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A diatom voucher flora from selected southeast rivers (USA)

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ABSTRACT

This flora is intended to serve as an image voucher for samples analyzed for the U.S. Geological Survey Southeast Stream Quality Assessment (SESQA). The SESQA study included measurement of watershed and water quality parameters to determine the factors that have the greatest potential to alter biotic condition. Algal samples were collected at 108 sites in 2014, from streams representing gradients in chemical and physical alteration across the southeast region. More than 375 taxa were identified during analysis for species composition and abundance. This manuscript documents the flora with light micrographs of specimens representative of their morphologic range. We define "voucher flora" as images of specimens and the names applied to those specimens for a given project. Taxonomic vouchers from federal programs have generally not been made public, yet they are a salient element of a well-documented species dataset, particularly for long-term studies. This study is part of a broader effort to improve and encourage taxonomic consistency in federal, state and local programs by accessible identification resources and inter-lab comparisons.

Key words: voucher specimens, voucher flora, taxonomic consistency, diatoms, rivers

INTRODUCTION

Species composition and abundance of diatoms in streams and rivers are a crucial measure of biotic condition (Davies & Jackson 2006), as diatoms are sensitive to impacts caused by human activities such as urbanization, flow alteration, and the loading of contaminants, nutrients and sediment. Regional surveys of rivers by the U.S. Geological Survey (USGS) National Water Quality Assessment Program (NAWQA) are designed to evaluate the effects of these stressors on aquatic organisms, including diatoms. The Southeast Stream Quality Assessment (SESQA) study characterized watershed and water quality parameters, with the goal of determining the factors that have the greatest potential to alter biotic condition across the region (Journey *et al.* 2015).

The practice of depositing voucher specimens in permanent archives is an accepted component of biological surveys, across a range of organisms, for providing a means to verify taxonomic identity (Huber 1998). For federal programs, permanent slides are typically archived in public herbaria, such as the Academy of Natural Sciences of Drexel University (ANS). In practice, however, analysts generally do not designate specimens (circled specimens) documenting voucher specimens, even though it is a requirement (Charles *et al.* 2002). The effort to document each individual specimen for most surveys is so great, that vouchers are simply not designated. While designation of voucher specimens on slides is labor- and cost-prohibitive, a series of images to document the specimens is not. Furthermore, sets of digital images encompassing the morphological range of voucher specimens are more practical than circled specimens, because voucher images are easily distributed and accessible by many users. For floristic surveys, it is recommended to archive permanent slides, and to document names applied to representative images of species by the taxonomists working on that survey.

We define this flora as a "voucher flora", which 1) is tied to specimens that are publicly available in herbaria; 2) promotes consistent application of names by analysts working on a project; 3) allows verification of specimens through images, so that taxonomic practice is transparent; 4) allows for reinterpretation of specimens and names at a later date; and 5) is especially important for long-term ecological studies, in which taxonomic consistency is vital. An example of such a voucher flora is the PIRLA iconograph (Camburn *et al.* 1986). The iconograph was published as a

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series of images to coordinate workers collaborating on diatom identification from sediment paleorecords of lakes in the northeast US.

A traditional flora, in contrast, serves as a practical guide to others, typically documenting species of a particular region or a taxonomic group. We define a voucher flora as a different type of document, in that it is not a guide to diatom identification. Instead, a voucher flora records specimens, their designation and a permanent record to support quantitative analysis. As such, scientific names may not be of primary importance in a voucher flora, but they serve to verify the practice of the scientific work. In the United States, federal and state programs have included diatoms in assessment since the early 1990's. Image documentation of species and their occurrence in lake and stream surveys, however, has been incomplete (Kociolek & Kingston 1999). These voucher floras in support of species count data need to be made public. The primary purpose of this voucher flora is to serve as an image voucher for samples analyzed for the SESQA study (Table 2).

While a number of works have been published on diatoms of the southeast U.S. (Hohn & Hellerman 1963, Patrick *et al.* 1966, Dillard 1967, Camburn *et al.* 1978), those publications were not widely available and some continue to receive little attention. Since the implementation of large-scale surveys by federal agencies (Barbour *et al.* 1999, Moulton *et al.* 2002, Miller *et al.* 2012), the use of European keys has been favored because of their perceived inclusiveness and wide availability. Many of taxa recognized in early studies have been overlooked in recent surveys and coerced into incorrect names. Inter-lab comparisons have made a significant improvement in coordination of analysts working in different countries (Kahlert *et al.* 2009, Kelly 2013, Kahlert *et al.* 2016), particularly for the coordination efforts to be made prior to analysis. This voucher flora is a part of a broader effort to improve taxonomic consistency in federal, state and local programs by communicating taxonomic practice and providing accessible identification resources (Spaulding *et al.* 2010).

This voucher flora will facilitate evaluating the effects of urbanization, agriculture and altered hydrological regime on diatom biotic condition. In general, algal assessments have focused on dominant and widely occurring diatom species (Manoylov 2014). Rare taxa are often down-weighted or omitted, yet these taxa are decisive in distinguishing reference from impacted sites in mountainous regions (Potapova & Charles 2004, Gillette *et al.* 2011). In this study, we directed additional effort to documenting rare taxa for inclusion in assessment. Rare taxa are more likely to occur in sites with less human impact (Potapova & Charles 2004), yet it is likely that rare taxa are less consistently identified correctly and are "lost" in the analysis by being reported at the genus level, rather than at the species level.

The southeastern region is defined here as within Level III Ecoregions (Ridge and Valley, Blue Ridge, Piedmont and Southeastern Plains) (Omernik 1987) including five large urban areas, Washington D.C., Atlanta, Greenville-Spartanburg, Charlotte and Raleigh-Durham. Annual precipitation ranges from 94–214 cm $year^{-1}$ over the region. Soils are largely clay and are generally poor in nutrients. Stream reaches were selected to cover urban, agricultural and hydrologic gradients. In addition, five sites were chosen to represent high agricultural influence, based on proximity to large poultry operations. Reference sites were located primarily in areas with minimal watershed disturbance (Journey *et al.* 2015).

MATERIALS AND METHODS

Perennial, wadeable stream sites were sampled for attached algal communities in August of 2014 using the NAWQA richest targeted habitat (RTH) field protocol (Moulton *et al.* 2002; Table 1). Habitats were sampled to capture the greatest diversity of organisms within the stream reach, typically from riffles, although samples were collected from woody snags when riffles were not present within the reach. Periphyton biofilms were scraped using a specialized brush (a single brush was used for each stream to prevent cross contamination) from 11 natural substrates and combined into a single composite sample. A total sample area of 150 cm^2 was targeted from each reach. Samples were preserved with unbuffered formalin (final sample concentration of 5%) and transported to the laboratory for processing.

In the laboratory, subsamples of the periphyton slurry were digested with concentrated nitric acid, using an Anton Paar microwave digester to remove organic matter. Digested samples were repeatedly rinsed with distilled water and centrifuged to obtain cleaned material. Subsamples were poured onto four replicate cover slips within Battarbee chambers (Battarbee 1973). Each coverslip was mounted using Naphrax (Brunel Microscopes Ltd) or Zrax (MicrAP Enterprises) mounting medium. The remaining cleaned material was dried and archived in vials at the INSTAAR Diatom Collection, University of Colorado.

TABLE 1. List of taxa encountered in this study, with authorship, voucher images, references to plates and figures and accessioned samples at INSTAAR, University of Colorado. The location and sample identifier for each site are shown in Table 2.

Taxon	Author	Plate & Figure	INSTAAR Sample ID
Achnanthes coarctata	(Brébisson ex W. Smith) Grunow	Pl. 7, Figs 7–8	15588
Achnanthes subhudsonis var. *kraeuselii*	(Cholnoky) Cholnoky	Pl. 7, Figs 14–16	15590; 15629; 15596
Achnanthidium alpestre	(Lowe & Kociolek) Lowe & Kociolek	Pl. 7, Figs 34–37	15608
Achnanthidium deflexum	(Reimer) Kingston	Pl. 7, Figs 47–49	15543
Achnanthidium druartii	Rimet & Couté	Pl. 7, Figs 31–33	15587
Achnanthidium exigua	(Grunow) Czarnecki	Pl. 7, Figs 28–30	15596; 15654
Achnanthidium gracillimum	(Meister) Lange-Bertalot	Pl. 7, Figs 17–19	15543
Achnanthidium latecephalum	Kobayasi	Pl. 7, Figs 25–27	15599; 15592
Achnanthidium minutissimum	(Kützing) Czarnecki	Pl. 7, Figs 38–40	15544; 15596; 15571
Achnanthidium pyrenaicum	(Hustedt) Kobayasi	Pl. 7, Figs 50–52	15590; 15542
Achnanthidium reimeri	(Camburn) Ponader & Potapova	Pl. 7, Figs 23–24	15574; 15571
Achnanthidium rivulare	Potapova & Ponader	Pl. 7, Figs 44–46	15608; 15576
Achnanthidium sp.6 SESQA		Pl. 7, Figs 41–43	15587
Achnanthidium sp.8 SESQA		Pl. 7, Figs 20–22	15547
Adlafia sp.3 SESQA		Pl. 13, Figs 63–65	15641; 15572
Adlafia sp.5 SESQA		Pl. 13, Figs 57–59	15548; 15595; 15594
Adlafia sp.6 SESQA		Pl. 13, Figs 54–56	15653
Amphipleura pellucida	(Kützing) Kützing	Pl. 15, Figs 27–29	15630; 15634
Amphora bicapitata	Hohn & Hellerman	Pl. 19, Figs 16–18	15649; 15606; 15549
Amphora copulata	(Kützing) Schoeman & Archibald	Pl. 19, Figs 10–12	15574; 15559; 15649
Amphora pediculus	(Kützing) Grunow	Pl. 19, Figs 13–15	15559; 15595; 15588
Asterionella formosa	Hassall	Pl. 2, Figs 35–37	15590; 15571
Aulacoseira alpigena	(Grunow) Krammer	Pl. 1, Figs 1–3	15565; 15632
Aulacoseira ambigua	(Grunow) Simonsen	Pl. 1, Figs 4–6	15637; 15623; 15642
Aulacoseira granulata	(Ehrenberg) Simonsen	Pl. 1, Figs 7–9	15565; 15552; 15547
Aulacoseira pusilla	(Meister) Tuji & Houk	Pl. 1, Figs 10–12	15577; 15636
Bacillaria paradoxa	Gmelin	Pl. 24, Figs 6–7	15612
Brachysira brebissonii	Ross	Pl. 15, Figs 35–37	15643; 15565
Brachysira microcephala	(Kützing) Compère	Pl. 15, Figs 24–26	15636; 15617
Brachysira ocalanensis	Shayler & Siver	Pl. 15, Figs 32–34	15632; 15574
Caloneis bacillum	(Grunow) Cleve	Pl. 11, Figs 25–26	15570; 15649
Caloneis fontinalis	(Grunow) Cleve-Euler	Pl. 11, Fig. 27	15590
Caloneis hyalina	Hustedt	Pl. 11, Figs 19–21	15571; 15656; 15574
Caloneis lewisii	Patrick	Pl. 11, Fig. 18	15548
Caloneis silicula	(Ehrenberg) Cleve	Pl. 11, Fig. 17	15554
Caloneis sp.3 SESQA		Pl. 11, Figs 22–24	15590; 15588; 15596
Capartogramma crucicula	(Grunow ex Cleve) Ross	Pl. 10, Figs 29–30	15640
Cavinula cocconeiformis	(Gregory ex Greville) D.G.Mann & Stickle	Pl. 11, Fig. 28	15621
Cocconeis fluviatilis	Wallace	Pl. 7, Figs 1–3	15555
Cocconeis neothumensis	Krammer	Pl. 7, Fig. 6	15623
Cocconeis pediculus	Ehrenberg	Pl. 7, Figs 4–5	15599
Cocconeis placentula	Ehrenberg	Pl. 7, Figs 9–11	15576; 15571; 15584
Craticula accomoda	(Hustedt) D.G.Mann	Pl. 14, Figs 4–5	15647; 15630
Craticula molestiformis	(Hustedt) Mayama	Pl. 14, Figs 1–3	15602; 15544
Craticula sp.1 SESQA		Pl. 14, Figs 6–7	15544
Craticula sp.3 SESQA		Pl. 14, Figs 8–10	15601; 15631; 15564
Craticula subminuscula	Wetzel & Ector	Pl. 14, Fig. 11	15603
Ctenophora pulchella	(Ralfs ex Kützing) Williams & Round	Pl. 3, Figs 1–2	15594; 15596
Cyclotella bodanica var. *lemanica*	(Müller) Bachmann	Pl. 1, Figs 34–35	15637; 15587
Cyclotella distinguenda	Hustedt	Pl. 1, Figs 17–19	15637; 15636
Cyclotella meneghiniana	Kützing	Pl. 1, Figs 24–26	15624; 15540; 15596
Cymbella affinis	Kützing	Pl. 17, Figs 7–11	15580; 15576; 15543
Cymbella aspera	(Ehrenberg) Cleve	Pl. 17, Figs 1–2	15546
Cymbella tumida	(Brébisson ex Kützing) Van Heurck	Pl. 17, Figs 3–6	15654; 15595; 15608; 15570
Cymbella turgidula	Grunow	Pl. 17, Figs 12–14	15615; 15576; 15596
Cymbopleura apiculata	Krammer	Pl. 18, Figs 1–2	15605; 15618
Cymbopleura sublanceolata	Krammer	Pl. 17, Figs 15–17	15571; 15654; 15632

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TABLE 1. (Continued)

Taxon	Author	Plate & Figure	INSTAAR Sample ID
Delicata sp.1 SESQA		Pl. 19, Figs 1–5	15543; 15636; 15605
Denticula sp.1 SESQA		Pl. 23, Figs 49–51	15649
Denticula tenuis	Kützing	Pl. 23, Figs 44–45	15636; 15587
Diadesmis confervacea	Kützing	Pl. 13, Figs 96–97	15612; 15596
Diatoma mesodon	(Ehrenberg) Kützing	Pl. 2, Fig. 8	15544
Diatoma moniliformis	Kützing	Pl. 2, Fig. 9	15587
Diatoma tenuis	Agardh	Pl. 2, Figs 10–12	15636; 15637
Diatoma vulgaris	Bory	Pl. 2, Figs 15–16	15587
Diploneis marginestriata	Hustedt	Pl. 14, Figs 43–44	15550; 15632
Diploneis oblongella	(Nägeli ex Kützing) Ross	Pl. 14, Figs 45–47	15553; 15632
Diploneis sp.2 SESQA		Pl. 14, Figs 48–50	15632; 15570
Diploneis sp.4 SESQA		Pl. 14, Fig. 42	15548
Discostella stelligera	(Cleve & Grunow) Houk & Klee	Pl. 1, Figs 30–32	15577; 15637
Encyonema appalachianum	Potapova	Pl. 18, Figs 19–21	15543
Encyonema hamsherae	Winter & Bahls	Pl. 18, Figs 12	15563
Encyonema hebridiforme	Krammer	Pl. 18, Figs 22–24	15619; 15544
Encyonema leibleinii	(Agardh) Silva, Jahn, Ludwig & Menezes	Pl. 18, Figs 3–4	15656; 15596
Encyonema lineolatum	Krammer	Pl. 18, Figs 25–30	15547; 15641; 15644; 15628
Encyonema minuta var. *pseudogracilis*	(Cholnoky) Reimer	Pl. 18, Figs 7–11	15588; 15548
Encyonema minutum	(Hilse) D.G.Mann	Pl. 18, Figs 13–15	15576; 15544
Encyonema pergracile	Krammer	Pl. 18, Figs 16–18	15643; 15617; 15577
Encyonema triangulum	(Ehrenberg) Kützing	Pl. 18, Figs 5–6	15586; 15572
Encyonopsis subminuta	Krammer & Reichardt	Pl. 18, Figs 31–34	15637; 15552; 15600
Eolimna sp.1 SESQA		Pl. 13, Figs 75–77	15630; 15646
Eolimna madida	Kociolek	Pl. 13, Fig. 69	15582
Eucocconeis laevis	(Østrup) Lange-Bertalot	Pl. 7, Figs 12–13	15587
Eunotia bilunaris	(Ehrenberg) Souza	Pl. 6, Figs 5–8	15571; 15646; 15632; 15654
Eunotia botuliformis	Wild, Norpel-Schempp & Lange-Bertalot	Pl. 6, Figs 14–15	15565
Eunotia braendlei	Lange-Bertalot & Werum	Pl. 5, Figs 26–28	15595; 15647
Eunotia cordillera	Hohn & Hellerman	Pl. 5, Fig. 23	15649
Eunotia flexuosa	(Brébisson ex Kutzing) Kützing	Pl. 6, Fig. 1	15643
Eunotia formica	Ehrenberg	Pl. 5, Figs 1–3	15617; 15555; 15553
Eunotia genuflexa	Norpel-Schempp	Pl. 6, Fig. 4	15623
Eunotia implicata	Nörpel, Alles & Lange-Bertalot	Pl. 6, Figs 10–12	15633; 15588; 15618
Eunotia incisa	Smith ex Gregory	Pl. 6, Figs 20–21	15553
Eunotia macroglossa	Furey, Lowe & Johansen	Pl. 6, Fig. 9	15564
Eunotia meisteri	Hustedt	Pl. 5, Figs 14–16	15564; 15630; 15595
Eunotia metamonodon	Lange-Bertalot	Pl. 5, Figs 4–6	15632; 15605
Eunotia microcephala	Krasske	Pl. 5, Fig. 13	15574
Eunotia minor	(Kützing) Grunow	Pl. 5, Figs 7–10	15643; 15652; 15577; 15571
Eunotia naegelii	Migula	Pl. 6, Figs 2–3	15617; 15574
Eunotia papilioforma	Furey, Lowe & Johansen	Pl. 6, Figs 16–19	15595; 15544; 15571; 15654
Eunotia paratridentula	Lange-Bertalot & Kulikovskiy	Pl. 5, Figs 20–22	15629; 15550; 15617
Eunotia pectinalis	(Kützting) Rabenhorst	Pl. 5, Figs 24–25	15643; 15637
Eunotia sp.1 SESQA		Pl. 6, Fig. 13	15544
Eunotia sp.15 SESQA		Pl. 6, Figs 22–23	15643
Eunotia sp.5 SESQA		Pl. 5, Figs 29–31	15559; 15570; 15643
Eunotia tenella	(Grunow) Hustedt	Pl. 5, Figs 11–12	15643; 15544
Eunotia varioundulata var. *suecica*	Lange-Bertalot, Van de Vijver & Jarlman	Pl. 5, Figs 17–19	15654; 15621; 15574
Fallacia subhamulata	(Grunow) D.G.Mann	Pl. 14, Figs 12–13	15603
Fragilaria amphicephaloides	Lange-Bertalot	Pl. 3, Fig. 15–17	15636
Fragilaria crotonensis	Kitton	Pl. 3, Figs 12–14	15559
Fragilaria delicatissima	(W. Smith) Lange-Bertalot	Pl. 3, Figs 18–19	15565; 15636
Fragilaria grunowii	Lange-Bertalot & Ulrich	Pl. 3, Fig. 24	15588
Fragilaria longifusiformis	(Hains & Sebring) Siver, Morales, Van de Vijver, Smits, Hamilton & Lange-Bertalot	Pl. 4, Fig. 21	15565

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TABLE 1. (Continued)

Taxon	Author	Plate & Figure	INSTAAR Sample ID
Fragilaria pectinalis	(Müller) Lyngbye	Pl. 4, Figs 29–32	15563; 15618; 15557
Fragilaria socia	(Wallace) Lange-Bertalot	Pl. 4, Figs 19–20	15540; 15612
Fragilaria sp.1 SESQA		Pl. 4, Figs 49–52	15553; 15632
Fragilaria sp.5 SESQA		Pl. 4, Figs 33–35	15544; 15584
Fragilaria sp.12 SESQA		Pl. 4, Figs 1–2	15623
Fragilaria sp.13 SESQA		Pl. 4, Figs 26–28	15630; 15630; 15553
Fragilaria sp.16 SESQA		Pl. 4, Figs 14–18	15565; 15605; 15644
Fragilaria sp.18 SESQA		Pl. 4, Figs 9–13	15565
Fragilaria sp.22 SESQA		Pl. 3, Figs 20–23	15565
Fragilaria sp.23 SESQA		Pl. 4, Figs 22–25	15636
Fragilaria sp.26 SESQA		Pl. 4, Figs 39–44	15617; 15636; 15637
Fragilaria sp.35 SESQA		Pl. 4, Figs 45–48	15636; 15654; 15605
Fragilaria vaucheriae	(Kützing) Petersen	Pl. 4, Figs 36–38	15576; 15550; 15654
Fragilariforma virescens	(Ralfs) Williams & Round	Pl. 2, Figs 21–23	15605; 15544
Frustulia amphipleuroides	(Grunow) Cleve-Euler	Pl. 16, Fig. 1	15654
Frustulia capitata	Graeff and Kociolek	Pl. 16, Figs 15–17	15592; 15635; 15571
Frustulia crassinervia	(Brébisson) Lange-Bertalot & Krammer	Pl. 15, Figs 29–31	15630; 15580; 15617
Frustulia inculta	Siver, Pelczar & Hamilton	Pl. 16, Figs 2–3	15592
Frustulia latita	Graeff and Kociolek	Pl. 16, Figs 9–11	15570; 15617; 15592
Frustulia vulgaris	(Thwaites) De Toni	Pl. 16, Figs 12–14	15571; 15541; 15596
Geissleria decussis	(Østrup) Lange-Bertalot & Metzeltin	Pl. 15, Figs 6–8	15596; 15558
Geissleria kriegeri	(Krasske) Lange-Bertalot	Pl. 15, Figs 1–2	15544; 15643
Geissleria punctifera	(Hustedt) Metzeltin, Lange-Bertalot & Garcia-Rodriquez	Pl. 15, Figs 3–5	15635; 15618; 15571
Gomphoneis minuta	(Stone) Kociolek & Stoermer	Pl. 21, Fig. 35	15586
Gomphonema acuminatum	Ehrenberg	Pl. 20, Fig. 9	15632
Gomphonema affine	Kützing	Pl. 20, Figs 22–24	15632; 15644; 15558
Gomphonema affine var. *rhombicum*	Reichardt	Pl. 20, Figs 1–3	15548; 15540
Gomphonema caperatum	Ponader & Potapova	Pl. 19, Figs 20–23	15576; 15558; 15639
Gomphonema celatum	Thomas & Kociolek	Pl. 20, Figs 19–21	15548; 15632
Gomphonema christensenii	Lowe & Kociolek	Pl. 21, Figs 30–31	15669
Gomphonema coronatum	Ehrenberg	Pl. 20, Figs 10–11	15643; 15634
Gomphonema incognitum	Reichardt, Jüttner & Cox	Pl. 19, Figs 24–27	15620; 15576; 15558
Gomphonema kobayasii	Kociolek & Kingston	Pl. 19, Figs 35–38	15559; 15656; 15625
Gomphonema louisiananum	Kalinsky	Pl. 19, Figs 28–31	15562; 15559; 15547; 15564
Gomphonema manubrium	Fricke	Pl. 21, Figs 7–9	15544
Gomphonema mehleri	Camburn	Pl. 21, Figs 32–34	15592; 15551
Gomphonema olivaceoides var. *hutchinsoniana*	Patrick	Pl. 21, Figs 12–14	15557; 15543
Gomphonema parvulum	(Kützing) Kützing	Pl. 21, Figs 18–20	15592; 15580; 15571
Gomphonema reimeri	Kociolek & Kingston	Pl. 21, Figs 26–29	15612; 15592
Gomphonema sierrianum	Stancheva & Kociolek	Pl. 19, Figs 44–48	15543; 15558
Gomphonema sp.7 SESQA		Pl. 19, Figs 53–55	15553; 15620
Gomphonema sp.9 SESQA		Pl. 20, Figs 4–5	15640; 15616
Gomphonema sp.11 SESQA		Pl. 20, Figs 17–18	15592
Gomphonema sp.15 SESQA		Pl. 19, Figs 39–43	15595; 15563; 15576; 15590
Gomphonema sp.20 SESQA		Pl. 20, Figs 25–26	15640; 15570
Gomphonema sp.25 SESQA		Pl. 21, Figs 21–23	15549
Gomphonema sp.26 SESQA		Pl. 19, Figs 56–59	15558; 15610; 15551; 15540
Gomphonema sp.28 SESQA		Pl. 19, Figs 49–52	15570; 15550; 15632
Gomphonema sp.33 SESQA		Pl. 21, Figs 15–17	15596; 15670
Gomphonema sp.35 SESQA		Pl. 20, Figs 6–8.	15657; 15659
Gomphonema sp.40 SESQA		Pl. 19, Figs 60–62	15544; 15621
Gomphonema sp.41 SESQA		Pl. 21, Figs 3–6	15632; 15612; 15555
Gomphonema sp.42 SESQA		Pl. 19, Figs 32–34	15653; 15544
Gomphonema sphaerophorum	Ehrenberg	Pl. 21, Figs 1–3	15558; 15543
Gomphonema truncatum	Ehrenberg	Pl. 20, Figs 14–15	15568; 15557
Gomphonema turgidum	Ehrenberg	Pl. 20, Figs 12–13	15544; 15670

