



## New records of the genus *Ramularia* in Iran

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### Abstract

Nine collections belonging to the plant pathogenic fungus genus *Ramularia* from different localities of Kohgiluyeh and Boyerahmad Province (SW Iran) were obtained during spring-autumn 2012–13. Eight species were identified: *Ramularia anchusae* on *Anchusa azurea*, *R. armoraciae* on *Barbarea plantaginea*, *R. cupulariae* on *Inula* sp., *R. cynarae* on *Carthamus tinctorius*, *R. epilobiana* on *Epilobium hirsutum*, *R. grevilleana* on *Potentilla reptans*, *R. lamii* on *Mentha longifolia* and *Mentha* sp. and *R. simplex* on *Ranunculus acris*. *Ramularia armoraciae*, *R. cupulariae* and *R. epilobiana* are new records to Iran while *Mentha longifolia* and *Ranunculus acris* are new hosts for *R. lamii* and *R. simplex* in Iran, respectively.

**Key words** – *Mycosphaerellaceae* – plant disease – *Ramularia* – taxonomy

### Introduction

Species of the genus *Ramularia* Unger are associated with leaf spot symptoms on various host plants and linked to the teleomorph genus *Mycosphaerella* Johanson. *Mycosphaerella s.str.* is restricted to *Ramularia* asexual forms (Groenewald et al. 2013). In the genus *Ramularia*, fungal structures are colourless and conidia are solitary or catenate. Specific morphological characters including conidial shape, size and septation, conidiophore morphology and conidiogenous loci have been used to describe and identify *Ramularia* species (Braun et al. 1998). Ershad (2009) provided a list of fungi of Iran, which included some *Ramularia* species. Although *Ramularia* species are widespread, Iranian records of the genus are relatively sparse. In recent years more than 60 new records of cercosporoid and ramularioid fungi (anamorphic *Mycosphaerellaceae*) have been published (Pirnia 2010, 2012a, b, c, d, Pirnia 2014, Hesami 2011, 2012, Khodaparast 2012, Bicharanlou 2013a, b, c, Behrooz 2015a, b, 2017, Bakhshi et al. 2014, 2015a, b). A lack of information about *Ramularia* species in SW Iran, encouraged the authors to determine species of the genus and their host plants in this region.

## Materials & Methods

Fungal structures were mounted in 50% lactic acid. Characters such as presence or absence of stomata and their development, shape and dimension of conidiophores and conidia, sporulation patterns (solitary, simple chain, branched chain), thickness and darkness of conidiogenous loci (scars) and hila were examined using standard light microscopy (Olympus CH40). Measurement of conidia and other structures were made using PixeLINKu scope program. Drawings were made using CorelDraw Graphics suite X3 software.

## Results

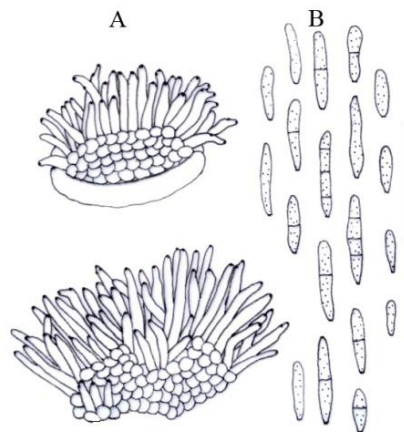
Taxa are described and listed in alphabetical order by species. Three species found to be new for Iran are treated in detail. Five species were new to Kohgiluyeh and Boyerahmad Province (SW Iran). Discussion and comments are added to each taxon. All material is deposited in the reference fungus collection of Iranian Research Institute of Plant Protection "IRAN".

***Ramularia anchusae*** C. Massal., *Malpighia* 8: 213, 1894.

Fig 1

Material examined – Iran, Yasouj (Kakan), on living leaves of *Anchusa azurea* Mill. (*Boraginaceae*), 12 Jul. 2013, Behrooz (IRAN 16553 F); Sisakht (Kohkhedan), 13 Oct. 2013, Behrooz (IRAN 16554 F); Yasouj (Dash Room), 4 Sep. 2013, Behrooz (IRAN 16555 F).

