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PHYTOPLANKTON IN VIRGINIA LAKES AND RESERVOIRS

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ABSTRACT

This study involves a phytoplankton summer/autumn survey in 46 Virginia lakes and reservoirs during 2010-2012. A total of 307 taxa were identified which included several filamentous and colonial cyanabacteria in bloom concentrations. With the exception of one natural lake, the other sites sampled represent impoundments created decades ago, with the majority presently classified as meso- or eutrophic. Among the cyanobacteria were 6 known toxin producers (*Anabaena circinalis, Anabaena spiroides, Aphanizomenon flos-aquae, Cylindrospermopsis raciborskii, Limnothrix redekei*, and *Microcystis aeruginosa*). The study characterizes phytoplankton populations in these aging freshwater habitats taken from a large number of sites over a broad geographical extent in Virginia. The results portend future concerns for increased presence of less favorable algal populations in Virginia lakes and reservoirs, including an increased occurrence of algal blooms, and presence of potential harmful species.

Keywords: Phytoplankton, lakes, reservoirs, Virginia

INTRODUCTION

There are numerous water habitats designated as lakes in Virginia, and these vary greatly in size ranging from expansive reservoirs to what may be considered large ponds. The Virginia Department of Game and Inland Fisheries has identified ca. 150 of these sites commonly used for recreational activities (VDGIF 2002). In addition to these there are numerous other lakes and reservoirs of various sizes and recreational usage throughout Virginia. There are two natural lakes in Virginia (Lake Drummond and Mountain Lake), plus others representing man-made lakes and reservoirs formed by impoundments of rivers and streams. Waters from several of these sites are made palatable by water treatment facilities, with many commonly utilized for public recreational activities. There are also general concerns associated with both of these practices that relate to shifts in the composition of the algal populations in lakes over time. This transition involves changing from a more favorable assemblage of algae to those considered less desirable that will negatively influence water quality, even resulting in potentially harmful effects to animals and humans (Funari and Testai 2008, O'Neil et al. 2012). This change in algal composition typically accompanies the transitional trophic changes in lakes as they age, with this pattern enhanced with increased nutrient input. These less favorable algae may be associated with taste and odor contamination to drinking water derived from these lakes, or associated with algal blooms and toxin production (Cronberg et al. 2003, Codd et al. 2005, Hoeger et al. 2005). Many of the Virginia lakes have reached, or are approaching the later trophic stages that favor development of these less desirable algal taxa. This study provides a current appraisal of phytoplankton composition from a broad selection of Virginia lakes and reservoirs, plus identifying the major bloom and potential toxin producing species in these waters.

There have been numerous freshwater algal studies in Virginia including Lewis et al. (1933) who identified 249 freshwater phytoplankton taxa from several streams and small swamps in the Piedmont region of Virginia. Forest (1954) identified 359 algae in the vicinity of Mountain Lake taken from ponds, creeks, soil, and rock habitats. Algal composition from a variety of regional sites within the James River Basin were extensively studied by Woodson (1959, 1960, 1962a, 1962b), Woodson and Holoman (1964, 1965), and Woodson and Prescott (1961). These collections primarily came from ponds, streams, and small swamps from this region, with Woodson and Holoman (1965) listing 631 algal species. A more restrictive survey based on chlorophytes and cyanobacteria was conducted by Nemeth (1969) in the two Virginia counties on the Delmarva Peninsula reporting 102 and 43 taxa respectively within these two categories. Palmer (1967) has also provided references mentioning algae from a variety of water habitats in Virginia. A comprehensive algal species list from Mountain Lake, including data from previous studies since 1930, was reported by Parson and Parker (1989). Their summary included 331 species from this lake with chlorophytes having the greatest representation with 180 taxa (54.3%), followed by 45 cyanobacteria (13.8%), 25 diatoms (7.5%), and other groups with lesser representation. There have also been numerous phytoplankton studies in Lake Drummond, a dystrophic lake in the Dismal Swamp of southeastern Virginia by Poore and Marshall (1972), Marshall (1976, 1979, 1990), and Phillips and Marshall (1993). Marshall (1979) identified 71 taxa from this natural lake which was dominated by diatoms and chlorophytes, with desmids a common component. Several of the other lakes in southeastern Virginia with phytoplankton listing include a borrow pit lake (Lake Trashmore, Sheavly and Marshall 1989), Hoffler Lake (Wolny 1999), plus the inclusion of Lake Kilby and Western Branch Reservoir (Muscio 2001).

