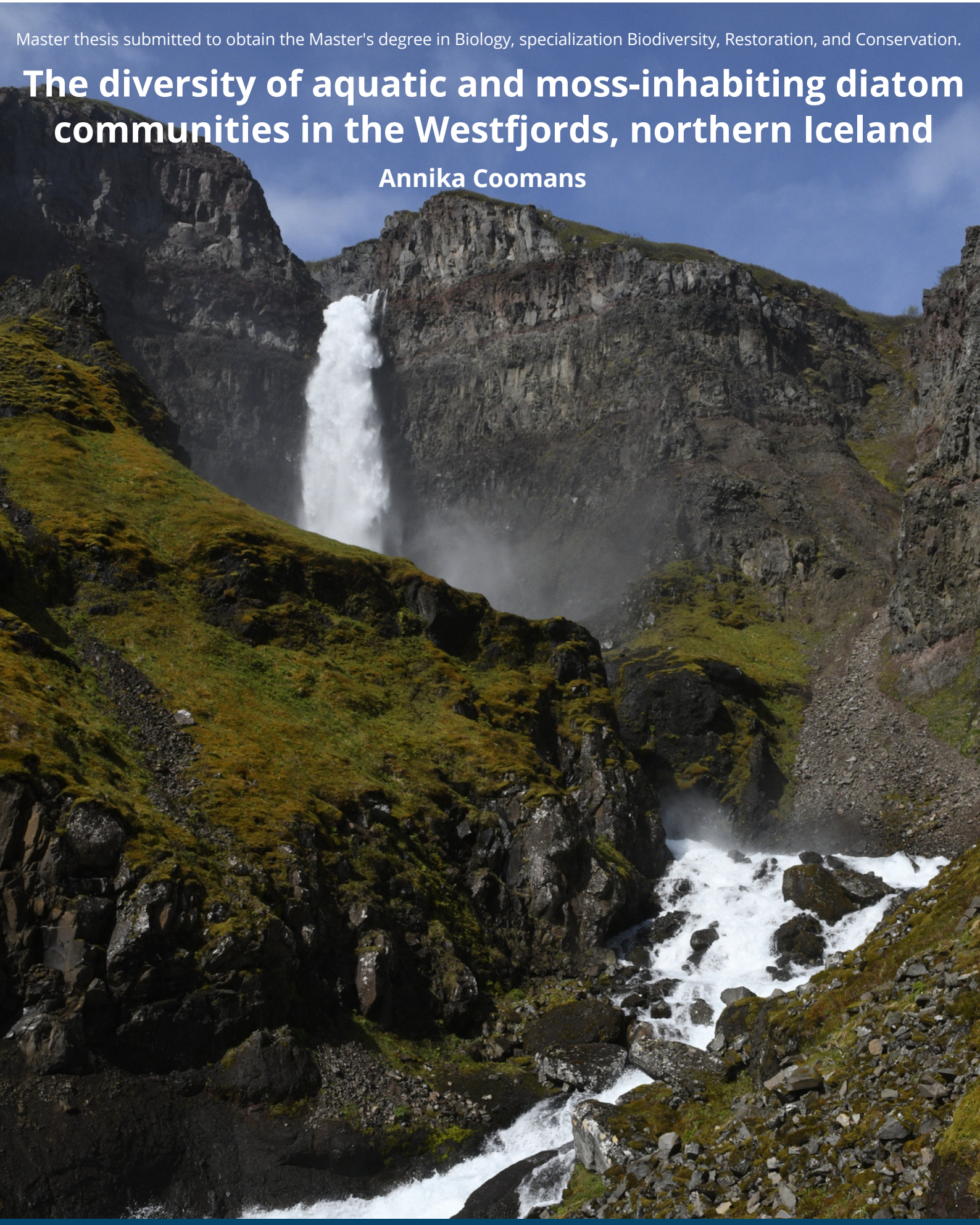
Master thesis submitted to obtain the Master's degree in Biology, specialization Biodiversity, Restoration, and Conservation.

# The diversity of aquatic and moss-inhabiting diatom communities in the Westfjords, northern Iceland

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# Abstracts

## English abstract

The biodiversity and ecological structure of freshwater diatom communities in Iceland remains incompletely documented and therefore poorly understood, particularly in remote regions such as the Westfjords, the most northwestern part of the island. This study investigated the freshwater diatom flora of the Westfjords and explored patterns in community composition across a range of aquatic and moss-associated habitats. Sixty-two samples collected from lakes, pools, rivers, streams, waterfalls and moss habitats were analysed using light and, when available, scanning electron microscopy. Diatom assemblages were identified to the lowest possible taxonomic level and analysed using diversity estimates, ordination techniques and community analyses. A total of 403 taxa belonging to 71 genera were recorded, including 317 taxa observed during quantitative counts and 86 additional taxa detected during qualitative observations. Species richness estimators indicated that a substantial proportion of the regional flora remains undocumented. More than 60% of all recorded taxa occurred in fewer than 5% of the analysed samples, demonstrating the importance of rare taxa in the diatom flora of the Westfjords. Three major diatom assemblages were identified, corresponding primarily to differences in habitat type and hydrological conditions. The study further contributed to the description and revision of several taxa, including the formal description of *Planothidium islandicum* as a species new to science. The results demonstrate that the Westfjords harbour a highly diverse and ecologically differentiated freshwater diatom flora and provide an important baseline for future biodiversity, biogeographical and environmental monitoring studies in Iceland.

