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SILICA-SCALED CHRYSOPHYTES FROM ECUADOR

CRISOFITAS ESCAMOSAS DE ECUADOR

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ABSTRACT

Thirty silica-scaled chrysophytes, from 60 Ecuadorian water bodies, were observed using transmission and scanning electron microscopy. The taxa comprised 27 Synurophyceae (19 *Mallomonas* spp., 7 *Synura* spp., and one *Chrysodidymus* species) and three Chrysophyceae (two species of *Paraphysomonas* and one species of *Spiniferomonas*). All are new reports for Ecuador, and one taxon (*Mallomonas lychenensis* f. *ecuadorensis*) is described as new. The number of taxa per sample varied from none to ten.

KEYWORDS: Chrysophyceae, South America, Synuraceae.

RESUMEN

Treinta crisófitas escamosas, obtenidos de 60 cuerpos de agua en Ecuador, fueron observados mediante microscopía electrónica. Los taxones comprenden 27 Synuraceae (19 *Mallomonas* spp., siete *Synura* spp., y una especie de *Chrysodidymus*) y tres Chrysophyceae (dos *Paraphysomonas* spp. y una especie de *Spiniferomonas*). Todas son nuevos informes para Ecuador y un taxon (*Mallomonas lychenensis* f. *ecuadorensis*) se describe como nuevo. El número de taxones por muestra varió de ninguno a diez.

PALABRAS CLAVE: América del Sur, Chrysophyceae, Synuraceae.

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. These silica-scaled chrysophytes are second in importance only after diatoms as indicators of the past ecology of lacustrine environments (Smol 1995; Stoermer 1999). For example, the effects of acid rain were demonstrated by examining present and past sediments for scaled chrysophytes to demonstrate changes in the environment over time (Smol 1995). Identifications of scaled chrysophytes are based upon the morphology of scales that often are preserved in sediments. Identifications based on light microscopy are of limited value as electron microscopy (EM) is usually necessary to distinguish sufficient morphology for species identification in the two groups (Kristiansen 1979).

Information is now becoming available on the ecology and distribution of Central and South American silica-scaled chrysophytes. An extensive literature based on EM has accumulated from several Latin American countries, especially Argentina (Vigna & Kristiansen 2002), Brazil (Franceschini & Kristiansen 2004), Chile (Dürrschmidt (1980, 1981, 1982a, 1982b, 1983a, 1983b, 1983c), and Costa Rica (Wujek 1984; Wujek *et al*. 1998). Reports from Mexico (Kristiansen & Tong 1995), Colombia (Vigna & Escobar 1999) and Belize (Carty & Wujek 2003) have also been published.

This study presents an account of scale-bearing chrysophytes (Chrysophyceae and Synurophyceae) from the equatorial area of Ecuador using scanning (SEM) and transmission electron microscopy (TEM). Correlations of these organisms with ecological conditions are discussed briefly.

MATERIALS AND METHODS

Sixty different sites from Ecuador were sampled (Table I). Most sites were located using a global positioning system. Plankton net samples were taken with 10 or 20 µm mesh nets. Samples were preserved with acid Lugol's solution (Gifford 1991) in plastic screw-cap vials. Collecting sites included rivers, ponds, lakes, temporarily flooded fields, and ephemeral ponds. Samples for TEM were subsampled onto Formvar-coated, carbon stabilized, 3 mm copper grids. After air drying, they were examined with a JEOL CM-10 TEM. Samples for scanning electron microscopy were prepared as described previously (Wujek & Elsner 1992).

RESULTS

Thirty taxa representing five genera were observed in the 60 samples (Table II). Taxa, including one new form of *Mallomonas*, are all new reports for Ecuador (Figs. 1-31). The taxon list includes 19 *Mallomonas* taxa, seven *Synura* taxa, including two forms of *S. petersenii*, two *Paraphysomonas* taxa, and one taxon each of *Chrysodidymus* and *Spiniferomonas*.