To date there has been no general or recent survey of phytoplankton composition in Virginia lakes and reservoirs, or to address the degree of potentially harmful taxa that are present in these waters. Since the majority of these lakes were created several decades ago many of these have progressively advanced toward trophic conditions that are more favorable to algal bloom production by a less desirable algal community (e.g. cyanobacteria dominance). The objectives of this paper are: 1) to identify the present phytoplankton composition from a large representation of Virginia lakes and reservoirs, and 2) to note potentially harmful phytoplankton species in these waters.

METHODS AND MATERIALS

Water samples for phytoplankton analysis came from 46 Virginia lakes and reservoirs (Fig. 1). Collections were made July through September over 3 years (2010-2012). Surface (<1m) water samples (500-1000 ml) were collected and preserved with

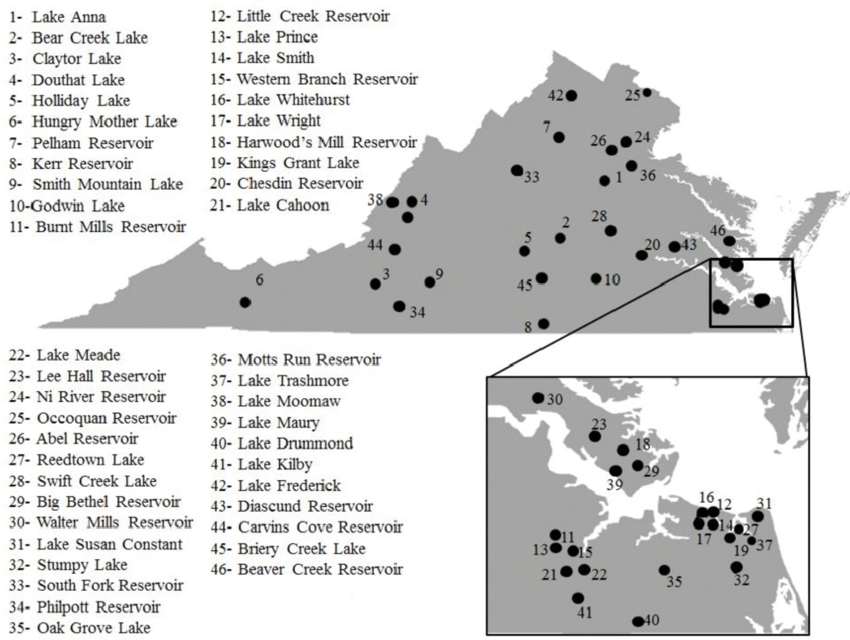

FIGURE 1. Locations of 46 Virginia lakes and reservoirs where phytoplankton samples were collected for analysis, 2010-2013.

Lugol's solution (1-2 ml). The most extensive collections were in 2012 when water samples were taken from 40 of the lakes and reservoirs. Data from 6 additional lakes from 2010 and 2011 are also included. An Utermöhl method of analysis using an inverted plankton microscope was used to examine concentrated aliquots of these samples at magnifications of 300X and 600x (Marshall 1976). Cyanobacteria filaments were counted as numbers per ml, with colonial and unicellular cyanobacteria, and the other algal groups counted as number of cells per ml.

RESULTS AND DISCUSSION

The lakes and reservoirs sampled came from several of Virginia's geographical regions. These were the Coastal Plain, Piedmont, Blue Ridge Mountains, and the Valley/Ridge. There were considerable differences among the lakes sampled regarding surface area, their age, depth, and elevation. The majority of these were impoundments created decades ago and have now progressed to later more nutritive levels of development. The trophic status for 39 of the 46 lakes was determined by VWCB (1992) using water quality values, with another 4 by the author based on their bloom and compositional status. The other 3 were not designated to a specific status due to lack of nutrient information. Based on these evaluations of the 43 sites, 25 (58.1%) were considered eutrophic, 12 (27.9%) mesotrophic, and 5 (11.6%) oligotrophic lakes, with 1 (2.3%) dystrophic lake. Thus, of these lakes 85% were in either a mesotrophic or eutrophic stage of development. In addition, 23 of these also represented a public water supply source. Depths for many were < 4 meters, while the greatest depths came from Kerr Reservoir (ca. 30m), with a mean depth of ca. 9.1m. Ten of the lakes (21.7%) had a surface area of <40 ha, with 18 (39.1%) a surface area ca. 40-200 ha, 7 lakes (15.2%) at ca. 200-400 ha, and 9 lakes (19.7%) ca. 400-4047 ha, plus the two largest sites (4.3%) were Kerr Reservoir and Smith Mountain Lake, with surface areas of ca. 19,790 and 8,336 ha respectively. Lake Godwin was among the smallest in area at ca. 6 ha. During these collections the surface (<1m) temperatures ranged from 19.6 to 33.3°C, with an average of 27.1°C.

