Phytotaxa 222 (2): 111–120
www.mapress.com/phytotaxa/

Article

ISSN 1179-3155 (print edition)
PHYTOTAXA
ISSN 1179-3163 (online edition)

http://dx.doi.org/10.11646/phytotaxa.222.2.3

Mallomonas alpestrina sp. nov. (Synurales, Chrysophyceae, Stramenopiles) and its spineless relatives—*Mallomonas alata* group

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Abstract

In this paper, we define the *Mallomonas alata* group and describe *M. alpestrina sp. nov.* from an oligotrophic high mountain glacial lake on the slopes of Haba Xue Shan (Haba Snow Mountain), China. The *Mallomonas alata* group is excluded from the *M. pumilio* group primarily based on the approximately triangular shape of the collar scales, the small hook-like protruded dome, and one considerably broader anterior flange of the body scale. We extend previous research on small species from the section Torquatae with reticulated scale-shield pattern. Molecular genetic data for the *Mallomonas alata* group species are not currently available; therefore, we provide detailed information on scale and scale-case morphology, environmental requirements, and geographical distribution of these species.

Introduction

The genus *Mallomonas* Perty (1852: 170) includes heterokont photosynthetic flagellates covered by overlapping silica scales. A cell contains a single, golden brown, deeply divided plastid. Pigment composition is dominated by the brown pigment fucoxanthin, chlorophyll *a*, and chlorophyll c_2. Currently, *ca*. 180 taxa have been described within the genus *Mallomonas* (Siver 1991, Kristiansen & Preisig 2007) based primarily on the silica scale morphology. However, recently descriptions based on both molecular data and scale morphology have been published (Jo *et al*. 2013, Kim *et al*. 2014). The term *Mallomonas pumilio* group [including *M. alata* Asmund *et al*. (1982: 391) f. *alata*] was introduced by Asmund *et al*. (1982). The group included species with small (7–20 µm) ovoid to ellipsoidal cells from the section Torquatae, which exhibited a reticulated scale-shield pattern with the reticulum meshes enclosing one to several pores at the bottom. Asmund *et al*. (1982) reported that the *Mallomonas pumilio* type [Harris & Bradley (1957: 45)] included two different species. They designated one species (their fig. 4 in Asmund *et al*. 1982) as a lectotype of *Mallomonas pumilio* Harris & Bradley (1957) *emend*. Asmund *et al*. (1982: 387) var. *pumilio*, and described the other as the new species *Mallomonas alata* f. *alata* (their Fig. 3). A new form from a paludal forest in southern Chile, *M. alata* f. *hualvensis* Asmund *et al*. (1982: 394), also was introduced in that paper. Subsequently, *M. alata* f. *hualvensis* was reported from Ontario, Canada (Nicholls 1988) and the Aquitaine Region, France (Němcová *et al*. 2012), which placed its endemic status in dispute.

Detailed revision and elaborate definition of the *Mallomonas pumilio* group based on scale morphology and scale shape analysis was provided by Němcová *et al*. (2013). To evaluate slight differences in scale morphology, landmark-based geometric morphometrics analysis was used. Two new species [*Mallomonas jubata* Němcová *et al*. (2013: 36) and *M. directa* Němcová *et al*. (2013: 40)] and two new varieties [*M. pumilio* var. *dispersa* Němcová *et al*. (2013: 42) and *M. solea-ferrea* var. *irregularis* Němcová *et al*. (2013: 40)] were introduced, and the emended definition of *M. pumilio* var. *pumilio emend*. Němcová *et al*. (2013: 44) was provided. The varieties *Mallomonas pumilio* var. *silvicola* Asmund *et al*. (1982: 391) and *M. pumilio* var. *munda* Asmund *et al*. (1982: 391) were erected to the species level *M. silvicola* Němcová *et al*. (2013: 38) and *M. munda* Němcová *et al*. (2013: 36), respectively. Only species exhibiting collar scales with a well-developed circular to oval dome, harboring smooth curved bristle, were retained in the *M. pumilio* group. Species exhibiting approximately triangular collar scales with a small hook-like protruded dome and body scales with one considerably broader anterior flange (*M. alata* f. *alata* and *M. alata* f. *hualvensis*) were not

Accepted by Saúl Blanco Lanza: 31 Jul. 2015; published: 14 Aug. 2015