EUROPEAN ACADEMIC RESEARCH
Vol. IV, Issue 6/ September 2016

Impact Factor: 3.4546 (UIF)
DRJI Value: 5.9 (B+)

ISSN 2286-4822
www.euacademic.org

An Updated Checklist of the Phytoplankton of the White Nile at Khartoum, Sudan

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Abstract:

The phytoplankton of the White Nile at Khartoum was studied during May 2000-May 2001. Over 125 species and varieties belonging to 86 genera of algae and Cyanobacteria encountered in net samples were identified. In terms of number of species, Chlorophyta surpassed other groups (78 species, 37 genera) > Bacillariophyta (39 species, 20 genera) > Cyanobacteria (22 species, 13 genera). The contribution of Euglenophyta and Pyrrhophyta was negligible. No xantophyceaen or chrysophyceaen alga was encountered in the plankton. Certain taxa which dominated the phytoplankton in the 1950s disappeared and new species appeared in appreciable numbers. Aulacoseira granulata and its variety angustissima and Anabaena flos–aquae f. spiroides continued to be the dominant taxa in the phytoplankton during the present study. Planktolyngbya limnetica and Anabaenopsis tanganyikae, which constituted important components of the phytoplankton in the early 1950s, maintained themselves in negligible numbers while Anabaenopsis cunningtonii which was common in the 1950s disappeared during the present study. Cocconeis placentula was

reported for the first time in the White Nile during the present study in large numbers in net samples.

Key words: Sudan, White Nile, tropical rivers, phytoplankton, diatoms, Cyanobacteria, *Aulacoseira granulata, Anabaena flos-aquae, Cocconeis placentula.*

INTRODUCTION

Checklists of phytoplankton species in the White Nile have been documented by few workers during the last century. Brook (1954) was the first to present a comprehensive systematic account of the phytoplankton of the White Nile collected during 1949-1952. Twenty years later during 1968–1970 Sinada (1972) presented an exhaustive list of the phytoplankton of the White Nile. Sinada and Abdel Rahman (2013) and Abdel Rahman and Sinada (2015) described in detail the water quality and the seasonal variations of the major planktonic algae of the White Nile at Khartoum respectively. The aim of the present study was to update the phytoplankton checklist of the White Nile at Khartoum, compare the systematic lists compiled in early 1950s and late1960s with data collected during the present study and to comment on changes which occurred during the last sixty years in the phytoplankton of the White Nile at Khartoum.

MATERIALS AND METHODS

The sampling site was described by Sinada and Abdel Rahman (2013). Phytoplankton samples were taken at two–week intervals from May 2000 to May 2001. To determine the species composition of the phytoplankton, net samples were obtained by hand towing a 55-µm mesh size standard phytoplankton net. For the taxonomic analysis of phytoplankton, the hauls were examined live on arrival to the laboratory before being

preserved in 4% formalin and left undisturbed until further thorough examination.

The algae were identified according to the standard works of West and West (1904-1912), Cleve-Euler (1951), Desikachary (1959), Prescott (1962), Krammer (1991a,b) and Wehr, and Sheath (2003). To enhance diatom identification, sub-samples of the net samples were acid-cleaned using a mixture of sulphuric acid and nitric acid.

RESULTS AND DISCUSSION

Systematic list of the phytoplankton of the White Nile

Table 1 shows the checklists compiled by the present authors, by Brook (1954) and by Sinada (1972). Sinada (1972) listed over 150 algal species belonging to 74 genera of the six algal classes Bacillariophyta, Cyanobacteria, Chlorophyta, Euglenophyta, Pyrrhophyta, and Xanthophyta. During the present study over 125 algal taxa belonging to 86 genera were encountered in the White Nile at Khartoum. Comparing these two lists with that of Brook (1954) compiled in 1949-1952, it is obvious that there was an increase in diversity of species recorded. Many algae appeared for the first time in 1970s and by the turn of the century during the present study though mostly in very small numbers; a few others disappeared altogether during the present study (Table 1).

In terms of biomass, the phytoplankton of the White Nile was constituted in the main by Bacillariophyceae and Cyanobacteria and to lesser extent Chlorophyceae. In terms of number of species, chlorophycean algae outnumbered all other groups. Euglenophyceae and Dinophyceae were meagerly represented in the open water. No member of the Xantophyceae or Chrysophyceae was encountered in the plankton of the White Nile.