A total of 307 phytoplankton taxa were identified (Table 1). They consisted of 126 chlorophytes (41.0%), 78 cyanobacteria (25.4%), 44 diatoms (14.3%), 38 euglenophytes (12.9 %), 10 dinoflagellates (3.2%), 5 cryptophytes 1.6%), 5 chrysophytes (1.6%), and 1 raphidophyte (<0.01%). There were also several unidentified, but not common chlorophytes and pennate diatoms among the samples. The general algal flora was characteristic for U.S. north temperate fresh water lakes (Prescott 1951). However, since the collections represent a limited series of collections (3 months of the year), a more comprehensive seasonal series of observations, plus additional sampling sites, would likely provide additional taxa and expand the species list. In this study, the greatest concentrations of algae and algal bloom development were associated with colonial and filamentous cyanobacteria. The sites having a more advanced trophic status also had a greater and more abundant representation of these cyanobacteria, and included Lake Maury, Little Creek Reservoir, Lake Whitehurst, and Pelham Reservoir. The most abundant cyanobacteria at these locations were: *Anabaen*a sp., *Aphanozomenon flos-aquae, Chroococcus dispersus, Cylindrospermopsis raciborskii, Glaucospira laxissima (Spirulina laxissima), Jaaginema metaphyticum (Oscillatoria angusta), Limnothrix redekei (Oscillatoria redekei), Merrismopedia tenuissima, Planktolyngbya contorta (Lyngbya contorta), Planktolyngbya limnetica (Lyngbya limnetica), Planktolyngbya* cf. *minor* (*Lyngbya limnetica* f. *minor*), *Pseudanabaena limnetica (Oscillatoria limnetica),* and *Woronichinia naegeliana.* The lakes having a lower trophic status (e.g. dystrophic, oligotrophic) contained a greater representation of chlorophytes and diatoms, with lower phytoplankton abundance and less diversity. Among these sites were: Abel Reservoir, Hungry Mother Lake, Douthat Lake, Lake Kilby, Lake Drummond, and Carvins Cove Reservoir. The common chlorophytes at these and the other sites included *Ankistrodesmus falcatus, Crucigenia tetrapedia, Closteriopsis longissima, Desmodesmus quadricauda, Monoraphidicum contortum, Scenedesmus bijuga,* and *Staurastrum* sp. Diatoms frequently present were *Aulacoseira granulata, Fragilaria crotonensis,* and a variety of pennate species. By using the concentrations of the various species at all of these lakes during the 2012 collections (e.g. 40 sites), the mean representation percentage in abundance among the major algal categories was: cyanobacteria (71.2%), chlorophytes (13.7%), diatoms (9.4%), cryptophytes (3.5%), euglenophytes (0.6%), raphidophytes (0.3%), chrysophytes (0.2%), and dinoflagellates (0.1%). A contributing factor regarding the high cyanobacterial abundance were their blooms during this period at 9 (22.5%) of the 40 sites sampled in 2012.

These 9 cyanobacteria blooms occurring during the 2012 collections, with their abundance maxima, were: *Chroococcus dispersus* (85,215 cells/ml), *Chroococcus minutus* (20,093 cells/ml), *Jaaginema subtillissimum* (12,259 filaments/ml), *Jaaginema*

TABLE 1. Phytoplankton species from water samples taken in July, August, and September 2010-2012 from 46 Virginia lakes and reservoirs.