The number of scale-bearing chrysophyte taxa observed per sample varied from none to ten (Table I). The most frequently observed species was *Paraphysomonas vestita* (Stokes) de Saedeleer (16% of samples). This was followed by three taxa in the genus *Synura*: *S. echinulata* Korshikov (12%), *S. petersenii* Korshikov f. *petersenii* (7%) and *S. spinosa* Korshikov (5%). Common species frequently observed from *Mallomonas* were *M. matvienkoae* var. *matvienkoae* (8%), and three taxa each at 5%, *M. mangofera* f. *foveata* Dürrschmidt, *M. papillosa* Harris & Bradley, and *M. striata* var. *serrata* Harris & Bradley. *Mallomonas akrokomos* Rutter, *M. fenestrata* Cronberg & Hickel, *M. lychenensis* Conrad, *M. lychenensis* f. *ecuadorensis* Wujek & Dziedzic, *M. parvula* Dürrschmidt and *M. pillula* f. *valdiviana* Dürrschmidt, and *Synura uvella* Ehrenberg em. Korshikov were only observed once.

A pond with large quantities of horse dung (sample 46) had the highest diversity (10 taxa). A small marsh (sample 45) and a shallow tributary of Lake Zancudo Cocha (sample M3), whose surface was covered by a "scum" were second with seven. Over half of the sites had four or fewer species each.

One new form of *Mallomonas lychenensis*, *M. lychenensis* f. *ecuadorensis*, was observed (Fig. 9). The epithet "*ecuadorensis*" refers to the type locality.

Mallomonas lychenensis Conrad f. *ecuadorensis* Wujek et Dziedzic *f. nov.*

Latin diagnosis: *Differt a f. lychenensis fasci scuti. Scutum 6-8 magnis lacunis irregulariter distributis. Scutum squamae areis papillarum dense obtectum. Squamae 3-3.5 x 5-6 mm. Lacunae magnae (0.5-1.2 mm diametro) scutarum quasi quadrangulares tres aut quatuor seriebus duabus distributae. Nec setae nec cystae observatae.*

Typus: Die 12 junii, anno 2001 in stagnum gramineum (02º46.58'S, 79º13.93'W), Ecuador. Figuris 9 monstratus, in collectione Universitatis Michiganensis Centralis, Mount Pleasant, Michigan. Holotypus: Fig. 9.

Description: This species differs from *M. lychenensis* f. *lychenensis* in the appearance of 6-8 large, irregularly arranged pits in the shield. The shield of scales is covered with well developed patches of closely spaced papillae (Fig. 9). The scales are 3-3.5 x 5-6 µm. Large pits (0.5-1.2 µm diameter) occur in two rows, three to four pits in each row. Bristles and cysts not observed.

Type locality: Pool with grass (02º46.58'S, 79º13.93'W), Ecuador, South America, 12 June 2001; deposited in the Central Michigan University Herbarium (CMC). Type figure: Fig. 9.

The unique size of the large pores in the shield separates this taxon from other forms. While the papillate shield area is structurally similar to *M. lychenensis* our taxon possess the very large double row of pits terminating with a large pit at the proximal end. Such a pit is lacking in f. *lychenensis*. It also resembles *M. lychenensis* f. *symposiaca* Skogstad & Kristiansen, but lacks the elongated and often irregular-shaped depressions or channels along the shield.

TABLE I. Ecuadorian site where silica-scaled chrysophytes were sampled, 1988-2001.