# Dutch abstract

De diversiteit van zoetwaterdiatomeeën in IJsland is nog onvoldoende gedocumenteerd, vooral in afgelegen regio's zoals de Westfjorden. Hierdoor blijft de biodiversiteit en ecologische structuur van diatomeeëngemeenschappen in deze regio grotendeels onbekend. In deze studie werd de zoetwaterdiatomeeënflora van de Westfjorden geïnventariseerd en werden patronen in de gemeenschapsstructuur onderzocht over verschillende aquatische en mosgebonden habitats. Tweeënzestig stalen afkomstig uit meren, poelen, rivieren, beken, watervallen en moshabitats werden geanalyseerd met behulp van lichtmicroscopie en, waar nodig, scanning-elektronenmicroscopie. De diatomeeëngemeenschappen werden geïdentificeerd tot op het laagst mogelijke taxonomische niveau en geanalyseerd aan de hand van diversiteitsschattingen, ordinatietechnieken en multivariate gemeenschapsanalyses. In totaal werden 403 taxa uit 71 genera geregistreerd, waaronder 317 taxa vastgesteld tijdens kwantitatieve tellingen en 86 aanvullende taxa die werden gedetecteerd tijdens kwalitatieve observaties. Schattingen van de soortenrijkdom suggereerden dat een aanzienlijk deel van de regionale flora nog niet werd waargenomen. Meer dan 60% van alle geregistreerde taxa kwam voor in minder dan 5% van de onderzochte stalen, wat wijst op het grote belang van zeldzame taxa binnen de diatomeeënflora van de Westfjorden. Er werden drie belangrijke diatomeeëngemeenschappen onderscheiden, die voornamelijk samenhingen met verschillen in habitattype en hydrologische omstandigheden. Daarnaast droeg het onderzoek bij aan de beschrijving en taxonomische herziening van verschillende taxa, waaronder de formele beschrijving van *Planothidium islandicum* als een nieuwe soort voor de wetenschap. De resultaten tonen aan dat de Westfjorden een uitzonderlijk diverse en ecologisch gedifferentieerde zoetwaterdiatomeeënflora herbergen. Deze studie levert een belangrijke basis voor toekomstig onderzoek naar biodiversiteit, biogeografie en ecologische veranderingen in IJslandse zoetwatersystemen.

## Layman's abstract

Freshwater diatoms are microscopic algae that form the basis of aquatic food webs and are widely used as indicators of environmental conditions. Despite their ecological importance, the diversity of freshwater diatoms in Iceland remains poorly documented, particularly in remote regions such as the Westfjords. As a result, little is known about the biodiversity and ecological structure of diatom communities in this region. This study investigated the freshwater diatom flora of the Westfjords across a wide range of habitats, including lakes, pools, rivers, streams, waterfalls and mosses. A total of 62 samples were analysed using microscopic techniques to identify diatoms and compare communities between habitats. In total, 403 taxa belonging to 71 genera were recorded, revealing a remarkably diverse flora. More than 60% of all taxa occurred in fewer than 5% of the analysed samples, indicating that the diatom flora of the Westfjords contains a large number of rare species. Diversity estimates suggested that many species remain undiscovered and that the actual diversity of the region is likely even higher. The analyses identified three major diatom communities that were mainly associated with differences in habitat type and hydrological conditions. Fast-flowing rivers and waterfalls supported different communities than lakes and pools, highlighting the importance of habitat characteristics in shaping diatom diversity. The study also contributed to the discovery and taxonomic revision of several species, including the formal description of *Planothidium islandicum*, a diatom species new to science. Overall, the results show that the Westfjords harbour a highly diverse and previously underexplored freshwater diatom flora. These findings provide an important foundation for future biodiversity research, environmental monitoring and studies on ecological change in Icelandic freshwater ecosystems.

# 1. Introduction

## 1.1. Morphology

Diatoms (Bacillariophyta) are unicellular eukaryotic algae characterised by a siliceous cell wall, known as the frustule. They represent one of the most diverse and evolutionarily successful groups of microalgae, comprising an estimated 100,000–200,000 species worldwide (Mann & Vanormelingen, 2013). Diatoms most likely originated between 190 and 250 million years ago, depending on whether estimations are based on fossils or molecular clocks (Benoiston et al., 2017).

From a phylogenetic perspective, diatoms can no longer be simply divided into "centric" and "pennate" forms, an old-fashioned way based on the symmetry of diatom valves. Modern molecular phylogenetic studies indicate that extant diatoms can roughly be subdivided into three major evolutionary lineages (Medlin & Kaczmarska, 2004; Medlin, 2016; Theriot et al., 2010; Nakov et al., 2018). The earliest-diverging lineage comprises the radial centric diatoms (Coscinodiscophyceae) showing a radial valve symmetry and containing predominately marine representatives. The second lineage includes the so-called polar centric diatoms (Mediophyceae), sharing the radial symmetry, differing, however, from the radial centrics in several morphological and reproductive features. This second group contains many marine planktonic taxa such as the genus *Thalassiosira*. The third, and most species-rich lineage, is formed by the pennate diatoms (Bacillariophyceae), with a typical bilateral symmetry. Pennate diatoms are further subdivided into araphid pennates, lacking a raphe system, and the raphid pennates that possess one (monoraphids) or two (biraphids) raphe slits that enable active gliding motility. Molecular evidence indicates that the evolution of the raphe was a major innovation, contributing to the remarkable diversification of raphid diatoms, particularly in freshwater and benthic habitats (Nakov et al., 2018).

