

Silica-scaled Chrysophyceae and Synurophyceae from Nigeria. III. Chrysophytes from rivers of Edo State

Daniel E. WUJEK¹, Medina O. KADIRI² & Ryan M. DZIEDZIC¹

¹Department of Biology, Central Michigan University, Mt. Pleasant, MI 48859, USA;
e-mail: wujek1de@cmich.edu

²Department of Botany, University of Benin, Benin, Nigeria

Abstract: A total of 18 species of silica-scaled chrysophytes (Chrysophyceae: one species each in *Chrysosphaerella*, *Spiniferomonas*, and *Paraphysomonas*; Synurophyceae: 11 *Mallomonas* spp. and four *Synura* spp.) was recorded from river samples collected in Edo State, Benin, Nigeria, from both dry and rainy seasons in 2003. Identifications were based on transmission electron microscopy. Five are new records for Nigeria, including four being newly reported for Africa. Two further species could not be identified.

Key words: Africa, Chrysophyceae, silica-scaled chrysophytes, Synurophyceae

Introduction

The Chrysophyceae and Synurophyceae, characterized by an exogenous siliceous envelope composed of scales and/or bristles have long been recognized as important indicators of environmental conditions. Light microscopy-based identifications are of limited value as electron microscopy (EM) usually is necessary to distinguish sufficient structure for species identification in the scaled chrysophytes (KRISTIANSEN 1979).

The Nigerian freshwater algal flora, and silica-scaled chrysophytes in particular (classes Chrysophyceae and Synurophyceae), is poorly documented. Compared to the electron microscopic (EM) studies elsewhere in Africa (Chad Republic, Kenya, Madagascar, Botswana, and Zimbabwe – see WUJEK et al. (2003/2004) for review), only two EM investigations of the chrysophyte flora of Nigeria have been published (WUJEK & OGUNDIPE 2003; WUJEK et al. 2003/2004). African chrysophyte studies in general have lagged behind those for the Americas, Europe, and Asia (KADIRI 1992, 2004; JANATKOVÁ & NĚMECOVÁ 2009). CRONBERG (1988, 1989, 1996) summarizes the literature on the tropics and more recent literature citations may be found in

HANSEN (1996a), WUJEK & MOGHADAN (2001) and KRISTIANSEN (2002).

In this study, the silica-scaled algal flora from samples collected in both dry and wet seasons in 2003 from ten river locations, Edo State, Nigeria, were examined using transmission (TEM) and scanning (SEM) electron microscopy. Of all the sampling sites, only Ikpoba Reservoir, dammed from the Ikpoba River, has a published phytoplankton record. This includes desmids (KADIRI 1988, 1993a, b, 1996; KADIRI & OPUTE 1989), euglenids (KADIRI & OPUTE 2000) and diatoms (KADIRI 2003; KADIRI & OPUTE 2003).

Material and methods

Phytoplankton samples collected with a 20 µm plankton net were made from ten different river locations, Edo State, Nigeria (Fig. 1, Table 1: Ovia, Nikorogha, Orionmwon, Okomu, Gelegele, Ikpoba, Ogba, Ugonoba, Ogbese, and Okokhou Rivers; the latter eight were collected twice, both in the dry season, February, and rainy season, September, 2003 while the first two were sampled only in the dry season). Preparations and observations were as previously described (WUJEK & OGUNDIPE 2003). All identifications were based on TEM. None of the measured ecological parameters correlated significantly with individual taxa or taxa number.

Table 1. Benin Region, Edo State, Nigeria, silica-scaled chrysophyte sampling sites in 2003.