Table 1 Checklists of planktonic algae encountered in net samples collected from the White Nile at Khartoum during the periods May 2000-May 2001 (present study), 1949-1952 (Brook 1954), and 1968-1970 (Sinada 1972)

(+) rare, (++) occasional-frequent and (+++) common-dominant.

Taxa	Present study	Brook (1954)	Sinada (1972)
1-CHLOROPHYCEAE			
Actinastrum hantzschii Lagerheim var. *intermedium* Teil.	–	++	–
Actinastrum hantzschii Lagerheim	+	–	–
Ankistrodesmus falcatus (Corda) Ralfs	+	++	+
Ankistrodesmus falcatus var. *acicularis* (A.Braun) West	+	–	–
Ankistrodesmus falcatus var. *duplex* (Kützing) G. W. West	–	++	–
Ankistrodesmus fractus (West &West) Brunnthaler	+	–	–
Ankistrodesmus spp.	+	–	–
*Arthrodesmus convergens*Ehrenberg	–	+	–
Arthrodesmus subtulatus Kützing	+	+	–
Asterococcus limneticus G.M. Smith	+	+	–
Centritractus belonophorus Lemmermann	+	+	–
Chlamydomonas spp.	+	+	–
Chlorella sp.	+	–	–
Closterium acerosum (Schrank) Ehrenberg ex Ralfs	+	–	++
Closterium acutum var. *variabile* Krieger.	–	+	–
Closterium lineatum Ehrenberg	–	+	–
Closterium moliniferum Ehrenberg	+	–	–
Closterium parvulum var. *angustum* West & Smith	+	+	–
Closterium setaceum Ehrenberg	+	+	+
Closterium strigonum Brébisson	–	+	–
Closterium substrigosum W. & G. West	–	+	–
Coelastrum combricum Archer	–	+	–
Coelastrum microsporum Nägeli	+	+	–
Coelastrum reticulatum (Dangeard) Senn	–	++	–
Coelastrum sp.	+	–	–
Coelastrum sphaericum Nägeli	+	++	+
Cosmarium blytii Wille	+	+	–
Cosmarium blytii Wille var. *novae-sylvae* W. & G. S. West	–	+	–
Cosmarium laeve Rabenhorst	–	+	–
Cosmarium leave Rabenhorst	+	++	–
Cosmarium moniliforme (Turpin) Ralfs.	+	+	–
Cosmarium spp.	+	–	–
Cosmarium subtumidum Nordst. var. *klebsii* (Gutw.) W. & G. S. West	–	+	–
Crucegenia quadrata Morren.	+	+	+
Crucegenia rectangularis (A.Braun) Gay	+	–	–
Crucegenia sp.	+	–	–
Crucegenia tetrapedia (Kirchner) West &West	+	–	–
Errerella sp.	+	–	+
Dictyosphaerium pulchellum H. C. Wood.	+	++	+
Euastrum divergens Joshua.	–	+	–
Euastrum spinulosum Delp. subsp. *africanum* Norgat.	+	++	–
Eudorina elegans Ehrenberg	+	++	+
Gloeocytis gigas (Kützing) Lagerheim	+	+	+
Gloeocytis major Gerneck	+	–	–
Gonatozygon aculeatum Hastings	–	++	–
Gonatozygon monotaenium De Bary	+	+	+
Dimorphococcus lunatus A. Braun	+	+	–
Kirchneriella lunaris (Kirchner) Moebius	+	+	–
Kirchneriella obesa (W. West) Schmidle	+	++	–