Sample	Date	Site Description	GPS coordinates	pH	Taxa
1	3 June 2001	3 year old oxbow	01°0.91'S, 77º0.85'W	6	4
2	3 June 2001	Oxbow	01°0.43'S, 77º2.40'W	6	2
3	3 June 2001	stream	01°0.41'S, 77º2.40'W	-	2
4	4 June 2001	oxbow	01°0.43'S, 77º2.40'W	-	2
5	5 June 2001	forest pond	---	-	1
6	5 June 2001	oxbow near Nenquipare	01°0.61'S, 77º3.48'W	-	4
7	5 June 2001	oxbow	01°0.61'S, 77º3.33'W	-	1
8	5 June 2001	oxbow	01°0.35'S, 77º3.48'W	-	2
9	6 June 2001	swamp	01º0.41'S, 77º3.07'W	6	1
10	6 June 2001	oxbow	01º0.37'S, 77º 2.70'W	6	1
11	6 June 2001	swamp	---	-	1
12	7 June 2001	pond behind dune along river	01º1.49'S, 76º59.20'W	7	1
13	7 June 2001	Schwar pond, herding corral nearby	01º1.49'S, 76º56.92'W	-	2
14	7 June 2001	pond by bridge over Rio Shiripuno	01º0.71'S, 76º56.40'W	-	0
15	7 June 2001	ditch along road near bridge	01º0.51'S, 76º56.70'W	-	1
16	7 June 2001	pond with floating lumber, oily	01º0.42'S, 76º53.2O'W	5.5	1
17	7 June 2001	petroleum company pond	00º38.57'S, 76º53.13'W	-	4
18	7 June 2001	grassy field pond	00º34.58'S, 76º53.58'W	-	2
19	7 June 2001	clear brown lake	---	5.5	3
20	7 June 2001	Pond, military camp near Coca	---	6	6
21	9 June 2001	Lago Cuicocha, crater lake	00º17.54'N, 78º21.46'W	7	3
22	9 June 2001	Lago San Pedro	00º12.90'N, 78º14.27'W	6.5	3
23	9 June 2001	alpine meadow, hoof prints	00º11.26'S, 78º35.14'W	-	3
24	10 June 2001	hot springs	00º14.03'S, 78º37.75'W	-	1
25	10 June 2001	quarry puddle	00º14.04'S, 78º36.24'W	-	1
26	12 June 2001	Dos Chorreras trout farm	02º47.07'S, 79º10.06'W	6	3
27	12 June 200	Caballo Shayana, shallow lake	02º47.23'S, 79º12.64'W	-	0
28	12 June 2001	shallow pond	02º47.17'S, 79º12.79'W	-	4
29	12 June 2001	pond	02º47.09'S, 79º12.87'W	-	4
30	12 June 2001	shallow pool, rocky bottom	02º47.14'S, 79º12.82'W	-	1
31	12 June 2001	grassy pond	02º47.17'S, 79º12.73'W	5	2
32	12 June 2001	Lago Torreodora	02º46.91'S, 79º13.5'W	6	2
33	12 June 2001	Lago Pallcacocha	02º46.79'S, 79º13.85'W	5.5	3
34	12 June 2001	pool with grass	02º46.58'S, 79º13.93'W	-	3
35	12 June 2001	pond	02º46.59'S, 79º13.91'W	-	1
36	12 June 2001	pool along road	02º47.31'S, 79º12.98'W	5.5	5
37	12 June 2001	deep pool with aquatic plants	02º47.39'S, 79º12.82'W	5.5	3
38	12 June 2001	pool	02º47.38'S, 79º12.81'W	-	2
39	12 June 2001	roadside pool	02º46.63'S, 79º14.57'W	-	1
40	13 June 2001	pond with aquatic plants present	02º54.13'S, 79º15.66'W	-	1
41	13 June 2001	boggy pond, shallow, silty bottom	02º54.15'S, 79º15.60'W	5.5	3
42	13 June 2001	pond with horse dung	01º54.59'S, 79º16.76'W	-	10
43	13 June 2001	one of the Lagunas de Angas	02º53.70'S, 79º17.58'W	-	0
44	13 June 2001	lake	02º53.26'S, 79º17.65'W	-	1
45	13 June 2001	small marsh	02º53.20'S, 79º17.76'W	-	7
46	13 June 2001	small pond	02º53.25'S, 79º17.71'W	5	3

Continuation Table I.

Sample	Date	Site Description	GPS coordinates	pH	Taxa
47	13 June 2001	grassy marsh	02º54.15'S, 79º17.01'W	-	1
48	13 June 2001	small pond	02º54.14'S, 79º16.94'W	-	0
49	13 June 2001	small pond	02º54.13'S, 79º16.94'W	5	6
50	13 June 2001	tiny pool between hummocks	02º54.12'S, 79º16.98'W	5	4
51	15 June 2001	park pond, Quito	01º11.29'S, 78º29.13'W	-	1
MI	14-May-88	Laguna Grande Cuyabeno, Amazonia	---	-	1
M2	17-May-88	Zancudo Cocha, Amazonia	---	-	7
M3	17-May-88	Zancudo Cocha, Amazonia tributary	---	-	7
M4	23-May-88	Laguna Grande Cuyabeno, flooded lake	---	-	2
M5	29 Dec 1991	El Junco, Galápagos	---	-	1
M6	13 July 1996	Culebrilla, Andean, Cajas, stream leaving lake	---	-	1
M7	5 May 1993	Temblandera, Oro Province Reservoir	---	-	1
M8	5 May 1993	San Martin coastal *Azolla* pond	---	-	0
M9	24-May-88	Texaco pond, Amazonia, Lago Agrio	---	-	0

