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Numerical taxonomy of selected species of Pottiaceae family in Iran

Fahimeh Salimpour*, Hamze Kolivand

Department of Biology, North Tehran Branch, Islamic Azad University, Tehran, Iran

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Abstract

To determining the phenetic similarities between 16 species of Pottiaceae family, 20 characters have been studied by numerical taxonomy. A cluster analysis based on Average Linkage method determined two main groups . P*terygoneurum ovatum* made one group based on its morphological traits. Second cluster consist of two subgroups. *Tortula* species are under one clade and other species are placed in separate groups. Characters of leaf including the shape of it, leaf apex and the margin of it besides the traits of stereid band the most effective factors in distinguishing and identified the species.

***Corresponding Author:** Fahimeh Salimpour ✉ drsalimpour@gmail.com

Introduction

The Pottiaceae form the most numerous true moss family and containing nearly 1500 species in the world (Buck and Goffinet,2000). Many of them are especially adapted to dry climates and they are often the dominant mosses in arid regions of the world (Werner *et al*., 2004).However, taxonomic treatment of the family has been notoriously difficult due to problems of poly-morphy, the unclear significance of several anatomical characters, the reduced size of many species, obscure areolation and the sterility of many species (Zander, 1993). Frey and Kurschner reported nearly 247 taxa in Middle East flora (Frey and Kurschner, 1998). Iran with a very diverse climate, is an attractive country for bryological studies(Akhani and Kurschner, 2004). Large parts of country in the central, Eastern and Southern parts with arid and semi-arid climate provide limited habitats for moisture requiring plants, the South Caspian forests along the Northern slopes of Alborz mountains and Zagros Oak forests provide extensive biotopes for a wide range of bryophytes such as Pottiaceae family (Akhani and Kurschner, 2004). Based on the checklist of the Iranian Bryoflora, 94 species of this family reported in Iran. there are a few investigation about their relationships based on their morpholgyical characters. Therefore, the aim of this study is to determine the phenetic relation between 16 species of this family using numerical taxonomy.

Material and methods

1. Sample collection

The materials are collected and procured from different places. The list of species is presented in Table 1.

2. Phenetic study

Five samples from each species were used for morphological studies. Observations were carried out with Olympus light microscope. Twenty characters were evaluated. After coding of qualitative and quantitative characters, hierachial clustering analysis were performed using SPSS software version 9 with Average linkage method (Norusis, 1999) and the resulting dendrogram was illustrated (Fig. 1).

Table 1. Species and their locations

Species	Location
Pterygoneurum ovatum (Hedw.) Dixon.	Hamedan: Nahavand, Dacal road, 1800m, Kolivand
Tortula mucronifolia Schwagr.	Tehran: Shemiran, 1930 m, Kolivand
Tortula muralis Hedw.	Tehran: Shemiran, 1930 m, Kolivand
Tortula demawendica Schiffn.	Tehran: Shemiran, 1930 m, Kolivand
Tortula. Obtusifoli (Schwagr.) Mathieu.*a*	Tehran: Shemiran, 1930 m, Kolivand
Tortula Vahliana (Schultz)Mont	Hamedan: Sarab giyan, 1700 m, Kolivand
Tortula solmsii(Schimp) Limpr.	Hamedan: Sarab giyan, 1700 m, Kolivand
Syntrichia inermis(Bridel) Bruch	Gilan; Gisoom forest, 0 m, Kolivand
Syntrichia ruralis (Hedw.)F.Weber&D.Mohr	Hamedan: Sarab giyan, 1700 m, Kolivand
Syntrichia Montana Nees	Hamedan: Sarab giyan, 1700 m, Kolivand
Barbula unguiculata Hedw.	Tehran: Shemiran, 1930 m, Kolivand
Tortella fragilis (Hook&Willson) Limpr.	Gilan; Gisoom forest, 0 m, Kolivand
Tortella flavovirens (Bruch) Broth.	Gilan; Gisoom forest, 0 m, Kolivand
Pottia commutate Limpr	Tehran: Shemiran, 1930 m, Kolivand
Pleurochaete squarrosa (Brid.) Lindb.	Gilan; Gisoom forest, 0 m, Kolivand
Didymodon australasiae Hook. & Grev.)	Gilan; Gisoom forest, 0 m, Kolivand