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TABLE 1. (Continued)

Taxon	Author	Plate & Figure	INSTAAR Sample ID
Gomphonema turris	Ehrenberg	Pl. 20, Fig. 16	15654
Gomphosphenia lingulatiformis	(Lange-Bertalot & Reichardt) Lange-Bertalot	Pl. 21, Figs 10–11	15588; 15544
Gomphosphenia stoermeri	Kociolek & Thomas	Pl. 21, Figs 24–25	15552; 15555
Gyrosigma acuminatum	(Kützing) Rabenhorst	Pl. 16, Figs 5–6	15588
Gyrosigma reimeri	Sterrenburg	Pl. 16, Fig. 4	15548
Gyrosigma scalproides	(Rabenhorst) Cleve	Pl. 16, Figs 7–8	15559; 15596
Halamphora montana	(Krasske) Levkov	Pl. 19, Fig. 19	15596
Hippodonta capitata	(Ehrenberg) Lange-Bertalot, Metzeltin & Witkowski	Pl. 14, Fig. 38	15571
Hippodonta pseudacceptata	(Kobayasi) Lange-Bertalot	Pl. 14, Figs 39–41	15563; 15656; 15550
Humidophila contenta	(Grunow) Lowe, Kociolek, Johansen, Van de Vijver, Lange-Bertalot & Kopalová	Pl. 13, Figs 93–95	15595; 15649; 15596
Humidophila perpusilla	(Grunow) Lowe, Kociolek, Johansen, Van de Vijver, Lange-Bertalot & Kopalová	Pl. 13, Figs 90–92	15670; 15560
Humidophila schmassmannii	(Hustedt) Buczkó & Wojtal	Pl. 13, Fig. 70	15595
Hydrosera whampoensis	(Schwartz) Deby	Pl. 1, Fig. 41	15540
Karayevia clevei	(Grunow) Bukhtiyarova	Pl. 6, Figs 38–40	15588; 15590
Karayevia suchlandtii	(Hustedt) Bukhtiyarova	Pl. 6, Fig. 37	15582
Kobayasiella madumensis	(Jørgensen) Lange-Bertalot	Pl. 13, Fig. 80	15643
Kobayasiella sp.1 SESQA		Pl. 13, Fig. 81	15560
Lindavia ocellata	(Pantocsek) Nakov *et al.*	Pl. 1, Figs 20–23	15600; 15562
Lindavia rossii	(Håkansson) Nakov *et al.*	Pl. 1, Figs 27–29	15587
Luticola cohnii	(Hilse) D.G.Mann	Pl. 14, Figs 34–35	15649; 15592
Luticola minor	(Patrick) Mayama	Pl. 14, Figs 19–21	15544; 15571; 15654
Luticola mutica	(Kützing) D.G.Mann	Pl. 14, Figs 32–33	15595; 15588
Luticola nivalis	(Ehrenberg) D.G.Mann	Pl. 14, Fig. 31	15574
Luticola sp.1 SESQA		Pl. 14, Figs 24–27	15544; 15596
Luticola sp.5 SESQA		Pl. 14, Figs 28–30	15592; 15654
Luticola sp.6 SESQA		Pl. 14, Figs 22–23	15649; 15576
Luticola sparsipunctata	Levkov, Metzeltin & Pavlov	Pl. 14, Figs 36–37	15649; 15649
Mayamaea agrestis	(Hustedt) Lange-Bertalot	Pl. 13, Fig. 79	15613
Mayamaea atomus	(Kützing) Lange-Bertalot	Pl. 13, Fig. 78	15640
Melosira varians	Agardh	Pl. 1, Figs 14–16	15576; 15588; 15629
Meridion alansmithii	Brant	Pl. 2, Figs 1–3	15621; 15544; 15608
Meridion circulare var. *constrictum*	(Ralfs) Van Heurck	Pl. 2, Figs 4–7	15548; 15646; 15595
Microcostatus krasskei	(Hustedt) Johansen & Sray	Pl. 13, Figs 88–89	15616; 15560
Navicula amphiceropsis	Lange-Bertalot & Rumrich	Pl. 9, Figs 20–22	15586; 15540; 15652
Navicula angusta	Grunow	Pl. 9, Figs 5–6	15621
Navicula antonii	Lange-Bertalot	Pl. 9, Figs 23–25	15618; 15576; 15555
Navicula antverpiensis	Van de Vijver & Lange-Bertalot	Pl. 9, Figs 7–8	15559
Navicula canalis	Patrick	Pl. 9, Figs 26–28	15656; 15613; 15559
Navicula capitatoradiata	Germain	Pl. 8, Fig. 24	15615
Navicula cari	Ehrenberg	Pl. 8, Fig. 34	15571
Navicula convergens	Patrick	Pl. 11, Fig. 30	15640
Navicula cryptocephala	Kützing	Pl. 8, Figs 17–20	15632; 15592; 15577; 15630
Navicula cryptocephala var. *perminuta*	(Grunow) Cleve	Pl. 13, Figs 66–68	15559; 15552; 15572
Navicula cryptotenella	Lange-Bertalot	Pl. 8, Figs 21–23	15617; 15592; 15590
Navicula dibola	Hohn	Pl. 9, Figs 38–39	15595; 15612
Navicula escambia	(Patrick) Metzeltin & Lange-Bertalot	Pl. 8, Figs 14–16	15615; 15614; 15656
Navicula geitleri	Hustedt	Pl. 15, Figs 22–23	15656
Navicula germainii	Wallace	Pl. 9, Figs 17–19	15549; 15596; 15615
Navicula geronimensis	Potapova	Pl. 8, Figs 4–5	15587
Navicula gregaria	Donkin	Pl. 9, Figs 29–31	15652; 15611; 15540
Navicula ingenua	Hustedt	Pl. 9, Figs 32–34	15616; 15555; 15631
Navicula kotschyi	Grunow	Pl. 9, Figs 35–37	15551; 15624; 15649
Navicula libonensis	Schoeman	Pl. 8, Fig. 10	15572
Navicula microcari	Lange-Bertalot	Pl. 8, Figs 28–30	15642; 15652; 15625
Navicula notha	Wallace	Pl. 9, Figs 10–13	15630; 15574; 15623; 15558
Navicula nugalis	Hohn & Hellerman	Pl. 13, Figs 71–73	15584; 15551; 15578

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TABLE 1. (Continued)

Taxon	Author	Plate & Figure	INSTAAR Sample ID
Navicula pseudoreinhardtii	Patrick	Pl. 8, Figs 25–27	15578; 15588
Navicula radiosa	Kützing	Pl. 8, Fig. 1	15599
Navicula radiosafallax	Lange-Bertalot	Pl. 9, Figs 3–4	15555; 15637
Navicula rhynchocephala	Kützing	Pl. 8, Figs 6–7	15643; 15610
Navicula rostellata	Kützing	Pl. 9, Figs 14–16	15624; 15596
Navicula sanctaecrucis	Østrup	Pl. 10, Fig. 31	15572
Navicula sp.22 SESQA		Pl. 9, Fig. 9	15587
Navicula sp.23 SESQA		Pl. 10, Fig. 32	15549
Navicula sp.7 SESQA		Pl. 9, Figs 1–2	15636; 15558
Navicula tripunctata	(Müller) Bory	Pl. 8, Figs 8–9	15590
Navicula trivialis	Lange-Bertalot	Pl. 8, Figs 11–13	15540; 15559
Navicula vilaplanii	(Lange-Bertalot & Sabater) Lange-Bertalot and Sabater	Pl. 8, Figs 31–33	15559; 15656; 15541
Navicula viridulacalcis subsp. *neomundana*	Lange-Bertalot & Rumrich	Pl. 8, Figs 2–3	15588; 15599
Neidium affine var. *amphirhynchus*	(Ehrenberg) Cleve	Pl. 11, Figs 7–9	15541; 15643; 15540
Neidium affine var. *longiceps*	(Gregory) Cleve	Pl. 11, Fig. 6	15588
Neidium alpinum	Hustedt	Pl. 11, Fig. 15	15556
Neidium ampliatum	(Ehrenberg) Krammer	Pl. 11, Figs 2–5	15564; 15595; 15627; 15606
Neidium bisulcatum	(Lagerstedt) Cleve	Pl. 11, Fig. 16	15649
Neidium densestriatum	(Østrup) Krammer	Pl. 11, Figs 12	15564
Neidium iridis	(Ehrenberg) Cleve	Pl. 11, Fig. 1	15574
Neidium sp.5 SESQA		Pl. 11, Figs 13–14	15633; 15571
Neidium sp.6 SESQA		Pl. 11, Figs 10–11	15564; 15643
Nitzschia acicularioides	Hustedt	Pl. 22, Figs 31–34	15602; 15630
Nitzschia acicularis	(Kützing) W.Smith	Pl. 23, Fig. 1	15627
Nitzschia amphibia	Grunow	Pl. 23, Figs 17–20	15611; 15540; 15577; 15555
Nitzschia amphibioides	Hustedt	Pl. 23, Figs 39–40	15584; 15549
Nitzschia apiculata	(Gregory) Grunow	Pl. 23, Figs 54–56	15631; 15649; 15548
Nitzschia brevissima	Grunow	Pl. 23, Fig. 16	15649
Nitzschia clausii	Hantzsch	Pl. 23, Figs 7–9	15548; 15549; 15654
Nitzschia dissipata	Hantzsch ex Rabenhorst	Pl. 22, Figs 5–7	15590; 15584
Nitzschia dissipata f. *undulata*	Sovereign	Pl. 22, Figs 2–4	15632; 15548
Nitzschia dissipata var. *media*	(Hantzsch) Grunow	Pl. 22, Figs 8–10	15643; 15549; 15634
Nitzschia draveillensis	Coste & Ricard	Pl. 23, Figs 2–3	15630
Nitzschia filiformis	(W.Smith) Schütt	Pl. 23, Figs 5–6	15649; 15566
Nitzschia fonticola	(Grunow) Grunow	Pl. 23, Figs 13–15	15590
Nitzschia frustulum	(Kützing) Grunow	Pl. 23, Figs 10–12	15616; 15612
Nitzschia frustulum var. *subsalina*	Hustedt	Pl. 23, Figs 25–28	15549; 15640; 15635
Nitzschia inconspicua	Grunow	Pl. 23, Figs 32–35	15600
Nitzschia levidensis	(W.Smith) Grunow	Pl. 23, Figs 57–58	15649; 15559
Nitzschia linearis	(Agardh) W.Smith	Pl. 22, Figs 38–40	15596; 15563; 15632
Nitzschia montanestris	Camburn	Pl. 22, Figs 20–22	15549; 15571
Nitzschia palea	(Kützing) W. Smith	Pl. 22, Figs 27–30	15640; 15624; 15612
Nitzschia palea var. *debilis*	(Kützing) Grunow	Pl. 22, Figs 17–19	15634; 15630; 15549
Nitzschia palea var. *tenurostris*	Grunow	Pl. 22, Figs 23–26	15631; 15541; 15549; 15629
Nitzschia recta	Hantzsch ex Rabenhorst	Pl. 22, Fig. 1	15612
Nitzschia sinuata var. delognei	(Grunow) Lange-Bertalot	Pl. 23, Figs 46–47	15603; 15540
Nitzschia sinuata var. tabellaria	(Grunow) Grunow	Pl. 23, Figs 41–43	15591; 15563; 15594
Nitzschia sociabilis	Hustedt	Pl. 22, Figs 14–16	15632; 15549; 15613
Nitzschia soratensis	Morales & Vis	Pl. 23, Figs 29–31	15649; 15586
Nitzschia sp.26 SESQA		Pl. 22, Figs 11–13	15610; 15630; 15635
Nitzschia sp.34 SESQA		Pl. 23, Figs 21–23	15654; 15592; 15632
Nitzschia sp.29 SESQA		Pl. 23, Fig. 24	15616
Nitzschia sp.7 SESQA		Pl. 23, Figs 36–38	15601; 15559; 15640
Nitzschia subconfinis	Cholnoky	Pl. 23, Fig. 4	15588
Nitzschia tenuis	Eulenstein	Pl. 22, Figs 35–37	15654; 15594; 15602
Nupela frezelii	Potapova	Pl. 13, Figs 85–87	15551; 15541

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TABLE 1. (Continued)

Taxon	Author	Plate & Figure	INSTAAR Sample ID
Nupela wellneri	(Lange-Bertalot) Lange-Bertalot	Pl. 13, Figs 82–84	15555; 15559; 15595
Parlibellus protracta	(Grunow) Witkowski, Lange-Bertalot & Metzeltin	Pl. 10, Figs 25–26	15586; 15572
Pinnularia acrosphaeria	(Brébisson) Smith	Pl. 12, Figs 9–10	15598; 15649
Pinnularia biceps	Gregory	Pl. 12, Figs 14–15	15540; 15651
Pinnularia borealis	Ehrenberg	Pl. 12, Fig. 19	15586
Pinnularia brebissonii	(Kützing) Rabenhorst	Pl. 12, Figs 16–18	15554; 15593; 15586
Pinnularia erratica	Krammer	Pl. 12, Figs 3–5	15641; 15596; 15645
Pinnularia parvulissima	Krammer	Pl. 12, Figs 11–13	15654; 15541; 15658
Caloneis schroederi	Hustedt	Pl. 11, Figs 31– 33	15559; 15555; 15588
Pinnularia saprophila	Lange-Bertalot, Kobayasi & Krammer	Pl. 12, Figs 20–22	15643; 15559; 15656
Pinnularia septentrionalis	Krammer	Pl. 12, Fig. 8	15649
Pinnularia sp.22 SESQA		Pl. 12, Fig. 6	15617
Pinnularia sp.23 SESQA		Pl. 12, Fig. 7	15548
Pinnularia sp.24 SESQA		Pl. 12, Fig. 26	15649
Pinnularia sp.11 SESQA		Pl. 11, Figs 37–38	15597; 15641
Pinnularia sp.15 SESQA		Pl. 13, Fig. 1	15632
Pinnularia sp.8 SESQA		Pl. 11, Fig. 29	15595
Pinnularia subcapitata	Gregory	Pl. 12, Figs 23–25	15605; 15558; 15643
Pinnularia subcapitata var. *paucistriata*	(Grunow) Cleve	Pl. 11, Figs 34–36	15570; 15552
Pinnularia viridis	(Nitzsch) Ehrenberg	Pl. 12, Figs 1–2	15559; 15588
Placoneis anglophila	(Lange-Bertalot) Lange-Bertalot	Pl. 15, Fig. 11	15559
Placoneis clementis	(Grunow) Cox	Pl. 15, Figs 18–19	15656; 15649
Placoneis elginensis	(Gregory) Cox	Pl. 15, Figs 13–14	15616; 15598
Placoneis neglecta	Lowe	Pl. 15, Figs 9–10	15598; 15640
Placoneis placentula	(Ehrenberg) Mereschkowsky	Pl. 15, Fig. 12	15649
Placoneis sp.6 SESQA		Pl. 15, Fig. 20	15559
Placoneis sp.8 SESQA		Pl. 15, Fig. 21	15588
Placoneis symmetrica	(Hustedt) Lange-Bertalot	Pl. 15, Figs 15–17	15578; 15572; 15656
Planothidium abbreviatum	(Reimer) Potapova	Pl. 6, Figs 58–61	15654; 15595
Planothidium daui	(Foged) Lange-Bertalot	Pl. 6, Fig. 43	15605
Planothidium frequentissimum	(Lange-Bertalot) Lange-Bertalot	Pl. 6, Figs 48–50	15584; 15632; 15540
Planothidium lanceolatum	(Brébisson ex Kützing) Lange-Bertalot	Pl. 6, Figs 51–54	15588; 15629; 15559; 15571
Planothidium peragalli	(Brun & Héribaud) Round & Bukhtiyarova	Pl. 6, Figs 44–47	15621
Planothidium rostratum	(Østrup) Lange-Bertalot	Pl. 6, Figs 55–57	15588; 15624; 15610
Platessa bahlsii	Potapova	Pl. 6, Figs 24–26	15586; 15550; 15595
Platessa hustedtii	(Krasske) Lange-Bertalot	Pl. 6, Figs 27–31	15574; 15641; 15544
Platessa stewartii	(Patrick) Lange-Bertalot	Pl. 6, Figs 32–34	15555; 15595; 15580
Pleurosira laevis	(Ehrenberg) Compère	Pl. 1, Fig. 40	15572
Prestauroneis integra	(W.Smith) Bruder	Pl. 10, Fig. 33	15649
Psammothidium helveticum	(Hustedt) Bukhtiyarova & Round	Pl. 6, Fig. 41	15669
Psammothidium levanderi	(Hustedt) Czarnecki	Pl. 6, Figs 35–36	15669
Psammothidium sp.5 SESQA		Pl. 6, Fig. 42	15617
Pseudofallacia monoculata	(Hustedt) Liu, Kociolek & Wang	Pl. 14, Figs 16–18	15596; 15616
Pseudofallacia tenera	(Hustedt) Liu, Kociolek & Wang	Pl. 14, Figs 14–15	15572
Pseudostaurosira brevistriata	(Grunow) Williams & Round	Pl. 2, Fig. 34	15574
Pseudostaurosira parasitica	(Smith) Morales	Pl. 2, Figs 31–33	15612; 15611
Pseudostaurosira trainorii	Morales	Pl. 2, Fig. 30	15654
Reimeria sinuata	(Gregory) Kociolek & Stoermer	Pl. 19, Figs 7–9	15542; 15590; 15566
Reimeria uniseriata	Sala, Guerrero & Ferrario	Pl. 19, Fig. 6	15590
Sellaphora atomoides	(Grunow) Wetzel & Van de Vijver	Pl. 13, Figs 27–29	15559; 15656; 15559
Sellaphora crassulexigua	(Reichardt) Wetzel & Ector	Pl. 13, Figs 30–33	15631; 15572
Sellaphora difficillima	Wetzel, Ector & D.G.Mann	Pl. 13, Figs 60–62	15641; 15656; 15654
Sellaphora elorantana	(Lange-Bertalot) Wetzel	Pl. 13, Fig. 74	15549
Sellaphora hustedtii	(Krasske) Lange-Bertalot & Werum	Pl. 13, Figs 45–47	15601; 15615; 15559
Sellaphora japonica	(Kobayasi) Kobayasi	Pl. 13, Figs 42–44	15548; 15612; 15548
Sellaphora laevissima	(Kützing) D.G.Mann	Pl. 13, Fig. 5	15585
Sellaphora pupula	(Kützing) Mereschkowsky	Pl. 13, Figs 8–9	15656; 15624
Sellaphora rugula	(Hohn & Hellerman) Potapova & Ponader	Pl. 13, Figs 2–4	15643; 15574; 15649
Sellaphora saugerresii	(Desmazières) Wetzel & D.G.Mann	Pl. 13, Figs 13–15	15624; 15656; 15540

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TABLE 1. (Continued)

