



## New *Fissidens* Species to Moss Flora of Saudi Arabia

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**F**ISSIDENS Hedw. is the unique genus in family Fissidentaceae Schimp. It is represented by only six taxa (out of ca. 440 species) in Saudi Arabia. In the present work three species, collected from Asir and Makkah regions, were recorded. One species (*Fissidens crispulus* Brid.) is a new record to Saudi Arabia, while the second (*F. arnoldii* R. Ruthe) is a new record to Makkah region and the third (*F. crispus* Mont.) was recorded previously from the study area. Key, comments, sites of collection, habitats, distributions and floristic elements of the three *Fissidens* species are given. The description, illustration and distribution map of the new recorded species in Saudi Arabia is also provided.

**Keywords:** Saudi Arabia, New record, *Fissidens crispulus*, Asir, Makkah.

### Introduction

*Fissidens* Hedw. is the unique genus in family Fissidentaceae Schimp., represented by ca. 440 species worldwide (Suzuki et al., 2018). Although its species occupy a wide range of habitats, most of them were recorded from humid ones at the tropics and subtropics (Beever, 2014; Suzuki et al., 2018).

Only 6 taxa of *Fissidens* were recorded from Saudi Arabia (out of 118 moss taxa) representing about 40% of *Fissidens* taxa recorded in Arabian Peninsula (Kürschner, 2000; Kürschner & Frey, 2011). These taxa are *Fissidens arnoldii* R. Ruthe, *F. bryoides* Hedw., *F. crassipes* Wilson ex Bruch & Schimp. subsp. *crassipes*, *F. crispus* Mont., *F. sciophyllus* Mitt., *F. viridulus* (Sw.) Wahlenb. var. *viridulus*. Only two of them; *Fissidens bryoides* and *F. crassipes* subsp. *crassipes* were restricted to Saudi Arabia.

All *Fissidens* taxa recorded in Saudi Arabia were found in the western part of the country (Fig. 1). *Fissidens viridulus* (Sw.) Wahlenb. then

*F. arnoldii* R. Ruthe. are the most common and widely distributed *Fissidens* species in Saudi Arabia (Fig. 1).

Eight *Fissidens* specimens (out of 15 collected samples) were studied during the investigation of the moss flora of Saudi Arabia. These samples were collected from two regions in the west; Asir region (Muhayil Asir & Bariq provinces) and Makkah region (Taif province); (see Fig. 2). These regions have good niches for moss growth. They lie at altitudes between 400-2200m a.s.l (Kürschner, 2000; Abo Salama et al., 2005). Their total average precipitation is between 200-700mm, mainly in April, May and November (Kürschner, 2000, National Meteorology and Environment Center, 2016). Maximum temperature recorded is 40-45°C in June and July; Minimum temperature recorded is 8-16°C in January and February (Kürschner, 2000; Abo Salama et al., 2005). Generally, the climate of the highlands there is moderate to very cold while it is warm to hot with humidity in the depressions.

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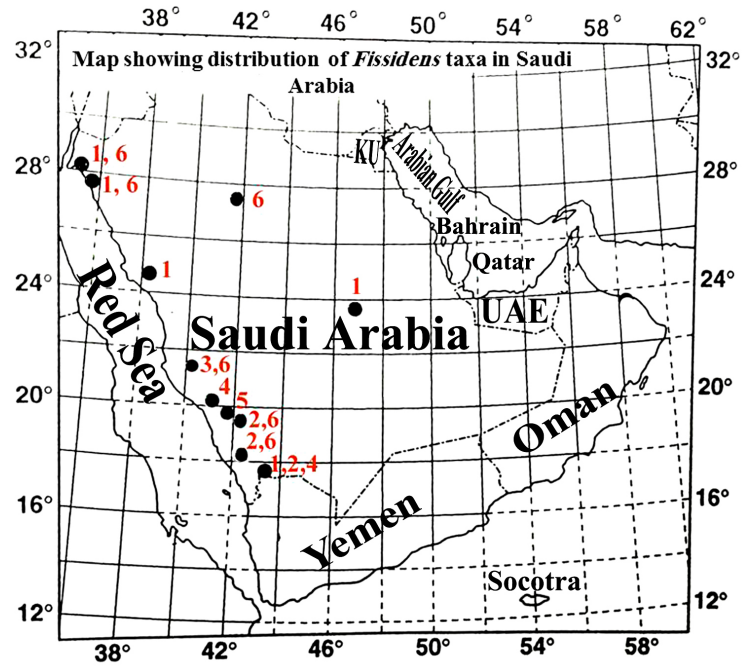


