SPORE VARIATION IN SINAPTERIDACEAE FROM IRAN

A. R. Khosravi

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A survey of spores on *Sinapteridaceae* from Iran with scaning electron microscope provides evidence on their relationships. Four type of sculpturing are found on the sporoderm of the Iranian species. Cristate for *Cheilanthes fragrans, C. persica* and *C. marantae*. Rugulose for *Cheilanthes persica*. Reticulate for *Cheilanthes coriacea* and verrucate for *Cheilanthes catanensis.*

Ahmad Reza Khosravi, Biology Department, College of Sciences, Shiraz University, Shiraz 71454, Iran.

تنوع هاگ در گونه‌های ایرانی تیره Sinapteridaceae

احمدرضا خسروی

بررسی هاگ در سرخسهای تیرهٔ *Sinapteridaceae* از ایران با میکروسکوپ الکترونی اسکن شواهد جدیدی از روابط خویشاوندی بین آنها را مشخص می‌کند. در بین گونه‌های ایرانی این تیره ۴ نوع از تزیینات سطح هاگ دیده می‌شود. تیغه‌دار (Cristate) در گونه‌های *C. persica, Chelianthes, fragans, C. marantae* . رگه‌دار (Rugulose) در *Chelianthes persica*. مشبک (Reticulate) در *Cheilanthes coriacea* و زگیلدار (Verrucate) در *Cheilanthes catanensis*.

Introduction

The family *Sinapteridaceae* is represented in Iran by 5 species included in two genera; *Cheilanthes* Sw. and *Notholaena* R. B. The generic differences between *Cheilanthes* and *Notholaena* are based on the organs which protect the young sorus. In the genus *Notholaena* the marginal sori are naked or at most covered by protrusions of the epidermis, whilst the sporangia of the species belonging to the genus *Cheilanthes* s. str. are covered by the reflexed margin of the pinnules (Fuchs 1961). Fuchs (l. c.) suggested that this character is not reliable and the generic value of *Notholaena* R. Br. is somewhat questionable and it seems that probably all species of this genus should be included in the genus *Cheilanthes*. Based on this suggestion the species *Notholaena marantae* (L.) Desv. and *Notholaena* catanensis should belong to the genus *Cheilanthes* namely *Cheilanthes marantae* (L.) Domin and *Cheilanthes catanensis* (Cosent.) H. P. Fuchs respectively. In determining the degree of relationship between species, other evidence is needed. Some characters can have a reliable diagnostic value but diagnostic characters do not necessarily bring evidence of affinity (Van Cotthem 1973).

Spore of *Sinapteridaceae* have been studied in previous surveys (Devi, Nayara and Knobloch 1971; Knobloch, Spink and Fulfs 1971; Nayara and Devi 1967; Tryon and Tryon 1973; Welman 1970). Examination of the spore of *Sinapteridaceae* with the scanning electron microscope has proven to be of value in determining the relationships in the group (Tryon and Tryon 1973). Studies of this kind have not been performed on the Iranian species. In this study, spore of all species from Iran were studied with scanning electron microscope based on criteria used by Tryon and Tryon (1973). The relationships among these species and other species of *Sinapteridaceae* will be discussed.

Materials and methods

In the present study, the spore of 5 species of *Sinapteridaceae* were examined and scanning electron micrographs were prepared. Materials for this study were obtained from the herbarium specimens at the Shiraz University (SHIRAZ) and Research Institue of Forests and Rangelands (TARI). Details of the studied

specimens are given below:

Cheilanthes catanensis (Cosent). H. P. Fuchs. -Fars: Kazerun, NE. of Parishan Lake, Sherenjan, 810 m, 18. 4. 1991, Khosravi & Nikookar (SHIRAZ).

Cheilanthes coriacea Decne. -Fars: Kazerun, NE. of Parishan Lake, Sherenjan, 810 m, 18. 4. 1991, Khosravi & Nikookar (SHIRAZ).

Cheilanthes fragrans (L. f.) Sw. -Fars: 12 km NE. of Arsanjan, Jamalabad, 1587 m, Khademian 79 (SHIRAZ).

Cheilanthes marantae (L.) Domin. -Azarbaijan: Arasbaran, Tolua Ali, 650 m, Assadi & Vosoughi 24941; Azarbaijan: Arasbaran, between Makidi and Veinagh, 1000-1700 m, Wendelbo & Assadi 17018 (TARI).

Cheilanthes persica (Bory) Mett. -Fars: 5 km NE. of Abadeh, 1907 m, 20. 4. 1992, Khosravi & Farrokhi 1907 (SHIRAZ).

The spores were coated, under vaccum with gold-palladium without any other treatments. Photographs were taken by Cambridge scanning electron microscope, model 360, Stereoscan in the Department of Material Science and Engineering at the University of Shiraz.