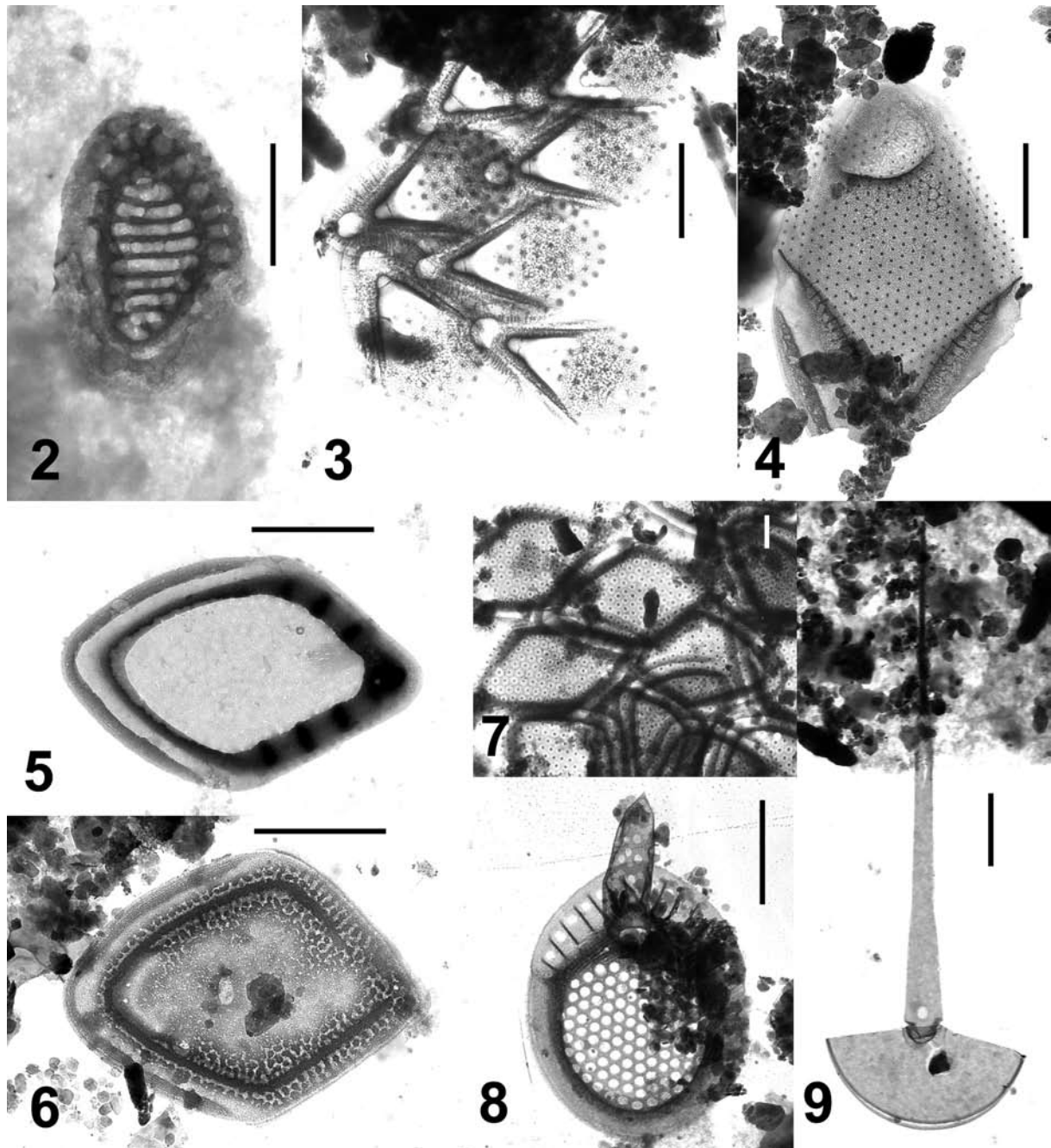
Locality	Coordinates	Date of sampling	Species richness Dry/Rainy
1. Ovia River	6° 34' 10'' E; 5° 31' 52'' N	13.2.	4
2. Nikorogha River	6° 14' 45'' E; 5° 21' 46'' N	14.2.	2
3. Orionmwon River	6° 13' 05'' E; 5° 56' 10'' N	13.2.; 19.9.	4/1
4. Okomu River	6° 15' 36'' E; 5° 06' 10'' N	07.2.; 19.9.	3/1
5. Gelegele River	6° 09' 15'' E; 5° 21' 00'' N	13.2.; 20.9.	10/0
6. Ikpoba River	6° 21' 25'' E; 5° 38' 20'' N	06.2.; 19.9.	1/3
7. Ogba River	6° 17' 05'' E; 5° 35' 10'' N	06.2.; 19.9.	2/0
8. Ugonoba River	6° 19' 05'' E; 5° 50' 10'' N	06.2.; 19.9.	3/0
9. Ogbese River	6° 45' 00'' E; 5° 33' 15'' N	13.2.; 19.9.	1/3
10. Okokhuo River	6° 34' 15'' E; 5° 36' 10'' N	17.2.; 19.9.	2/0

Table 2. Benin Region, Edo State, Nigeria, silica-scaled chrysophytes [(*) new record for Africa; (**) new for Nigeria; (D) dry season, (R) rainy season; localities see Table 1].