DISCUSSION

The scaled chrysophyte flora of Ecuador is similar to that reported for other parts of South and Central America. The species found are distributed in temperate and tropical regions (Cronberg 1989, 1996; Hansen 1996). Most surprising was the low occurrence of *Synura uvella*, a ubiquitous species which was observed in only one of our samples (Table II).

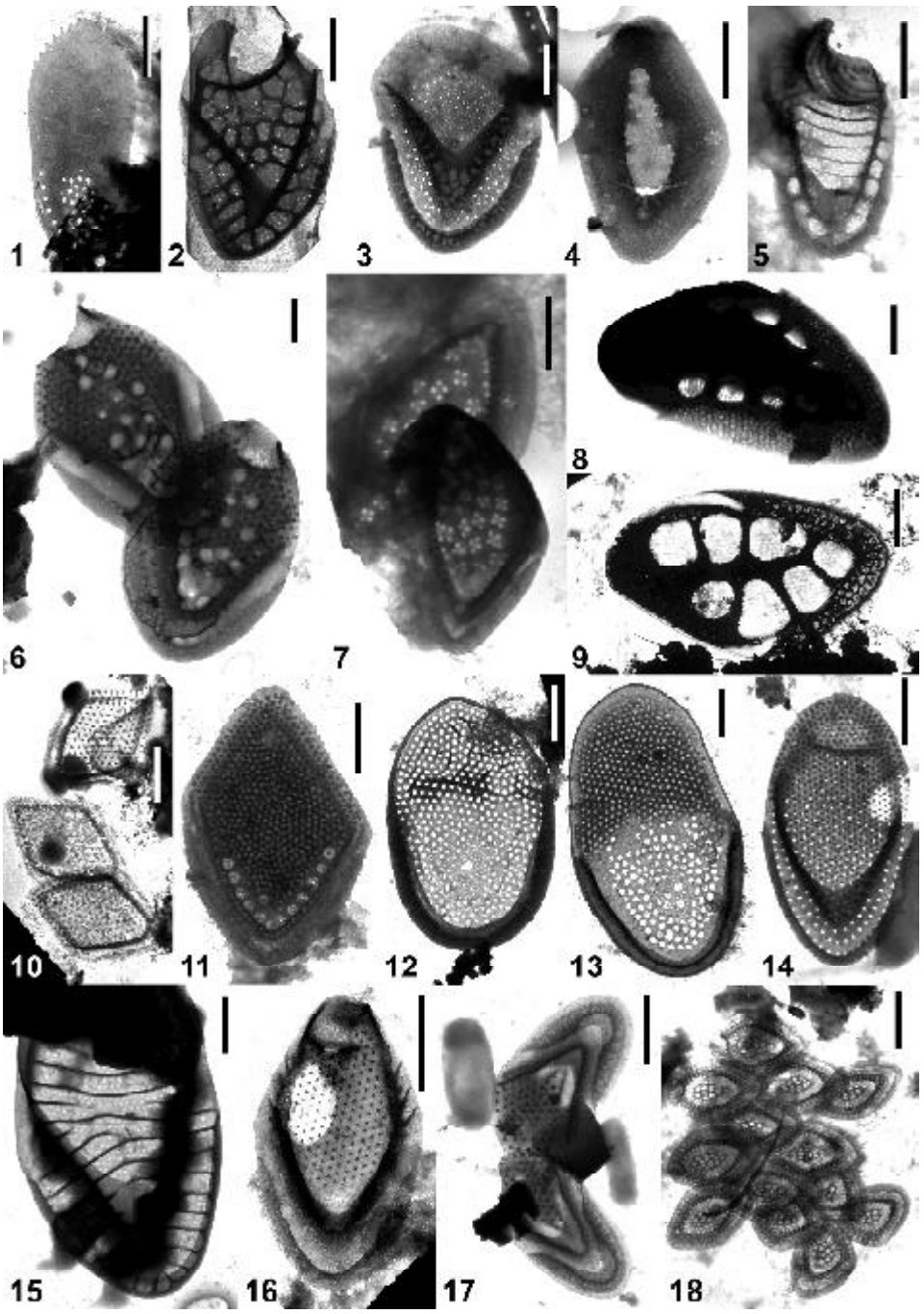
Mallomonas lanalhuensis (Fig. 7) is reported for only the second time since its original description from Chile (Dürrschmidt 1983a). Similarly, the occurrence of *Mallomonas fenestrata* (Fig. 4) from a small marsh represents the fourth report of a species to date found only in South America (Cronberg & Hickel 1985; Cronberg 1989; Kristiansen & Menezes 1998). Some of the other taxa that we observed were originally described from South and Central America, but have since been shown to be cosmopolitan. Examples include *Mallomonas cristata*, *M. guttata*, *M. multisetigera*, *M. parvula* and *M. pillula* f. *valdiviana*.