Taxon	Author	Plate & Figure	INSTAAR Sample ID
Sellaphora sp.19 SESQA		Pl. 13, Fig. 41	15612
Sellaphora sp.20 SESQA		Pl. 13, Fig. 16	15613
Sellaphora sp.22 SESQA		Pl. 13, Figs 25–26	15615; 15616
Sellaphora sp.23 SESQA		Pl. 13, Figs 6–7	15597; 15552
Sellaphora sp.24 SESQA		Pl. 13, Fig. 12	15641
Sellaphora sp.25 SESQA		Pl. 13, Figs 18–20	15658; 15544; 15602
Sellaphora sp.26 SESQA		Pl. 13, Figs 21–24	15555
Sellaphora sp.27 SESQA		Pl. 13, Fig. 17	15600
Sellaphora sp.28 SESQA		Pl. 13, Figs 36–38	15580; 15555
Sellaphora sp.29 SESQA		Pl. 13, Figs 34–35	15616
Sellaphora stauroneioides	(Lange-Bertalot) Veselá & Johansen	Pl. 13, Figs 51–53	15564; 15588
Sellaphora stroemii	(Hustedt) Kobayasi	Pl. 13, Figs 39–40	15659; 15623
Sellaphora subfasciata	Potapova	Pl. 13, Figs 10–11	15553; 15588
Sellaphora wallacei	(Reimer) Potapova & Ponader	Pl. 13, Figs 48–50	15603; 15654; 15564
Simonsenia delognei	(Grunow) Lange-Bertalot	Pl. 23, Fig. 48	15590
Spicaticribra kingstonii	Johansen, Kociolek & Lowe	Pl. 1, Figs 36–39	15636; 15654; 15637
Stauroneis acidoclinatopsis	Bahls	Pl. 10, Fig. 5	15571
Stauroneis agrestis	Petersen	Pl. 10, Fig. 20	15567
Stauroneis borrichii	(Petersen) Lund	Pl. 10, Figs 16–19	15654; 15544; 15584
Stauroneis gracilis	Ehrenberg	Pl. 10, Figs 1–4	15574; 15564; 15632
Stauroneis kriegeri	Patrick	Pl. 10, Figs 27–28	15656
Stauroneis limnetica	Kociolek	Pl. 10, Figs 6–7	15641; 15571
Stauroneis pseudagrestis	Lange-Bertalot & Werum	Pl. 10, Fig. 8	15559
Stauroneis smithii	Grunow	Pl. 10, Figs 9–10	15553; 15548
Stauroneis smithii var. *incisa*	Pantocsek	Pl. 10, Figs 21–24	15654; 15643
Stauroneis thermicola	(Petersen) Lund	Pl. 10, Figs 13–15	15627; 15559; 15555
Stauroneis thermicola f. *lanceolata*	(Hustedt) Hustedt	Pl. 10, Figs 11–12	15630; 15544
Staurosira construens var. *venter*	(Ehrenberg) Hamilton	Pl. 2, Figs 26–29	15600; 15554
Staurosira sp.1 SESQA		Pl. 2, Figs 24–25	15600
Staurosirella martyii	(Héribaud) Morales & Manoylov	Pl. 2, Figs 38–39	15592; 15571
Staurosirella pinnata	(Ehrenberg) Williams & Round	Pl. 2, Figs 46–49	15587; 15636; 15552
Staurosirella rhomboides	(Grunow) Morales & Manoylov	Pl. 2, Figs 42–45	15637; 15587; 15636
Staurosirella sp.5 SESQA		Pl. 2, Figs 40–41	15592; 15654
Stenopterobia curvula	(Smith) Krammer	Pl. 24, Fig. 1	15643
Stenopterobia delicatissima	(Lewis) Van Heurck	Pl. 24, Figs 3–5	15654; 15643; 15669
Stephanodiscus minutulus	(Kützing) Cleve & Möller	Pl. 1, Fig. 13	15597
Surirella angusta	Kützing	Pl. 24, Figs 18–20	15615; 15571; 15646
Surirella brebissonii	Krammer & Lange-Bertalot	Pl. 24, Figs 15–17	15631; 15649
Surirella minuta	Brébisson	Pl. 24, Figs 12–14	15605; 15649; 15540
Surirella splendida	(Ehrenberg) Kützing	Pl. 24, Fig. 9	15540
Surirella sp.6 SESQA		Pl. 24, Fig. 8	15601
Surirella suecica	Van Heurck	Pl. 24, Figs 10–11	15632; 15615
Surirella tenera	Gregory	Pl. 24, Fig. 21	15588
Synedra goulardii	Brébisson ex Cleve & Grunow	Pl. 3, Figs 3–5	15558
Synedra pulchella var. *flexella*	Boyer	Pl. 4, Figs 3–8	15557; 15544; 15540; 15577
Tabellaria flocculosa	(Roth) Kützing	Pl. 2, Figs 13–14	15654; 15544
Tetracyclus rupestris	(Braun ex Rabenhorst) Grunow	Pl. 2, Figs 17–20	15621
Thalassiosira weissflogii	(Grunow) Fryxell & Hasle	Pl. 1, Fig. 33	15559
Tryblionella debilis	Arnott ex O'Meara	Pl. 23, Figs 52–53	15540; 15572
Tryblionella hungarica	(Grunow) Frenguelli	Pl. 24, Fig. 2	15649
Ulnaria contracta	(Østrup) Morales & Vis	Pl. 3, Figs 9–11	15558; 15543
Ulnaria ramesi	(Héribaud) Hustedt	Pl. 3, Figs 6–8	15558; 15547
Ulnaria ulna	(Nitzsch) Compère	Pl. 3, Figs 25–27	15640; 15632; 15643

The flora presented in this manuscript represents the reconciled working flora that two independent analysts used during the counting process to promote taxonomic consistency in the SESQA survey of 108 sites. Prior to sample analysis, approximately 80% of the slides were examined and specimens representing the taxa present and their range of variation were imaged. The initial documentation produced nearly 1200 images, far more than could be practically presented in a manuscript, that analysts collaboratively organized into a working flora. Additional taxa were imaged

and added as they were encountered during the formal analysis. All slides were examined under the light microscope using differential interference contrast (DIC) with a 100x oil immersion objective (Olympus BX53F). Efforts were made to document the morphological range of each species, with several digital micrographs for most taxa, in order to characterize the southeast flora. By developing a working flora, the analysts were able to identify species from a common document. Once the formal analyses were completed, key images were selected for inclusion in this voucher. The works of Camburn *et al.* (1978), Kociolek & Kingston (1999), Lowe *et al.* (2007), Johansen *et al.* (2008), Furey *et al.* (2011) and Siver & Hamilton (2011), along with additional resources, were consulted to determine formal species names.

TABLE 2. Site information for samples analyzed in this study.

INSTAAR Accession Numbers	Site Name	City or Town, State	USGS Station ID	Latitude (dd)	Longitude (dd)
15540	Accotink Creek	Annandale, VA	01654000	38.81289066	-77.22831581
15541	Back Creek	Sunrise, VA	02011470	38.19040156	-79.81172007
15542	Back Creek	Mountain Grove, VA	02011500	38.0695688	-79.89700034
15543	Back Creek	Sunrise, VA	02011460	38.24540129	-79.76866328
15544	Beaverdam Creek at Vanna Road	Royston, GA	02188350	34.24805556	-83.04861111
15545	Big Creek at Ga9	Cumming, GA	02335580	34.15593045	-84.21853052
15546	Big Haynes Creek at Jack Turner Dam	Milstead, GA	02207418	33.72916667	-83.93722222
15547	Blackburn Fork Little Warrior River	Holly Springs, NC	02455185	33.86065442	-86.44581776
15548	Bolin Creek at Village Drive	Chapel Hill, NC	0209734440	35.92230556	-79.06600000
15549; 15550	Bonbrook Creek	Whiteville, VA	02034414	37.57008333	-78.24094444
15551	Briar Creek	Charlotte, NC	0214642825	35.23611111	-80.77111111
15552	Buckhorn Creek	Corinth, NC	02102192	35.55972222	-78.97361111
15553	Buckskin Creek at Rt609	Mckenny, VA	02045370	36.92583333	-77.63811111
15554	Campbell Creek	Charlotte, NC	02146562	35.18666667	-80.73666667
15555	Cane Creek	Orange Grove, NC	02096846	35.98722222	-79.20611111
15556	Carlan Creek at Ga326	Carnesville, GA	021912435	34.30305556	-83.30694444
15557	Catawba River near Pleasant Gardens	Bridgewater, NC	02138520	35.74036111	-81.83466667
15558	Catawba River at Sr1223 Bl Lk James	Pleasant Gardens, NC	02137727	35.68583333	-82.06027778
15559	Cellar Creek at Rt610	Spainville, VA	02040919	37.20275	-77.97083333
15560	Cheoah River near Bearpen Gap	Tapoco, NC	0351706800	35.43833333	-83.91888889
15561; 15562	Chewacla Creek at Chewacla State Park	Auburn, AL	02418760	32.5481918	-85.48050441
15563	Clear Creek at Sr3181	Mint Hill, NC	0212466000	35.20833333	-80.5800000
15564	Coldwater Creek (Cr 60)	Nuberg, GA	02187660	34.24705085	-82.93653012
15565	Contentnea Creek	Lucama, NC	02090380	35.69111111	-78.10972222
15566	Difficult Run above Fox Lake	Fairfax, VA	01645704	38.88469518	-77.33242934
15567	Difficult Run	Great Falls, VA	01646000	38.97594346	-77.24581439
15568	Dog River at Ga5	Fairplay, GA	02337410	33.65380556	-84.82102778
15570	Doolittle Creek at Flat Shoals Rd	Decatur, GA	02203831	33.70566259	-84.29242299
15571	Durbin Creek	Fountain Inn, SC	02160381	34.71678818	-82.1737222
15572	Ellerbe Creek	Gorman, NC	02086849	36.05931106	-78.83250647
15573	Eno River	Hillsborough, NC	02085000	36.07111111	-79.09555556
15574	Enoree River	Pelham, SC	02160326	34.85650727	-82.22622468
15576	Flat River	Bahama, NC	02085500	36.18277778	-78.87888889
15577	Flat River at Dam	Bahama, NC	02086500	36.14861111	-78.82888889
15578	Goose Creek at Sr1525	Indian Trail, NC	0212467595	35.12500000	-80.60277778
15579	Hickory Log Creek	Canton, GA	02391840	34.26500000	-84.47388889
15580	Hillabahatchee Creek at Thaxton Rd	Franklin, GA	02338523	33.34067171	-85.2268901
15582	Holiday Creek	Andersonville, VA	02038850	37.41542434	-78.63583923
15583	Honey Creek at Ga212	Conyers, GA	02204130	33.57983406	-84.06408054
15584; 15585	Irvins Creek at Sr3168	Charlotte, NC	0214657975	35.15861111	-80.71333333
15586	Ivy River	Marshall, NC	03453000	35.76972222	-82.62083333
15587	Jackson River Bl Gathright Dam	Hot Springs, VA	02011800	37.94845825	-79.94922369
15588	Kiokee Creek at Ga104	Evans, GA	02195320	33.60096698	-82.23262169
15590	Little Back Creek	Sunrise, VA	02011490	38.21456767	-79.83755462
15591	Little Cahaba River at Cah Bea Rd	Cahaba Heights, AL	02423414	33.43982948	-86.69887582
15592	Little Haynes Creek at Dial Mill Rd	Milstead, GA	02207435	33.71111111	-83.91444444
15593	Little Hope Creek at Seneca Place	Charlotte, NC	02146470	35.16444444	-80.85305556
15594	Little River Bl Little River Trib	Fairntosh, NC	0208524975	36.11333333	-78.85972222

...continued on the next page

TABLE 2. (Continued)

INSTAAR Accession Numbers	Site Name	City or Town, State	USGS Station ID	Latitude (dd)	Longitude (dd)
15595	Long Branch (Rd 705)	Kings Mountain State Park, SC	02153778	35.13500000	-81.35583333
15596	Ltl Sugar Creek at Medical Center Dr	Charlotte, NC	02146409	35.20361111	-80.83694444
15597	Manchester Creek	Rock Hill, SC	02146110	34.94444444	-80.97972222
15598	Marsh Creek	New Hope, NC	0208732885	35.81694444	-78.59305556
15599	Maury River	Rockbridge Baths, VA	02021500	37.90735266	-79.42198289
15600	Mayo Creek	Bethel Hill, NC	02077670	36.54083333	-78.87194444
15601	Mcalpine Creek at Sr3150	Idlewild, NC	0214655255	35.17583333	-80.71916667
15602	Mckee Creek at Sr2804	Wilgrove, NC	0212430653	35.25388889	-80.64805556
15603	Mcmullen Creek at Sharon View Rd	Charlotte, NC	02146700	35.14083333	-80.82000000
15604	Middle Creek	Clayton, NC	02088000	35.57083333	-78.59055556
15605	Middle Fork Broad River at Red Root Rd	Toccoa, GA	021890105	34.50055556	-83.43194444
15606	Middle Tyger River	Lyman, SC	02157510	34.94011872	-82.12344214
15607; 15608	Mill Creek	Crandall, GA	02384540	34.87202382	-84.72132621
15609	Mill Shoal Creek at Parham-Dudley Rd	Harrison, GA	02191284	34.19611111	-83.10166667
15610	Mine Run	Burr Hill, VA	01667850	38.34346319	-77.85888351
15611	Morgan Creek	Chapel Hill, NC	02097517	35.89333333	-79.01972222
15612	Morgan Creek	White Cross, NC	02097464	35.92361111	-79.11500000
15613; 15614	Mountain Creek at Sr1617	Bahama, NC	0208524090	36.14972222	-78.89666667
15615	Mountain Run	Burr Hill, VA	01667870	38.35374076	-77.89360649
15616	North Buffalo Creek at Westover Terrace	Greensboro, NC	02095181	36.07916667	-79.81277778
15617	North Tyger River	Wellford, SC	02156999	34.94000000	-82.05333333
15619	Nancy Creek at West Wesley Road	Atlanta, GA	02336410	33.83843787	-84.43937342
15620	Nantahala River	Hewitt, NC	03505550	35.30500000	-83.65222222
15621; 15669	Nantahala River	Rainbow Springs, NC	03504000	35.12750000	-83.61861111
15623	Pole Bridge Creek at Evans Mill Rd	Lithonia, GA	02204037	33.6684422	-84.15102873
15624	Proctor Creek at Jackson Parkway	Atlanta, GA	02336526	33.79427255	-84.47437467
15625	Reedy Fork	Oak Ridge, NC	02093800	36.17250000	-79.95277778
15627	Reedy River	Greenville, SC	02164000	34.80011831	-82.36512125
15628	Rottenwood Creek at Interstate N Pkwy	Smyrna, GA	02335910	33.89371431	-84.45770758
15629	South Fork Little Difficult Run Above Mouth	Vienna, VA	01645762	38.90888916	-77.33826272
15630	South Fork Quantico Creek	Independent Hill, VA	01658500	38.5873427	-77.4285958
15631	Sandy Creek at Cornwallis Rd	Durham, NC	0209722970	35.9832222	-78.9568056
15632	Sappony Creek at Route 646	Dewitt, VA	02046160	36.99347222	-77.64063889
15633	Shoal Creek at Columbia Drive	Atlanta, GA	02203863	33.69319444	-84.25388889
15635	Shoal Creek at Shoal Creek Rd	Lavonia, GA	02183650	34.43694444	-83.04361111
15636	Smith River	Bassett, VA	02072500	36.77013709	-80.00087509
15637	Smith River	Philpott, VA	02072000	36.7806925	-80.02476468
15639	Sope Creek	Marietta, Ga	02335870	33.95388889	-84.44333333
15640	South Buffalo Creek	Pomona, Nc	02094659	36.04944444	-79.85527778
15641	South Fork Peachtree at Casa Rd	Clarkston, GA	02336152	33.81044444	-84.24797222
15642	South Rabon Creek	Gray Court, SC	02165200	34.52011957	-82.15705141
15643	South Saluda River	Cleveland, SC	02162290	35.06345088	-82.650128
15644	South Toe River	Celo, NC	03463300	35.83138889	-82.18416667
15645	Stewart Creek at State St	Charlotte, NC	0214627970	35.24027778	-80.86833333
15646	Sweathouse Creek at Route 708	Scotts Fork, VC	02041038	37.27913889	-77.86111111
15647	Swift Creek	Apex, NC	02087580	35.71888889	-78.75222222
15648	Swift Creek	Mccullars Crossroads, NC	0208758850	35.69361111	-78.69222222
15649	Third Fork Creek at Woodcroft Parkway	Blands, NC	02097280	35.92263889	-78.95241667
15651	Tools Fork Creek	Rock Hill, SC	021473426	34.95653054	-81.10618816
15652	Torrence Creek at Bradford Hill Ln	Huntersville, NC	0214265808	35.40361111	-80.88277778
15653	Tuckasegee River at Sr1172	Cullowhee, NC	03508050	35.28777778	-83.14388889
15654	Twelvemile Creek	Liberty, SC	02186000	34.8015012	-82.74847246
15655	West Fork Pigeon River above Lake Logan	Hazelwood, NC	03455500	35.39611111	-82.93750000
15656	West Br Rocky River B Mth of South Prong River	Cornelius, NC	0212393300	35.46777778	-80.79027778
15657	West Fork Pigeon River	Retreat, NC	0345577330	35.42666667	-82.91972222
15658	Wildcat Creek	Rock Hill, SC	021473428	34.88958672	-81.06924597
15659	Yellowjacket Creek-Hammett Rd	Hogansville, GA	02338840	33.13956653	-84.97521504
15670	Chattooga River at Burrells Ford	Pine Mtn, GA	02176930	34.97452778	-83.11616667

RESULTS

More than 375 taxa were identified (Table 1). A limited number of taxa (16) in the Class Coscinodiscophyceae were encountered in this study. Genera documented included *Aulacoseira* Thwaites (1848: 167), *Cyclotella* (Kützing) de Brébisson (1838: 19), *Discostella* Houk & Klee (2004: 204), *Hydrosera* Wallich (1858: 251), *Lindavia* (Schutt) De Toni & Forti (1900: 553), *Melosira* Agardh (1824: 14), *Pleurosira* (Meneghini) San Leon (1848: 96), *Spicaticribra* Johansen *et al.* (2008: 368), *Stephanodiscus* Ehrenberg (1845: 72), and *Thalassiosira* Cleve (1873: 6). This group of diatoms, however, is typically found in planktonic habitats, rather than associated with benthic, attached algae. A number of the sites were below reservoir impoundments, and planktonic species can be incidental as they are swept downstream and included in stream collections (Stevenson & Peterson 1991). More taxa (43) were present from the Class Fragilariophyceae, with taxa from *Asterionella* Hassall (1850: 231), *Ctenophora* (Grunow) Williams & Round (1986: 330), *Diatoma* Bory de Saint-Vincent (1824: 461), *Fragilaria* Lyngbye (1819: 182), *Fragilariforma* Williams & Round (1988: 265), *Meridion* Agardh (1824: 14), *Pseudostaurosira* Williams & Round (1988: 276), *Staurosira* Ehrenberg (1843: 45), *Staurosirella* Williams & Round (1988: 274), *Synedra* Ehrenberg (1830: 60), *Tabellaria* Ehrenberg ex Kützing (1844: 127), *Tetracyclus* Ralfs (1843: 105) and *Ulnaria* (Kützing) Compère (2001: 100). As is typical of attached habitats, the greatest species richness was found in the Class Bacillariophyceae (333), which includes the eunotioid, monoraphid, symmetric biraphid, asymmetric biraphid, nitzschioid and surirelloid taxa. Within this class, the genera with the highest number of species were *Navicula* Bory de Saint-Vincent (1822: 128) (36), *Nitzschia* Hassall (1845: 435) (33), *Gomphonema* Ehrenberg (1832: 87) (34), *Eunotia* Ehrenberg (1837: 44) (23) and *Sellaphora* Mereschkowsky (1902: 186) (25). Comments on autecology and water quality preferences are provided in the "taxon pages" for many species in the Diatoms of the United States online flora (Spaulding *et al.* 2010).

Taxa within the genus *Fragilaria* were highly diverse and likely include species complexes that were not amenable to consistent distinction into species. For example, the "species" shown here (Plates 3–4) are separated into 19 morphological species. The high diversity of forms, however, and number of "groups" that we were not able to formally name, lead us to believe that we were not able to adequately separate species using light microscopy. There are likely a great number of taxa present, but we are not able to distinguish them in a meaningful way. Others have also reported that the identification of species within the *Fragilaria capucina* complex, along with other key groups, has proven to be problematic in assessments (Lavoie *et al.* 2008, Kahlert *et al.* 2012, Kahler *et al.* 2016). Similar to the species complexes within *Fragilaria*, there are swarms of closely related taxa, particularly in *Gomphonema* and *Nitzschia,* that we were able to treat only in the broad sense. The southeast states have been shown to possess a unique flora, with characteristic taxa (Desianti *et al.* 2015, Potapova 2014) and high species richness, particularly in *Achnanthidium* Kützing (1844: 75), *Eunotia, Gomphonema* and *Sellaphora*.

The genus *Achnanthidium* is particularly rich in the southeast (Ponader and Potapova 2007) and includes potential species complexes that we were not able to distinguish. The images here (Plate 7, Figs 17–52) show the taxa, including undescribed species, within *Achnanthidium*. Several of these taxa reach their greatest abundances in the streams with the steepest gradients, in sites of the Blue Ridge and Ridge and Valley ecoregions.

The genus *Navicula*, in the strict sense of the genus, had the greatest species diversity (Plates 8, 9, 10: 31–32, 13: 66–68, 70–73). Note, however, that several of the species included here (*N. ingenua* Hustedt (1957: 19), *N. kotschyi* Grunow (1860: 538), *N. dibola* Hohn (1961: 162), *N. cryptocephala* var. *perminuta* (Grunow in Van Heurck) Cleve (1895: 14) and *N. nugalis* Hohn & Hellerman (1963: 37)) lack the features of *Navicula sensu stricto* and will, at some point, be transferred to other genera.

Sellaphora also had high diversity (Plate 13, Figs 2–53, 60–62, 69, 74). For many of these taxa, we were not able to determine formal names and they are presented here with provisional designations. Most undescribed species were found in low abundance, so their range of size and morphology has not yet been characterized. Of the formally described species, many are only known from the southeast states (Enache & Potapova 2009, Potapova & Ponader 2008).

Lastly, several taxa could not be identified, and likely belong to species that have not yet been described by science. These taxa are indicated by provisional names that are specific to this survey, for example, "*Staurosira* sp.1 SESQA". Note that the same undescribed taxon could have a different provisional designation in another survey. An important function of this manuscript is to visually document these taxa that have not yet been described. It is our intent that thorough documentation of taxa within each survey will allow later coordination.

DISCUSSION

We see the increased importance and need for voucher floras, as defined here, and as distinct from identification floras. The purpose of this voucher flora is to document both the described and undescribed diatom taxa present in the material collected during the 2014 SESQA regional survey. Many of these taxa are rare and were not encountered during the counting process. These taxa were not included in the formal analysis of abundance count data, as they were only encountered in the initial process of constructing the flora, through a visual screening of the microslides. The initial image library served as the primary means to coordinate multiple analysts, so that analysts could refer to each taxon in a consistent manner for sample identification and enumeration. The use of this voucher flora by analysts, in conjunction with other newly implemented quality assurance methods, was effective in preventing measurable "analyst effect" (Bishop *et al.* in prep). This voucher flora represents a reduced version of that working flora, with specimens selected to show the greatest size and morphological range for most taxa.