Fig. 1 Map showing distribution of *Fissidens* taxa in Saudi Arabia; 1. *Fissidens arnoldii* R. Ruthe, 2. *F. bryoides* Hedw., 3. *F. crassipes* Wilson ex Bruch & Schimp. subsp. *crassipes*, 4. *F. crispus* Mont., 5. *F. sciophyllus* Mitt., 6. *F. viridulus* (Sw.) Wahlenb. var. *viridulus* (Kürschner, 2000), KU. Kuwait, UAE. United Arab Emirate.

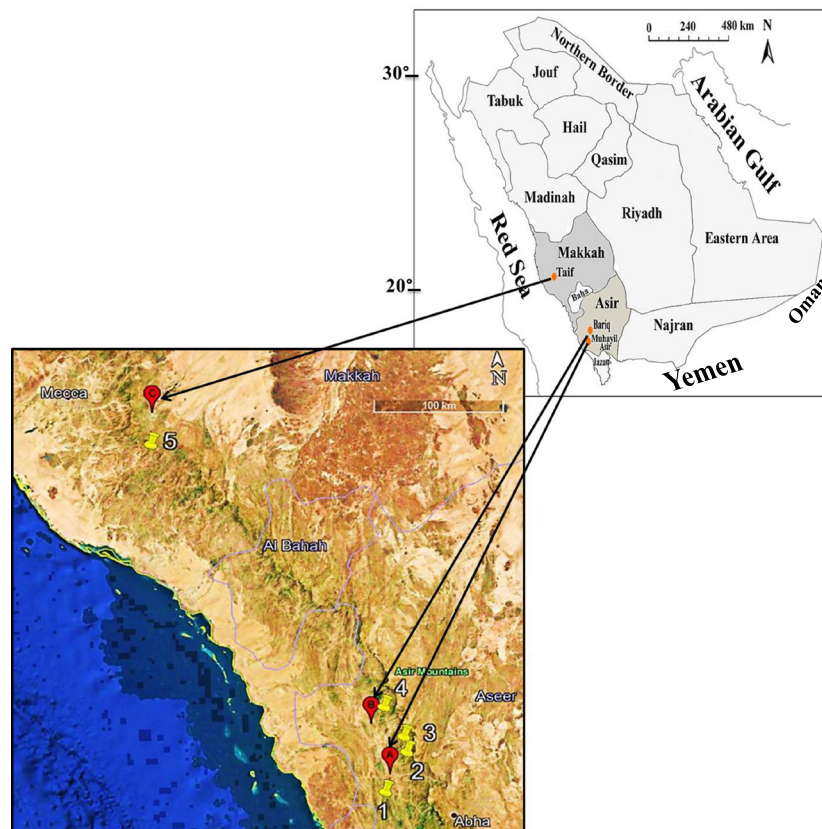


Fig. 2 Map showing five sites of collection: 1. Qana, 2. Okbt-Juadah, 3. Durm Mountain, 4. Athrb Mountain, 5. South of Al-Hadban park, in three provinces A. Muhayil Asir, B. Bariq and C. Taif at two regions Asir and Makkah regions (Alqurashi et al., 2016 ; <https://earth.google.com>, 2018).