The number of species in each sample was relatively low. The total is considerably less than might have been expected considering that, with only two exceptions, all of the samples came from sites where pH was less than 7.0 (Table I). This is surprising, because acidic conditions have been shown to be optimal for scaled chrysophyte growth (Roijackers & Kessels 1986; Siver 1988, 1989, 1991).

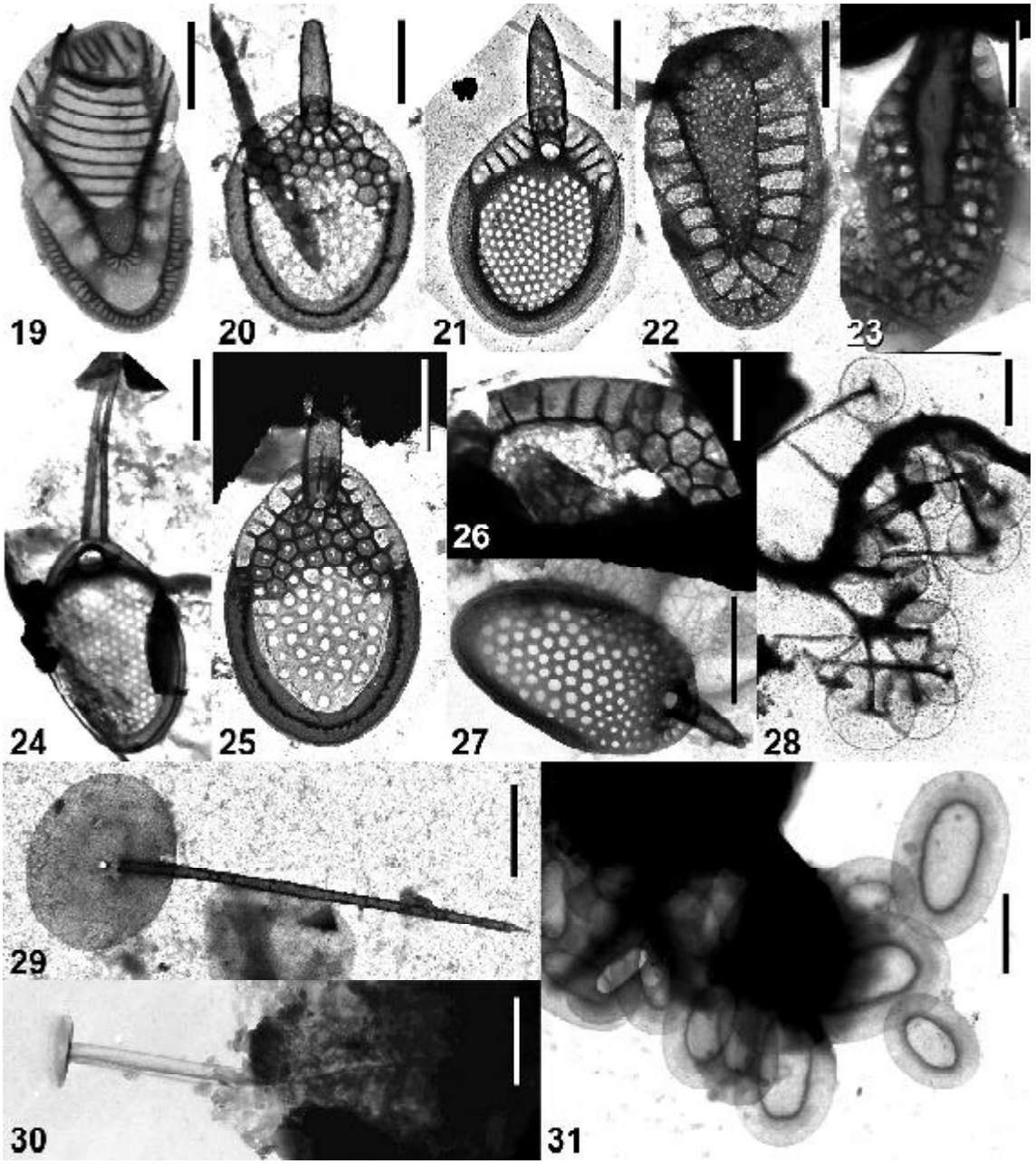
Although water temperatures were not taken at time of sampling, the species observed tolerate wide ranges and are therefore considered as eurythermal (Takahashi 1978). Future South American studies should include this ecological parameter. Roijackers and Kessels (1986) have demonstrated in temperate waters the abundance of a particular species is mostly controlled by water temperature. In subtropical and tropical areas, Saha and Wujek (1990) and Wujek and Saha (1996) have suggested that where average air or water temperatures are at 20°C continuously, these temperatures could affect development and diversity of scaled chrysophyte populations.