Already, this effort has been effective in promoting taxonomic consistency and the voucher flora will serve to document the identity of species in southeast rivers. Taxonomic vouchers from federal programs are a crucial step in producing a well-documented species dataset, particularly for long-term studies such as the US Geological Survey Status and Trends program (Rowe *et al.* 2010). This study is part of a broader effort to improve taxonomic consistency in federal, state and local programs by accessible identification resources and inter-lab comparisons.

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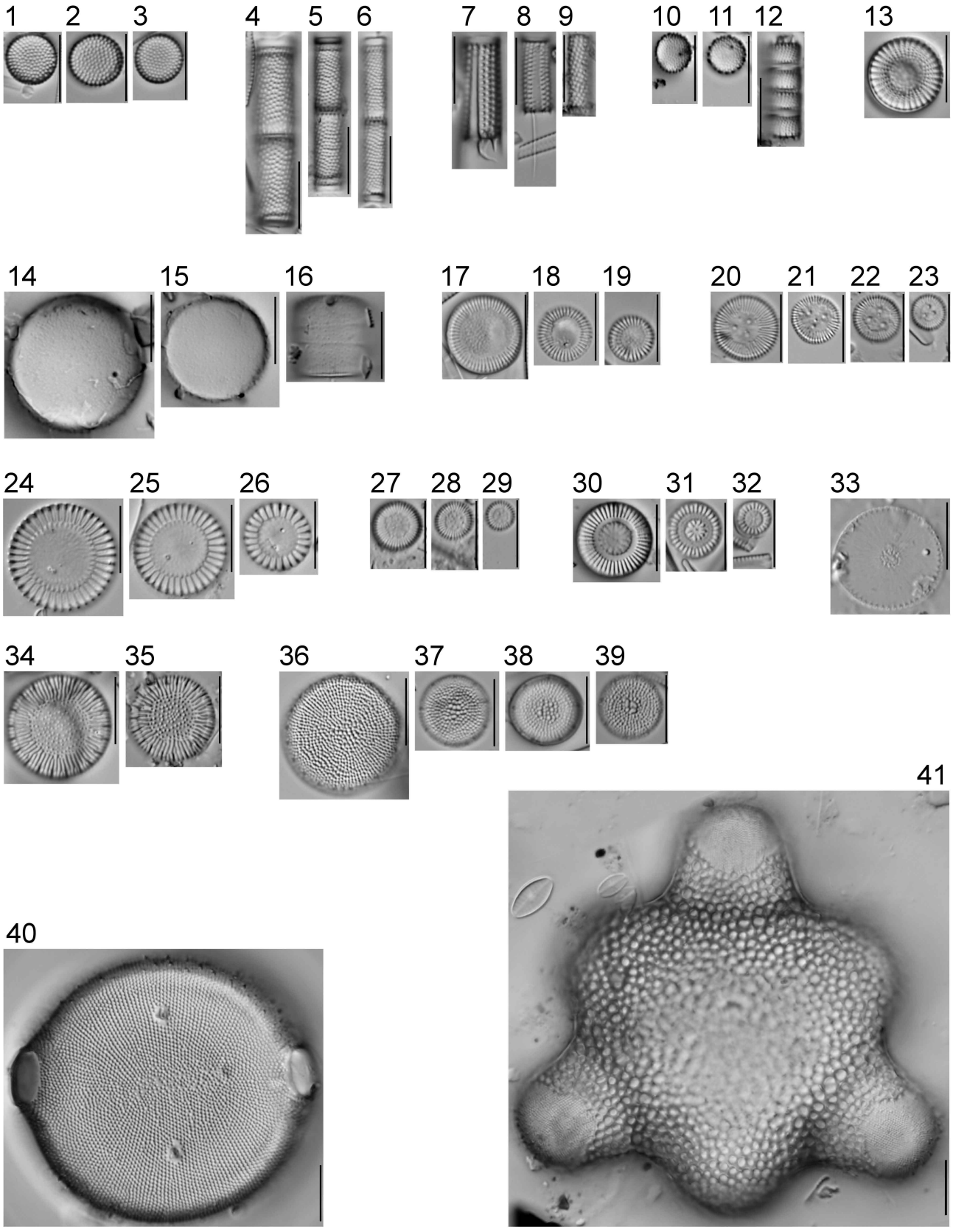

PLATE 1. Light micrographs of centric taxa. Figs 1–3. *Aulacoseira alpigena*. Figs 4–6. *A. ambigua*. Figs 7–9. *A. granulata*. Figs 10–12. *A. pusilla*. Fig. 13. *Stephanodiscus minutulus*. Figs 14–16. *Melosira varians*. Figs 17–19. *Cyclotella distinguenda*. Figs 20–23. *Lindavia ocellata*. Figs 24–26. *C. meneghiniana*. Figs 27–29. *L. rossii*. Figs 30–32. *Discostella stelligera*. Fig. 33. *Thalassiosira weissflogii.* Figs 34–35. *C. bodanica* var. *lemanica*. Figs 36–39. *Spicaticribra kingstonii*. Fig. 40. *Pleurosira laevis*. Fig. 41. *Hydrosera whampoensis.* Scale bars: 10 µm.

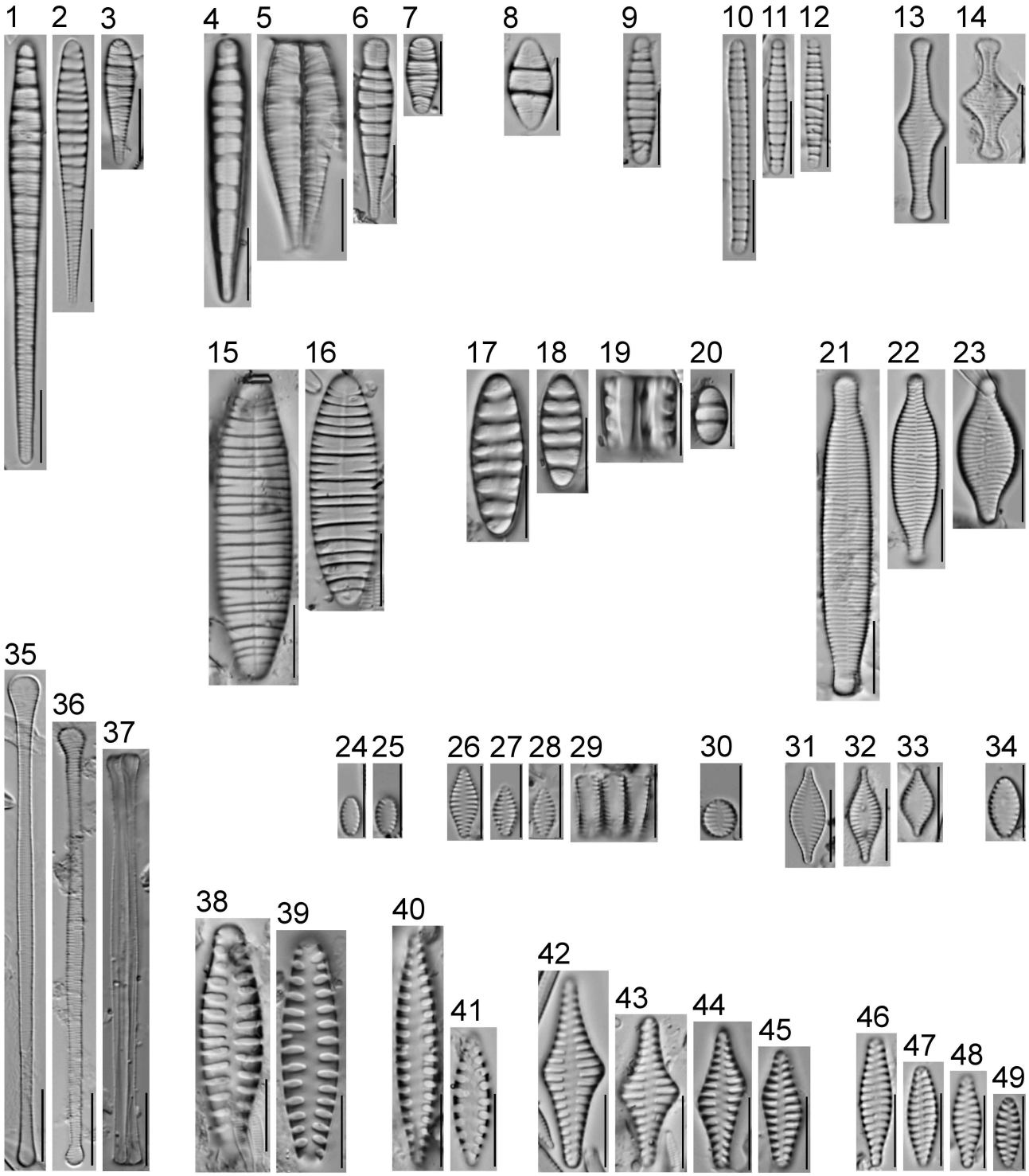

PLATE 2. Light micrographs of araphid taxa. Figs 1–3. *Meridion alansmithii.* Figs 4–7. *M. circulare* var. *constrictum.* Fig. 8. *Diatoma mesodon*. Fig. 9. *D. moniliformis*. Figs 10–12. *D. tenuis.* Figs 13–14. *Tabellaria flocculosa*. Figs 15–16. *D. vulgaris*. Figs 17–20. *Tetracyclus rupestris*. Figs 21–23. *Fragilariforma virescens*. Figs 24–25. *Staurosira* sp.1 SESQA. Figs 26–29. *Staurosira construens* var. *venter*. Fig. 30. *Pseudostaurosira trainorii*. Figs 31–33. *P. parasitica*. Fig. 34. *P. brevistriata.* Figs 35–37. *Asterionella formosa*. Figs 38–39. *Staurosirella martyii*. Figs 40–41. *Staurosirella* sp.5 SESQA Figs 42–45. *S. rhomboides.* Figs 46–49. *S. pinnata*. Scale bars: 10 µm.

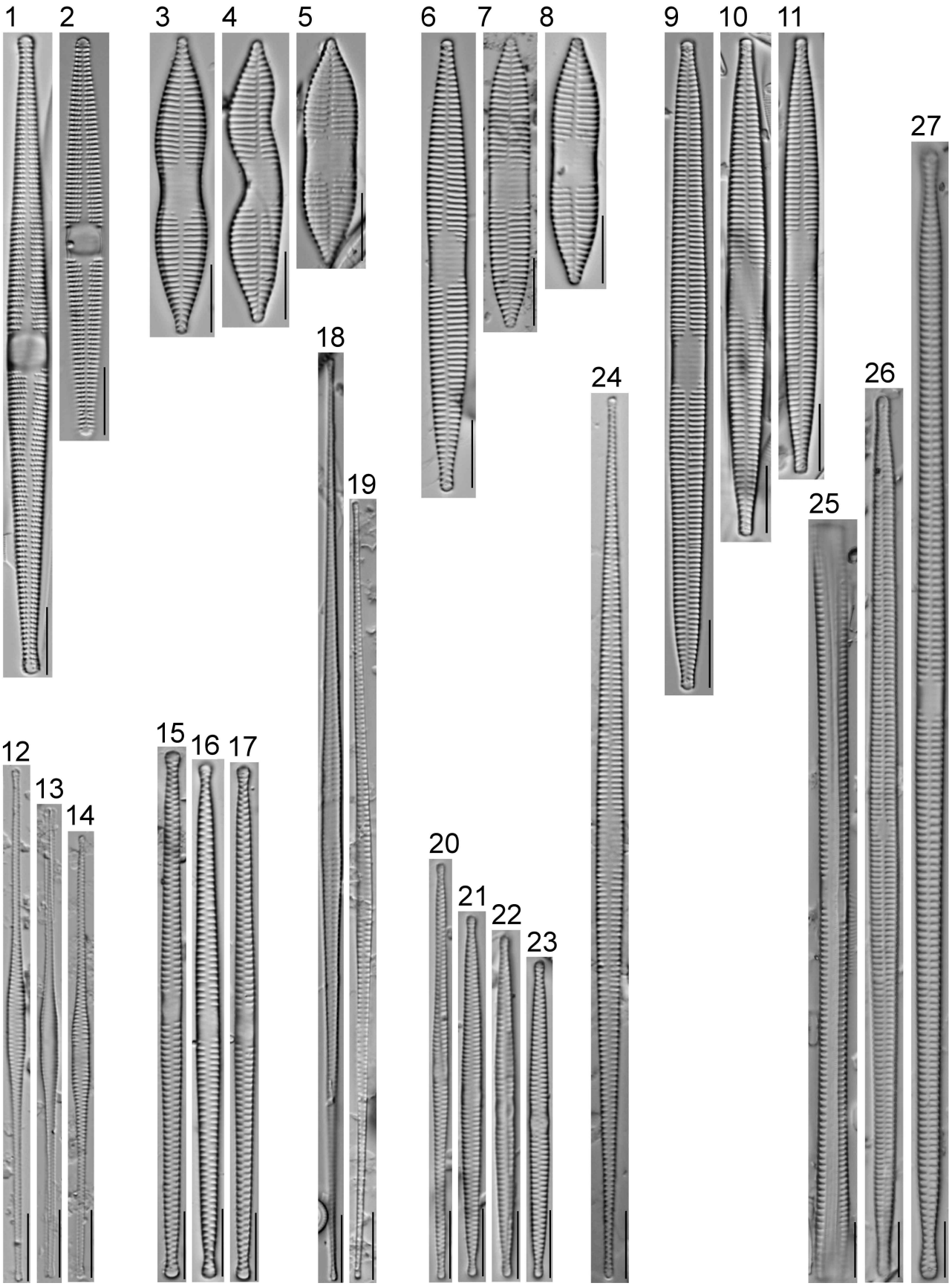

PLATE 3. Light micrographs of araphid taxa. Figs 1–2. *Ctenophora pulchella*. Figs 3–5. *Synedra goulardii*. Figs 6–8. *Ulnaria ramesi*. Figs 9–11. *U. contracta*. Figs 12–14. *Fragilaria crotonensis.* Figs 15–17. *F. amphicephaloides*. Figs 18–19. *F. delicatissima*. Figs 20–23. *Fragilaria* sp.22 SESQA. Fig. 24. *F. grunowii*. Figs 25–27. *U. ulna*. Scale bars: 10 µm.

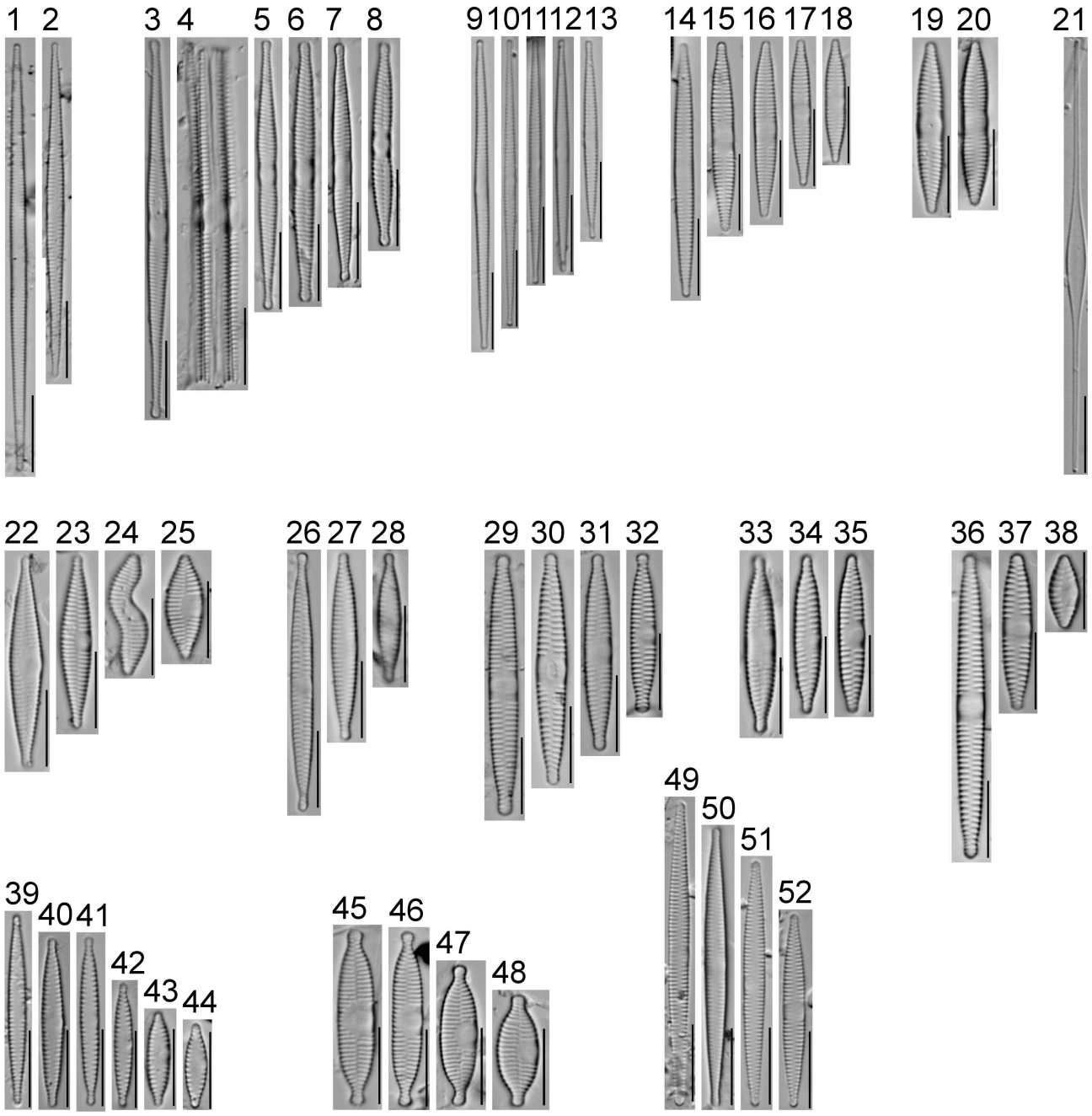

PLATE 4. Light micrographs of araphid taxa. Figs 1–2. *Fragilaria* sp.12 SESQA. Figs 3–8. *Synedra pulchella* var. *flexella*. Figs 9–13. *Fragilaria* sp.18 SESQA. Figs 14–18. *Fragilaria* sp.16 SESQA. Figs 19–20. *F. socia*. Fig. 21. *Fragilaria longifusiformis*. Figs 22–25. *Fragilaria* sp.23 SESQA. Figs 26–28. *Fragilaria* sp.13 SESQA. Figs 29–32. *Fragilaria pectinalis.* Figs 33–35. *Fragilaria* sp.5 SESQA. Figs 36–38. *Fragilaria vaucheriae.* Figs 39–44. *Fragilaria* sp.26 SESQA. Figs 45–48. *Fragilaria* sp.35 SESQA. Figs 49–52. *Fragilaria* sp.1 SESQA. Scale bars: 10 µm.

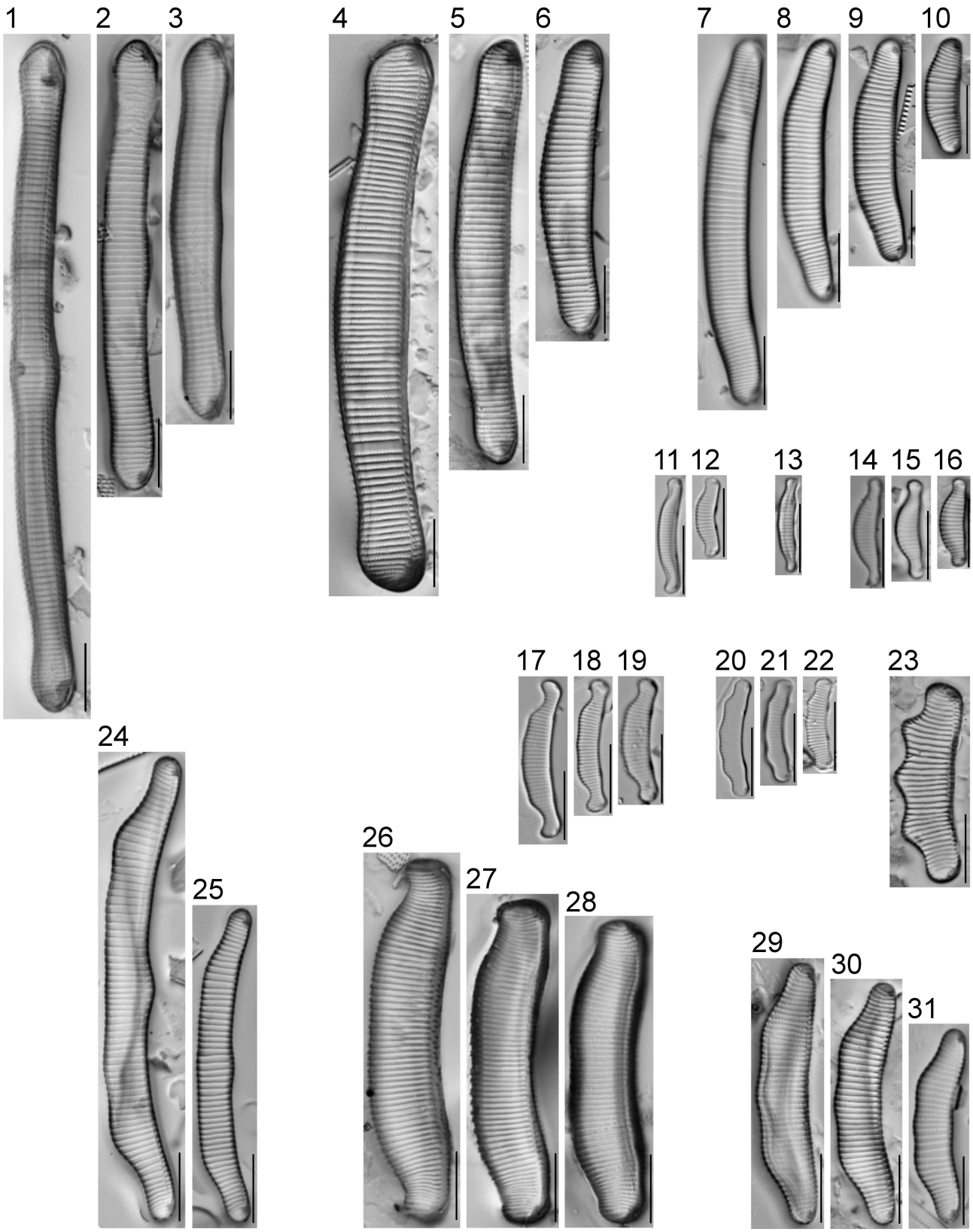

PLATE 5. Light micrographs of eunotioid taxa. Figs 1–3. *Eunotia formica.* Figs 4–6. *E. metamonodon*. Figs 7–10. *E. minor*. Figs 11–12. *E. tenella*. Fig. 13. *E. microcephala*. Figs 14–16. *E. meisteri*. Figs 17–19. *E. varioundulata* var. *suecica*. Figs 20–22. *E. paratridentula*. Fig. 23. *E. cordillera*. Figs 24–25. *E. pectinalis*. Figs 26–28. *E. braendlei*. Figs 29–31. *Eunotia* sp.5 SESQA. Scale bars: 10 µm.