## Results

During the investigation of moss samples (15 samples) collected from Muhayil Asir, Bariq and Taif provinces, eight specimens of *Fissidens* were separated. These specimens represented by 3 species namely, *Fissidens arnoldii*, *F. crispulus* and *F. crispus*. *Fissidens crispulus* is a new record to the bryoflora of Saudi Arabia, while *F. arnoldii* is a new record to Makkah region. All the collected *Fissidens* species were shown to be mixed with 11 taxa belonging to three families; Bartramiaceae, Encalyptaceae and Pottiaceae. All the studied samples were deposited at CAIA. Sample number is followed by the acronym "S" denoting Saudi Arabia and "HS" or "M" denoting Hanaa Shabbara or Manal Mohammed Aseeri (the collectors).

Key, synonyms (reported only from Saudi Arabia based on Frey & Kürschner, 1991; Kürschner & Frey, 2011), comments, sites of collection, habitat, distribution and floristic elements of the three *Fissidens* species are given. While the new recorded species, *F. crispulus* Brid., in Saudi Arabia is also described, illustrated and its world distribution map was drawn.

### Key

0. Leaves bordered (limbate).....*F. crispus* Mont.

0. Leaves not bordered (elimbate) .....1

1. Leaves ovate, oblong-ovate, oblong lingulate, apiculate; margins entire to nearly entire, rarely crenate .....*F. arnoldii* R. Ruthe

1. Leaves lanceolate apiculate, oblong lanceolate; margins mamilllose to unipapillose, or serrate with single mammillae projection.....*F. crispulus* Brid.

1. *Fissidens arnoldii* R. Ruthe

Syn.: *Fissidens obtusifolius* Wilson

- *Comment:* *Fissidens arnoldii* may be confused with *F. pellucidus* Hornsch. which was recorded from Socotra (island South Yemen), but the former can be easily distinguished by small cell dimensions range from 2.5-7.5 µm, while cell dimensions of the latter are (11) 15-18µm. Also, the upper part of dorsal lamina of *F. arnoldii* is shorter than vaginant one

while those of *F. pellucidus* are ± have equal lengths.

- *Specimen examined:* Makkah region, Taif province, Shafa area, South of Al-Hadban park (Fig. 2); at the foot of a small plateau (rocks of different sizes were spread out):

- N 21°06'549'', E 40°21'836''; 2025m a.s.l.; on the surface of the soil between the small rocks; sloped; semi-shaded; 24/6/2011; leg. Hanaa Shabbara; 53 S.HSc (CAIA).

- N 21°06'561'', E 40°21'863''; 2012m a.s.l.; at the base of the rock; vertical; semi-shaded; 20/6/2011; leg. Hanaa Shabbara; 22 S.HSc (CAIA).

- N 21°06'563'', E 40°21'861''; 2029m a.s.l.; in the cavity between the large rock; sloped; semi-shaded; 20/6/2011; leg. Hanaa Shabbara; 25 S.HSc (CAIA).

- *Distribution in Saudi Arabia:* Asir, Madinah, Tabuk and Riyadh (Fig. 2).

- *Distribution in the world:* Algeria, Australia, Bulgaria, Canada, Croatia, Egypt (Sinai, Gabel Alba), Estonia, France, Germany, Hungary, Iraq, Israel, Jordan, Kuwait, Latvia, Lithuania, New Zealand, Oman, Russia, Saudi Arabia, Sudan, Syria, Turkey, Turkmenistan, Ukraine (main land), United Arab Emirates, United states, Yemen (Agnew & Vondráček, 1975; Catcheside, 1980; Kürschner, 2000; Shabbara & El-Saadawi, 1999, 2001; Heyn & Herrstadt, 2004; Ignatov et al., 2006; O'Shea, 2006; Lüth, 2008; Ros et al., 2013; Erzberger, 2016).

- *Floristic element:* Circum-Mediterranean (Kürschner, 2008).