Results and discussion

Tryon and Tryon (1973) have recognized six distinct types of structural elements in the sculpturing of the sporoderm in *Sinapteridaceae*. These are: cristate, reticulate, rugulose, verucate, echinate and granulose. Of these types, cristate, rugulose, verrucate and reticulate are found in the Iranian species, (Fig. 1, 2).

Cristate type are found in *Cheilanthes fragrans*, *C. persica* and *C. marantae*. It consits of more or less disconnected irregular ridges. Cristate type occurs in widely diverse species of the *Sinapteridaceae* (Tryon and Tryon 1973). Rugulose sporoderm, composed of low, more or less compact rugae that was observed in *C. persica*. Tryon and Tryon (l. c.) have mentioned that the rugulose type seems to have close relationships to cristate type, and some species have spores intermediate between these two forms. Presence of cristate and rugulose types in *C. persica* suggests that these two forms may represent two states of the development in this group. Tryon and Tryon (1973) also have mentioned that the presence of high frequency of cristate and

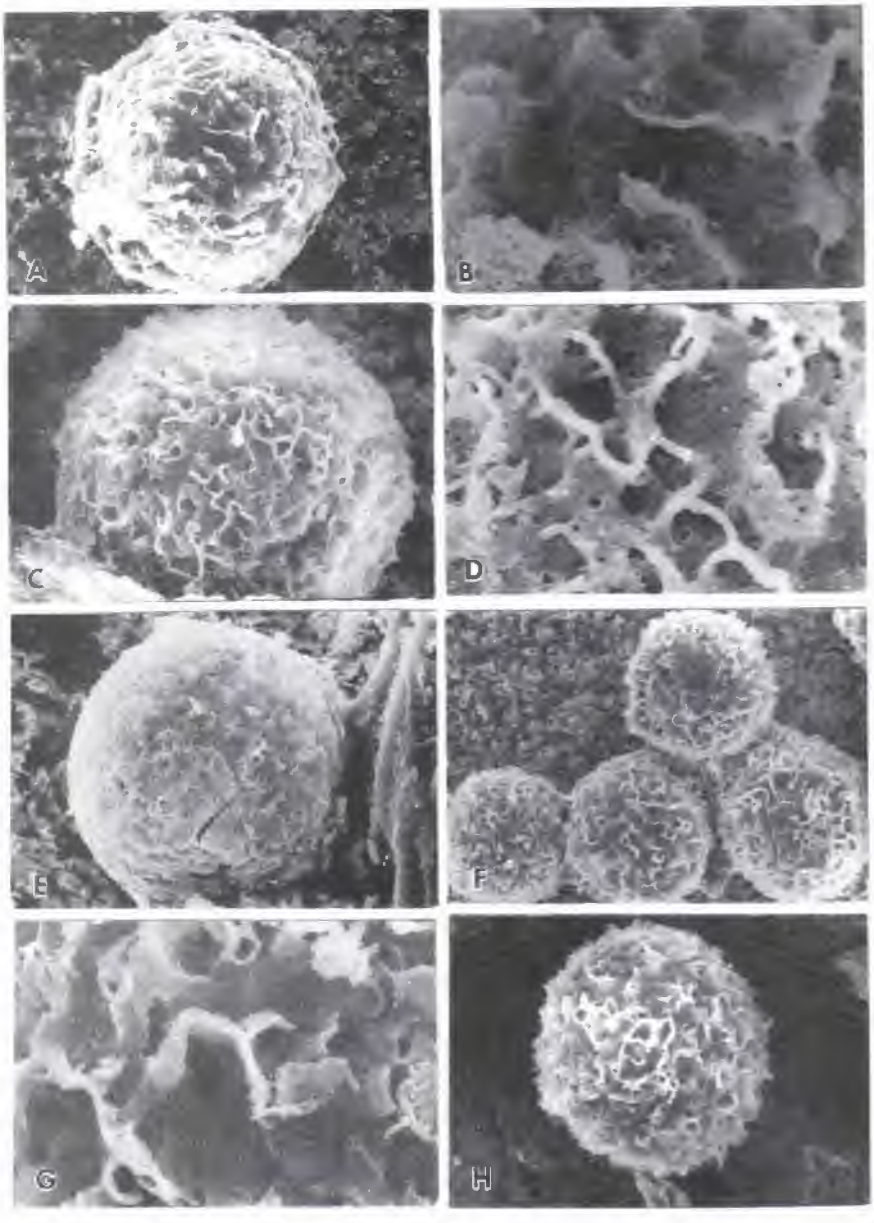

Fig. 1. Spore variation in *Sinapteridaceae.* -A-E. *Cheilanthes persica.* A. cristate (x 700); B. detail (x 2600); C. cristate (x 800); D. detail (x 3000); E. Rugulose (× 800). -F, G. *C. fragrans*. F. cristate (x 350); G detail (x 2200). - H. *Notholaena marantae*, cristate (x 600).