The most conspicuous morphological feature of diatoms is their cell wall, composed of hydrated silica ($SiO_2 \cdot nH_2O$), commonly called biogenic silica. The intricate silica architecture of the frustule combines mechanical strength with a relatively low weight and allows the formation of typical species-specific patterns. These structures are remarkably resistant to degradation and can remain preserved in sediments for thousands of years (Kooistra & Pohl, 2015). Each frustule is composed of two valves that can differ slightly in size, age, and structure: the older, larger valve is called the epivalve and the younger, smaller one is known as the hypovalve (Round et al., 1990). Both valves are tightly connected using girdle bands,

otherwise known as cingulum (John, 2015; Taylor & Cocquyt, 2016). Diatom valves are characterised by a complex pattern of morphological structures on their surface (Figure 1). The valves are perforated by pores, called areolae, which can form striae if arranged in continuous series. In the Bacillariophyceae the valve contains a slit-like structure known as the raphe (Figure 1), enabling active movement along substrates. In addition to the raphe, diatom valves may possess a variety of other morphological structures, including spines, apical pore fields and diverse ornamentation patterns (Round et al., 1990; Taylor & Cocquyt, 2016).

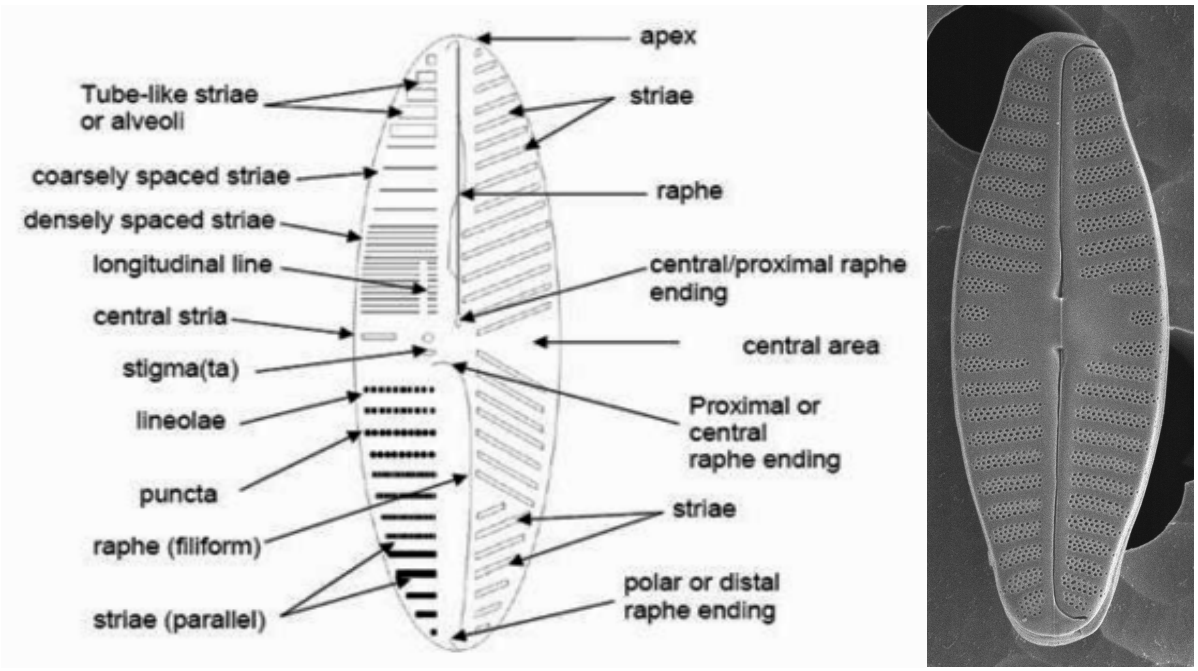



*Figure 1: Morphological features of a raphid diatom. Left: schematic representation of the principal valve structures and diagnostic morphological features of a raphid diatom (Taylor et al., 2006). Right: scanning electron microscope (SEM) image of a raphid diatom frustule showing some of the features illustrated in the drawing. (photo ©Bart Van de Vijver).*

The morphology of diatoms is highly diverse, as species may vary considerably in valve shape, dimensions, symmetry and ornamentation, ranging from simple elliptical forms to highly elaborate structures. This morphological diversity forms the basis for their classification and species identification.

Apart from its taxonomic importance, the frustule also plays a central role in the life cycle of diatoms. Diatoms reproduce both asexually and sexually. Repeated asexual cell division results in a gradual reduction in average cell size because each daughter cell inherits one parental valve and forms a slightly smaller new valve. Once a critical minimum size is reached, sexual reproduction may occur, leading to the formation of an auxospore that restores the maximum cell size characteristic of the species (Round et al., 1990).