Kirchneriella spp.	+	–	–
Lagerheimia ciliata (Lagerheim) Chodat	+	–	+
Micractinium pusillum Fresenius	+	++	+
Micrasterias crux-melitensis (Ehrenberg) Hassall	+	+	–
Micrasterias tropica Nordst.	–	+	–
Mougeotia sp.	+	++	+
Nephrocytium lunatum G. S. West	+	++	–
Oedogonium spp.	+	–	+
Oocystis borgei Snow	+	+	+
Oocystis elliptica W. West	+	–	–
Pandorina morum (O. Müller) Bory	+	++	–
Pediastrum boryanum (Turpin) Meneghini	–	++	–
Pediastrum duplex Meyen.	–	++	–
Pediastrum duplex var. *reticulatum* Lagerheim	–	++	–
Pediastrum simplex var. *duodenarium* (Bailey) Rabenhorst	+	–	++
Pediastrum tetras (Ehrenberg) Ralfs	+	+	–
Scenedesmus accuminatus (Lagerhein) Chodat	+	+	–
Scenedesmus bijuga var. *alternans* Peinsch Hansgrig	+	+	–
Scenedesmus bijugatus (Turpin) Lagerheim	+	++	+
Scenedesmus dimorphus (Turpin) Kützing	+	+	+
Scenedesmus incrassatulus Bohlin	+	–	–
Scenedesmus obliguus (Turpin) Kützing	+	–	–
Scenedesmus opoliensis Richter..	–	+	–
Scenedesmus quadricauda (Turpin) Brébisson	+	++	–
Scenedesmus spp.	+	–	–
Schroederia setigera (Schröder) Lemmermann	+	+	+
Schroederia sp.	+	–	–
Selenastrum capricornicum Printz.	–	+	–
Selenastrum westii G.M. Smith	+	–	+
Sphaerocystis schröteri Chodat	+	++	–
Spirogyra sp.	+	+	+
Staurastrum gracile Ralfs	+	+	+
Staurastrum leptocladum Norst.	–	+	–
Staurastrum limneticum Schmidle	–	+	–
Staurastrum sp.	+	–	–
Staurastrum volans W. & G. S. West	–	+	–
Tetradesmus wisconsinense G.M. Smith.	+	–	+
Tetraedron bifurcatum (Wille) Lagerheim	–	+	–
Tetraedron constrictum G. M. Smith	+	–	+
Tetraedron minimum (A. Braun) Hansgirg	–	+	–
Tetraedron muticum (A. Braun) Hansgirg	+	–	+
Tetraedron planktonicum G. M. Smith	–	+	–
Tetraedron proteiforme (Turn.) Brunnth.	–	+	–
Tetraedron tetragonum (Nägeli) Hansgirg	–	++	–
Tetraedron trigonum (Nägeli) Hansgirg	–	++	–
Ulothrix sp.	+	–	–
Volvox aureus Ehrenberg	+	++	+
Volvox globator (L.) Ehrenberg	–	+	–
Westella botryoides (W. West) de Wildemann	+	++	–
EUGLENOPHYCEAE			
Euglena granulata W. Smith	–	+	–
Euglena sp.	+	–	–
Phacus longicauda (Ehrenberg) Duj.	–	+	–
Phacus pleuronectes (O. F. Müller) Duj.	–	+	–
Trachellomonas spp.	+	–	–
DINOPHYCEAE			
Glenedinium sp.	+	–	–
CHRYSOPHYCEAE			
Centritractus belonophorus Lemmermann	–	+	–
Ophiocytium capitatum var. *longispinum* Lemmermann	–	+	–
Stipitococcus urceoplatus W. & G. S. West	–	++	+

BACILLARIOPHYCEAE			
Amphora sp..	+	–	–
Aulacoseira agassizii (Ostenf.) Simonsen	+	++	–
Aulacoseira agassizii var. *malayensis* (Hustedt) Simonsen	–	++	–
Aulacoseira ambigua (Grunow) Simonsen	+	+	+
Aulacoseira distans (Ehrenberg) Simonsen.	++	++	+
Aulacoseira granulata (Ehrenberg) Simonsen	+++	+++	+++
Aulacoseira granulata var. *angustissima* (Müller) Simonsen	+++	++	+++
Aulacoseira granulata var.*valida* (Hustedt) Simonsen	–	+	–
Aulacoseira nyassensis var. *victoriae* (Müller) Simonsen.	++	+	–
Caloneis amphisbaena (Bory) Cleve	+	–	–
Cocconeis placentula Ehrenberg	+++	–	–
Cocconeis placentula var. *lineate* (Ehrenberg) Cleve	+	–	–
Cyclotella comta (Ehrenberg) Kützing	–	+	–
Cyclotella kuetzingiana Chauvin	+	++	++
Cyclotella meneghiniana Kützing	+	+	+
Cyclotella sp.	+	–	–
Cyclotella sp.	+	–	–
Cymatopleura elliptica (Brébisson) W. Smith	+	+	+
Cymbella spp.	+	–	–
Diploneis spp.	+	–	–
Fragilaria capucina Desmzazier	++	–	–
Fragilaria crotonensis Kitton	+	–	+
Fragilaria sp.	+	–	–
Gomphonema spp.	+	–	–
Gyrosigma acuminatum (Kützing) Rabenhorst	+	–	+
Gyrosigma spp.	+	–	–
Hantzschia amphioxys (Ehrenberg) Grunow	+	–	+
Melosira varians C.A.Agardh	+	–	++
Navicula spp.	+++	+	+
Nitzschia acircularis (Kützing) W. Smith	+	+++	+
Nitzschia lanceolata W. Smith	–	+	–
Nitzschia nyassensis O. F. Müller	–	+	–
Nitzschia palea (Kützing) W. Smith	+	++	–
Nitzschia spp.	+	–	+
Pinnularia gibba Ehrenberg	+	–	–
Pinnularia sp.	+	–	–
Rhopalodia gibba (Ehrenberg) O. Müller	+	–	+
Rhopalodia spp.	+	–	–
Surirella linearis W. Smith	+	+	++
Surirella spp.	+	–	–
Synedra acus var. *radians* (Kützing) Hustedt	++	+	+
Synedra cunningtonii G. S. West	–	++	–
Synedra nyansae G. S. West	–	+	–
Synedra ulna (Nitzsch.) Ehrenberg	++	++	+
Synedra ulna var. *danica* (Kuetzing) Grunow	+	–	–
Synedra ulna var.*spathulifera* Grunow	–	++	–
Ulnaria acus (Kützing) M. Aboal	+	+	++
CYANOPHYCEAE (CYANOBACTERIA)			
Anabaena aphanizomenoides Forti.	–	++	–
Anabaena flos-aquae (Lyngbye) Brébisson f. *spiroides* (Woron.) Elenkin	+++	+++	+++
Anabaena sp.	+	–	–
Anabaenopsis circularis (West) Wolosz & Miller	+	–	+
Anabaenopsis cunningtonii W. R. Taylor	–	++	–
Anabaenopsis tanganyikae (West) Wolosz & Miller	+	+++	+
Aphanizomenon sp.	+	–	–
Aphanocapsa delicatissima West & West	+	++	–
Chroococcus disperses var. *minor* G.M. Smith	+	+	–
Chroococcus dispersus var. *minor* G.M. Smith	–	+	–
Chroococcus limneticus Lemmermann	+	++	–
Chroococcus turgidus (Kützing) Nägeli	+	+	–