Taxon	Locality
Chrysophyceae	
<i>Chrysosphaerella annulata</i> KRISTIANSEN et D. TONG	5D
** <i>Spiniferomonas septispina</i> K.H. NICHOLLS	6R
<i>Paraphysomonas vestita</i> (STOKES) DE SAEDELEER	1D, 3R, 4D, 4R, 5D, 6D, 7D, 8D, 9D, 10D
Synurophyceae	
<i>Mallomonas cyathellata</i> var. <i>kenyana</i> WUJEK et ASMUND	3D, 5D
* <i>M. doignonii</i> var. <i>doignonii</i> BOURRELLY em. ASMUND et CRONBERG	1D
<i>M. lemuriocellata</i> P. HANSEN	5D, 10D
<i>M. matvienkoae</i> var. <i>matvienkoae</i> (MATVIENKO) ASMUND et KRISTIANSEN	1D, 2D, 5D
<i>M. multisetigera</i> DÜRRSCHMIDT	2D, 5D
* <i>M. parvula</i> DÜRRSCHMIDT	4D
* <i>M. paxillata</i> (D.E. BRADLEY) L.S. PÉTERFI et MOMEU	9R
<i>M. peronoides</i> (K. HARRIS) L.S. PÉTERFI et MOMEU	1D, 5D, 6R
<i>M. rasilis</i> DÜRRSCHMIDT	9R
* <i>Mallomonas</i> sp. 3	3D
* <i>Mallomonas</i> sp. 4	5D

Table 2 Cont.

<i>Synura curtispina</i> (J.B. PETERSEN et J.B. HANSEN) ASMUND	3D, 5D
<i>S. echinulata</i> KORSHIKOV	3R, 4D, 6R, 7D, 8D, 9R
* <i>S. leptorrhabda</i> (ASMUND) K.H. NICHOLLS in K.H. NICHOLLS et GERRATH	8D
<i>S. spinosa</i> KORSHIKOV	5D



Figs 2–9. (2) *Mallomonas doignonii* var. *doignonii*: body scale; (3) *M. parvula*: body scales; (4) *M. paxillata*: body scale; (5) *Mallomonas* sp. 3: scale; (6) *Mallomonas* sp. 4: scale; (7) *M. lemuriocellata*: body scales; (8) *Synura leptorrhabda*: body scale; (9) *Spiniferomonas septispina*: spine scale. Scale bar 1 μ m.

Table 3. Benin Region, Edo State, Nigeria. Ecological data of river sampling sites, 2003 [(D) dry season, (R) rainy season].

Locality	pH		Conductivity ($\mu\text{S}\cdot\text{cm}^{-1}$)		Total Dissolved Solids (mg.l ⁻¹)		Total Alkalinity (mg.l ⁻¹)		PO ₄ -P (mg.l ⁻¹)		NO ₃ -N (mg.l ⁻¹)		SO ₄ (mg.l ⁻¹)	
	D	R	D	R	D	R	D	R	D	R	D	R	D	R
1. Ovia River	6.7		32		15		11.0		0.4		0.034		0.002	
2. Nikorogha River	6.7		25		12.0		8.5		0.27		0.045		0.009	
3. Orionmwon River	6.6	5.1	27	15	13.0	7.0	11.0	2.0	0.19	0.82	0.018	0.005	0.003	0.01
4. Okomu River	6.1	6.3	12	19	6.0	9.0	5.0	11.0	0.65	0.31	0.025	0.015	0.001	0.019
5. Gelegele River	6.8	6.6	25	60	12.0	28.0	7.0	0	0.30	0.56	0.015	0.019	0.0033	0.007
6. Ikpoba River	6.3	6.3	14	17	7.0	8.0	10.0	12.0	0.41	0.21	0.08	0.012	0.003	0.002
7. Ogba River	5.8	6.0	19	27	9.0	13.0	17.0	11.0	1.01	0.77	0.018	0.018	0.026	0.001
8. Ugonoba River	6.3	6.5	13	14	6.0	6.0	15.0	10.0	0.34	0.42	0.021	0.032	0.003	0.007
9. Ogbese River	6.7	5.1	82	16	41.0	7.0	26.0	29.0	0.79	0.60	0.036	0.012	0.002	0.001
10. Okokhuo River	6.6	5.4	15	1	7.0	7.0	2.0	0.0	0.22	0.50	0.024	0.057	0.004	0.003

silica-scaled chrysophyte flora. Three EM silica-scaled chrysophyte studies of Nigerian samples have been conducted to date resulting in 31 observed taxa. These 31 species include only two, *M. lemuriocellata* and *P. nigeriensis*, which have not also been reported from temperate regions (see CRONBERG 1989; KRISTIANSEN 2001; WUJEK et al. 2003/2004). As HANSEN (1996a) stated “many unsolved questions remain regarding biogeography and ecology of the silica-scaled Chrysophyceae and Synurophyceae in the tropics.”

Acknowledgements

We thank G. Williams for the preparation of the carbon-coated grids, B. Roberts for assistance in the preparation of the plates and Dr. Jørgen Kristiansen for commenting on some of our micrographs. Festus Arijiode is also gratefully acknowledged for his assistance in the collection of samples.