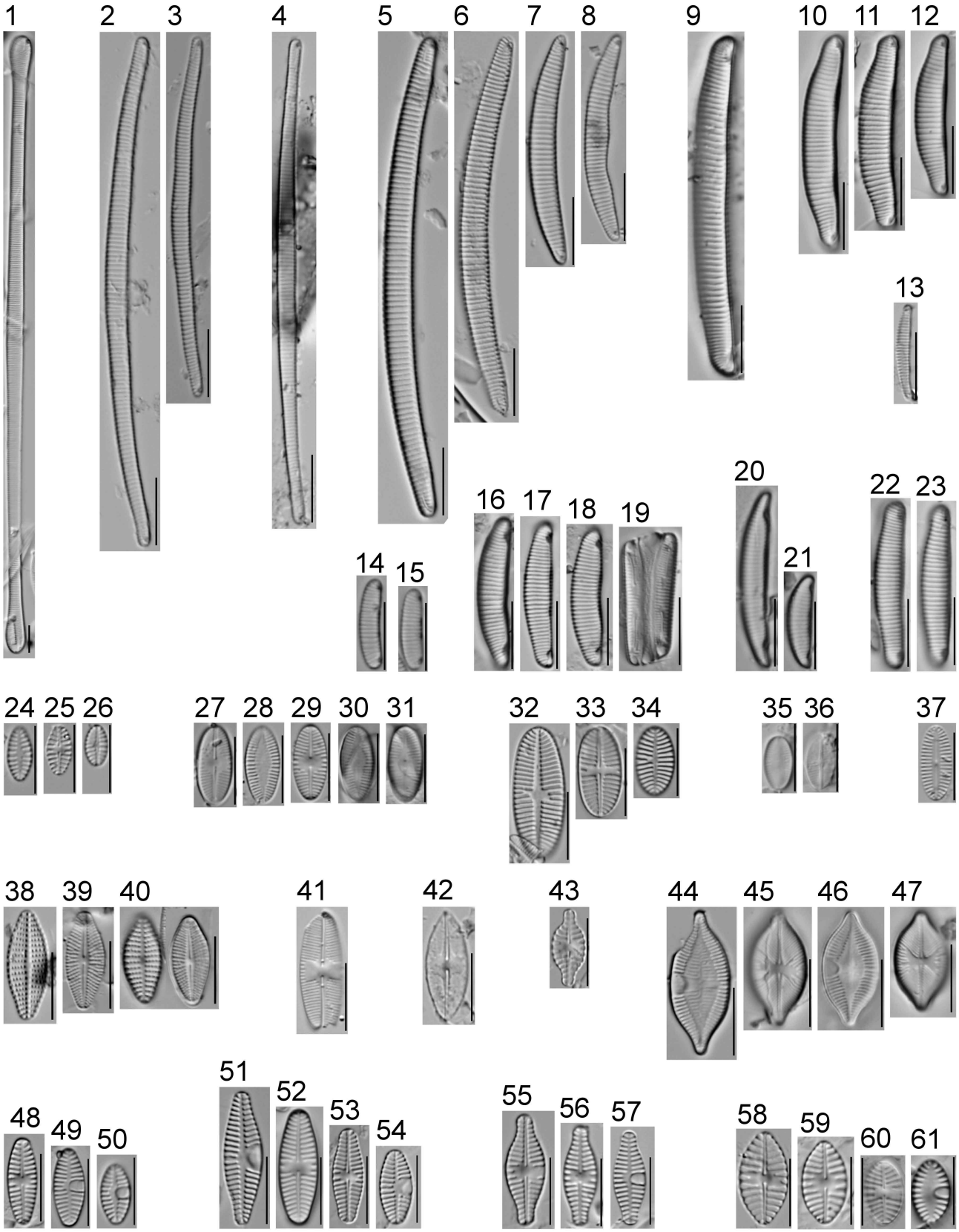

PLATE 6. Light micrographs of eunotioid and monoraphid taxa. Fig. 1. *Eunotia flexuosa*. Figs 2–3. *E. naegelii*. Fig. 4. *E. genuflexa*. Figs 5–8. *E. bilunaris*. Fig. 9. *E. macroglossa*. Figs 10–12. *E. implicata*. Fig. 13. *Eunotia* sp.1 SESQA. Figs 14–15. *E. botuliformis*. Figs 16–19. *E. papilioforma*. Figs 20–21. *E. incisa*. Figs 22–23. *Eunotia* sp.15 SESQA. Figs 24–26. *Platessa bahlsii*. Figs 27–31. *P. hustedtii*. Figs 32–34. *P. stewartii*. Figs 35–36. *Psammothidium levanderi*. Fig. 37. *Karayevia suchlandtii*. Figs 38–40. *K. clevei*. Fig. 41. *Psammothidium helveticum*. Fig. 42. *Psammothidium* sp.5 SESQA. Fig. 43. *Planothidium daui*. Figs 44–47. *P. peragalli*. Figs 48–50. *P. frequentissimum*. Figs 51–54. *P. lanceolatum*. Figs 55–57. *P. rostratum*. Figs 58–61 *P. abbreviatum*. Scale bars: 10 μm.

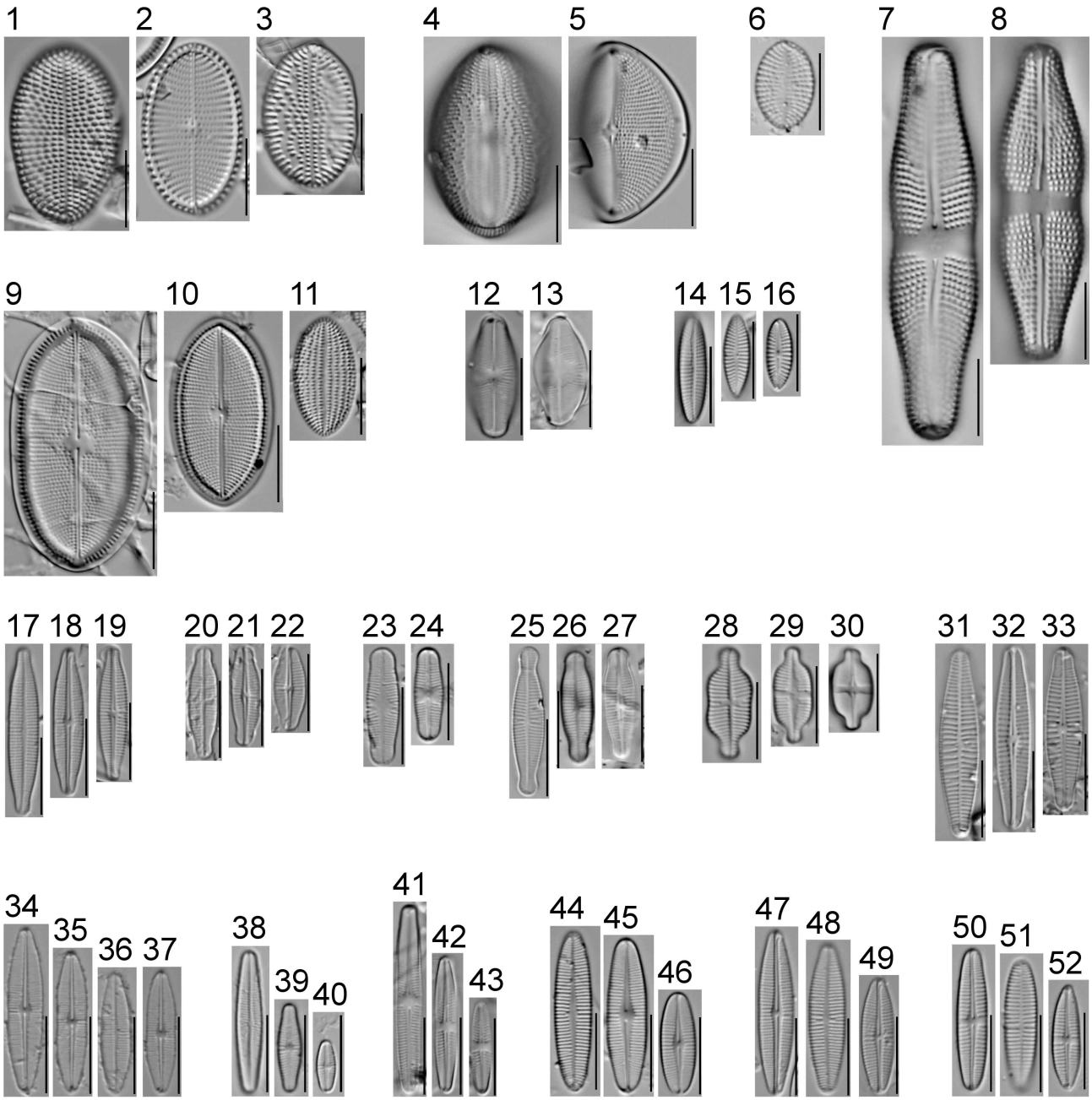

PLATE 7. Light micrographs of monoraphid taxa. Figs 1–3. *Cocconeis fluviatilis*. Figs 4–5. *C. pediculus*. Fig. 6. *C neothumensis*. Figs 7–8. *Achnanthes coarctata.* Figs 9–11. *C. placentula.* Figs 12–13. *Eucocconeis laevis*. Figs 14–16. *Achnanthes subhudsonis* var. *kraeuselii*. Figs 17–19. *Achnanthidium gracillimum*. Figs 20–22. *Achnanthidium* sp.8 SESQA. Figs 23–24. *A. reimeri*. Figs 25–27. *A. latecephalum*. Figs 28–30. *A. exigua*. Figs 31–33. *A. druartii*. Figs 34–37. *A. alpestre*. Figs 38–40. *A. minutissimum.* Figs 41–43. *Achnanthidium* sp.6 SESQA. Figs 44–46. *A. rivulare*. Figs 47–49. *A. deflexum*. Figs 50–52. *A. pyrenaicum*. Scale bars: 10 µm.

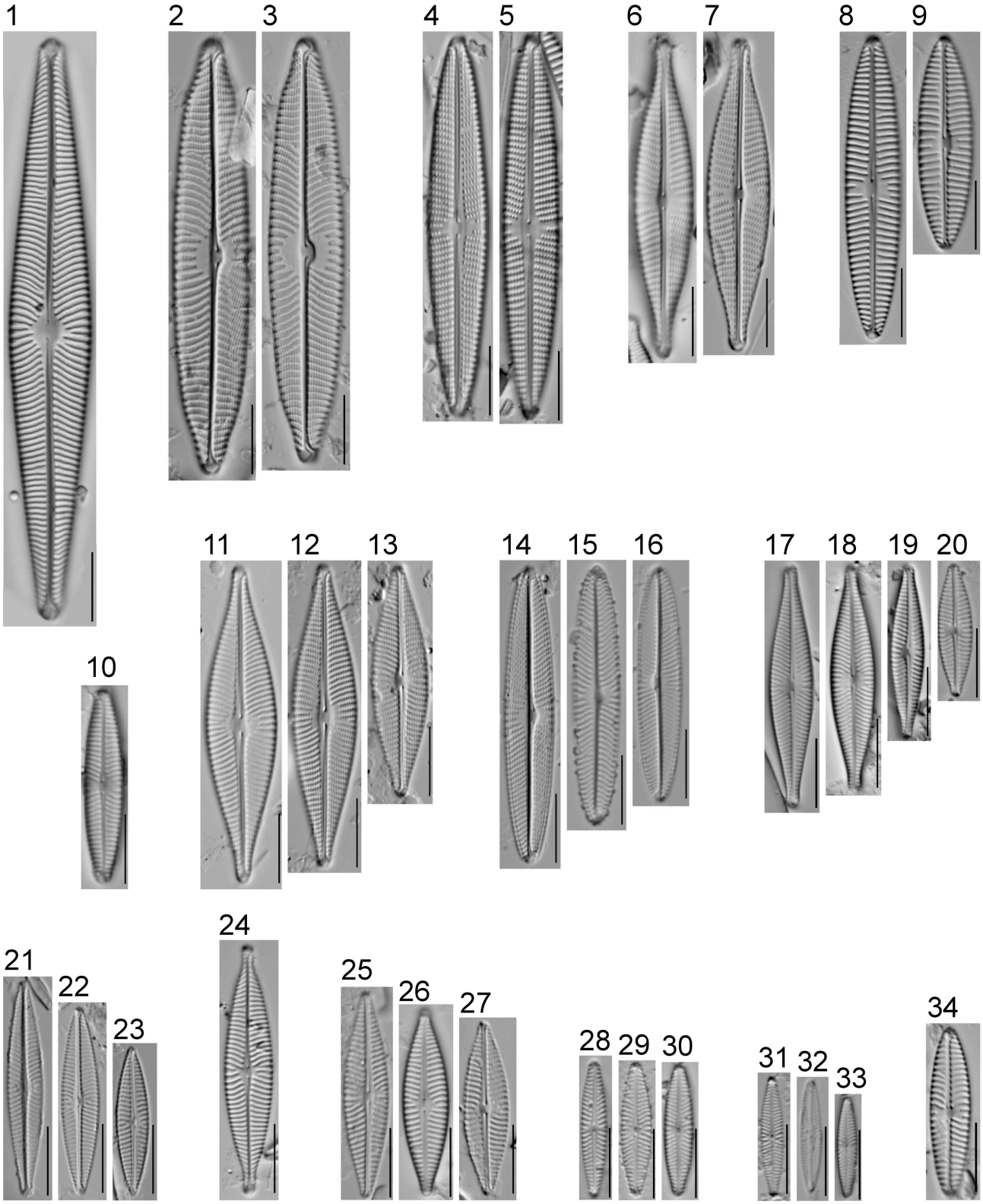

PLATE 8. Light micrographs of symmetric biraphid taxa. Fig. 1. *Navicula radiosa*. Figs 2–3. *N. viridulacalcis* subsp. *neomundana*. Figs 4–5. *N. geronimensis*. Figs 6–7. *N. rhynchocephala*. Figs 8–9. *N. tripunctata*. Fig. 10. *N. libonensis.* Figs 11–13. *N. trivialis.* Figs 14–16. *N. escambia*. Figs 17–20. *N. cryptocephala.* Figs 21–23. *N. cryptotenella.* Fig. 24. *N. capitatoradiata.* Figs 25–27. *N. pseudoreinhardtii*. Figs 28–30. *N. microcari*. Figs 31–33. *N. vilaplanii*. Fig. 34. *N. cari*. Scale bars: 10 µm.

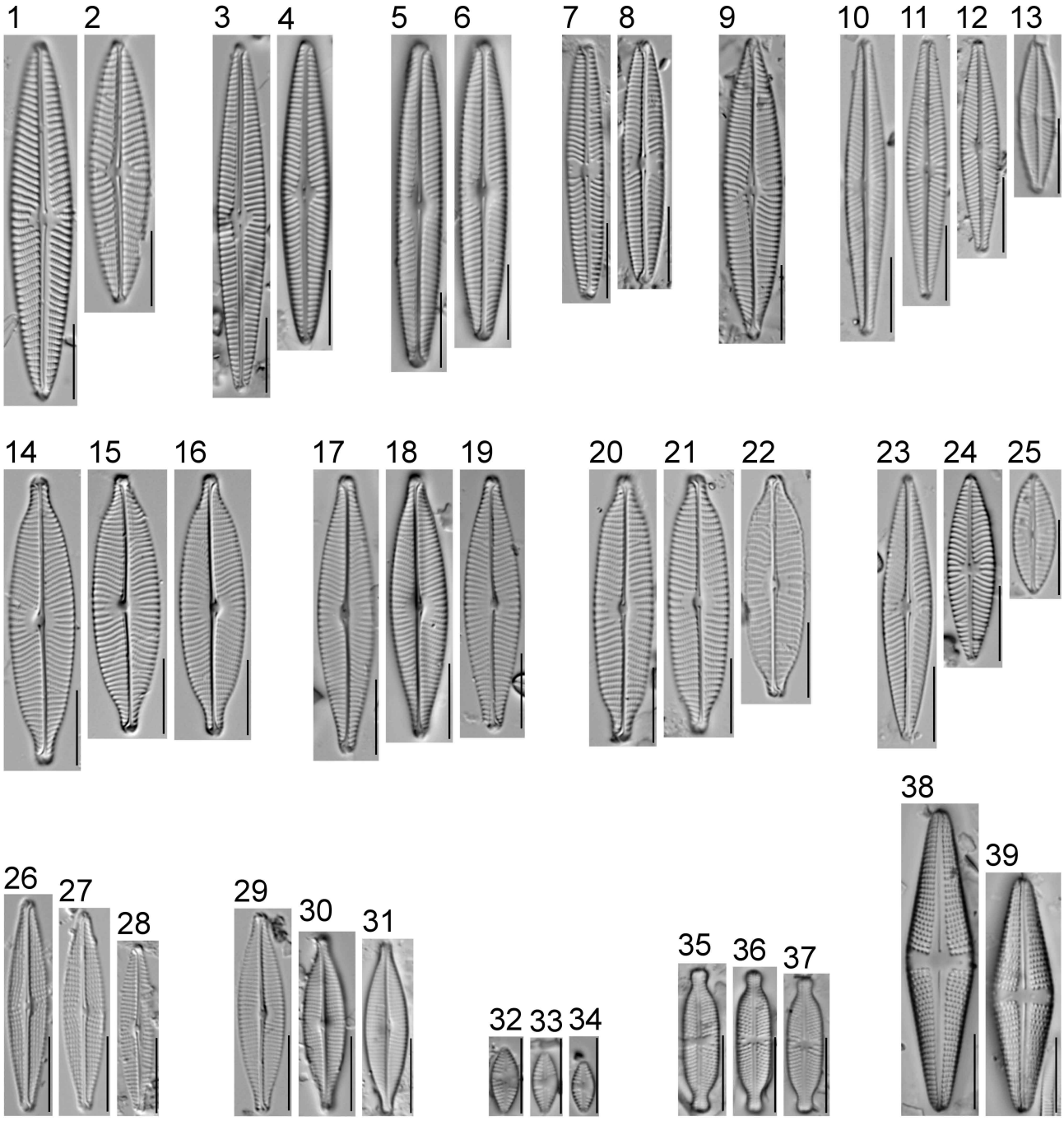

PLATE 9. Light micrographs of symmetric biraphid taxa. Figs 1–2. *Navicula* sp.7 SESQA. Figs 3–4. *N. radiosafallax*. Figs 5–6. *N. angusta*. Figs 7–8. *N. antverpiensis*. Fig. 9. *Navicula* sp.22 SESQA. Figs 10–13. *N. notha*. Figs 14–16. *N. rostellata*. Figs 17–19. *N. germainii*. Figs 20–22. *N. amphiceropsis*. Figs 23–25. *N. antonii.* Figs 26–28. *N. canalis*. Figs 29–31. *N. gregaria*. Figs 32–34. *N. ingenua*. Figs 35–37. *N. kotschyi.* Fig. 38–39. *N. dibola*. Scale bars: 10 µm.

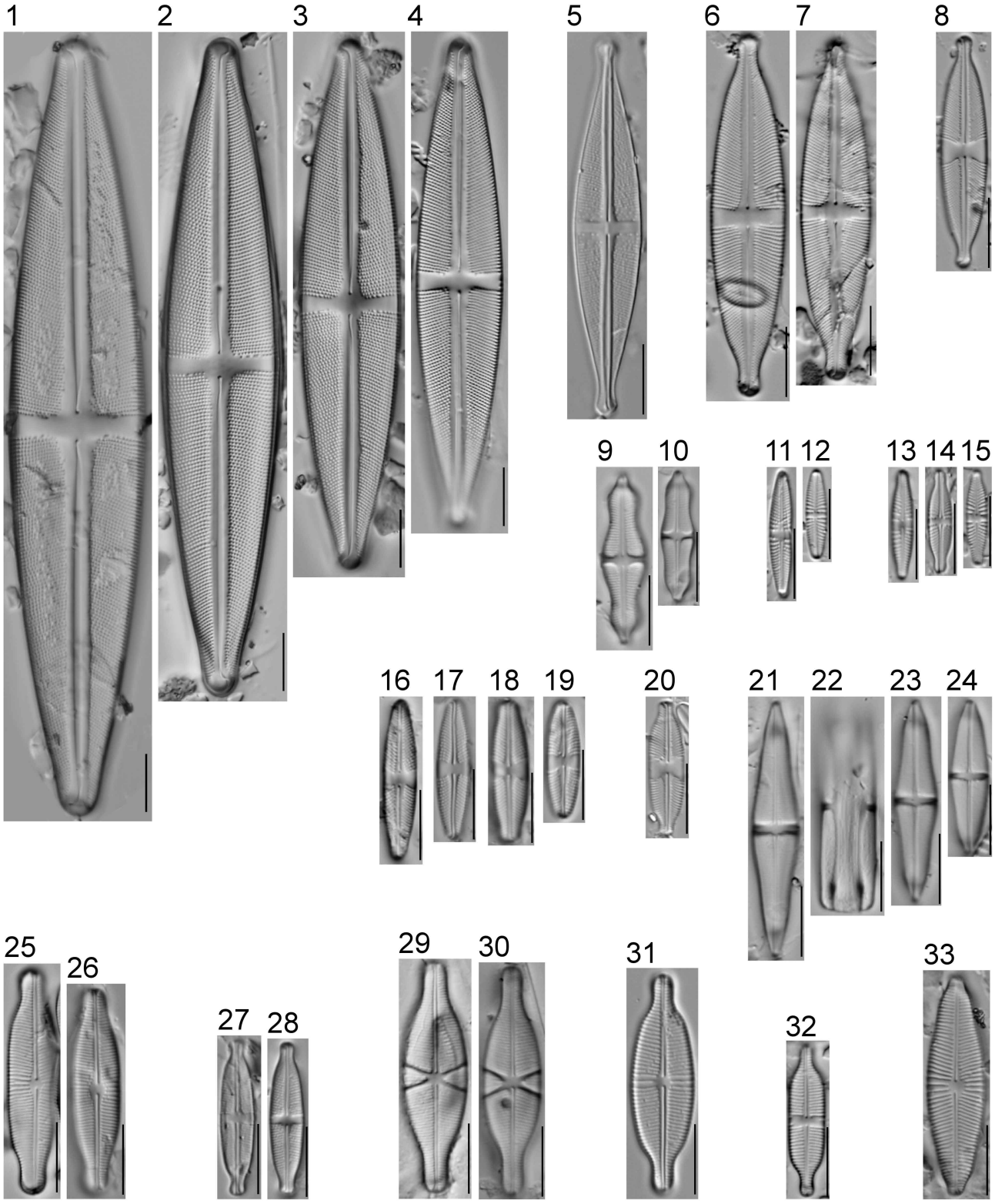

PLATE 10. Light micrographs of symmetric biraphid taxa. Figs 1–4. *Stauroneis gracilis*. Fig. 5. *S. acidoclinatopsis.* Figs 6–7. *Stauroneis limneticus.* Fig. 8. *S. pseudagrestis*. Figs 9–10. *S. smithii*. Figs 11–12. *S. thermicola* f. *lanceolata.* Figs 13–15. *S. thermicola.* Figs 16–19. *Stauroneis borrichii.* Fig. 20. *S. agrestis*. Figs 21–24. *S. smithii* var. *incisa*. Figs 25–26. *Parlibellus protracta*. Figs 27–28. *S. kriegeri.* Fig. 29–30. *Capartogramma crucicula*. Fig. 31. *Navicula sanctaecrucis*. Fig. 32. *Navicula* sp.23 SESQA. Fig. 33. *Prestauroneis integra*. Scale bars: 10 µm.

