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Morphological variability of new chrysophyte stomatocyst forming a single-cyst assemblage in a low-conductivity tropical lake in the Guineo-Congolian rainforest

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Abstract

Morphological variation of the chrysophyte stomatocyst found in surface sediments of a small, shallow lake in the Guineo-Congolian rainforest in eastern Cameroon, is described, illustrated and discussed. Neither living cells nor scales of chrysophytes were observed in the lake. The stomatocyst cannot be assigned to any known cyst and is described as new to science (stomatocyst #49) using International Statospore Working Group (ISWG) guidelines. This is the third report of stomatocysts in Africa, and the second from the tropical part of this continent. Some basic ecological information on the sampling site is provided and compared with similar data from other sampling sites of chrysophytes in Africa.

Key words: Africa, Cameroon, chrysophytes, Lower Guinea, paleotropics, stomatocyst

Introduction

Chrysophyte algae that belong to two classes Chrysophyceae and Synurophyceae (Yang *et al.* 2012, Škaloud *et al.* 2013) are characterized (among others) by the ability to produce siliceous resting stages called stomatocysts. They are classified independently of the free-living forms because of their importance and practical use in the paleoecological studies as well as in different biodiversity assessments in situations where living chrysophytes are not observed. Stomatocysts are species-specific, but only 10–15% of them are conclusively linked with living chrysophytes (e.g. Smol 1984, Cronberg 1988a, 1989a, 1992, 1995, Kristiansen 1989, Siver 1991, Zeeb & Smol 2001, Cronberg & Laugaste 2005, Coradeghini & Vigna 2008, Kim & Kim 2008, Piątek & Kowalska 2008, Findenig *et al.* 2010, Piątek *et al.* 2012), mainly because of difficulty with findings of encysting chrysophytes in nature and culture experiments.

The assemblages of chrysophyte stomatocysts have been studied in diverse climatic regions, including arctic, boreal, temperate and alpine areas of the Northern Hemisphere (Duff *et al.* 1995, Facher & Schmidt 1996, Hansen 2001, Pla 2001, Wilkinson *et al.* 2001, Piątek & Piątek 2005, 2008, Piątek 2006, 2007, Wołowski *et al.* 2011, 2013), rarely Antarctic and sub-Antarctic areas (Mrozińska *et al.* 1998, van de Vijver & Beyens 1997a, b, 2000, Coradeghini & Vigna 2008) as well as subtropical and tropical areas (Zeeb & Smol 1996, Rull & Vegas-Vilarrúbia 2000, Vilaclara *et al.* 2005, Piątek *et al.* 2009, 2012). The assemblages were usually composed of several different morphotypes of stomatocysts, ranging from 7 to 32 morphotypes in one sampling site (recent, subfossil or fossil stomatocysts) (e.g. Rull & Vegas-Vilarrúbia 2000, Coradeghini & Vigna 2001, 2008, Cabała 2005, Piątek & Piątek 2005, 2008, Vilaclara *et al.* 2005, Piątek *et al.* 2009, Huber *et al.* 2009, Baumann *et al.* 2010).

During recent examination of materials collected in different water reservoirs in Cameroon, three samples from small, shallow lake in the Guineo-Congolian rainforest included stomatocyst specimens composed of one morphotype as observed by light microscope. The stomatocyst occurred abundantly in surface sediments, though without any direct or indirect connection with free-living chrysophyte. The examination of the material in scanning electron microscope revealed some degree of morphological variability between cyst specimens that still could be attributable to the same stomatocyst.

The inter-specimens variability within a single stomatocyst, linked or not to live chrysophyte species, has been rarely studied (e.g. Sandgren 1983, Smol 1984, Cronberg 1988a, 1989a, 1992, Siver 1991, Piątek & Piątek 2008).

could also depend on asexual or sexual formation, but according to Duff *et al.* (1995) "the stomatocysts produced by either mode are morphologically identical". It is impossible to conclude which of these factors was responsible for morphological variability between specimens of stomatocyst #49 in sediments of the tropical lake in Cameroon. It should be also pointed out that Sandgren (1983) believed that "most cysts produced in nature are fully developed to the extent the environment will permit when they are deposited on the sediments". If such scenario is taken into account, then specimens assigned to three developmental stages of stomatocyst #49 could be produced in years with different environmental conditions. On the other hand, Cronberg (1986) illustrated different developmental stages of stomatocyst in the same colony of *Synura* sp., indicating that different stages of development could be produced during the same encystment process.

Other than describing variability of stomatocyst #49, this study provides some contribution to the knowledge on ecological requirements of chrysophytes in tropical Africa. Although many water samples were collected in Cameroon, only in some fraction of them chrysophytes or stomatocysts were observed. The stomatocyst #49 occurred in warm, small, undisturbed natural lake embedded within rainforest, having low electrolytic conductivity and circumneutral pH. This may be compared with observations on chrysophytes in other African samples, from ponds of Cameroon, Nigeria and Zimbabwe, for which some basic ecological data are known. Therein, the chrysophytes were found in water reservoirs with similar temperatures (between 22–29 °C in Lake Kariba, around 30 °C in two other ponds in Zimbabwe—Cronberg & Hickel 1985, Cronberg 1988b, 1989b; between 26–33 °C in Lekki Lagoon, Nigeria—Wujek *et al.* 2003–2004; 29.5 °C in small pond in Cameroon—Piątek *et al.* 2012), pH (between 7.26–8.15 in Lake Kariba, Zimbabwe—Cronberg 1989b; between 6.1–7.7 in Lekki Lagoon, Nigeria—Wujek *et al.* 2003–2004; 7.8 in small pond in Cameroon—Piątek *et al.* 2012), with similar (35 $\mu S \cdot cm^{-1}$ in small pond in Cameroon—Piątek *et al.* 2012), but usually with much higher electrolytic conductivity (640–1230 $\mu S \cdot cm^{-1}$ in Lake Kariba, Zimbabwe—Cronberg 1989b; 200–1000 $\mu S \cdot cm^{-1}$ in Lekki Lagoon, Nigeria—Wujek *et al.* 2003–2004). Interestingly, similar environmental conditions (pH between 5.8–6.8, conductivity between 12–82 $\mu S \cdot cm^{-1}$) were detected in several Nigerian rivers that have diverse assemblages of chrysophyte species (Wujek *et al.* 2010). In general, Cronberg (1989b) concluded that chrysophytes in the tropics (including Afrotropics) are more frequent in small water reservoirs than in large lakes, and the present observation in Cameroon is also from a small lake. Anyway, the ecological data for African chrysophytes are still sparse and fragmentary. Further observations are required to understand the habitat and ecological preferences (and consequently evolutionary adaptations) of chrysophytes in Africa.

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