2. *Fissidens crispulus* Brid. (Plate 1: Figs. 1-12)

### Description:

Plants small, yellowish green, 3mm high. Stem un-branched; axillary hyaline nodules having different development present, 1-6 cells each, with rhizoids at bases; central strand present; sclerodermis well developed. Leaves about 15 leaf pairs, in-rolled from the tips when dry, patent when moist, lanceolate, oblong lanceolate, apiculate, 0.6-1mm long, 0.2-0.3mm wide; vaginant 2/3 to 3/4 length of leaf; dorsal lamina ending at insertion; apex acute

to acuminate; margins un-bordered (elimbate), plane, mammillose to unipapillose, or serrate with single mammillae projection; costa ending below apex (up to 6 cells); lamina cells bulging, smooth, uni- or bi-papillose, unistratose, thick walled; upper and basal lamina cells quadrate, sub quadrate, rectangular, 5-8 (10) $\mu$ m.

-*Comment:* *Fissidens crispulus* may be confused with *F. taxifolius* Hedw. in having elimbate leaves, mammillose lamina cells and long vaginant lamina but the later taxon has oblong lingulate leaves, short excurrent costa and larger

lamina cells (Manjula & Manju, 2016).

It is noticed from studying *F. crispulus* at the study area and from its comparing with that recorded in available floras that, costa length is a variable character for this taxon. It varies from being ending below apex by 2-6 cells at the same plant in the studied area, and being ending below apex by 3-5 cells in India (Manjula & Manju, 2016), while being percurrent to short excurrent in New Zealand (Beever, 2014). This notice coincides with that mentioned by Stone (1990) as being polymorphic taxon.