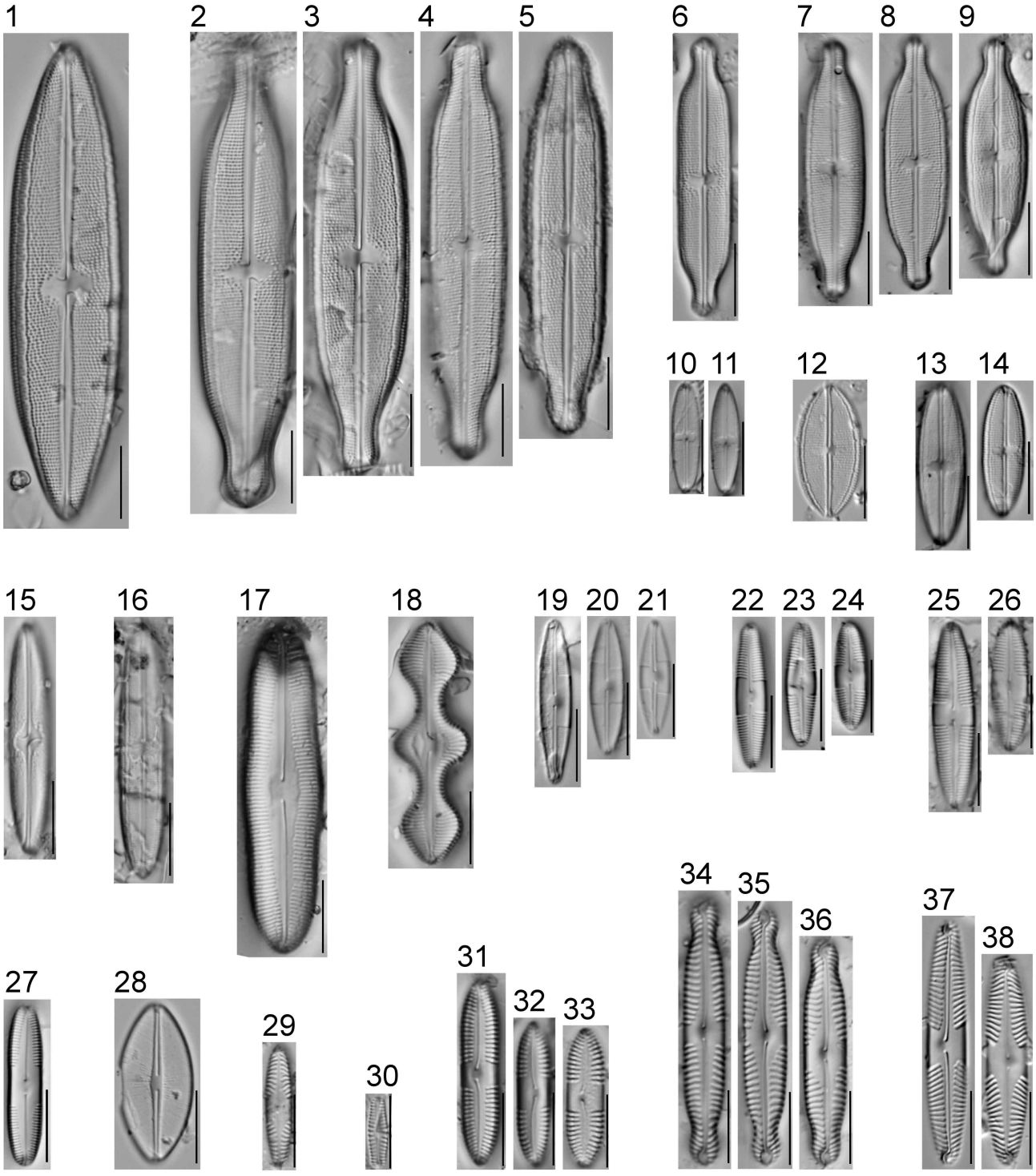

PLATE 11. Light micrographs of symmetric biraphid taxa. Fig. 1. *Neidium iridis*. Figs 2–5. *N. ampliatum.* Fig. 6. *N. affine* var. *longiceps.* Figs 7–9. *N. affine* var. *amphirhynchus.* Figs 10–11. *Neidium* sp.6 SESQA. Fig. 12. *N. densestriatum*. Figs 13–14. *Neidium* sp.5 SESQA. Fig. 15. *N. alpinum*. Fig. 16. *N. bisulcatum*. Fig. 17. *Caloneis silicula*. Fig. 18. *C. lewisii.* Figs 19–21. *C. hyalina*. Figs 22–24. *Caloneis* sp.3 SESQA. Figs 25–26. *C. bacillum*. Fig. 27. *C. fontinalis*. Fig. 28. *Cavinula cocconeiformis*. Fig. 29. *Pinnularia* sp.8 SESQA. Fig. 30. *Navicula convergens*. Figs 31– 33. *Caloneis schroederi*. Figs 34–36. *Pinnularia subcapitata* var. *paucistriata*. Figs 37–38. *Pinnularia* sp.11 SESQA. Scale bars: 10 µm.

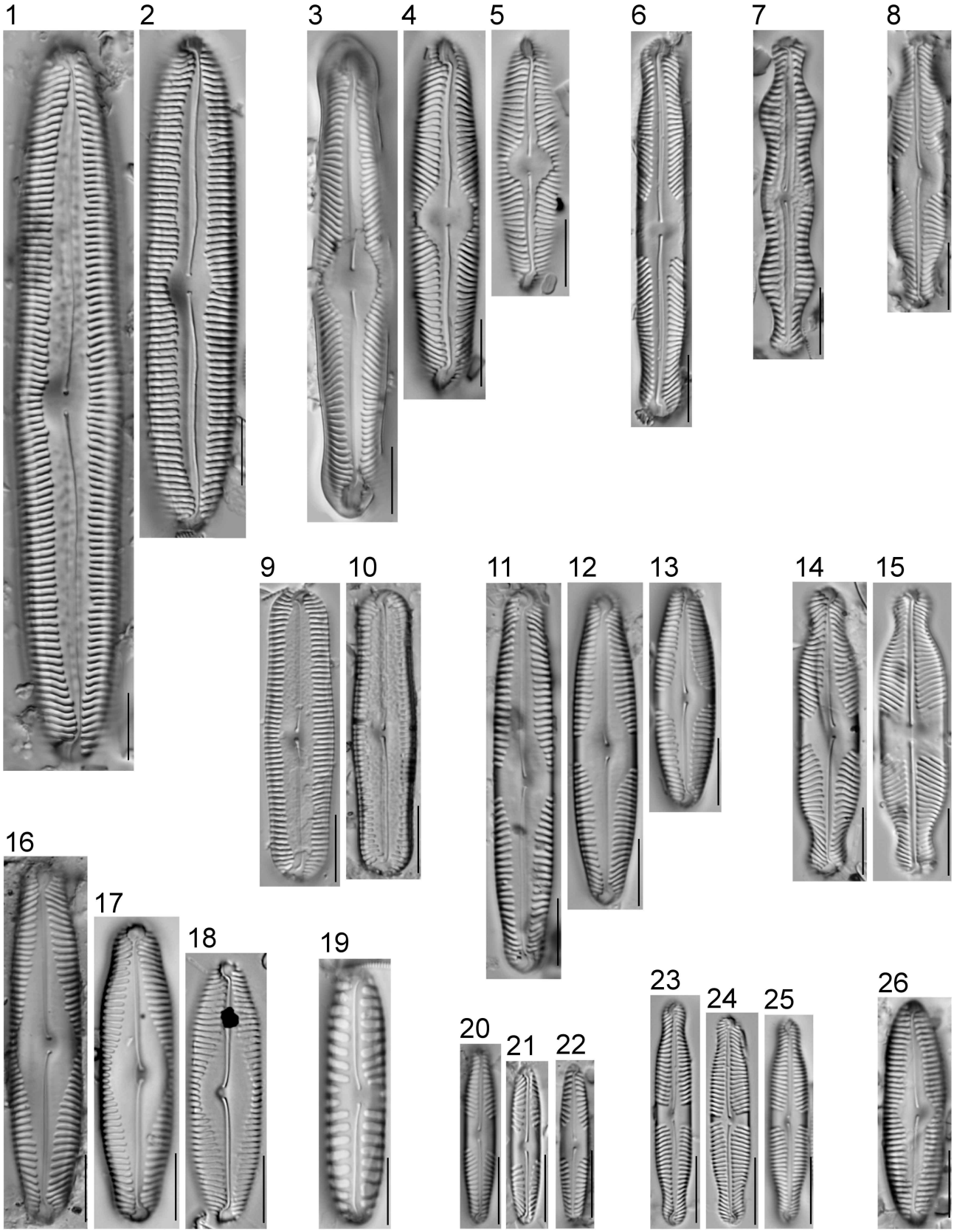

PLATE 12. Light micrographs of symmetric biraphid taxa. Figs 1–2. *Pinnularia viridis*. Figs 3–5. *P. erratica*. Fig. 6. *Pinnularia* sp.22 SESQA. Fig. 7. *Pinnularia* sp.23 SESQA. Fig. 8. *P. septentrionalis*. Figs 9–10. *P. acrosphaeria*. Figs 11–13. *P. parvulissima*. Figs 14–15. *P. biceps*. Figs 16–18. *P. brebissonii*. Fig. 19. *P. borealis*. Figs 20–22. *P. saprophila*. Figs 23–25. *P. subcapitata*. Fig. 26. *Pinnularia* sp.24 SESQA. Scale bars: 10 µm.

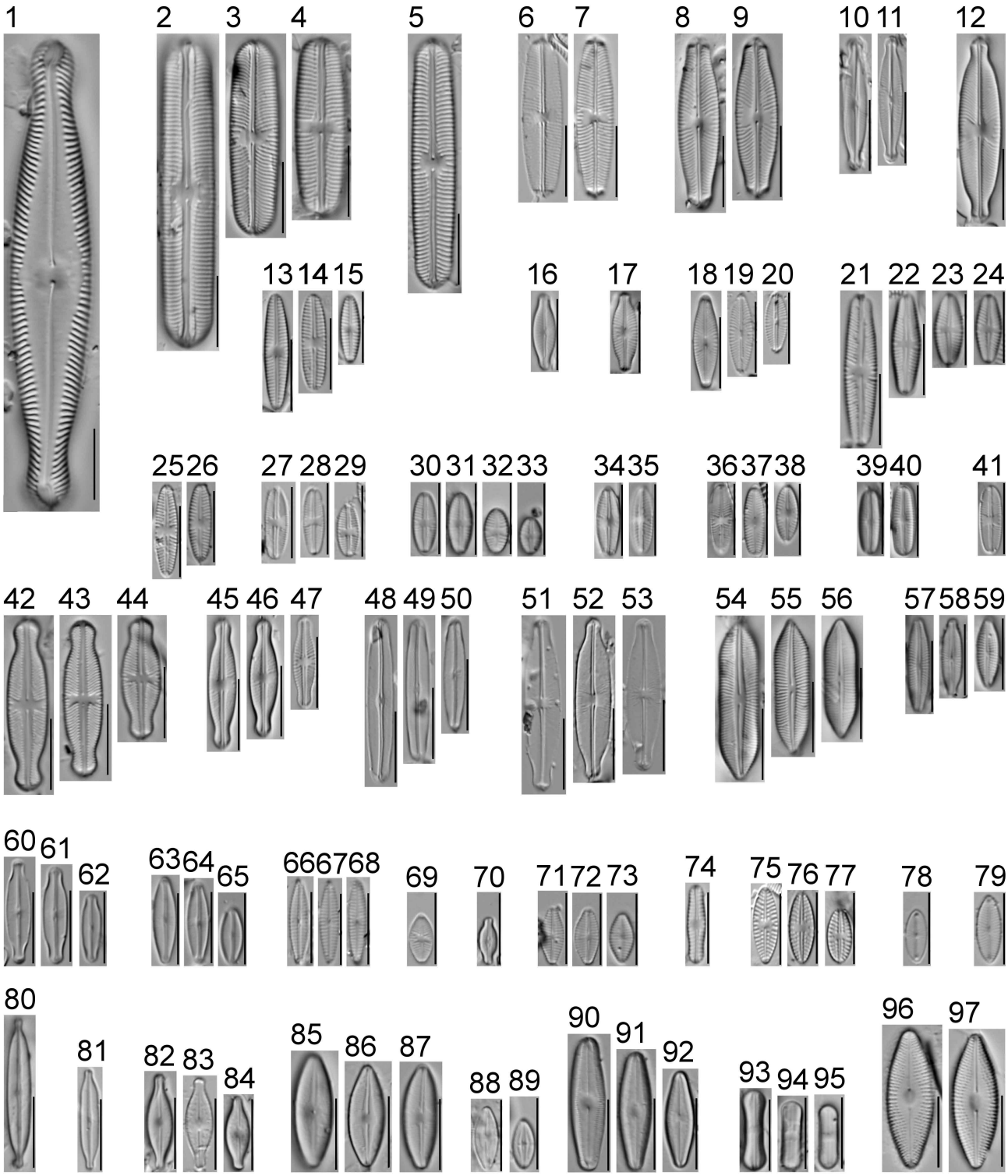

PLATE 13. Light micrographs of symmetric biraphid taxa. Fig. 1. *Pinnularia* sp.15 SESQA. Figs 2–4. *Sellaphora rugula*. Fig. 5. *S. laevissima.* Figs 6–7. *Sellaphora* sp.23 SESQA. Figs 8–9. *S. pupula*. Figs 10–11. *S. subfasciata*. Fig. 12. *Sellaphora* sp.24 SESQA. Figs 13–15. *S. saugerresii.* Fig. 16. *Sellaphora* sp.20 SESQA. Fig. 17. *Sellaphora* sp.27 SESQA. Figs 18–20. *Sellaphora* sp.25 SESQA. Figs 21–24. *Sellaphora* sp.26 SESQA. Figs 25–26. *Sellaphora* sp.22 SESQA. Figs 27–29. *S. atomoides*. Figs 30–33. *S. crassulexigua.* Figs 34–35. *Sellaphora* sp.29 SESQA. Figs 36–38. *Sellaphora* sp.28 SESQA. Figs 39–40. *S. stroemii*. Fig. 41. *Sellaphora* sp.19 SESQA. Figs 42–44. *S. japonica*. Figs 45–47. *S. hustedtii*. Figs 48–50. *S. wallacei*. Figs 51–53. *S. stauroneioides.* Figs 54–56. *Adlafia* sp.6 SESQA. Figs 57–59. *Adlafia* sp.5 SESQA. Figs 60–62. *S. difficillima.* Figs 63–65. *Adlafia* sp.3 SESQA. Figs 66–68. *Navicula cryptocephala* var. *perminuta*. Fig. 69. *Eolimna madida*. Figs 70. *Humidophila schmassmannii*. Figs 71–73. *Navicula nugalis*. Fig. 74. *S. elorantana*. Figs 75–77. *Eolimna* sp.1 SESQA. Fig. 78. *Mayamaea atomus*. Fig. 79. *M. agrestis*. Fig. 80. *Kobayasiella madumensis.* Fig. 81. *Kobayasiella* sp.1 SESQA. Figs 82–84. *Nupela wellneri*. Figs 85–87. *N. frezelii*. Figs 88–89. *Microcostatus krasskei*. Figs 90–92. *Humidophila perpusilla*. Figs 93–95. *Humidophila contenta*. Figs 96–97. *Diadesmis confervacea.* Scale bars: 10 µm.

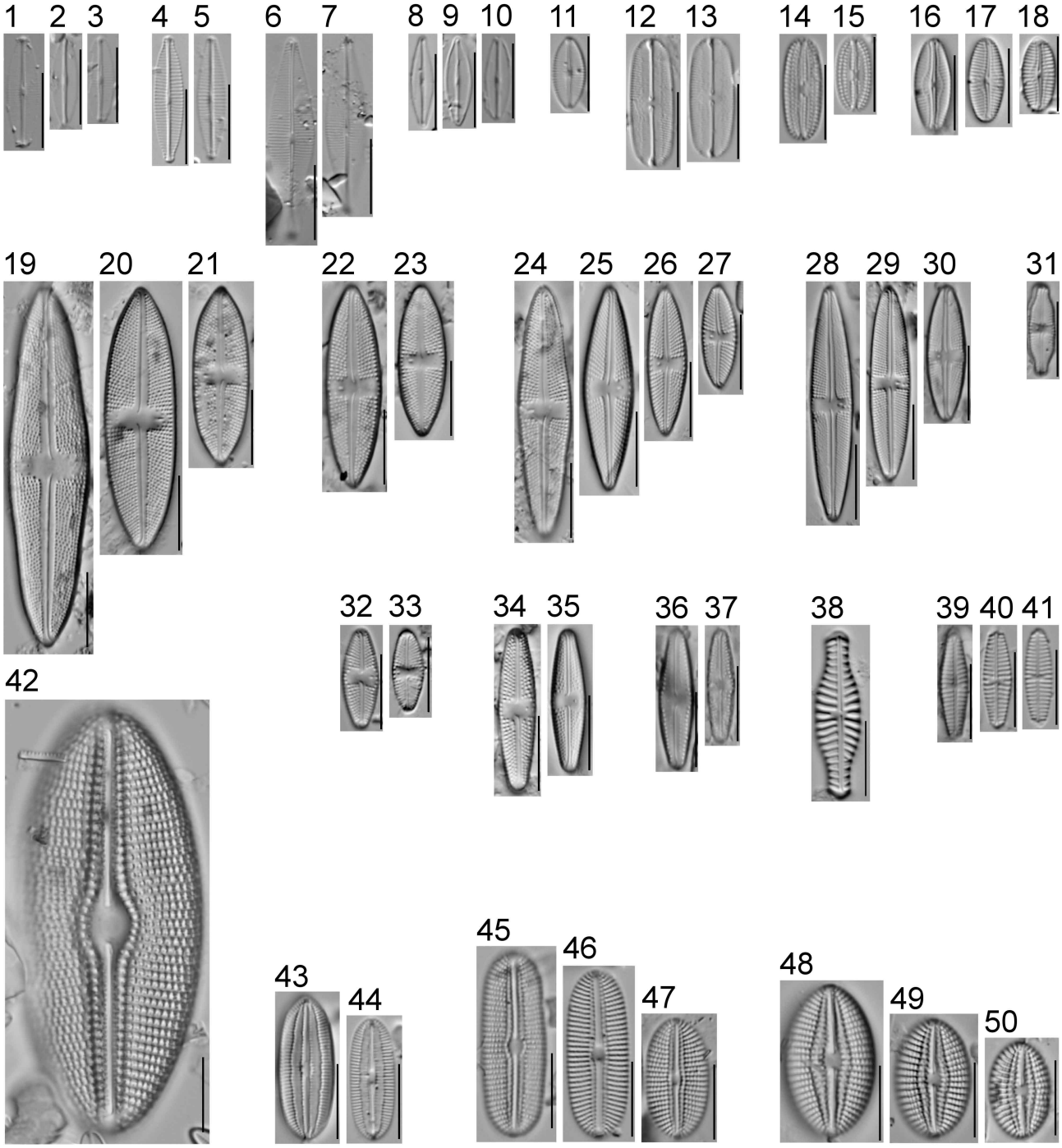

PLATE 14. Light micrographs of symmetric biraphid taxa. Figs 1–3. *Craticula molestiformis*. Figs 4–5. *C. accomoda*. Figs 6–7. *Craticula* sp.1 SESQA. Figs 8–10. *Craticula* sp.3 SESQA. Fig. 11. *C. subminuscula*. Figs 12–13. *Fallacia subhamulata*. Figs 14–15. *Pseudofallacia tenera*. Figs 16–18. *P. monoculata*. Figs 19–21. *Luticola minor*. Figs 22–23. *Luticola* sp.6 SESQA. Figs 24–27. *Luticola* sp.1 SESQA. Figs 28–30. *Luticola* sp.5 SESQA. Fig. 31. *L. nivalis*. Figs 32–33. *L. mutica*. Figs 34–35. *L. cohnii*. Figs 36–37. *L. sparsipunctata.* Fig. 38. *Hippodonta capitata*. Figs 39–41. *H. pseudacceptata*. Fig. 42. *Diploneis* sp.4 SESQA. Figs 43–44. D. *marginestriata*. Figs 45–47. *D. oblongella*. Figs 48–50. *Diploneis* sp.2 SESQA. Scale bars: 10 µm.