## 1.2. Ecology

Diatoms as a group can be considered both cosmopolitan (i.e., worldwide distribution from poles to tropics) and ubiquitous, which means that they are commonly present in almost every habitat (oceans, lakes, rivers, moss vegetations, soils, …), as long as it contains a minimum amount of water. Some species are considered planktonic (floating in the water column) or benthic (attached to sediments, plants, or rocks) (Taylor & Cocquyt, 2016). Diatoms exhibit all kinds of life-forms, appearing as free-living single cells or attached to stones, aquatic plants, sand grains and even other organisms, or can join their cells into long colonies (Round et al., 1990). Apart from a few exceptions, almost all diatom species are photosynthetic organisms and possess chlorophyl a and c pigments (Round et al., 1990). Through photosynthesis, diatoms contribute substantially to global primary production and are estimated to account for at least 20% of the Earth's oxygen production (Seckbach & Gordon, 2019; Celi et al., 2022). In addition, they play a crucial role in the global carbon cycle by assimilating atmospheric carbon dioxide and incorporating it into their biomass. Upon cell death, a proportion of this carbon is transferred to the benthic environment through sedimentation, facilitating long-term carbon sequestration (Seckbach & Gordon, 2019). Furthermore, diatoms form the foundation of many aquatic food webs, serving as primary producers that support higher trophic levels, including zooplankton, crustaceans, fish, and ultimately larger consumers (Dehingia et al., 2025).

The distribution and composition of diatom communities are seldomly random. Rather, they are strongly structured by environmental conditions, habitat characteristics, and species-specific ecological requirements (Lowe, 1974; Stevenson et al., 1996; Smol & Stoermer, 2010). Individual diatom taxa exhibit distinct ecological preferences and tolerances with respect to a broad array of variables, such as pH, conductivity, nutrient availability, temperature, light availability, and substrate characteristics, resulting in predictable changes in community composition along environmental gradients (van Dam et al., 1994; Potapova & Charles, 2003). These environmental gradients function as ecological filters, selectively favouring taxa whose physiological adaptations allow them to persist under particular conditions while excluding less tolerant species (Leibold et al., 2004; Rimet & Bouchez, 2012). Consequently, differences in abiotic factors, including water chemistry, hydrological regime, altitude, habitat stability, and nutrient status, frequently generate distinct diatom assemblages among aquatic systems (Stevenson et al., 1996; Smol & Stoermer, 2010). Changes in these environmental parameters, whether caused by natural processes or anthropogenic disturbances, can therefore result in marked shifts in species composition, community structure, and functional characteristics of

diatom assemblages (Battarbee et al., 2001; Smol & Stoermer, 2010). Because of their rapid response to environmental change, short generation times, and well-documented ecological preferences, diatoms are considered one of the most widely used biological indicators for assessing water quality, ecosystem change, and past environmental conditions (Round et al., 1990; Stevenson et al., 2010).

## 1.3. Biogeography

As stated earlier, diatoms are among the most widespread groups of microorganisms on Earth, ranging from the poles to the tropics (Round et al., 1990). Our understanding of diatom biogeography has changed considerably over the past decades. Traditionally, individual diatom species were considered ubiquitous and cosmopolitan microorganisms, due to their enormous population sizes and presumed high dispersal capacity, a view formalised by Baas Becking (1934), who summarised microbial biogeography with the famous statement: “Everything is everywhere, but the environment selects.” According to this hypothesis, microorganisms possess sufficient dispersal capacity to reach virtually all suitable habitats, resulting in species distributions that are determined primarily by local environmental conditions rather than by geographical barriers or dispersal limitations (Becking, 1934; Finlay et al., 1996; Finlay, 2002). However, this view has been challenged by more recent studies. Using a global freshwater diatom genus dataset, Vyverman et al. (2010) demonstrated that both local and regional genus richness exhibit pronounced latitudinal gradients and strong asymmetries between the Northern and Southern Hemispheres. Such patterns would not be expected if diatoms were truly ubiquitous and unlimited by dispersal processes (Vyverman et al., 2010).

Furthermore, successful long-distance dispersal requires organisms to survive potentially harsh environmental conditions. Several studies have shown that many freshwater diatoms are sensitive to environmental stressors such as abrupt temperature changes, desiccation and other unfavourable conditions, suggesting that dispersal may be more restricted than previously assumed (Souffreau et al., 2010). These findings suggest that diatom communities are not solely structured by environmental filtering, as proposed by the ubiquity hypothesis. Instead, both dispersal limitation and ecological processes contribute to the observed distribution patterns (Vyverman et al., 2010). Following these recent findings, a new biogeographical division of the diatom floras in the Antarctic realm was recently suggested with a clear distinction between the different regions (Verleyen et al., 2021). Other studies suggest that islands have lower diversities and different diatom flora compositions, which would be impossible should the Ubiquity-hypothesis prevail (Pérez-Burillo et al., 2023; Martín-Devasa et al., 2024).

## 1.4. Taxonomy

Diatom taxonomy has undergone substantial revisions over the past centuries, due to changing interpretations of species boundaries and species concepts. During the second half of the 20th century, many taxonomists adopted relatively broad species concepts, resulting in extensive taxonomic "lumping" whereby morphologically variable populations, who were previously independently described, were grouped under a single species name (Hustedt, 1930; Krammer & Lange-Bertalot, 1986-1991). Independent taxa were often regarded as conspecific because observed morphological differences were interpreted as manifestations of intraspecific variation or phenotypic plasticity in response to environmental conditions (Mann, 1999, 2010). As microscopy techniques improved and molecular methods became available, these broad species concepts were increasingly challenged. Numerous taxa previously considered a single species were found to comprise multiple distinct evolutionary lineages and were subsequently separated into independent taxa again (Mann et al., 2008; Evans et al., 2007; Pinseel et al., 2017). Consequently, many genera and species have been redefined, transferred to different taxonomic groups or split into multiple taxa. This has resulted in a complex and continuously evolving classification system, creating challenges for ecological and biogeographical studies that rely on accurate species identification (Mann, 2010; Kociolek et al., 2017).