Chlorophytes
Actinastrum hantzschii Langerheim
Actinastrum gracilimnia G.M. Smith
Ankistrodesmus falcatus (Corda) Ralfs
Ankistrodesmus falcatus v. *acicularis* (Braun) G.S. West
Ankistrodesmus falcatus v. *mirabilis* (West et West) G.S.West
Ankistrodesmus nannoselene Skuja
Botryococcus sudeticus Lemmermann
Botryococcus braunii Kützing
Centritractus belenophorus Lemmermann
Chlamydomonas globosa Snow
Chlamydomonas gloeogama Korshikov
Chlamydomonas reinhardtii Dangeard
Chlamydomonas sp.
Chlorella ellipsoida Gerneck
Chlorella minutissima Fott et Novakova
Chlorella vulgaris (Beyerinck) Beijerinck
Chlorococcum echinozygotum Starr
Chlorococcum humicola (Nägeli) Rabenhorst
Chlorococcum infusionum (Schrank) Meneghiini
Chloromonas tenbraria (Skuja) Gerloff et Ettl
Closteriopsis acicularis (G. M. Smith) Belcher et Swale
Closteriopsis longissima (Lemmermann) Lemmermann
Coelastrum microsporum Nägeli
Coelastrum reticulum (Dangeard) Senn
Coelastrum sphaericum Nägeli
Crucigenia fenestrata Schmidle
Crucigenia tetrapedia (Kirchner) W. et G.S.West
Crucigenia truncata G.M. Smith
Crucigeniella crucifera (Wolle) Komárek
Desmodesmus armatus (Chodat) Hegewald
Desmodesmus armatus v. longispina (Chodat) Hegewald
Desmodesmus brasiliensis (Bohlin) Hegewald
Desmodesmus maximus (W.& G.S. West) Hegewald
Desmodesmus opoliensis (Richter) Hegewald
Desmodesmus quadricauda (Turpin) Hegewald
Desmodesmus sp.
Dictyosphaerium pulchellum Wood
Dimorphococcus lunatus A. Braun
Eudorina elegans Ehrenberg
Franceia sp.
Golenkiniopsis sp.
Gonium pectoral O.F. Müller
Kirchneriella contorta (Schmidle) Bohlin
Kirchneriella lunaris (Kirchner) Möbius
Kirchneriella lunaris v. irregularis G.M. Smith
Krichneriella obesa v. *major* (Bernard) G.M. Smith
Lagerheimia sp. Chodat
Lauterborniella elegantissima Schmidle
Micractinium pusillum Fresenius
Microspora pachyderma (Wille) Lagerheim
Monoraphidium arcuatum (Korshikov) Hindák
Monoraphidium contortum (Thuret) Komárková-Legnerová
Monoraphidium irregulare (G.M. Smith) Komárková-Legnerová
Mougeotia sp.
Oedogonium sp.

TABLE 1. Continued.

Oocystella borgei J. Snow
Oocystis elliptica West
Oocystis lacustris Chodat
Oocystis marssonii Nägeli
Pandorina morum (Müller) Bory de Saint-Vincent
Pediastrum biradiatum Meyen
Pediastrum duplex Meyen
Pediastrum duplex v. gracillimum West & G.S. West
Pediastrum obtusum Lucks
Pediastrum simplex (Meyen) Lemmermann
Pediastrum tetras (Ehrenberg) Ralfs
Pediastrum tetras v. *tetraodon* (Corda) Rabenhorst
Quadrigula closterioides (Bohlin) Printz
Quadrigula lacustris (Chodat) G.M. Smith
Rhizoclonium hieroglyphicum (C.A. Agardh) Kützing
Scenedesmus acuminatus (Lagerheim) Chodat
Scenedesmus bijuga (Turpin) Lagerheim
Scenedesmus denticulatus Lagerheim
Scenedesmus dimorphus (Turpin) Kützing
Scenedesmus incrassatulus Bohlin
Scenedesmus opoliensis P. Richter
Scenedesmus sp. Meyen
Schroederia setigera (Schröder) Lemmermann
Selenastrum bibraianum Reinsch
Selenastrum minutum (Nägeli) Collins
Selenastrum westii G.M. Smith
Spirogyra sp.
Tetraedron enorme (Ralfs) Hansgirg
Tetraedron gracile (Reinsch) Hansgirg
Tetraedron incus (Teiling) G.M. Smith
Tetraedron minimum (Braun) Hansgirg
Tetraedron regulare Kützing
Tetraedron trigonum v.*gracile* (Reinsch) Detoni
Tetrahedron muticum (A. Braum) Hansgirg
Trichonema bourrellyi (J.W.G. Lund) Anagnostidis
Treubaria setigerum (Archer) G.M. Smith
Ulothrix sp.
Westella linearis G.M. Smith
Zygnema sp.