Gloeocapsa sp.	+	–	–
Merismopedia glauca (Ehrenberg) Nägeli	+	+	+
Microcystis aeruginosa (Kützing) Kützing	+	++	–
Microcystis flos-aquae (Wittrock) Kirchner	+	++	+
Microcystis pulvera var. *incerta* (Lemmermann.) Crow.	–	++	–
Nodularia spumigena Mertens	+	+	+
Oscillatoria agardhii var. *isothrix* Skuja	++	++	–
Oscillatoria geminata Gomont	–	++	–
Oscillatoria limnetica lemmermann	–	+	–
Oscillatoria planktonica Wolos.	–	++	–
Oscillatoria princeps Vauch.	–	+	–
Oscillatoria tenuis C.A.Agardh ex Gomont	+	–	+
Phormidium mucicola Naumann & Huber Pestalozzi	+	++	–
Planktolyngbya (formerly *Lyngbya) limnetica* Lemmermann	+	+++	+
Planktothrix limnetica (Lemmermann) Komarek	++	+	+
Planktothrix spp.	+	–	–
Raphidiopsis curvata Fritsch	–	++	–
Raphidiopsis mediterranea Skuja	+	–	–
Spirulina major Kützing	+	–	+
Spirulina subtlissima Kützing	–	+	–

Bacillariophyceae:

A total of 39 diatoms belonging to 20 genera were recorded. Only few diatoms contributed appreciably to the total phytoplankton at different times of the year, thus *Aulacoseira granulata* and its variety *angustissima*, *A. distans*, *A. nyassensis* var. *victoriae*, *Ulnaria acus*, *Fragilaria* spp., and *Cocconeis placentula*. The latter diatom was encountered for the first time in the White Nile in large numbers during the present study.

Cyanophyceae (Cyanobacteria)

A total of 22 Cyanobacteria belonging to 13 genera were identified. However, only two cyanobacterial genera contributed appreciably to the total phytoplankton biomass, thus: *Oscillatoria* and *Anabaena*.

Chlorophyceae:

In terms of number of species chlorophycean algae formed the most abundant group in the plankton of the White Nile contributing more species than any other class. A total of 78 species belonging to 37 genera were recorded. However, in terms of biomass green algae rarely contributed appreciably to the total algal biomass. Quantitatively they were far less

important than diatoms and cyanobacteria contributing < 0.5% to total biomass.

ACKNOWLEDGEMENTS

The authors wish to express their gratitude to Mr. R. Ross, Department of Botany, Natural History British Museum, for the identification of *Aulacoseira distans*. The funding supports from University of Khartoum and Ministry of Higher Education and Scientific Research are appreciated.

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