This paper raises the known silica-scaled chrysophyte flora of Ecuador to a total of 30 taxa. This is far fewer than the numbers observed from Argentina (58), Brazil (52) and Chile (40). However these three countries have had their scaled chrysophyte flora studied more extensively. It is hoped our study will stimulate further Ecuadorian studies. Collections and observations representing other seasons and/or other Ecuadorian geographic regions and habitat types will undoubtedly yield additional species.

Some types of habitat have yet to be thoroughly studied worldwide, including in Ecuador. Kristiansen (1986) has stated that one such habitat type in need of research is high altitude lakes in tropical mountains. This is supported by Cronberg (1989) who states "that many more species belonging to this algal group will be found if systematic investigations of the tropics at different seasons of the year and over several years are undertaken".



FIGURES. 1-18. *Mallomonas*. 1. *M. akrokomos*, slipper scale. 2. *M. crassisquama*, apical scale. 3. *M. cristata*, body scale. 4. *M. fenestrata*, body scale. 5. *M. flora*, body scale. 6. *M. guttata*, body scale. 7. *M. lanalhuensis*, body scales. 8. *M. lychenensis*, body scale. 9. *M. lychenensis* f. *ecuadorensis*, body scale. 10. *M. mangofera* f. *mangofera*, body scales. 11. *M. mangofera* f. *foveata*, body scale. 12. *M. matvienkoae* var. *matvienkoae*, body scale. 13. *M. matvienkoae* var. *grandis*, body scale. 14. M. *multisetigera*, body scale. 15. *M. paludosa*, body scale. 16. *M. papillosa*, body scale. 17. *M. parvula*, body scale. 18. *M. pillula* f. *valdiviana*, body scales. Scale bar = 1 µm.



FIGURES 19-31. *Mallomonas striata* var. *serrata*, body scale. Figs. 20-26. *Synura*. 20. *S. curtispina*, body scale. 21. *S. echinulata*, body scale. 22. *S. petersenii* f. *petersenii*, body scale. 23. *S. petersenii* f. *kufferathii*, body scale. 24. *S. sphagnicola*, body scale. 25. *S. spinosa*, body scale. 26. *S. uvella*, body scale. Fig. 27. *Chrysodidymus synuroideus*, body scale. Figs. 28-29. *Paraphysomonas*. 28. *P. vestita*, body scales. 29. *P. imperforata*, body scale. Figs. 30-31. *Spiniferomonas trioralis*. 30. Spine scale. 31. Plate scales. Scale bar = 1 μm.

TABLE II. Taxa observed in the Ecuador collections. See Table I for locations.