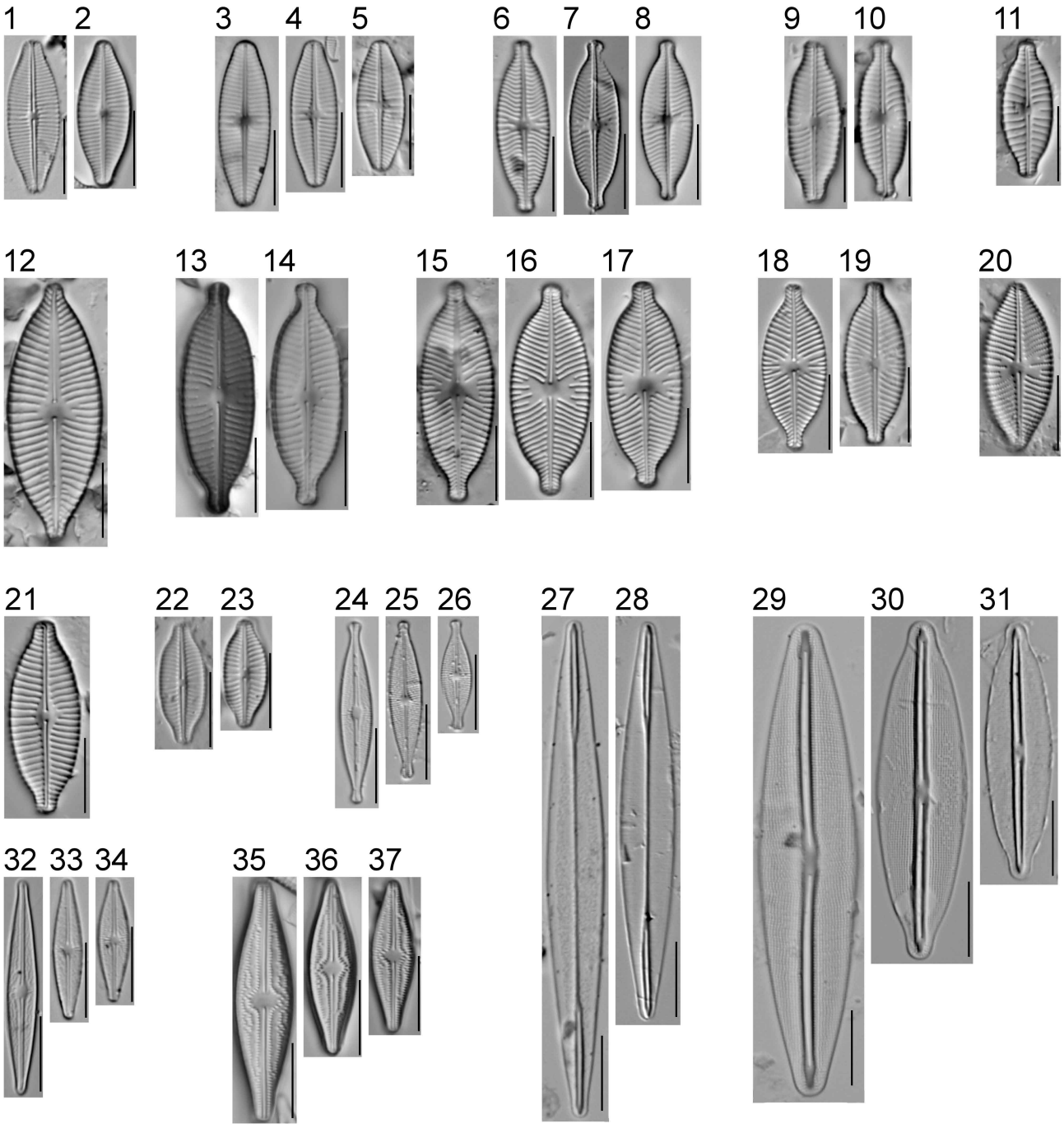

PLATE 15. Light micrographs of symmetric biraphid taxa. Figs 1–2. *Geissleria kriegeri*. Figs 3–5. *G. punctifera*. Figs 6–8. *G. decussis*. Figs 9–10. *Placoneis neglecta*. Fig. 11. *P. anglophila*. Fig. 12. *P. placentula*. Figs 13–14. *P. elginensis*. Figs 15–17. *P. symmetrica*. Figs 18–19. *P. clementis*. Fig. 20. *Placoneis* sp.6 SESQA. Fig. 21. *Placoneis* sp.8 SESQA. Figs 22–23. *Navicula geitleri*. Figs 24–26. *Brachysira microcephala*. Figs 27–28. *Amphipleura pellucida*. Figs 29–31. *Frustulia crassinervia*. Figs 32–34. *B. ocalanensis*. Figs 35–37. *B. brebissonii*. Scale bars: 10 µm.

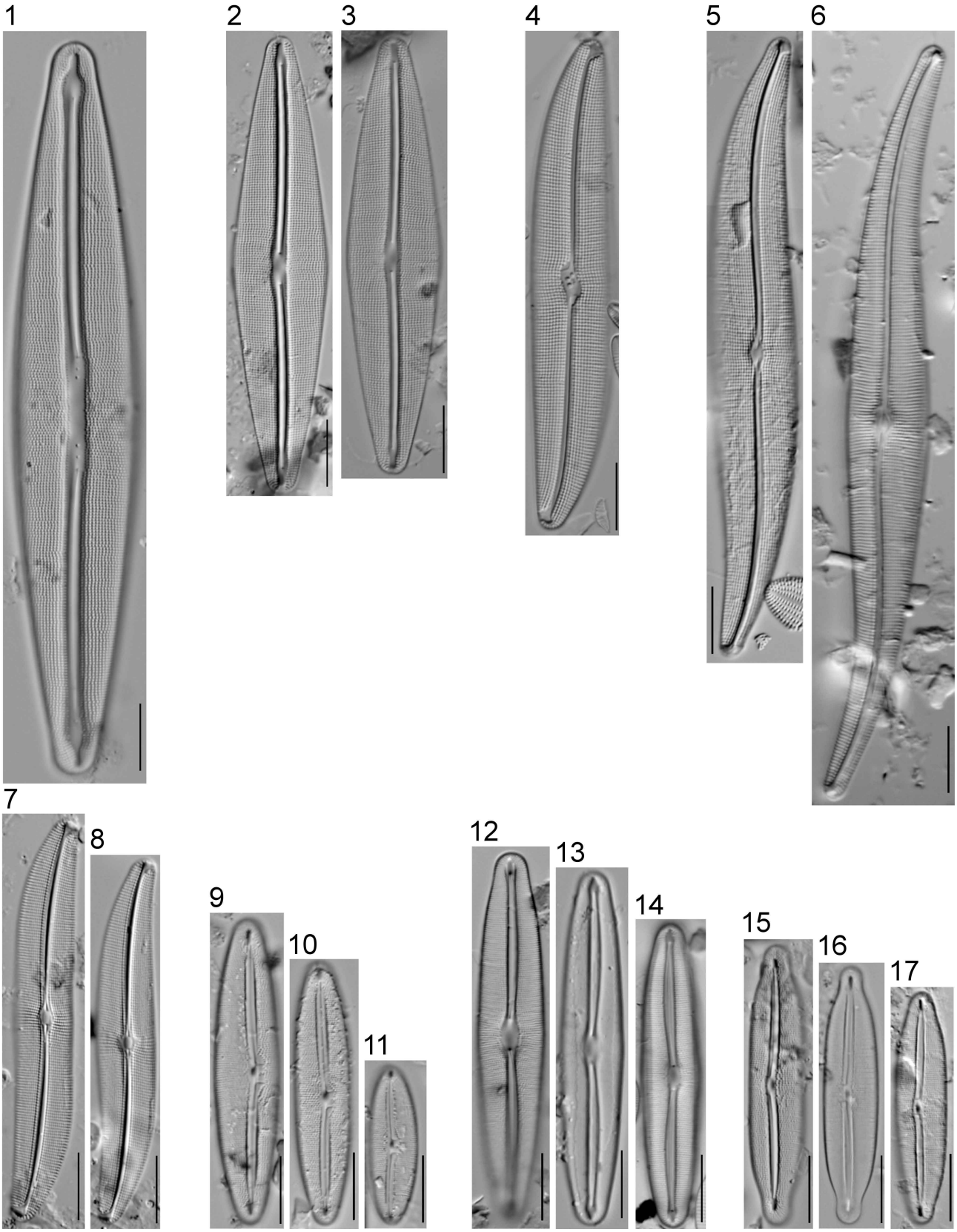

PLATE 16. Light micrographs of symmetric biraphid taxa. Fig. 1. *Frustulia amphipleuroides*. Figs 2–3. *Frustulia inculta*. Fig. 4. *Gyrosigma reimeri.* Figs 5–6. *G. acuminatum.* Figs 7–8. *G. scalproides*. Figs 9–11. *F. latita*. Figs 12–14. *F. vulgaris*. Figs 15–17. *F. capitata*. Scale bars: 10 μm.

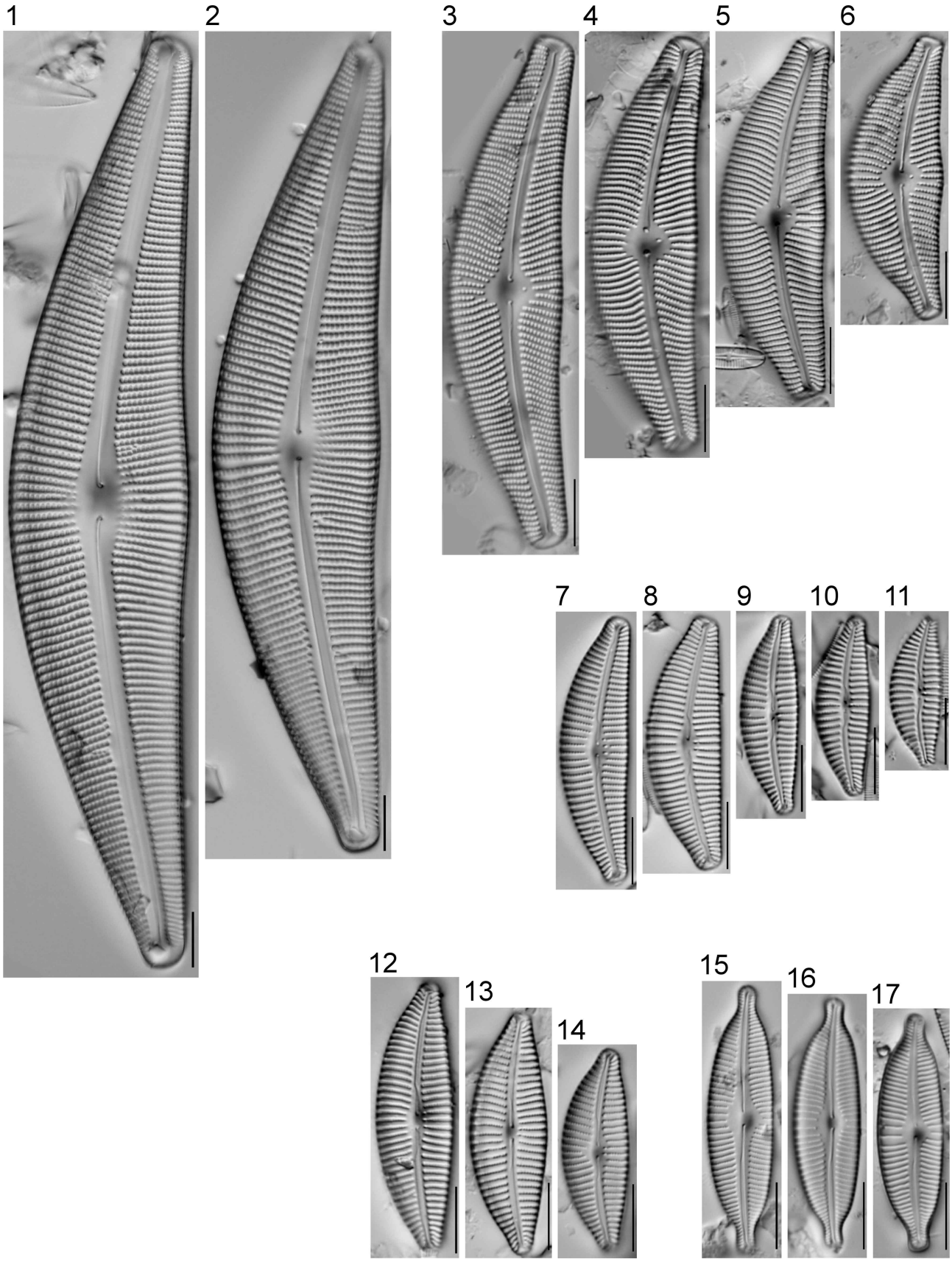

PLATE 17. Light micrographs of asymmetric biraphid taxa. Figs 1–2. *Cymbella aspera*. Figs 3–6. *C. tumida*. Figs 7–11. *C. affinis.* Figs 12–14. *C. turgidula*. Figs 15–17. *Cymbopleura sublanceolata*. Scale bars: 10 µm.

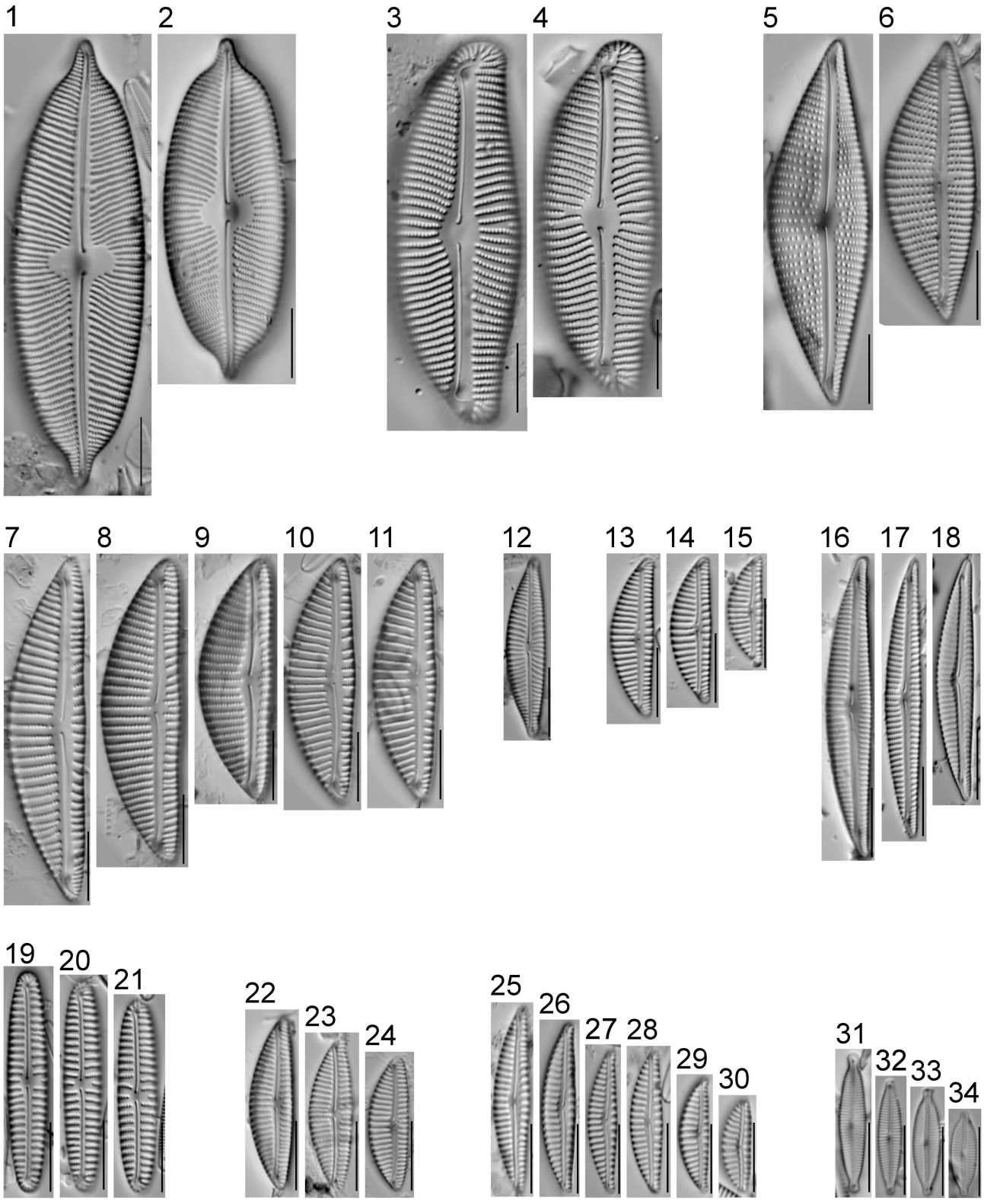

PLATE 18. Light micrographs of asymmetric biraphid taxa. Figs 1–2. *Cymbopleura apiculata*. Figs 3–4. *Encyonema leibleinii*. Figs 5–6. *E. triangulum*. Figs 7–11. *E. minuta* var. *pseudogracilis*. Fig 12. *E. hamsherae*. Figs 13–15. *E. minutum*. Figs 16–18. *E. pergracile*. Figs 19–21. *E. appalachianum*. Figs 22–24. *E. hebridiforme*. Figs 25–30. *E. lineolatum*. Figs 31–34. *Encyonopsis subminuta*. Scale bars: 10 µm.

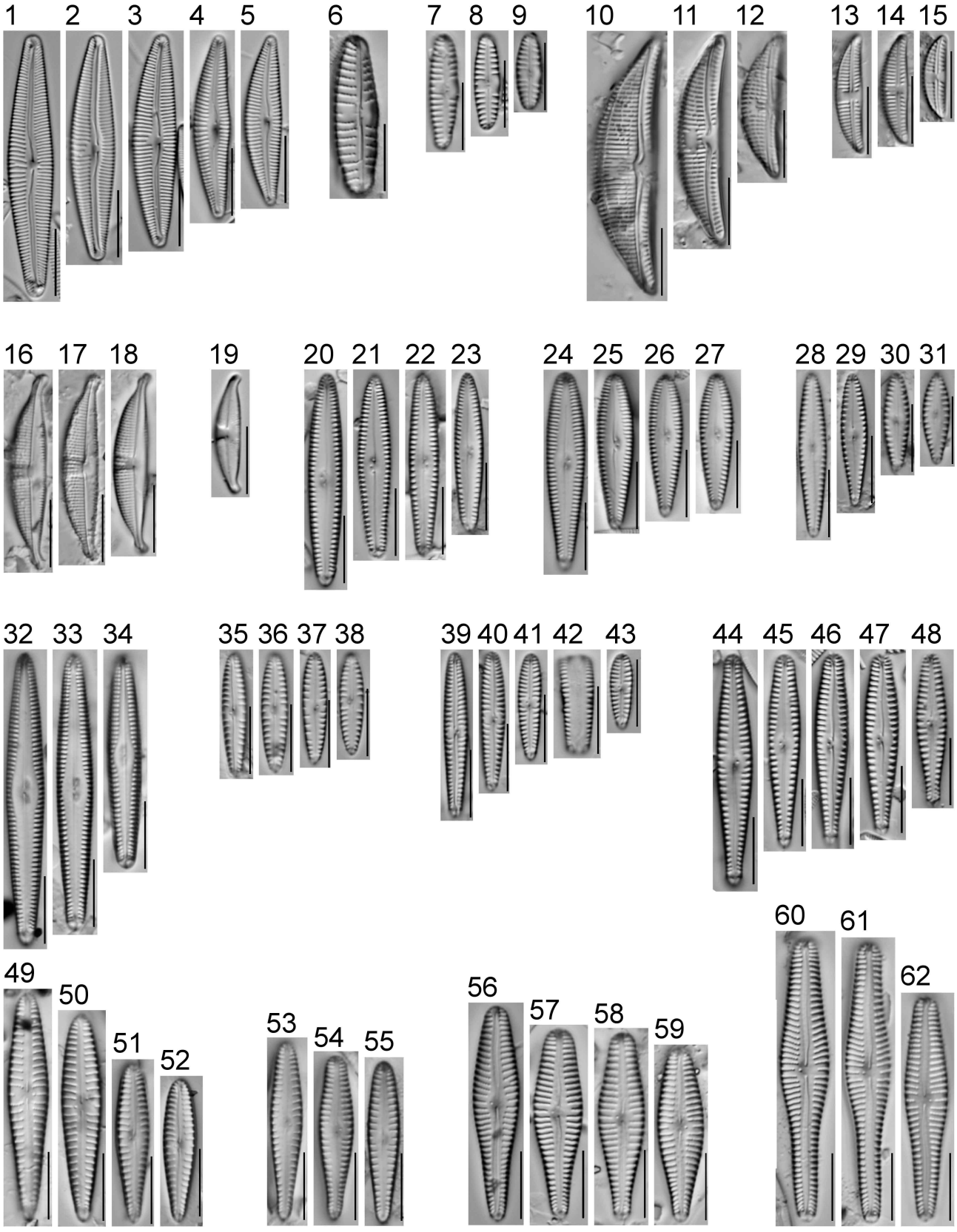

PLATE 19. Light micrographs of asymmetric biraphid taxa. Figs 1–5. *Delicata* sp.1 SESQA. Fig. 6. *Reimeria uniseriata*. Figs 7–9. *R. sinuata*. Figs 10–12. *Amphora copulata*. Figs 13–15. *A. pediculus*. Figs 16–18. *A. bicapitata*. Fig. 19. *Halamphora montana*. Figs 20–23. *Gomphonema caperatum*. Figs 24–27. *G. incognitum*. Figs 28–31. *G. louisianananum*. Figs 32–34. *Gomphonema* sp.42 SESQA. Figs 35–38. *G. kobayasii*. Figs 39–43. *Gomphonema* sp.15 SESQA. Figs 44–48. *G. sierrianum*. Figs 49–52. *Gomphonema* sp.28 SESQA. Figs 53–55. *Gomphonema* sp.7 SESQA. Figs 56–59. *Gomphonema* sp.26 SESQA. Figs 60–62. *Gomphonema* sp.40 SESQA. Scale bars: 10 µm.