Chlorophytes: Desmidiaceae
Arthrodesmus incus v. *extensus* Anderson
Closterium gracile Brébisson
Closterium lineatum Ehrenberg
Closterium rostratum Ehrenberg
Closterium setaceum Ehrenberg
Closterium sp.
Cosmarium circulare Reinsch
Cosmarium portianum Archer
Cosmarium sp.
Desmidium aptogonum Brébisson
Desmidium sp.
Desmidium swartzii Agardh
Euastrum bidentatum Nägeli
Eusastrum divaricatum Lundell
Gonatozygon kinahani (Archer) Rabenhorst
Hyalotheca disseliens (Smith) Brébisson
Micrasterias radata Hassall
Micraterias sp.
Penium margaritaceum (Ehrenberg) Brébisson
Spirotaenia condensata Brébisson

TABLE 1. Continued.

Staurasstrum paradoxum Meyen
Staurastrum americanum (West et West) G.M. Smith
Staurastrum chaetoceras (Schröder) G.M. Smith
Staurastrum cingulum (West et G.S. West) G.M. Smith
Staurastrum leptocladum Nordstedt
Staurastrum manfeldtii Delponte
Staurastrum obiculare Ralfs
Staurastrum paradoxum Meyen
Staurastrum quadricuspedatum Turner
Staurastrum sp.
Triplocerus gracile Bailey
Xanthidium sp. Ehrenberg

Diatoms
Asterionella formosa Hassal
Asterionella formosa v. ralfsii (W. Smith) Wolle
Aulocosiera distans (Ehrenberg) Simonsen
Aulacoseira granulata (Ehrenberg) Simonsen
Aulacoseira granulata v. angustissima (O. Müller) Simonsen
Aulacoseira herzogii (Lemmermann) Simonsen
Aulacoseira islandica (O. Müller) Simonsen
Cocconeis sp.
Cyclotella caspia Grunow
Cyclotella meneghiniana Kützing
Cyclotella sp.
Cyclotella stelligera Cleve et Grunow
Cymbella ehrenbergii Kützing
Epithemia turgida (Ehrenberg) Kützing
Eunotia curvata (Kützing) Lagerheim
Eunotia pectinalis (Kützing) Rabenhorst
Eunotia sp.
Fragilaria capucina Desmarzières
Fragilaria crotenensis Kitton
Fragilaria crotenensis v. oregona Sovereign
Fragilaria sp.
Frustulia rhomboids (Ehrenberg) DeToni
Gyrosigma sp.
Meridion circulare (Greville) C. Agardh
Navicula sp.
Neidium iridis v. *vernalis* Reichelt
Nitzschia acicularis W. Smith
Nitzschia sp.
Pinnularia acuminata W. Smith
Pinnularia biceps Gregory
Pinnularia gibba Ehrenberg
Pinnularia lata (Brébisson) Rabenhorst
Pinnularia latevittata Cleve
Pinnularia sp.
Pleurosigma angulatum (Queckett) W. Smith
Pleurosigma sp.
Surirella biseriata v. *constricta* (Ehrenberg) Grunow
Surirella sp.
Synedra acus Kützing
Synedra delicatissima W. Smith
Synedra radians Kützing
Synedra ulna f. *lingissima* (W. Smith) Brun
Tabellaria fenestrata (Lyngbye) Kützing
Tabellaria flocculosa (Roth) Kützing

Euglenophytes
Euglena acus Ehrenberg
Euglena caudata Hübner
Euglena convoluta Korshikov

TABLE 1. Continued.