Results

The results showed that there were differences and similarities regarding the traits under study between the genera. Based on fig. 1, two main clades are identified. P*terygoneurum ovatum* made one group at level 25 and the 2nd main clade is further divided into two subclades as A and B. In subclade A, the species with two abdominal and dorsal stereid bands were grouped. *Pleurochaete squarrosa* is a distinct species at level 19. Moreover, *Didymodon australasiae* is separated from *Tortella* branch at distance 6, which is due to difference regarding the distinguishing characters such as leaf margin, leaf apex, and surface formation of blade cells. Moreover, *T. fragilis* and *T. flavovirens*, due to traits such shape of leaf, blade cells, form of leaf and margin of leaf, are two close species. The 2nd sub-clade is divided into two sub groups: in group A, *Tortula* species are under subgroup I. Two species of *T. solmsii* and *T. vahliana* are located close to each other and the major difference between them is superficial differences of the leaf blade cell and form of the leaf margin as well. Under subgroup II, T. *demawendica* near to *Pottia commutate* due to similarity of characters such as shape of the leaf, dorsal stereid band, and tip of the leaf. Group B is also divided into two groups at taxonomic level 16. Subgroup I includes *T. mucronifolia* and *T. muralis*, which is next to *S. inermis* with wide taxonomic distance between them. Some characters such as shape of the leaf, apex of the leaf, stereid band and cells of blade surface, are similar in these two species. Also, *Syntrichia* species are placed in subclade II. Factor analysis showed that the sources of variable data. Characters of leaf including the shape of it, leaf apex and the margin of it besides the traits of stereidbands the most effective factors in distinguishing and identified the species.

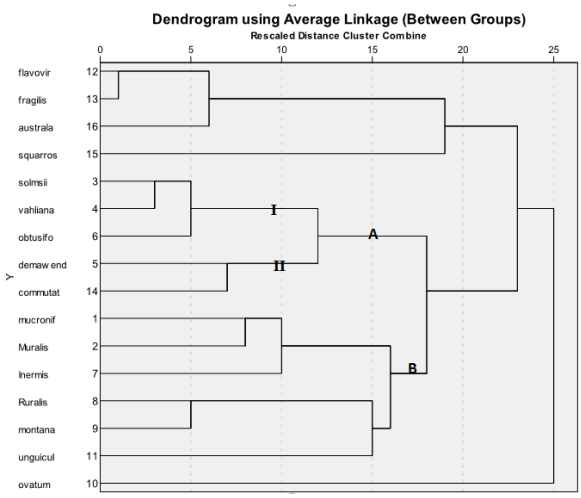

Fig 1. Cluster analysis of 16 species of Pottiaceae family

Tortula mucronifolia, T. muralis , T. solmsii , T. demawendica, T. obtusifolia, T. Vahliana , Syntrichia inermis , S. ruralis , S. Montana , Pterygoneurum ovatum, Barbula unguiculata , Tortella fragilis, Tortella flavovirens , Pottia commutate , Pleurochaete squarrosa , Didymodon australasiae

Discussion

The results confirmed that morphological characters such as shape of leaf, apex of leaf, and abdominal and dorsal strid band can be useful for distinguishing the apecies in Pottiaceae family. *Pleurochaete squarrosa Tortella flavovirens*, *Tortella fragilis*, and *Barbula unguiculata* have considerable similarities including two dorsal and abdominal stridbands on veins and lanceolate form of the leaf and their apex of leaves, which distinguish this group from other species. These results are consistent with those by Zander (1993) on Pottiaceae family. Moreover, *Didymodon australasae* was placed in the cluster next to *Tortella fragilis* and *Tortella flavovirens*. With characters such as general shape of leaf, apex of leaf, two dorsal and abdominal strid bands on veins, dorsal epidermis, tip of leaf, blade cells and their formation, *Pleurochaete squarrosa* was placed at the cluster near to *Didymodon austalasiae*. These results are consistent with the results by Grundman (2004).

Werner (2004) showed similar results too by usind rps4 genome. *Tortula vahiliana* was introduced as a new species in Iran based on the characters such as tongue-like leaf, obtuse leaf tip, acute tip, green projection of veins from the tips, 1-2 rows of outstanding cells among blade cells, and formation at the surface of blade cells. With traits such as obtuse leaf tip, shape of leaf, blade and base cells the species is distinguishable from *Pottia commutate* and *T. demawendica* are separated from each other.

Werner (2004) studied different species of Pottiaceae based on rps4 chloroplast sequence and found results consistent with ours.

Werner (2005) distinguished species based on ITS sequence of gens and found no considerable classification and differences, so that species of Pottiaceae family were completely mixed in one group while three genera T*richosomum*, *Weissia*, *Tortella* having the largest number of species were not fully distinguished.

As illustrated in fig. 1, species of genus *Syntrichia* are generally distinguished from those of genus *Tortula*. This is due to lack of dorsal epidermis and the shape of strid band in *Syntrichia* genus. In NCBI database *Syntrichiai nermis* named as *Tortula inermis*. However, based on chloroplast genome and nucleus sequence, Korshner's checklist (2008) and Werner (2004) have differentiated *Syntrichia* genus from those of *Tortula* genus. Taking into consideration Werner (2005), it appears that in spite of efficiency of nucleus genomic traits and ITS for distinguishing species, nucleous and chloroplast genome have been more effective on distinguishing the taxa of primary plants at family and sub family levels.

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