Notes – The species is distinguished by the presence of a well-developed stomata, short conidiophores and 0–3-septate conidia. The width of conidia mostly increases from base to tip. This is the first report of the species from Kohgiluyeh and Boyerahmad Province (SW Iran).



**Fig 1** – *Ramularia anchusae* on *Anchusa azurea*, (A) stromata and conidiophores (B) conidia. Bar = 50  $\mu$ m.

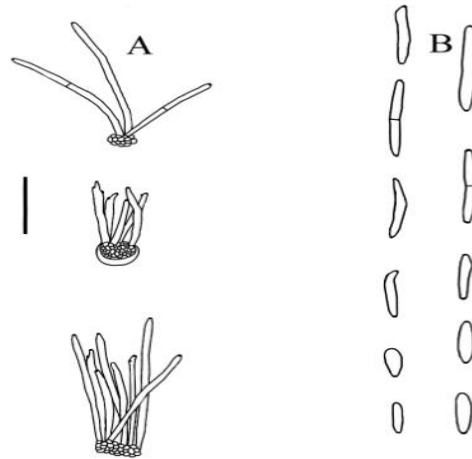
***Ramularia armoraciae*** Fuckel, *Jahrb. Nass. Ver. Naturk.* 23–24: 361, 1870.

Fig 2

Leaf spots circular to elongate with grey center, surrounded by olivaceous margin, 2–15 mm diam.; caespituli amphigenous; stromata small, hyaline; conidiophores in small fascicles, 3–8 stalks, straight, subcylindric to geniculate-sinuous, arising from stromata, emerging through stomata or erumpent, not branched, hyaline, smooth, 0–1-septate, (6–)8–38(–40)  $\times$  1.5–2.5(–3)  $\mu$ m; conidial scars somewhat thickened and darkened; conidia catenate, rarely in branched chains, ellipsoid-ovoid to subcylindric-fusiform, hyaline, smooth, 0–1-septate, (8–)10–30(–35)  $\times$  2–3.5(–4)  $\mu$ m; hilum somewhat thickened and darkened.

Material examined – Iran, Sisakht (Kohkhedan), on living leaves of *Barbarea plantaginea* DC. (*Brassicaceae*), 11 Sep. 2013, Behrooz (IRAN 16550 F).

Notes – The species is reported on various crucifers in Asia, Europe, Africa and North America and characterized by having ellipsoid-ovoid to subcylindric-fusiform conidia. *R. armoraciae* is a new record for Iranian mycoflora.



**Fig 2** – *Ramularia armoraciae* on *Barbarea plantaginea*, (A) stromata and conidiophores (B) conidia. Bar = 20  $\mu\text{m}$ .

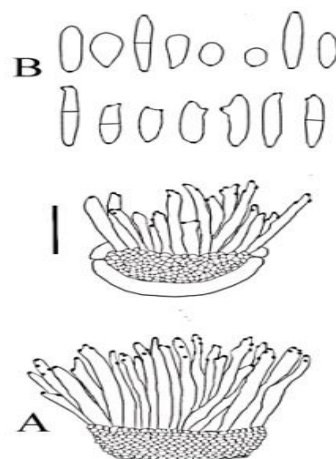
***Ramularia cupulariae*** Pass., Hedwigia 15: 107, 1876.

Fig 3

Leaf spots irregular; caespituli amphigenous, greyish white, very dense; stromata present, small, hyaline, 35–50  $\mu\text{m}$  in diam.; conidiophores arising from stromata, emerging through stomata, in very dense fascicles, subcylindric to geniculate-sinuuous, not branched, hyaline, smooth, mostly aseptate, (16–)20–40(–45)  $\times$  2–3  $\mu\text{m}$ ; conidial scars somewhat thickened and darkened; conidia catenate, occasionally in branched chains, ellipsoid-obovoid, subcylindric, ends rounded to somewhat attenuated, hyaline, smooth, 0-1 septate, (6–)8–25(–27)  $\times$  (3.5–)4–6(–6.5)  $\mu\text{m}$ ; hilum moderately thickened and darkened.