Taxon	Sites
Synurophyceae	
Mallomonas akrokomos Ruttner	32
M crassisquama (Asmund) Fott	M6
M cristata Dürrschmidt	26,M2,M3
M fenestrata Cronberg & Hickel	45
M flora Harris & Bradley	42,47
M guttata Wujek	17,20
M lacalhuensis Dürrschmidt	42,46,49
M lychenensis Conrad	42
M lychenensis f. *ecuadorensis* Wujek & Dziedzic	34
M mangofera Harris & Bradley f. *mangofera*	1,4,6,13,20
M mangofera f. *foveata* Dürrschmidt	1,6,12,17,18,20,M2,M3
M matvienkae (Matvienko) Asmund & Kristiansen var. *matvienkae*	2,3,7,13,16,17,19,20,21 23,42,45
M matvienkae var. *gracilis* Dürrschmidt & Cronberg	16,17
M. *multisetigera* Dürrschmidt	5,23,42,45,49
M paludosa Fott	49,50,M2,M3
M papillosa Harris & Bradley	22,31,32,34,36,41,42
M parvula -like Dürrschmidt	42
M pillula Harris f. *valdiviana* Dürrschmidt	2
M striata Asmund var. *serrata* Harris & Bradley	16,28,29,37,41,42,45
Synura curtispina (Petersen & Hansen) Asmund	13,14
S echinulata Korshikov	19,20,23,28,29,30,33,37,38,41,42,45,47,
S petersenii Korshikov f. *petersenii*	1,3,4,6,26,33,36,45,46,49
S petersenii f. *kufferathii* Petersen & Hansen	2,3,8,42
S sphagnicola Korshikov	M2
S spinosa Korshikov	6,28,29,34,36,39,50,M1
S uvella Ehrenberg em. Korshikov	26
Chrysodidymus synuroideus Prowse	31,48,M2,M3
Chrysophyceae	
Paraphysomonas imperforata Lucas	22,36
P vestita (Stokes) de Saedeleer	6,10,11,15,16,18,20,22,24,25,28,33,35, 36,37,40,42,44,49,51,M2,M3,M7
Spiniferomonas trioralis Takahashi	7,16

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BIBLIOGRAPHY

CARTY, S. & D.E. WUJEK. 2003. A new species of *Peridinium* and new records of dinoflagellates and silica-scaled chrysophytes from Belize. Caribbean Journal of Science 39:136-139.

CRONBERG, G. 1989. Biogeographical studies on scaled chrysophytes from the tropics. Nova Hedwigia 95: 191-232.

CRONBERG, G. 1996. Scaled chrysophytes from the Okavango Delta, Botswana, Africa. Beihefte zur Nova Hedwigia 114: 91-108.

CRONBERG, G. & B. HICKEL. 1985. *Mallomonas fenestrata* sp. nov. and *M. perforata* sp. nov. (Chrysophyceae. Mallomonadaceae) from tropical lakes. Nordic Journal of Botany 5: 105-110.

DÜRRSCHMIDT, M. 1980. Studies on the Chrysophyceae from Rio Cruces, Prov. Valdivia, South Chile, by scanning and transmission electron microscopy. Nova Hedwigia 33: 353-388.

DÜRRSCHMIDT, M. 1981. *Mallomonas cristata* sp. nov. (Chrysophyceae, Synuraceae) from south Chilean inland waters. Phycologia 20: 298-302.

DÜRRSCHMIDT, M. 1982a. Studies on the Chrysophyceae from south Chilean inland waters by means of scanning and transmission electron microscopy, 2. Algological Studies 31: 121-163.

DÜRRSCHMIDT, M. 1982b. *Mallomonas parvula* sp. nov. and *Mallomonas retifera* (Chrysophyceae, Synuraceae) from south Chile. Canadian Journal of Botany 60: 651-656.

DÜRRSCHMIDT, M. 1983a. Three new species of *Mallomonas* (Chrysophyceae, Mallomonadaceae) from Lake Lanalhue, Chile. Nordic Journal of Botany 3: 423-430.

DÜRRSCHMIDT, M. 1983b. A taxonomic study of *Mallomonas mangofera* group (Synuraceae, Chrysophyceae) including the description of four new taxa. Plant Systematic and Evolution 143: 175-196.