One of the main reasons for these taxonomic difficulties is the high morphological diversity exhibited by diatoms, combined with the limitations of traditional morphological species concepts. In addition, many species display considerable intraspecific morphological variation, such as *Sellaphora pupula* (Kützing) Mereschkovsky and related taxa, where extensive variation in valve morphology led to the recognition of multiple cryptic species after detailed morphological and molecular analyses (Mann et al., 2004; Evans et al., 2007). Conversely, other species are morphologically very similar despite representing genetically distinct evolutionary lineages, as demonstrated in the *Navicula cryptocephala* Kützing complex (Poulíčková et al., 2010), the *Nitzschia palea* (Kützing) W.Smith species complex (Trobajo et al., 2013), and several *Gomphonema* lineages (Kociolek & Stoermer, 2009). Such cryptic diversity complicates species delimitation and may lead to misidentifications when relying solely on morphological observations.

The identification of diatoms is traditionally based on the morphological characteristics of their siliceous frustules, particularly the structures present on the valves. Diagnostic features include valve shape, valve dimensions, symmetry, stria density and arrangement, raphe structure, and the presence or absence of specific morphological ornamentations such as areolae, costae,

spines, or other valve surface structures (Round et al., 1990; Cox, 2010). These characteristics are most commonly examined using light microscopy (LM), which remains the primary method for routine identification in ecological surveys. Although valve morphology remains the primary basis for traditional diatom identification, ultrastructural characters observed through scanning electron microscopy (SEM) or in girdle view can be essential for resolving the taxonomic status of closely related taxa. Features such as the detailed structure of the raphe system, areola architecture, girdle bands, and valve mantle characteristics may provide critical diagnostic information that is not visible using light microscopy alone (Round et al., 1990; Cox, 2010; Krammer, 2000). Consequently, modern diatom taxonomy increasingly integrates multiple sources of evidence, combining LM, SEM, and molecular data to improve species delimitation and clarify phylogenetic relationships (Mann et al., 2004; Evans et al., 2007; Kociolek & Stoermer, 2009). This integrative approach has revealed substantial hidden diversity within morphologically similar groups and has become an essential framework for resolving taxonomic uncertainties in freshwater diatoms (Pinseel et al., 2019; Kollár et al., 2026).

Accurate species identification often requires comparison with type material. In biological nomenclature, a type specimen (or other designated type element, such as a type illustration or preparation) serves as the permanent reference upon which the application of a scientific name is based, rather than representing the complete morphological concept of a species itself (Turland et al., 2025). When uncertainty exists regarding the identity of a taxon, researchers may need to consult the original descriptions, historical literature, and available type material in order to determine whether newly collected individuals correspond to the taxon originally described (Mann, 2010; Jahn & Schmid, 2007). This process is particularly important in diatoms, where historical descriptions were sometimes brief or based on limited observations using early light microscopy and often lacked detailed information on ultrastructural characters that are now considered taxonomically important (Kociolek & Stoermer, 2009; Mann, 2010). Re-examination of type material has frequently led to major taxonomic revisions in diatoms, including the recognition of previously overlooked cryptic species, the synonymising of taxa that were incorrectly considered distinct, and the transfer of species between genera following improved understanding of morphological and phylogenetic relationships (Mann et al., 2004; Evans et al., 2007; Heudre et al., 2021; Van de Vijver et al., 2022, 2023; Danz et al., 2024). Consequently, type specimens remain essential resources for maintaining nomenclatural

stability, resolving taxonomic uncertainties, and ensuring consistency in species identification (Mann, 2010; Turland et al., 2025).

Accurate taxonomic identification is fundamental for studies investigating diatom community composition, biodiversity patterns, ecological preferences, and species–environment relationships. Misidentifications can obscure ecological patterns, bias estimates of species distributions, and affect interpretations of environmental responses, particularly in biomonitoring studies where individual taxa may have specific ecological indicator values (Kelly et al., 1998; Bellinger et al., 2006; Lange-Bertalot & Van de Vijver, 2022; Jüttner et al., 2023). Therefore, reliable (i.e., accurate) taxonomy and careful species determination forms the foundation for biodiversity assessments, and ecological and biogeographical studies, and improve our understanding of freshwater diatom communities, especially in poorly explored regions where unknown diversity and historical identification uncertainties remain major challenges.

## 1.5. Diatoms in the (sub)Arctic realm

There is a long tradition of freshwater diatom research in the (sub)Arctic realm which started already in the second half of the nineteenth century. Although the Westfjords selected as study area in this master thesis strictly spoken do not belong to the true Arctic region, it is important to briefly mention a few important highlights in freshwater diatom research in this region as parts of this flora can be found more southern from the Arctic.

Pioneer work was published by Lagerstedt (1873) and Cleve & Grunow (1880), the latter considered to be the first true monograph on Arctic diatoms, containing descriptions, illustrations, taxonomy and distribution of hundreds of taxa (although a considerable part of them originated from non-Arctic localities). The past century, freshwater diatom research expanded as can be seen in numerous publications on diatoms from Greenland (Østrup, 1898, 1910; Foged, 1953, 1955, 1973), Spitsbergen (Hustedt, 1937; Foged, 1964), the Canadian Arctic (Antoniades et al., 2008), Alaska (Patrick & Freese, 1961; Foged ,1981), and the Russian Arctic (Lange-Bertalot & Genkal, 1999).