Material examined – Iran, Yasouj (Dasht Room), on living leaves of *Inula* sp. (*Asteraceae*), 4 Sep. 2013, Behrooz (IRAN 16551 F).

Notes – Morphology of the specimen examined agrees with the description of *Ramularia cupulariae* provided by Braun (1998). The species is new for mycobiota of Iran.



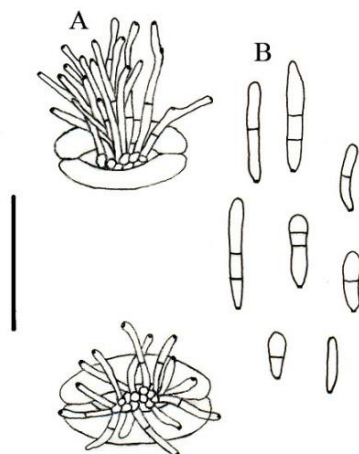
**Fig 3** – *Ramularia cupulariae* on *Inula* sp., (A) stromata and conidiophores (B) conidia. Bar = 20  $\mu\text{m}$ .

***Ramularia cynarae*** Sacc., Michelia 1(5): 536, 1879.

Fig 4

Material examined – Iran, Gachsaran (Imamzadeh Jafar), on living leaves of *Carthamus tinctorius* L. (*Asteraceae*), 9 Jul. 2013, Behrooz (IRAN 16556 F).

Notes – Pirnia et al. (2012d) previously reported the species from the north of Iran. Occurrence of the species in Kohgiluyeh and Boyerahmad Province (SW Iran) is new.



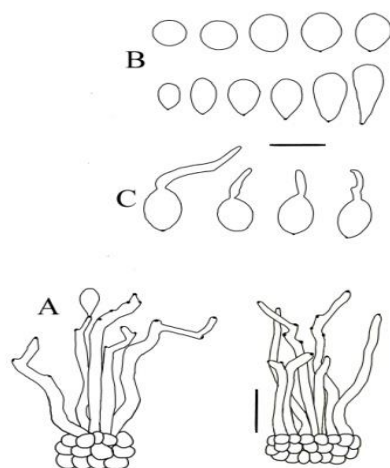
**Fig 4** – *Ramularia cynarae* on *Carthamus tinctorius*, (A) stromata and conidiophores (B) conidia. Bar = 50  $\mu$ m.

***Ramularia epilobiana*** (Sacc. & Fautrey) B. Sutton & Piroz., Transactions of the British Mycological Society 46(4): 513, 1963. Fig 5

Leaf spots circular, rarely angular-irregular, grey, 1–4 mm diam.; caespituli amphigenous, mostly hypophyllous, loose to moderately dense; stromata lacking or small, hyaline, 15–40  $\mu$ m in diam.; conidiophores emerging through stomata, fascicles small to moderately dense, straight to curved, subcylindric, hyaline, smooth, usually aseptate or with one septum, (6–)40–135(–150)  $\times$  3–7(–8)  $\mu$ m; conidial scars somewhat thickened and darkened; conidia solitary, obovoid, ellipsoid, globose to subglobose, smooth or almost so, apex usually rounded, base rounded to somewhat attenuated, aseptate, (8–)10–22(–25)  $\times$  (8–)10–15  $\mu$ m; hilum thickened and darkened.

Material examined – Iran, Sisakht (Kohkhedan), on living leaves of *Epilobium hirsutum* L. (*Onagraceae*), 11 Sep. 2013, Behrooz (IRAN 16552 F).

Notes – The species is characterized by having solitary obovoid to subglobose or ellipsoid conidia. *Ramularia epilobiana* is a new record for mycobiota of Iran.

