



New sources of taxonomic information for earthstars (*Geastrum*, Geastraceae, Basidiomycota): phenoloxidases and rhizomorph crystals

JUAN CARLOS ZAMORA^{1*}, FRANCISCO D. CALONGE¹ & MARÍA P. MARTÍN¹

¹Real Jardín Botánico-CSIC. Pza. de Murillo 2. E-28014, Madrid, Spain.

*Corresponding author: jczamora@rjb.csic.es

Abstract

The taxonomic utility of two characters not previously used for identification of *Geastrum* species is evaluated. First, macrochemical spot tests with chemicals detecting phenoloxidase enzymatic activity (1-naphthol, guaiac gum, and syringaldazine), are performed. In addition, the usefulness of the crystalline deposits from the rhizomorphs, formed by calcium oxalate as monohydrate or whewellite, and dihydrate or weddellite, was evaluated. These features provide valuable data to distinguish some taxa difficult to separate using traditional morphology, such as *G. lageniforme*, *G. saccatum*, and *G. triplex*.

Introduction

Geastrum Persoon (1774: 85) : Persoon (1801: 131) is a genus of gasteroid Basidiomycota, widely known as earthstars due to the star-like shape of the mature fruitbodies (Sunhede 1989). The genus is world-wide distributed (Ponce de León 1968) and, according to Kirk *et al.* (2008), it consists of roughly 50 species. The taxonomy of the earthstars, as in many other macrofungi, has been traditionally based on morphological features of the basidiomata (Sunhede 1989). Traits such as the peristome type (fibrillose or sulcate), its delimitation in respect to the rest of the endoperidial body, the presence or absence of a stalk connecting the endoperidium and the exoperidium, the hygrometric behaviour of the exoperidial rays, and the structure of the mycelial layer, are the characters most frequently used for species identification and infrageneric subdivisions (Staněk 1958, Ponce de León 1968, Sunhede 1989, Calonge 1998). However, some species are rather difficult to identify, and misidentifications or mixed collections are commonly seen when revising herbarium specimens, as in the case of the *G. congolense* Dissing & Lange (1962: 37) type material, where at least two different species were mixed (Sunhede 1986).

There are some particularly problematic groups that have been variously treated by different authors. For instance, *G. pectinatum* Persoon (1801: 132), *G. striatum* DC. in Lamarck & de Candolle (1805: 267), and *G. schmidelii* Vittadini (1842: 13) are three species generally accepted as well-defined, but they were considered as a single, variable taxon by Ponce de León (1968). *Geastrum morganii* Lloyd (1901: 78) was reduced to a synonym of *G. triplex* Junghuhn (1840: 287) by Ponce de León (1968), considered conspecific with *G. elegans* Vittadini (1842: 15) by Calonge (1998), and treated as a well-defined, autonomous species by other authors such as Staněk (1958) and Sunhede (1989). Even more troublesome is the distinction of *G. lageniforme* Vittadini (1842: 16), *G. saccatum* Fries (1829: 16), and *G. triplex*, historically confused and treated as three different species by Staněk (1958), Sunhede (1989), and Calonge (1998), but not by other authors, such as Quélet (1886), Coker (1924), Cunningham (1944), and Ponce de León (1968). With the rise of molecular techniques, an even higher complexity of these taxa is coming to light, as shown in the *G. triplex* complex (Kasuya *et al.* 2012). Therefore, discovering and using new sources of taxonomic information may be desirable, at least as an attempt to clarify some of these difficult groups.