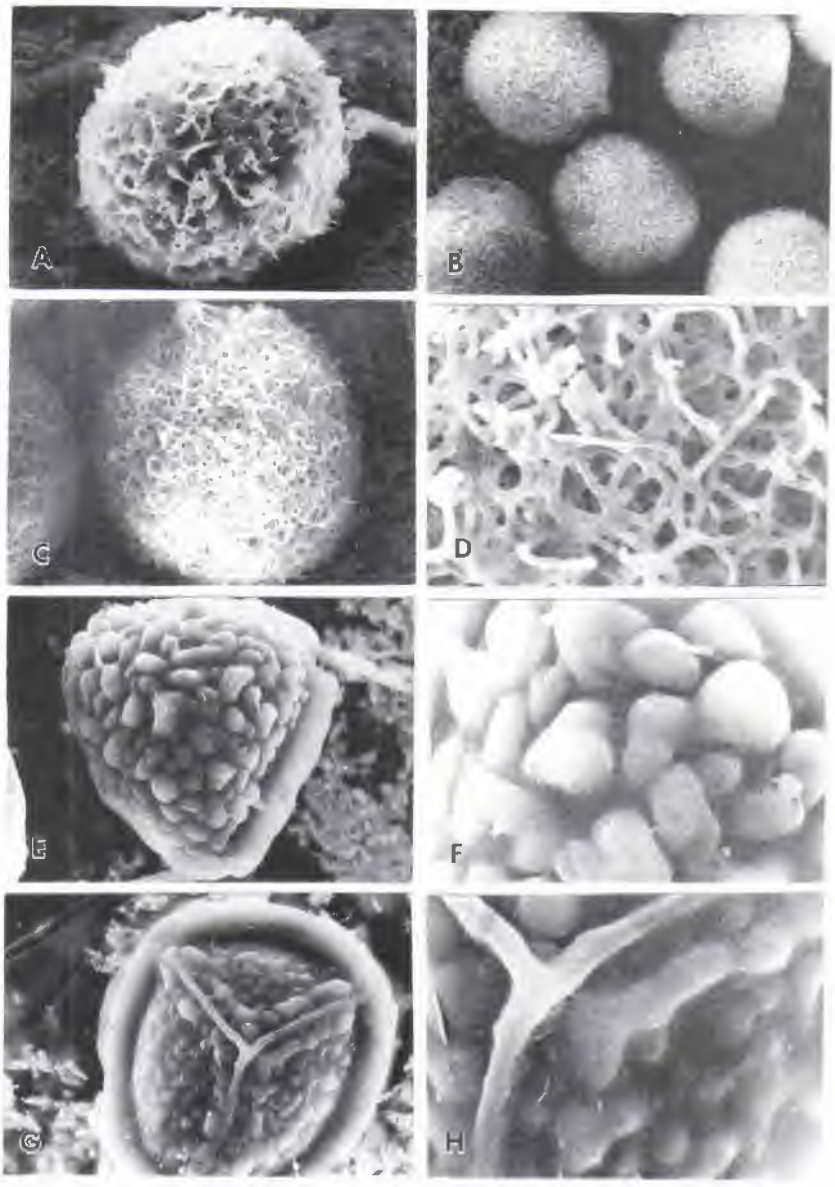

Fig. 2. Spore variation in *Sinapteridaceae*. -A. *Notholaena marantae*, cristate (x 600). -B-D. *Cheilanthes cariaceae*. B. reticulate (x 400); C. reticulate (x 750); D. detail (x 3000). -E-H. *Notholaena catanensis*. E. verrucate (x 900); F. detail (x 2800); G. verrucate (x 850); H. detail (x 3100).

rugulose forms of sporoderm in *Sinapteridaceae* suggests that the represent basic spore types of species have been derived from a common ancestral group. Presence of cristate type of sporoderm in *C. marantae* used by some taxonomists under the genus *Notholaena* indicates that this species is more related to *Cheilanthes fragrans* and *C. persica* than to *C. catanensis*.

Reticulate type is found in *C. coriacea*. The sporoderm exhibits a complex reticulate structure. This type also is found in *C. argentea* (Tryon and Tryon 1973). The possibilities of *C. argentea* being present in Iran have been indicated by Parsa (1978).

Verrucate type is found in *C. catanensis*. It consists of sporoderm with large and low rounded tubercules. Verrucate spores are distinctive and characteristics of a group among the American species of *Notholaena*, such as *N. squamosa* (Tryon and Tryon 1973). Presence of verrucate type in *C. catanensis* suggests a close relationship between *C. catanensis* and American species of *Notholaena*. Tryon and Tryon (1973) mentioned that this unique form of sporoderm suggests that this group of species has been possibly originated independently compared with the other *Sinapteridaceae* which converge in the form and scaly indument of lamina. Besides the shape of spore in *C. catanensis* is tetragonal (like *N. squamosa*) while other species from Iran have spherical shape.

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