Despite this interest in Arctic diatoms, comprehensive studies on freshwater diatoms from Iceland are rather scarce. The first (pioneer) works date from the early twentieth century, most of them published by Danish researchers. The first major taxonomic work on Icelandic diatoms was published (posthumously) by the Dane Ernst Vilhelm Østrup (1845–1917) in 1918. Despite being more than a century old, it is considered one of the most important studies on Icelandic

freshwater diatoms, with more than 500 diatom taxa reported from lakes, streams, ponds and springs throughout the island. A second diatom pioneer in Iceland was another Danish researcher Johannes Boye Petersen (1887–1961). Although he mainly worked in cyanobacteria, Petersen published in 1928 an important taxonomic contribution to the aerophilic diatom flora of Iceland describing several new diatoms species that nowadays are still widely reported in Iceland. The German botanist Georg Krasske (1889–1951) provided one of the early systematic accounts of the diatom flora of Iceland, with particular emphasis on the distinctive assemblages of Icelandic thermal waters (Krasske, 1938). Finally, the Danish botanist Niels Foged (1906–1988) produced in 1974 a comprehensive well-illustrated guide on Icelandic diatoms, in which he revised the older works by Østrup, Krasske, and Petersen adding crucial information on the ecology and distribution of freshwater diatoms in Iceland, based on the analysis of several tens of samples collected throughout the entire island. The past decades, pure taxonomic or floristic studies are lacking, apart from Furey et al. (2020) and Van de Vijver et al. (2025[a]) who described a new species from the Westfjords, the most northwestern part of Iceland. Although all these studies contributed to the knowledge of Icelandic diatom diversity, large parts of the country remain poorly explored, particularly remote regions such as the Westfjords in northwestern Iceland. Consequently, the distribution and ecological preferences of many taxa in this region remain insufficiently documented. This limited knowledge hampers our understanding of biodiversity patterns and may obscure the presence of rare, previously overlooked or misidentified taxa. Detailed floristic surveys are essential to improve our understanding of diatom diversity in Iceland and to provide a stronger basis for ecological and biogeographical studies.

## 1.6. Importance of the Westfjords as selected study area

Located at the interface between Arctic and boreal biogeographical influences, Iceland represents a comparatively isolated island system where colonisation history, dispersal limitation, and postglacial environmental changes have played major roles in determining present-day species distributions (Cox, 2001). The above-mentioned Westfjords represent a biogeographically important Icelandic region within the North Atlantic Subarctic, where the interaction between geographic isolation, climatic gradients, and habitat heterogeneity has shaped the distribution and composition of terrestrial and freshwater biota. Within Iceland, these Westfjords are particularly significant due to their complex topography, extensive coastline, and mosaic of habitats ranging from oligotrophic lakes and streams to peatlands,

springs, waterfalls, and moss-dominated terrestrial environments. The combination of steep climatic gradients, variable hydrological conditions, and localised habitat availability creates strong environmental heterogeneity over relatively short spatial scales, promoting the coexistence of taxa with different ecological requirements (Sigurðsson et al., 2005).

For freshwater microorganisms such as diatoms, the Westfjords provide a natural laboratory for investigating the influence of environmental filtering, dispersal processes, and historical constraints on community composition. Diatom assemblages are strongly shaped by local environmental factors, including water chemistry, substrate characteristics, temperature, and nutrient availability, while regional patterns, being located between the Eurasian and North American continents, are also influenced by dispersal and habitat connectivity (Leibold et al., 2004; Smol & Stoermer, 2010). The isolation of individual fjord systems, combined with the presence of numerous small and environmentally distinct freshwater habitats, may promote the occurrence of locally differentiated assemblages and provide opportunities for detecting regional biogeographic patterns. Consequently, the Westfjords represent a valuable study area for assessing how geological history, climate, and landscape configuration interact to influence freshwater biodiversity in a Subarctic island environment.

## 1.7. Objectives

Although freshwater diatom floras in the Arctic have been studied in the past, it was usually based on a too broad species concept, lumping taxa into groups and complexes, underestimating the actual biodiversity. Moreover, diatoms are generally considered to be excellent bio-indicators for a broad array of environmental parameters, but the lack of detailed information regarding their occurrence and ecological preferences in the (sub)Arctic region hampers the use of diatoms as a proxy for environmental reconstructions in this region, mainly due to historic force-fitting, incorrect identifications and the lack of a fine-grained species concept. The study of the actual Arctic diatom flora of a small region in Iceland is a first step to set up baseline data that can be used in the future monitoring of possible impacts of climatic change.

This study will focus on the following objectives:

1. ***Document the freshwater diatom diversity of the Westfjords region of Iceland.***
   The present-day diatom flora will be studied in a selection of more than 60 samples from the Westfjords, thereby identifying all present taxa to the lowest taxonomic level possible using both light and scanning electron microscopy.

2. ***Compare diatom community composition among different habitat types, including mosses, pools, rivers, streams, lakes, seepages and waterfalls.***

   By selecting 62 samples from a large diatom collection made in 2023 based on intrinsic habitat features (basic environmental parameters such as pH and conductivity, habitat type), an attempt will be made to characterise the diatom communities per habitat type.