DÜRRSCHMIDT, M. 1983c. New taxa of the genus *Mallomonas* (Mallomonadaceae, Chrysophyceae) from southern Chile. Nova Hedwigia 38: 717-726.

FRANCESCHINI, I.M. & J. KRISTIANSEN. 2004. New records of scale-bearing chrysophytes for Florianópolis, Santa Catarina Island, Southern Brazil. Algological Studies 111: 63-77.

GIFFORD, D.J. 1991. The protozoan-metazoan link in pelagic ecosystems. Journal of Protozoology 38: 81-86.

HANSEN, P. 1996 Silica-scaled Chrysophyceae and Synurophyceae from Madagascar. Archiv für Protistenkunde 147: 145-172.

KRISTIANSEN, J. 1979. Problems in classification and identification of Synuraceae (Chrysophyceae). Schweizerische Zeitschrift für Hydrologie 40: 310-319.

KRISTIANSEN, J. 1986. Identification, ecology, and distribution of silica-scale-bearing Chrysophyceae, a critical approach. In: Chrysophytes: aspects and problems (eds J. Kristiansen & R.A. Andersen), pp. 229-239. Cambridge University Press, Cambridge.

KRISTIANSEN, J. & M. MENEZES. 1998. Silica-scaled chrysophytes from an Amazonian flood-plain lake, Mussurá, northern Brazil. Algological Studies 90: 97-118.

KRISTIANSEN, J. & D. TONG. 1995. A contribution to the knowledge of the silica-scaled chrysophytes in Mexico. Archiv für Hydrobiologie 77: 1-6.

ROIJACKERS, R.M.M. & H. KESSELS. 1986. Ecological characteristics of scale-bearing Chrysophyceae from the Netherlands. Nordic Journal of Botany 6: 373-385.

SAHA, L.C. & D.E. WUJEK. 1990. Scaled-chrysophytes from northeast India. Nordic Journal of Botany 10: 343-354.

SIVER, P.A. 1988. Distribution of scaled chrysophytes in 17 Adirondack (New York) lakes with special reference to pH. Canadian Journal of Botany 66: 1391-1403.

SIVER, P.A. 1989. The distribution of scaled chrysophytes along a pH gradient. Canadian Journal of Botany 67:2120-2130.

SIVER, P.A. 1991. The Biology of *Mallomonas*: Morphology, Taxonomy and Ecology. Kluwer, The Netherlands. 230 pp.

SMOL, J.P. 1995. Applications of chrysophytes to problems in paleoecology. In: Chrysophytes Algae: Ecology, Phylogeny and Development (eds. C. Sandgren, J.P. Smol & J. Kristiansen), pp. 303-329. Cambridge University Press, Cambridge.

STOERMER, E.F. 1999. The Diatoms: Applications for the Environmental and Earth Sciences. Cambridge University Press, Cambridge. 469 pp.

TAKAHASHI, E. 1978. Electron microscopical studies of the Synuraceae (Chrysophyceae) in Japan. Tokai University Press, Tokyo. 194 pp.

VIGNA, M.S. & S.D. ESCOBAR. 1999. Silica-scaled chrysophytes from the Amazonian region in Colombia. Nova Hedwigia 69: 151-162.

VIGNA, M.S. & J. KRISTIANSEN. 2002. Chrysophyceae y Synurophyceae de Tierra del Fuego. Monografias del Museo Argentino de Ciencias Naturales, Nº 9. 45 pp.

WUJEK, D.E. 1984. Scale-bearing Chrysophyceae (Mallomonadaceae) from North-Central Costa Rica. Brenesia 22: 309-313.

WUJEK, D.E. & P.R. ELSNER. 1992. *Pterocystis ebelii*, a new heliozoa from India. Transactions of the American Microscopical Society 111: 143-148.

WUJEK, D.E. & L.C. SAHA. 1996. Scale bearing chrysophytes from India. II. Beihefte Nova Hedwigia 112: 365-375.

WUJEK, D.E., R.E. CLANCY, JR. & S.P. HORN. 1998. Silica scaled Chrysophyceae and Synurophyceae from Costa Rica. Brenesia 49-50: 11-19.

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