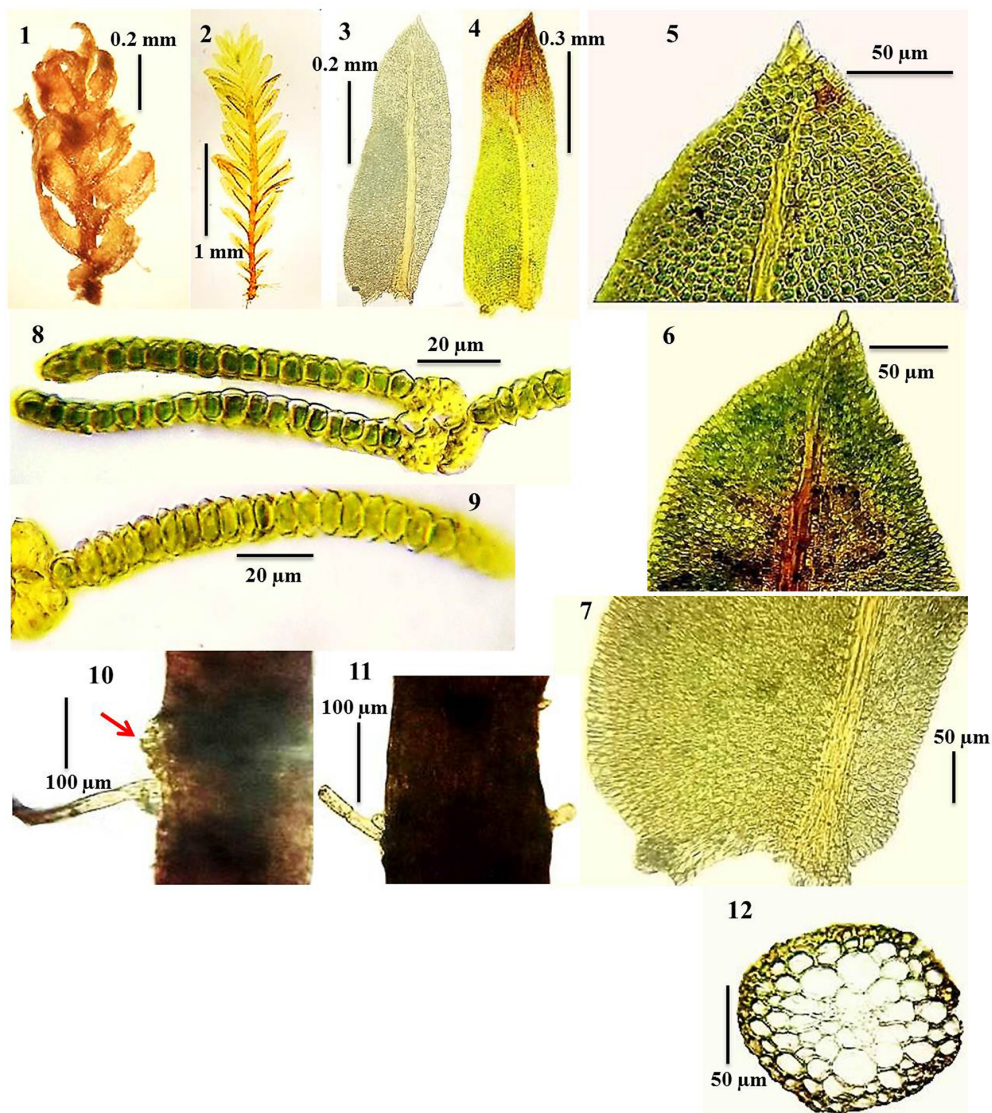


Plate 1 (Figs. 1-12) *Fissidens crispulus* Brid. Fig. 1: Dry plant, Fig. 2: Wet plant, Figs. 3 & 4: Different leaves, Fig. 5: Upper part of leaf no. 3, Fig. 6: Upper part of leaf no. 4, Fig. 7: Basal part of leaf, Fig. 8: Leaf section at mid-leaf showing bulging uni-papillose upper surface of vaginant lamina cells, Fig. 9: Leaf section showing bulging uni- to bi-papillose, and/or crenulated both surfaces of dorsal lamina cells, Fig. 10: Axillary hyaline nodule, Fig. 11: Axillary paraphysis (hyaline hairs multicellular), Fig. 12: Stem section.

Studying the distribution of *F. crispulus* (Fig. 3) shows that its occurrence area lies between 34.5°N (in Osaka province at Japan) and 45°S (in New Zealand).

- *Diagnostic characters*: Differentiated axillary hyaline nodules; leaves lanceolate to narrowly lanceolate, elimbate, vaginant 2/3 to 3/4 length of leaf; apex acute to acuminate; margins plane mammillose to unipapillose, or serrate with single mammillae projection.

- *Specimen examined*: Asir region, North West Muhayil Asir province, Durm Mountain (Fig. 2), ca. 110km North Abha; N 18°42'367'', E 42°07'063'', 687m a.s.l.; on soil; sloped; semi-shaded; 24/10/2011; leg. Manal Aseeri; 118 S.Ma (CAIA).

-Asir region, Bariq province, Athrb Mountain (Fig. 2); N 18°57'860'', E 41°59'947'', 1230m a.s.l.; on soil between the rocks; sloped; shaded; 29/6/2012; leg. Manal Aseeri; 170 S.Md (CAIA).

- Asir region, Muhayil Asir province, Qana (Fig.

2), a rocky low valley; N 18°29'681'', E 41°57'992'', 414m a.s.l.; on the side of the valley; vertical; semi-shaded; 25/10/2011; leg. Manal Aseeri; 128 S.Ma (CAIA).