3. ***Investigate the relationships between diatom community composition and environmental variables such as pH, conductivity, temperature and altitude.***

   Although only basic environmental parameters were collected due to logistic constraints, the influence of these parameters on the present diatom communities and individual species will be investigated in order to refine the ecological preferences of some of the key species in the Westfjords

4. ***Contribute baseline taxonomic and ecological data for future biodiversity monitoring and climate change studies in Subarctic freshwater ecosystems.***

   All obtained data will be grouped in order to produce a well-illustrated overview of the diatom flora of the Westfjords including an excellent iconography and refined ecological and morphological data. The publication of this monograph will be completed after the master thesis but the data will be collected during the thesis and can be considered a final objective.

# 2. Material & Methods

## 2.1. Study area

### 2.1.1. Geology

Iceland is a 103,000 km² volcanic island located just south of the Arctic Circle, between 63° and 66.6° north latitudes and 13°–24° west longitudes (Arnalds et al., 2016) on top of the Mid-Atlantic Ridge. This Mid-Atlantic Ridge divides Iceland, with the eastern section situated on the Eurasian Plate and the western part on the North American Plate, which separate at a pace of 20 mm per year (Einarsson, 2008).

The study was conducted in the Westfjords (Vestfirðir), a remote, highly isolated peninsula in northwestern Iceland located along the Denmark Strait (65°44′15″N 22°10′14″W). The Westfjords are one of the oldest and most geologically distinctive regions of the country characterised by a landscape that is dominated by extensive sequences of Tertiary basaltic lava flows, formed approximately 16–13 million years ago, when this region was part of Iceland's active volcanic system. During the Quaternary, repeated glacial advances profoundly modified the pre-existing basalt landscape, carving U-shaped valleys and fjord systems, while subsequent marine processes produced raised shorelines and coastal terraces. The present-day geomorphology therefore reflects the combined influence of volcanic construction, long-term denudation, glacial erosion, and postglacial marine processes (Thordarson & Höskuldsson, 2008; Ellero et al., 2023; Jones, 2025). The current landscape is shaped by deeply incised fjords, steep mountain slopes and a sparse human population of less than 7,500 inhabitants, spread over more than 8,800 km².

### 2.1.2. Climate

The climate of the Westfjords is classified as subpolar oceanic, strongly influenced by the surrounding North Atlantic Ocean, the Irminger Current, and frequent cyclonic activity. Despite their high latitude (approximately 65–66°N), maritime conditions moderate temperature extremes, resulting in relatively mild winters but cool summers, with mean annual temperatures generally around 3–5 °C at sea level and mean summer temperatures commonly below 10 °C. Precipitation is highly variable due to the complex topography, with exposed mountain slopes receiving substantially greater precipitation than sheltered fjord areas. Persistent cloud cover, strong winds, rapid weather changes, and prolonged snow cover at higher elevations strongly influence ecosystem development and vegetation patterns (Bannan & Hennig, 2022).

### 2.1.3. Hydrology

Iceland's hydrology is highly variable and controlled by an interaction between climate, glacier dynamics, seasonal snow accumulation and melt, and underlying geological conditions. Glaciers represent a major component of the Icelandic water cycle (Björnsson, 2009; Flowers et al., 2005). Seasonal snow accumulation acts as an important temporary water reservoir, regulating the timing of spring and early summer runoff through snowmelt processes (Helgason & Nijssen, 2024). However, the relative importance of these hydrological controls varies considerably across Iceland due to regional differences in climate, topography, glacier cover, and bedrock characteristics (Einarsson, 1984; Björnsson, 2009; Helgason & Nijssen, 2024).

The hydrological regime of the Westfjords differs substantially from that of the wetter, glacier-influenced regions of southern Iceland. Western (and northern) coastal areas generally experience a lower contribution from glacier meltwater and are instead controlled by precipitation- and snowmelt-driven runoff regimes (Helgason & Nijssen, 2024). Although the region may experience longer periods of relatively low precipitation compared with southern Iceland, the complex topography of the fjord landscape enhances orographic precipitation processes, whereby moist air masses are forced to rise over steep mountain slopes, resulting in localised high-intensity rainfall events (Einarsson, 1984; Bannan et al., 2022). Rivers in the Westfjords therefore tend to exhibit rapid hydrological responses to rainfall events, but reduced flow stability during prolonged dry periods due to limited catchment storage capacity (Helgason & Nijssen, 2024). In western and northern Iceland, a substantial proportion of annual precipitation falls as snow, producing a seasonal increase in discharge during spring and early summer as accumulated snow melts (Björnsson & Pálsson, 2008; Helgason & Nijssen, 2024). The combination of geological heterogeneity, diverse freshwater habitats and geographical isolation makes the Westfjords therefore an interesting region for investigating freshwater diatom diversity and environmental controls on community composition.