Euglena deses Ehrenberg
Euglena ehrenbergii Klebs
Euglena mutabilis Schmitz
Euglena oxyuris Schmarda
Euglena proxima Dangeard
Euglena sp.
Euglena spirogyra Ehrenberg
Gonyostomum sp.
Leptocinclis ovum (Ehrenberg) Lemmermann
Leptocinclis sp.
Phacus acuminatus Stokes
Phacus caudatus Hübner
Phacus curvicauda Swirenko
Phacus lemmermannii (Swirenko) Skvortosov
Phacus longicauda (Ehrenberg) Dujardin
Phacus obicularis Hübner
Phacus sp.
Phacus suecicus Lemmermann
Phacus tortus (Lemmermann) Skvortsov
Phacus undulatus (Skvortzov) Pochmann
Strombomonas longicauda (Swirenko) Deflandre
Trachelomonas acanthophora Stokes
Trachelomonas acanthostoma Stokes
Trachelomonas alisoviana Skvortsov
Trachelomonas armata (Ehrenberg) Stein Lemmermann
Trachelomonas gibberosa Playfair
Trachelomonas globularis v. *boyeri* (Palmer) Conrad
Trachelomonas hispida (Perty) Stein
Trachelomonas hispida v. *coronata* Lemmermann
Trachelomonas intermedia Dangeard
Trachelomonas raciborskii Woloszyńska
Trachelomonas similis Swirenko
Trachelomonas sp.
Trachelomonas superba Swirenko
Trachelomonas volvocina Ehrenberg

Cryptophytes
Chroomonas sp.
Cryptomonas erosa Ehrenberg
Cryptomonas marssonii Skuja
Cryptomonas ovata Ehrenberg
Cryptomonas sp.

Raphidophyte
Gonyostomum semen (Ehrenberg) Diesing

Chrysophytes
Dinobryon bavericum Imhof
Dinobryon divergens Imhof
Dinobryon sertularia Ehrenberg
Mallomonas acaroids Perty
Synura caroliniana Whitford

Dinoflagellates
Ceratium cornutum (Ehrenberg) Claparède et Lachmann
Ceratium hirundinella (Müller) Dujardin
Gymnodinium sp.
Peridinium aciculiferum Lemmermann
Peridinium bipes Stein
Peridinium inconspicuum Lemmermann
Peridinium pusillum (Lenard) Lemmermann
Peridinium sp.
Peridinium westii Lemmermann
Peridinium wisconsinense Eddy

Cyanobacteria
Anabaena affinis Lemmerman
Anabaena circinalis Rabenhorst

TABLE 1. Continued.

Anabaena perturbata v. tumida (Nygaard) Cronberg et Komárek
Anabaena planctonica Brunnthaler
Anabaena spiroides Klebahn
Anabaena sp.
Anabaena viguieri Denis et Frémy
Anabaena wisconsinense Prescott
Anabaenopsis elenkinii Muller
Aphanizomenon flos-aquae (L.) Ralfs
Aphanizomenon gracile (Lemmermann) Lemmermann
Aphanizomenon issatschenkoi (Ussaczew)) Proschkina-Laurenko
Aphanocapsa delicatissima W. et G.S. West
Aphanocapsa elaschista W. et G.S. West
Aphanocapsa incerta (Lemmermann) Cronberg et Komárek
Aphanocapsa pulchra (Kützing) Rabenhorst
Aphanothece clathrata W. et. G.S. West
Aphanothece minutissima (W. West) Komárková-Legnerová et Cronberg
Aphanothece nidulans Richter
Chroococcus dispersus (Keissler) Lemmermann
Chroococcus limneticus Lemmermann
Chroococcus minor (Kützing) Nägeli
Chroococcus minutus (Kützing) Nägeli
Chroococcus pallidus (Nägeli) Nägeli
Chroococcus sp.
Chroococcus turgidus (Kützing) Nägeli
Coelosphaerium kuetzingianum Nägeli
Cylindrospermopsis philippinensis (Taylor) Komárek
Cylindrospermopsis raciborskii (Woloszyńska) Seenayya et Subba Raju
Dactylococcus acicularis Lemmermann
Dactylococcus fascilularis Lemmermann
Dactylococcus rhaphidiodes Hansgrig
Dactylococcus sp.
Geitlerinema amphibium (Agardh) Anagnostidis
Glaucospira agilissima Lagerheim
Glaucospira laxissima G.S. West
Gleocapsa punctata Nägeli
Gloeocapsa sp.
Gomphosphaeria aponina Kützing
Jaaginema metaphyticum Komárek
Jaaginema neglectum (Lemmermann) Anagnostidis et Komárek
Jaaginema subtilissimum (Kützing) Anagnostidis et Komárek
Limnothrix planctonica (Woloszyńska) Meffert
Limnothrix redekei (Van Goor) Meffert
Lyngbya birgei G.M. Smith
Lyngbya major Meneghini
Merismopedia elegans A. Braun
Merismopedia glauca (Ehrenberg) Kützing
Merismopedia punctata Meyen
Merismopedia tenuissima Lemmermann
Microcystis aeruginosa (Kützing) Kützing
Microcystis incerta Lemermann

TABLE 1. Continued.

