, the inner one consists of 1 or sometimes 2 cells larger than the rest of the costa cells, in *G. dissimulata* guide cells in one layer and distinctly elliptic, in *G. meridionalis* guide cells also in one layer but more or less rounded.

However, the three studied taxa are widely distributed in the world with slight differences in their distribution, so *Grimmia orbicularis* is sub-Mediterranean thermophilus species with a preference for sunny, basic substrates, limestone and rocks which is similar to the habitats (on land and on rocks exposed to sunlight) in which studied samples were found (Maier, 2002a; Flora of North America Editorial Committee, 2007; Erzberger, 2009; Porley, 2016; Maier *et al.*, 2017). In this regard, *G. orbicularis* was not recorded above 2,000 m, neither in Asia nor in Europe, South Africa and North America (Maier, 2002a; Maier *et al.*, 2017), as well as the present study. While *G. pulvinata* is usually common in temperate areas of the northern hemisphere (with some extensions northward into boreal zones) and rarely southward to subtropical areas. In the southern hemisphere it is recorded from Australia, New Zealand, southern South America (Chile and Uruguay), and from southern Africa (Maier *et al.*, 2017). So, it may be better considered a temperate species with some pole ward extensions (Maier *et al.*, 2017). Although *G. pulvinata* was not recorded above 2,000 m above sea level in Europe, Asia and South Africa (Maier, 2002a; Maier *et al.*, 2017) but in North America records above 2,000 m are known (Flora of North America Editorial Committee, 2007), moreover the samples studied here were recorded slightly higher than 2,000 m (i.e. 2056 m). It is worth mentioning that 7 samples out of 11 recorded slightly higher than 2,000 m had sporophytes beside their purity which according to Daring (1979) is an explanation of their high establishment in the area.

Grimmia trichophylla, mostly grows in siliceous habitats, on slightly strongly acidic stones, boulders and various rock surfaces of sandstone, quartzite and volcanic rock, mostly in shaded situations, but rarely on open sunny slopes (Kürschner, 2000; Maier, 2002b; Porley, 2016; Shirzadian and Darzikolaei, 2016). Also, the studied *G. trichophylla* found in similar some of its habitats (on vertical substrate of rocks and between rocks). In the Northern Hemisphere, *G. trichophylla* is principally a lowland species, occurring in the mountains up to about 2000 m, rarely higher. In the Southern Hemisphere, it may be found up to 4000 m (Flora of North America Editorial Committee, 2007). Thus, the studied *G. trichophylla* were found in altitude range of

Northern Hemisphere (i.e. 1700 - 2388 m a.s.l.).

In conclusion the present work raised the number of mosses known from Taif Province to 29 taxa belonging to 9 families. The 9 families are arranged in a descending order according to the number of taxa each includes as follows: Pottiaceae 15, Fissidentaceae, Funariaceae and Grimmiaceae each 3 taxa, Bartramiaceae, Encalyptaceae, Fabroniaceae, Leskeaceae and Orthotrichaceae each one taxon. Also, this work provided the descriptions and illustrations of the three studied taxa for the

first time from Saudi Arabia and relevant information about regional variation, floristic elements, distributions and comparisons with the most related taxa.

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نحو فلورة حزازيه الطائف ومجاورتها، المملكة العربية السعودية ٢- Grimmiaceae

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رفعت *G. trichophylla* Grev. Sm., في منطقة الدراسة. رفعت هذه الدراسة إجمالي عدد الحزازيات التي تم تعريفها بشكل كامل والمسجلة من محافظة الطائف إلى ٢٩ وحدة تصنيفية تنتمي إلى ٩ عائلات. كما تم وصف الأنواع الثلاثة المسجلة وتصويرها لأول مرة من المملكة العربية السعودية مع معلومات عن موائلها، العناصر الفلورية، والتوزيع.

تحتوي الفصيلة Grimmiaceae في المملكة العربية السعودية على ٨ أنواع تنتمي إلى جنسين هما: *Grimmia* و *Schistidium* Bruch & Schimp Hedw. تم تسجيل فصيلة الـ Grimmiaceae هنا لأول مرة في محافظة الطائف (مدينة الطائف ومجاورتها) بمنطقة مكة المكرمة، المملكة العربية السعودية. تم رصد ثلاثة أنواع هي: *Grimmia orbicularis* Bruch ex Wilson, *G. pulvinata* (Hedw.)