- *New to Saudi Arabia*

- *Distribution in the world* (Fig. 3): Algeria, Bioko, Borneo, Burma, Cameroon, Celebes, Central African Republic, Chad, China, Comoros, Democratic Republic of the Congo (Zaire), East Nepal, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Hongkong, India (common species in South India), Ivory Coast, Japan, Java, Kenya, Madagascar, Malawi, Malaysia, Mauritius, New Zealand, Nigeria, Oman, Philippines, Reunion, Rodrigues, Rwanda, Samoa, São Tomé and Príncipe, Seychelles, Sierra Leone, Sri Lanka, Sudan, Sumatra, Tanzania, Taiwan, Thailand, Togo, Vietnam, Zambia, Zimbabwe (Gangulee, 1971; Tan & Iwatsuki, 1991; Kürschner, 2000; Chien & Crosby, 2001; Suzuki & Iwatsuki, 2002; Tan & Meng-Shyan, 2002; O'Shea, 2006; Daniels, 2010; Beaver, 2014; Schwarz, 2014; Manjula & Manju, 2016; <http://www.tropicos.org>, 2018).

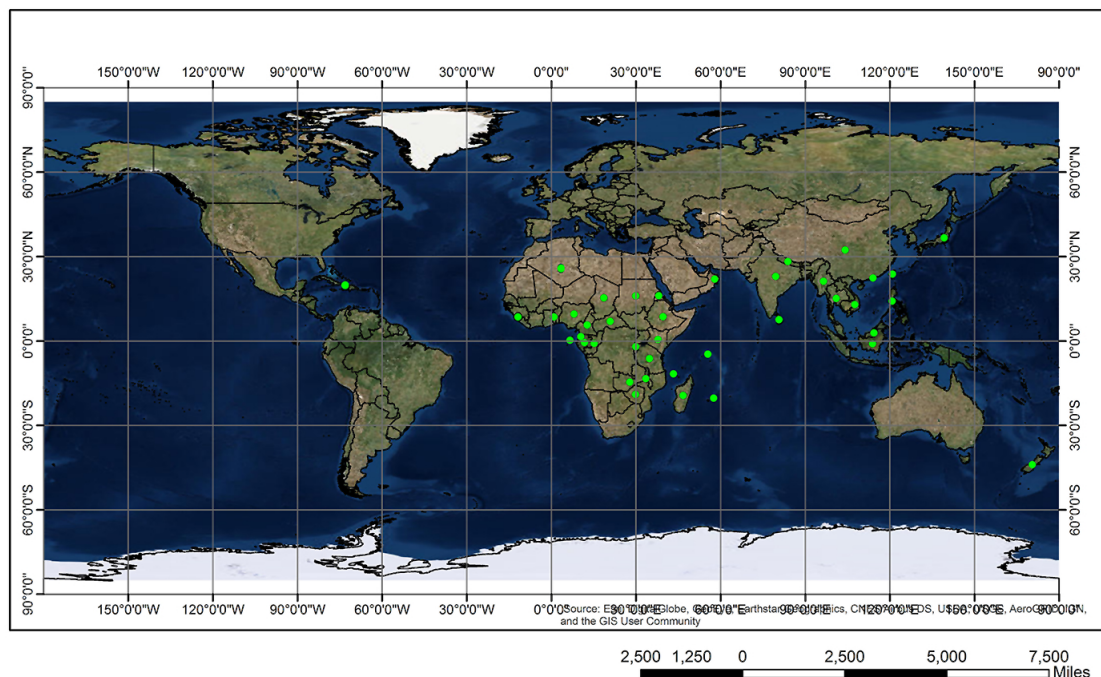


Fig. 3. Map showing distribution of *Fissidens crispulus* Brid. in the world i.e. (Algeria, Bioko, Borneo, Burma, Cameroon, Celebes, Central African Republic, Chad, China, Comoros, Democratic Republic of the Congo (Zaire), East Nepal, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Hongkong, India (common species in South India), Ivory Coast, Japan, Java, Kenya, Madagascar, Malawi, Malaysia, Mauritius, New Zealand, Nigeria, Oman, Philippines, Reunion, Rodrigues, Rwanda, Samoa, São Tomé and Príncipe, Seychelles, Sierra Leone, Sri Lanka, Sudan, Sumatra, Tanzania, Taiwan, Thailand, Togo, Vietnam, Zambia, Zimbabwe).