Microcystis smithii Komárek et Anagnostidis	*Pseudanabaena acicularis* (Nygaard) Anagnostidis et Komárek
Microcystis viridis (A. Braun) Lemmermann	*Pseudanabaena limnetica* (Lemmermann) Komárek
Nostoc commune Vaucher	*Raphidiopsis curvata* Fritsch
Nostoc sp.	*Rhabdoderma lineare* Schmidle et Lauterborn
Oscillatoria limosa Agardh	*Rhabdogloea smithii* (R. et F. Chodat) Komárek
Oscillatoria princeps Vaucher	*Snowella lacustris* (Chodat) Komárek et Hindák
Oscillatoria sp.	Snowella litoralis (Häyerén) Komárek et Hindák
Phormidium sp.	*Spirulina laxa* G.S. Smith
Planktolyngbya contorta (Lemmermann) Anagnostidis et Komárek	*Spirulina meneghiniana* Zanardini
Planktolyngbya limnetica (Lemmermann) Komárková-Legnerová et Cronberg	*Spirulina subsalsa* Oersted
Planktolyngbya minor (Geitler) Komárek et Cronberg	*Spirulina weissii* Drouet
Planktothrix agardhii (Gomont) Anagnostidis et Komárek	*Synechococcus* sp.
	Trichodesmium lacustre Klebahn
	Woronichinia naegeliana (Unger) Elenkin

metaphyticum (19,315 filaments/ml), *Microcystis aeruginosa* (43,056 cells/ml), *Planktolyngbya contorta* (13,933 filaments/ml), *Planktolyngbya limnetica* (39,169 filaments/ml), *Pseudanabaena limnetica* (41,860 filaments/ml), and *Woronichinia naegeliana* (472,056 cells/ml). Another algal bloom occurring at one site during this time period was by the chlorophyte *Rhizoclonium hieroglyphicum* (2,332 filaments/ml). The number of cells in the algal filaments varied greatly within and between species (e.g. 8-38 cells/filament). In contrast to the cyanobacteria blooms that were more common in the open expanse of these waters, the *R. hieroglyphicum* bloom occurred in a narrow and shallow (<2m) extension of the eutrophic Lake Smith. *Ceratophyllum demersum* (Hornwort), an aquatic angiosperm, provided an extensive submerged growth that extended beneath and intermingled with the *R. hieroglyphicum* filaments. This was a long lasting bloom that was noted in early August and continued into November 2012.

Included among the phytoplankton were 6 species known to be potential toxin producers (Cronberg et al. 2003). These were *Anabaena circinalis, Anabaena spiroides, Aphanizomenon flos-aquae, Cylindrospermopsis raciborskii, Limnothrix redekei*, and *Microcystis aeruginosis*. Of the 46 lakes sampled 27 (58.6%) contained at least 1 of these species, with 19 (41.4 %) sites not having any during these collections.

Aphanizomenon flos-aquae was in 14 (30.4%) of the lakes, with *Limnothrix redekei* in 10 (21.7%), and *Cylindrospermopsis raciborskii* in 7 (15.2%) of the lakes and reservoirs. Eleven (23.9%) of the lakes had 2-3 of these HABs, and only Lake Prince had 4 (*A. circinalis, A. spiroides, A. flos-aquae, C. raciborskii*). During these collections none of these taxa attained major bloom status, nor were there any known fish kills or harmful impacts associated with these algae.

SUMMARY

A total of 307 freshwater algae were identified from 46 Virginia lakes and reservoirs. The majority of these locations represented advanced (meso-eutrophic) stages of development that provided favorable conditions for algal diversity and growth. Of note was the abundance of several bloom-producing filamentous and colonial cyanobacteria, including 6 potentially harmful species (with at least one of these in over half of the sites sampled). These data indicate there are numerous freshwater sites in Virginia among those sampled here that are favorable locations for bloom producing algae, including the less desirable species associated with degraded water quality and toxin production.

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