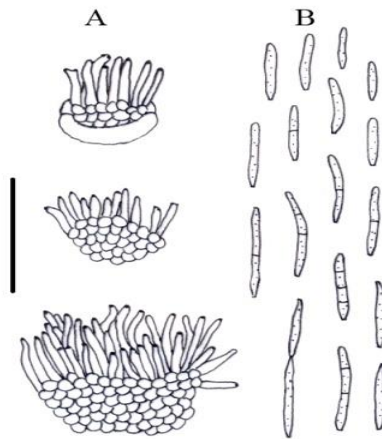


**Fig 5** – *Ramularia epilobiana* on *Epilobium hirsutum*, (A) stromata and conidiophores (B) conidia (C) germinated conidia. Bar = 20  $\mu$ m.

***Ramularia grevilleana*** (Tul. & C. Tul.) Jørst., Meldinger fra Statens Plantepatologiske Institutt 50: 17, 1945. Fig 6

Material examined – Iran, Yasouj (Dasht Room), on living leaves of *Potentilla reptans* L. (*Rosaceae*), 10 Jul. 2013, Behrooz (IRAN 16558 F); Yasouj (Kakan), 12 Oct. 2013, Behrooz (IRAN 16559 F); Sisakht (Kohkhedan), 13 Oct. 2013, Behrooz (IRAN 16560 F)

Notes – *Ramularia grevilleana* has a wide host range on genera of *Rosaceae*. This is the first report of the species in Kohgiluyeh and Boyerahmad Province (SW Iran).



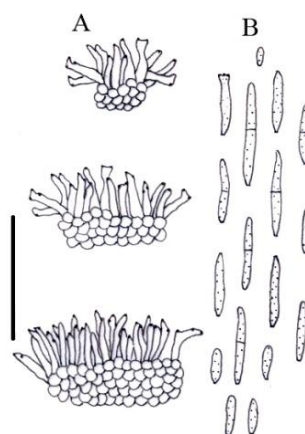
**Fig 6** – *Ramularia grevilleana* on *Potentilla reptans*, (A) stromata and conidiophores (B) conidia. Bar = 50  $\mu$ m.

***Ramularia lamii*** Fuckel, Jahrb. Nass. Ver. Naturk. 23–24: 361, 1870.

Fig 7

Material examined – Iran, Gachsaran (Marin), on living leaves of *Mentha longifolia* (L.) L. (*Lamiaceae*), 13 Apr. 2013, Behrooz (IRAN 16561 F); Basht (Khan Ahmad), on living leaves of *Mentha* sp., 10 Apr. 2013, Behrooz (IRAN 16562 F).

Notes – Morphology of fungal structures agree with the description of *R. lamii* provided by Braun (1998). The species has a wide host range on *Lamiaceae*, subfamily *Lamioideae*. This is the first report of the species on *Mentha longifolia* in Iran. Pirnia et al. (2012d) previously reported the species from Iran on *M. piperita*. Occurrences of *Ramularia lamii* in Kohgiluyeh and Boyerahmad Province (SW Iran) is new.



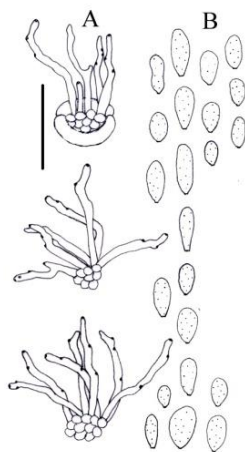
**Fig 7** – *Ramularia lamii* on *Mentha longifolia*, (A) stromata and conidiophores (B) conidia. Bar = 50  $\mu$ m.

***Ramularia simplex*** Pass., Erbario Crittogamico Italiano: no. 1181, 1882.

Fig 8

Material examined – Iran, Yasouj (Dash Room), on living leaves of *Ranunculus acris* L. (*Ranunculaceae*), 10 Jul. 2013, Behrooz (IRAN 16563 F).

Notes – Moaven (2003) and Pirnia et al. (2012d) previously reported *Ramularia simplex* on *Ranunculus oxyspermus* and *R. sahendicus*, respectively. This is the first report of the species from Kohgiluyeh and Boyerahmad Province (SW Iran). *Ranunculus acris* is a new host for the species in Iran.



**Fig 8** – *Ramularia simplex* on *Ranunculus acris*, (A) stromata and conidiophores (B) conidia. Bar = 50  $\mu$ m.

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