-*Floristic element*: Strictly Palaeotropical (Kürschner, 2008).

### 3. *Fissidens crispus* Mont.

Syn.: *Fissidens limbatus* Sull., *F. minutulus* Sull., *F. schmidii* Müll. Hal.

-Comment: *Fissidens crispus* may be confused with *F. rufescens* Hornsch. = *F. marginatus* Schimp. ex Müll. Hal. recorded from Tanzania but the former can be easily recognized by its ± closed vaginant lamina, thinner limbidia on all laminae and smaller cell dimensions than *F. rufescens* one (Magill, 1981; Bruggeman – Nannenga, 2013).

- *Specimen examined*: Asir region, North West Muhayil Asir province, Belahmar area, Okbt-Juadah (Fig. 2), ca. 68km North Abha; N 18°39'764'', E 42°12'254''; 1597m a.s.l.; very steep and risk heights; on soil between the rocks; sloped; shaded; 25/1/2012; leg. Manal Aseeri; 159 S.Mb (CAIA).

-Asir region, Bariq province, Athrb Mountain (Fig. 2); N 18°57'862'', E 41°59'948'', 1232m a.s.l.; on soil between the rocks; sloped; shaded; 26/4/2012; leg. Manal Aseeri; 171 S.Mc (CAIA).

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

- *Distribution in the world*: Argentina, Belize, Bioko, Bolivia, Brazil, Cameroon, Canada, Caribbean, Central African Republic, Chile, China (Taiwan), Colombia, Costa Rica, Democratic Republic of the Congo, Ecuador, El Salvador, Ethiopia, Fiji Islands, Gabon, Guatemala, Guinea, Honduras (Central America), Hungary, Iberian peninsula and the Balearic Islands, India, Iringa, Japan, Kenya, Kilimanjaro, Lesotho, Malawi, Malaysia, Mbeya, Mexico, Nicaragua, Nigeria, Panama (Central America), Paraguay, Peru, Philippines, SaoTome, Saudi Arabia, Sri Lanka, Tanga, Tanzania, Uganda, United States, Uruguay, Venezuela, Yemen (Gangulee, 1971; Eddy, 1988; Iwatsuki, 1991; Crum & Eckel, 1994; Iwatsuki & Suzuki, 1996; Kürschner, 2000; O'Shea, 2006; Casas et al., 2006; Bruggeman-Nannenga, 2013; Erzberger, 2016).

-*Floristic element*: Pantropical (Bruggeman-Nannenga, 2013).

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### تسجيلا جديدا للفيسيدنس على الفلورا الحزازية في المملكة العربية السعودية

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إن جنس الفيسيدنس هو الجنس الوحيد في الفصيلة الفيسيدنتاويه وهو ممثل بستة أنواع (من حوالى 440 نوعا الممثلين له) في المملكة العربية السعودية وفي البحث الحالي تم تسجيل ثلاثة أنواع، تم تجميعهم من منطقتي عسير ومكة المكرمة، أحد هذه الأنواع (*Fissidens crispulus* Brid.) يعد تسجيلا جديدا على المملكة العربية السعودية والآخر (*F. arnoldii* R. Ruthe) يعد تسجيلا جديدا على منطقة مكة المكرمة أما الثالث (*F. crispus* Mont.) قد سبق تسجيله في منطقة الدراسة في المملكة العربية السعودية. في هذا البحث تم عمل مفتاح تعريفي وتم ذكر التعليقات ومواقع وموائل التجميع وكذلك ذكر التوزيع في المملكة العربية السعودية ومنطقة شبه الجزيرة العربية والعالم والعناصر الفلورية للأنواع الثلاثة المدروسة. وتم إضافة وصف وصور النبات المسجل لأول مره في المملكة العربية السعودية مع خريطه التوزيع العالمي الخاصة به