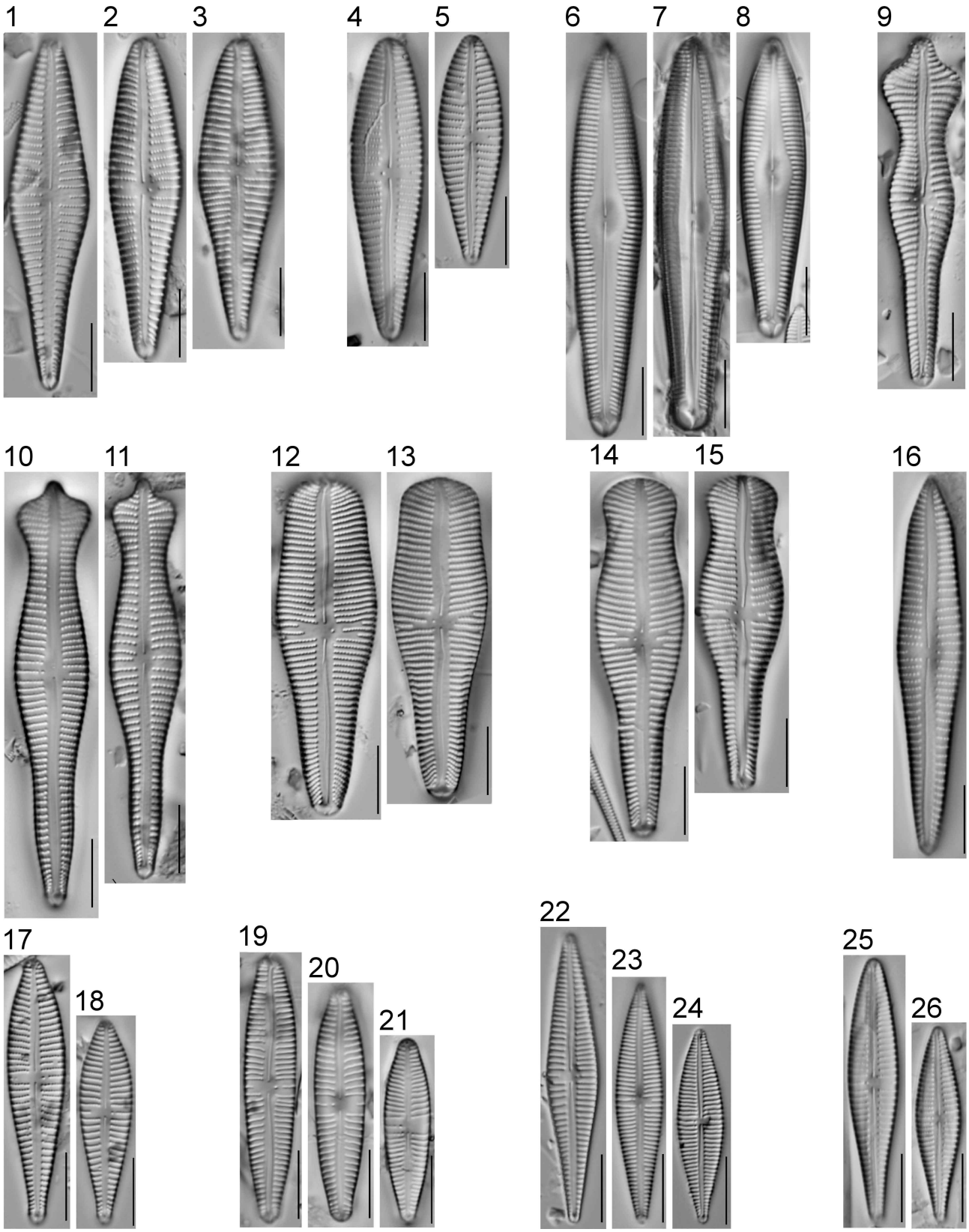

PLATE 20. Light micrographs of asymmetric biraphid taxa. Figs 1–3. *Gomphonema affine* var. *rhombicum*. Figs 4–5. *Gomphonema* sp.9 SESQA. Figs 6–8. *Gomphonema* sp.35 SESQA. Fig. 9. *G. acuminatum*. Figs 10–11. *G. coronatum*. Figs 12–13. *G. turgidum*. Figs 14–15. *G. truncatum*. Fig. 16. *G. turris.* Figs 17–18. *Gomphonema* sp.11 SESQA. Figs 19–21. *G. celatum*. Figs 22–24. *G. affine.* Figs 25–26. *Gomphonema* sp.20 SESQA. Scale bars: 10 µm.

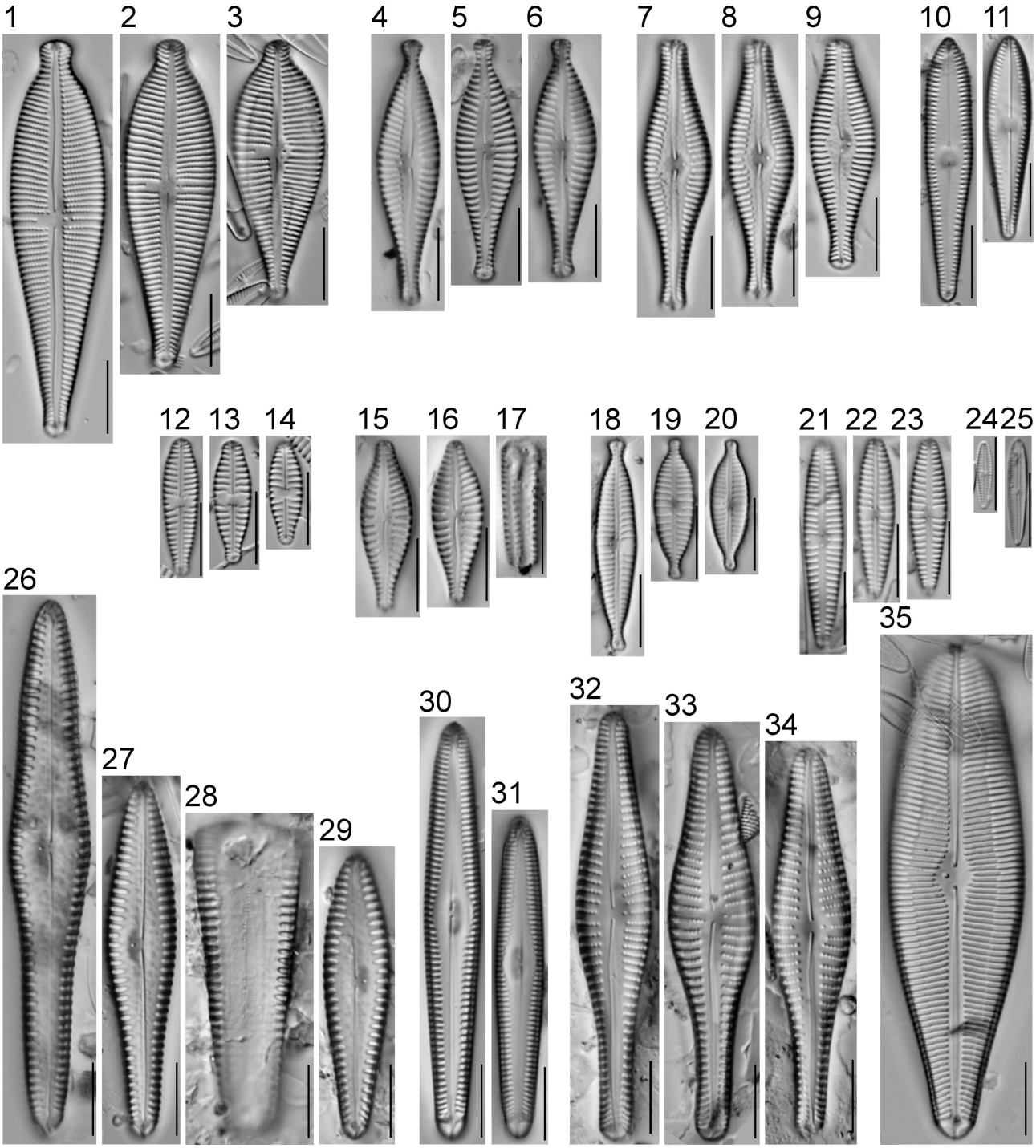

PLATE 21. Light micrographs of asymmetric biraphid taxa. Figs 1–3. *Gomphonema sphaerophorum*. Figs 4–6. *Gomphonema* sp.41 SESQA. Figs 7–9. *G. manubrium*. Figs 10–11. *Gomphosphenia lingulatiformis*. Figs 12–14. *Gomphonema olivaceoides* var. *hutchinsoniana*. Figs 15–17. *Gomphonema* sp.33 SESQA. Figs 18–20. *G. parvulum*. Figs 21–23. *Gomphonema* sp.25 SESQA. Figs 24–25. *Gomphosphenia stoermeri*. Figs 26–29. *Gomphonema reimeri*. Figs 30–31. *G. christensenii*. Figs 32–34. *G. mehleri*. Fig. 35. *Gomphoneis minuta*. Scale bars: 10 µm.

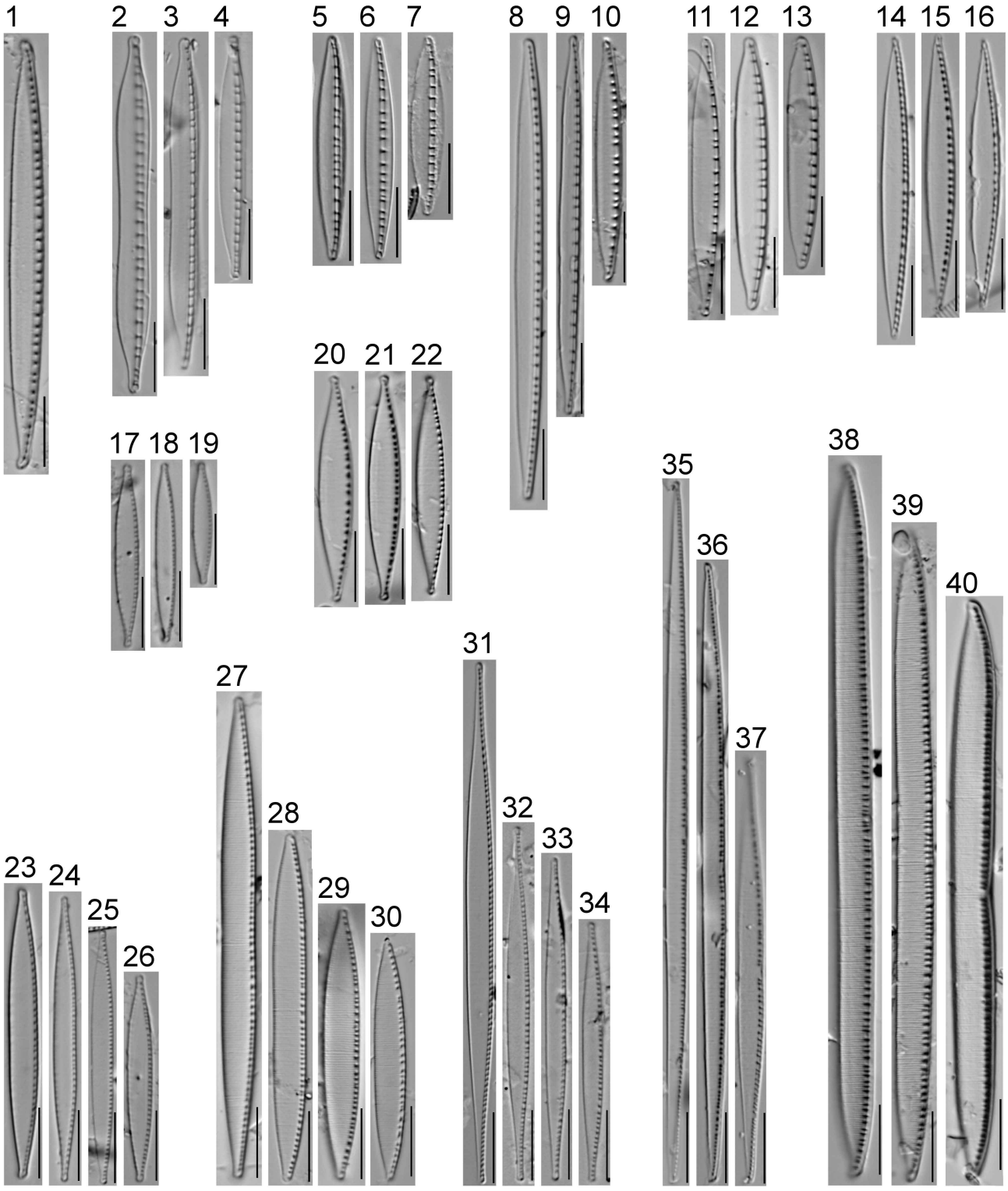

PLATE 22. Light micrographs of nitzschioid taxa. Fig. 1. *Nitzschia recta*. Figs 2–4. *Nitzschia dissipata f. undulata*. Figs 5–7. *N. dissipata*. Figs 8–10. *N. dissipata* var. *media*. Figs 11–13. *Nitzschia* sp.26 SESQA. Figs 14–16. *N. sociabilis*. Figs 17–19. *N. palea* var. *debilis*. Figs 20–22. *N. montanestris*. Figs 23–26. *N. palea* var. *tenuirostris*. Figs 27–30. *N. palea*. Figs 31–34. *N. acicularioides*. Figs 35–37. *N. tenuis*. Figs 38–40. *N. linearis.* Scale bars: 10 µm.

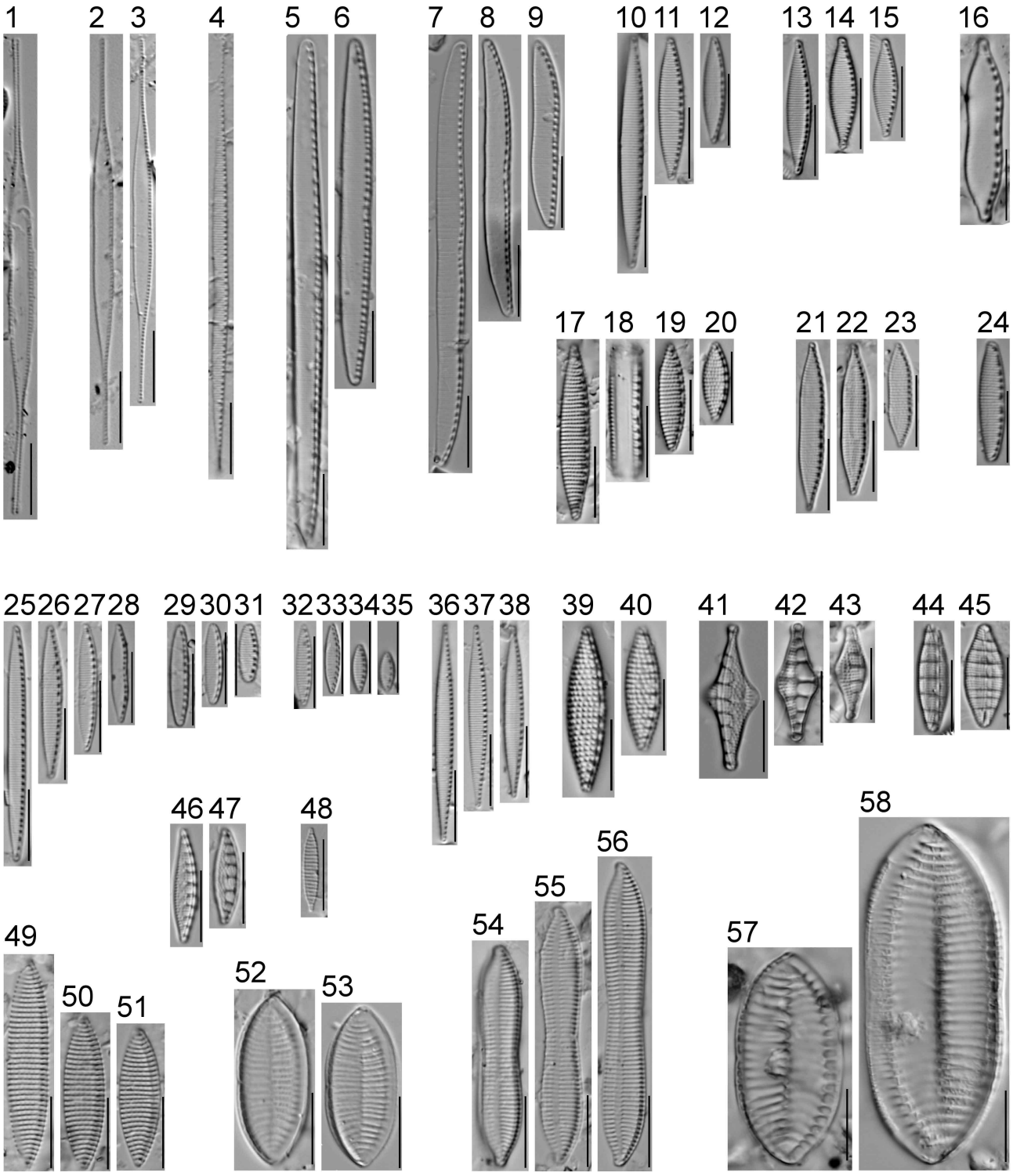

PLATE 23. Light micrographs of nitzschioid taxa. Fig. 1. *Nitzschia acicularis*. Figs 2–3. *N. draveillensis*. Fig. 4. *N. subconfinis*. Figs 5–6. *N. filiformis*. Figs 7–9. *N. clausii*. Figs 10–12. *N. frustulum*. Figs 13–15. *N. fonticola.* Fig. 16. *N. brevissima*. Figs 17–20. *N. amphibia*. Figs 21–23. *Nitzschia* sp.34 SESQA. Fig. 24. *Nitzschia* sp.29 SESQA. Figs 25–28. *Nitzschia frustulum* var. *subsalina*. Figs 29–31. *Nitzschia soratensis*. Figs 32–35. *N. inconspicua*. Figs 36–38. *Nitzschia* sp.7 SESQA. Figs 39–40. *N. amphibioides*. Figs 41–43. *N. sinuata var. tabellaria*. Figs 44–45. *Denticula tenuis*. Figs 46–47. *N. sinuata var. delognei*. Fig. 48. *Simonsenia delognei*. Figs 49–51. *Denticula* sp.1 SESQA. Figs 52–53. *Tryblionella debilis*. Figs 54–56. *T. apiculata*. Figs 57–58. *T. levidensis*. Scale bars: 10 µm.

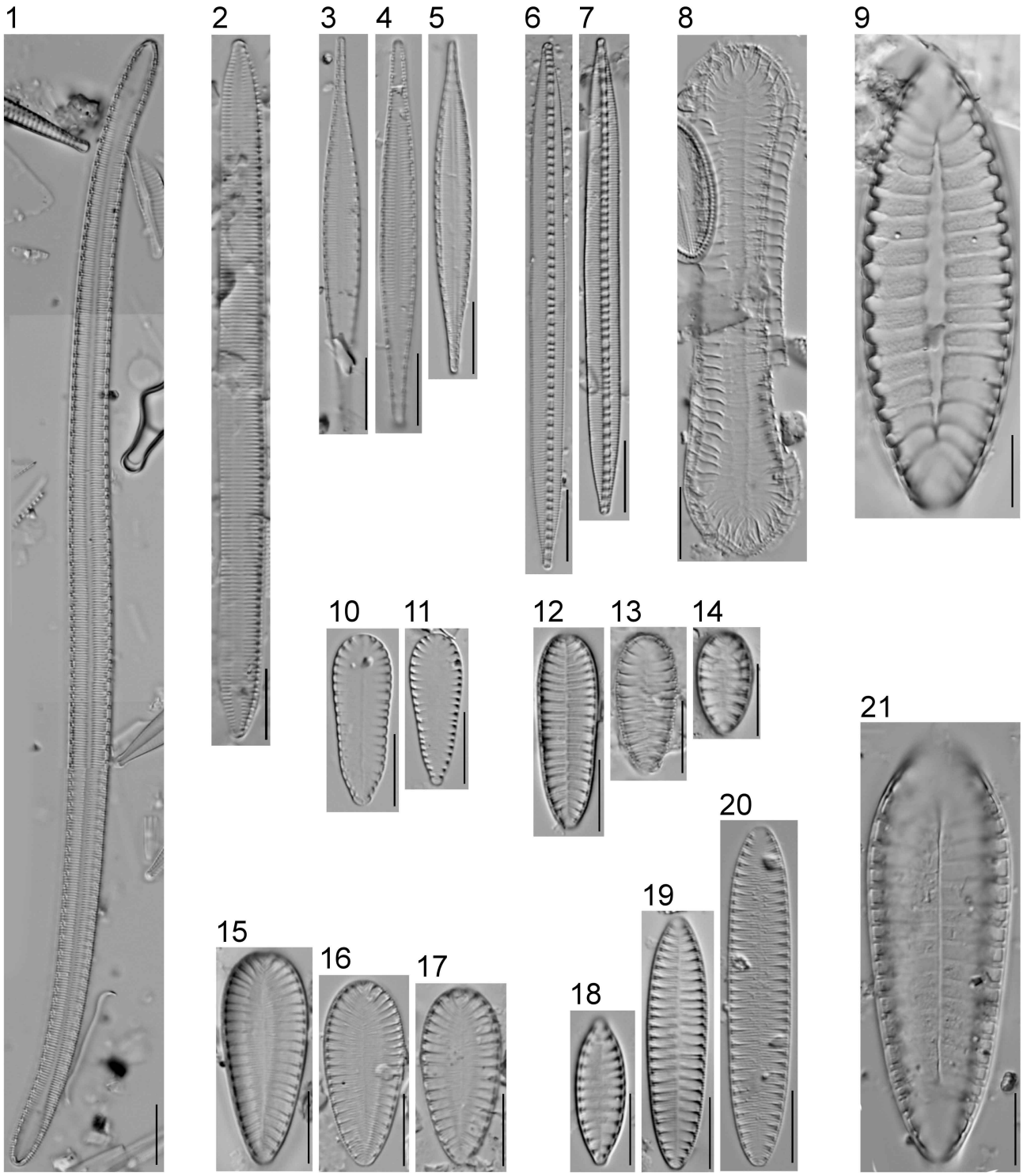

PLATE 24. Light micrographs of nitzschioid and surirelloid taxa. Fig. 1. *Stenopterobia curvula*. Fig. 2. *Tryblionella hungarica*. Figs 3–5. *S. delicatissima*. Figs 6–7. *Bacillaria paradoxa*. Fig. 8. *Surirella* sp.6 SESQA. Fig. 9. *S. robusta*. Figs 10–11. *Surirella suecica.* Figs 12–14. *S. minuta*. Figs 15–17. *S. brebissonii*. Figs 18–20. *S. angusta*. Fig. 21. *S. tenera*. Scale bars: 10 µm.