References

- CRONBERG, G. (1988): *Mallomonas stellata*, a new silica-scaled chrysophycean from Zimbabwe. – *Kirkia* 13: 143–152.
- CRONBERG, G. (1989): Scaled chrysophytes from the tropics. – *Beih. Nova Hedwigia* 95: 191–232.
- CRONBERG, G. (1996): Scaled chrysophytes from the Okavango Delta, Botswana, Africa. – *Beih. Nova Hedwigia* 114: 91–108.
- HANSEN, P. (1996a): Silica-scaled Chrysophyceae and Synurophyceae from Madagascar. – *Arch. Protistenkd.* 147: 145–172.
- HANSEN, P. (1996b): *Spiniferomonas cetrata* sp. nov. (Chrysophyceae), from an event of stomatocyst formation in the tropics. – *Beih. Nova Hedwigia* 114: 71–80.
- HANSEN, P. & KRISTIANSEN, P. (1995): *Mallomonas madagascariensis*, *M. lemuriocellata* and *M. crocodilorum* (Synurophyceae), three new species from Madagascar. – *Nord. J. Bot.* 15: 215–223.
- JANATKOVÁ, K. & NĚMCOVÁ, Y. (2009): Silica-scaled chrysophytes of Southern Bohemian water bodies, including *Mallomonas conspersa* Dürschmidt with occurrence so far reported from Japan and New Zealand. – *Fottea* 9: 93–99.
- KADIRI, M.O. (1988): A taxonomic study of the genus *Closterium* (Nitzsch, 1817) Ralfs 1848 (Desmidiaceae), with ecological notes. – *Tropical Freshwater Biol.* 1: 71–80.
- KADIRI, M.O. (1992): Freshwater algae of West Africa: A bibliography, 1956–1991. – *Polsk. Arch. Hydrobiol.* 39: 199–211.
- KADIRI, M.O. (1993a): Records of members of the genus

- Cosmarium* Corda ex Ralfs (Desmidiaceae, Chlorophyta) in a shallow West African reservoir. – *Nova Hedwigia* 57: 109–122.
- KADIRI, M.O. (1993b): Further desmids from the Ikpoba Reservoir (Nigeria) compared with other records from Africa. – *Arch. Hydrobiol./Algological Studies* 71: 23–35.
- KADIRI, M.O. (1996): More desmids from the Ikpoba Reservoir, Nigeria: Comparison with other African records. – *Arch. Hydrobiol./Algological Studies* 80: 87–98.
- KADIRI, M.O. (2003): Diatoms from Nigeria. – *Arch. Hydrobiol./Algological Studies* 110: 17–26.
- KADIRI, M.O. (2004): African freshwater algae: A bibliographic update. – *Acta Bot. Hung.* 46: 179–200.
- KADIRI, M.O. & OPUTE, F.I. (1989): A rich flora of *Micrasterias* from the Ikpoba Reservoir, Nigeria. – *Arch. Hydrobiol.* 116: 391–399.
- KADIRI, M.O. & OPUTE, F.I. (2000): The Euglenoids of the Ikpoba reservoir. – *Biologia* 55: 351–356.
- KADIRI, M.O. & OPUTE, F.I. (2003): SEM observations of some noteworthy diatoms from the Ikpoba reservoir, Nigeria. – *Plant Biosyst.* 137: 215–229.
- KRISTIANSEN, J. (1979): Problems in classification and identification of Synuraceae (Chrysophyceae). – *Schweiz. Zeitschr. Hydrol.* 40: 310–319.
- KRISTIANSEN, J. (2001): Biogeography of silica-scaled chrysophytes. – *Beih. Nova Hedwigia* 122: 23–29.
- KRISTIANSEN, J. (2002): The genus *Mallomonas* (Synurophyceae). A taxonomic survey based on the ultrastructure of silica scales and bristles. – *Opera Bot.* 139: 1–218.
- WUJEK, D.E. & MOGHADAN, L.A. (2001): Scaled chrysophytes from Florida. VII. Observations on the flora from the southeast. – *Florida Sci.* 64: 274–282.
- WUJEK, D.E. & OGUNDIPE, O.T. (2003): Silica-scaled Chrysophyceae and Synurophyceae (Chrysophyta) from western Nigeria. – *Nigerian J. Bot.* 16: 108–111.
- WUJEK, D.E. & SIVER, P.A. (1997): Studies on Florida Chrysophyceae (Paraphysomonadaceae) and Synurophyceae (Mallomonadaceae). V. The flora of north-central Florida. – *Florida Sci.* 60: 21–27.
- WUJEK, D.E., ADESALU, T.A. & NWANKWO, D.I. (2003/2004): Silica-scaled Chrysophyceae and Synurophyceae (Chrysophyta) from Nigeria. II. Lake Lekki. – *Tropical Freshwater Biol.* 13: 99–103.

© Czech Phycological Society

Received May 13, 2009

Accepted September 5, 2009