A wide range of freshwater habitats was sampled throughout the Westfjords to capture the environmental diversity present within the study area. The survey includes several river systems representing different hydrological conditions. These comprised the Mórilla River, a glacial river originating from the Drangajökull glacier and flowing through the Kaldalón valley (66°5'49.9"N/22°21'53.6"W) towards Kaldalón Bay, where it forms braided channels and extensive sediment deposits. The Lambagilsá (65°54'25.8"N/ 23°0'18.3"W), a small river flowing through the Lambagil canyon on the northern coast of the Westfjords, was also sampled, including the Búlafoss waterfall located along its course. Additional river samples

were collected from the Miðdalsá (65°53′21″N/ 22°17′45″W), a clear mountain-fed river flowing from upland lakes into Steingrímsfjörður Bay, and the Norðurdalsá, a tributary of the Breiðdalsá river system. To complete the sampling survey, several smaller unnamed rivers and brooks were also sampled throughout the study area.

In addition to river habitats, several waterfalls were also included in the survey. These comprised the Valagil Waterfall (65°57'23.7"N/23°6'54.8"W), a multi-drop waterfall located in a lava ravine near the head of Álftafjörður, as well as several smaller unnamed seasonal waterfalls. Furthermore, samples were collected from a variety of lakes and pools, most of them lacking official names. Together, these habitats provided a broad representation of freshwater environments across the Westfjords.

### 2.1.4. Habitat classification

For the purpose of this study, habitat types were defined arbitrarily according to hydrological characteristics observed in the field. ***Pools*** were defined as small standing water bodies, typically shallow, exhibiting limited water movement, and often strongly influenced by local precipitation, groundwater seepage, and evaporation. ***Lakes*** were defined as permanent standing water bodies of relatively large size and depth, and exhibiting a clear open-water zone. ***Rivers*** were defined as relatively large flowing freshwater systems with a well-developed channel and a continuous flow regime. ***Streams*** were defined as smaller flowing freshwater systems, typically characterised by narrower channels, and a less permanent flow regime than rivers. Of these, the term ***seepage*** was used to define stony and rocky bottoms with a thin film of water flowing over it. ***Waterfalls*** represent dynamic lotic habitats characterised by turbulent water flow, increased oxygenation, and coarse rocky substrates. ***Moss habitats*** were defined as samples collected from bryophyte communities ranging from permanently submerged aquatic mosses to periodically wet or terrestrial moss vegetation (Fisher et al., 2012; Johnes, 1994). Representative examples of the sampled habitats are shown in appendix D, Figures D6 and D7.

### 2.1.5. Vegetation

Terrestrial vegetation in the Westfjords reflects these harsh Subarctic conditions and is dominated by low-growing tundra communities, dwarf shrubs, moss-rich habitats, and wetlands. Although Iceland was historically more extensively forested, particularly with downy birch (*Betula pubescens*), centuries of grazing, wood harvesting, soil erosion, and climatic fluctuations have resulted in the present largely treeless landscape. Common vegetation types include dwarf-shrub heath dominated by species such as *Betula nana*, *Salix herbacea*, *Empetrum nigrum* and *Vaccinium uliginosum*, together with extensive moss-rich communities

and peatlands dominated by *Sphagnum*, sedges, and other wetland plants (Einarsson, 1984; Magnússon et al., 2009).

## 2.2. Sampling

### 2.2.1. Sampling method

During the second week of June 2023 (5–21/06/2023), 120 samples were collected in the Westfjords region of Iceland by my supervisor in the framework of a FWO-PhD project. Sampling sites were selected in such a way as to assure that most habitat types in the Westfjord region were included, covering the entire Westfjords study area. Sampling was done across a wide range of altitudes, habitat types, and moss vegetation moisture levels, including a range of aquatic and semi-aquatic habitats such as pools, ponds, waterfall surroundings, and wet (terrestrial) moss substrates. For each sample, moss species, sampling location, and environmental variables (pH, conductivity, temperature, and height) were recorded. A calibrated handheld Garmin GPSMAP64st was used to determine GPS coordinates and altitude (m).

Out of the 120 samples, 60 were collected from the littoral sediment of waterbodies in the area (small streams, rivers, waterfalls, pools and lakes). Samples were obtained by scraping off the first 5 mm of the bottom with a 25 mm PVC bottle. Due to logistic and financial constraints, only a limited number of environmental parameters could be collected. A Greisinger G1500+GE 114 pH meter was used to measure the pH of each sample, while a Hanna Instruments HI98312 Water Conductivity Meter was used to measure the temperature (°C) and conductivity (µS/m). All samples were fixed with 95% ethanol.

The remaining 60 samples were collected from aquatic and wet to almost dry, terrestrial moss vegetations. Aquatic and wet mosses were collected by squeezing the water out of a handful of bryophytes, which was collected in PVC bottles and fixed with 95% ethanol. A few moss plants were included in each sample. The moisture content of each moss sample was determined using Jung's F-classification (1936), a humidity scale derived from on the water content as follows: FI = submerged mosses, FII = free-floating mosses, FIII = very wet (water drips from sample without pressure), FIV = wet (water drips by slight pressure), FV = quasi wet (water drips after moderate pressure), FVI = moist (little water produced after high pressure), FVII = quasi-dry (only a few drops of water can be squeezed out), FVIII = dry (contains no water). Mosses were later identified upon species level by Mr Dirk De Beer using a broad range of identification works (see appendix A2 for a complete list). Dirk De Beer is a renowned Belgian bryologist

associated with Meise Botanic Garden as an honorary research associate in bryology, known for his contributions to field bryology, species inventories, and conservation-oriented surveys. Table C1 in Appendix C lists all moss samples included in this study, together with their associated recorded data. Figure 2 provides an overview of the geographical distribution of all samples used in this study.

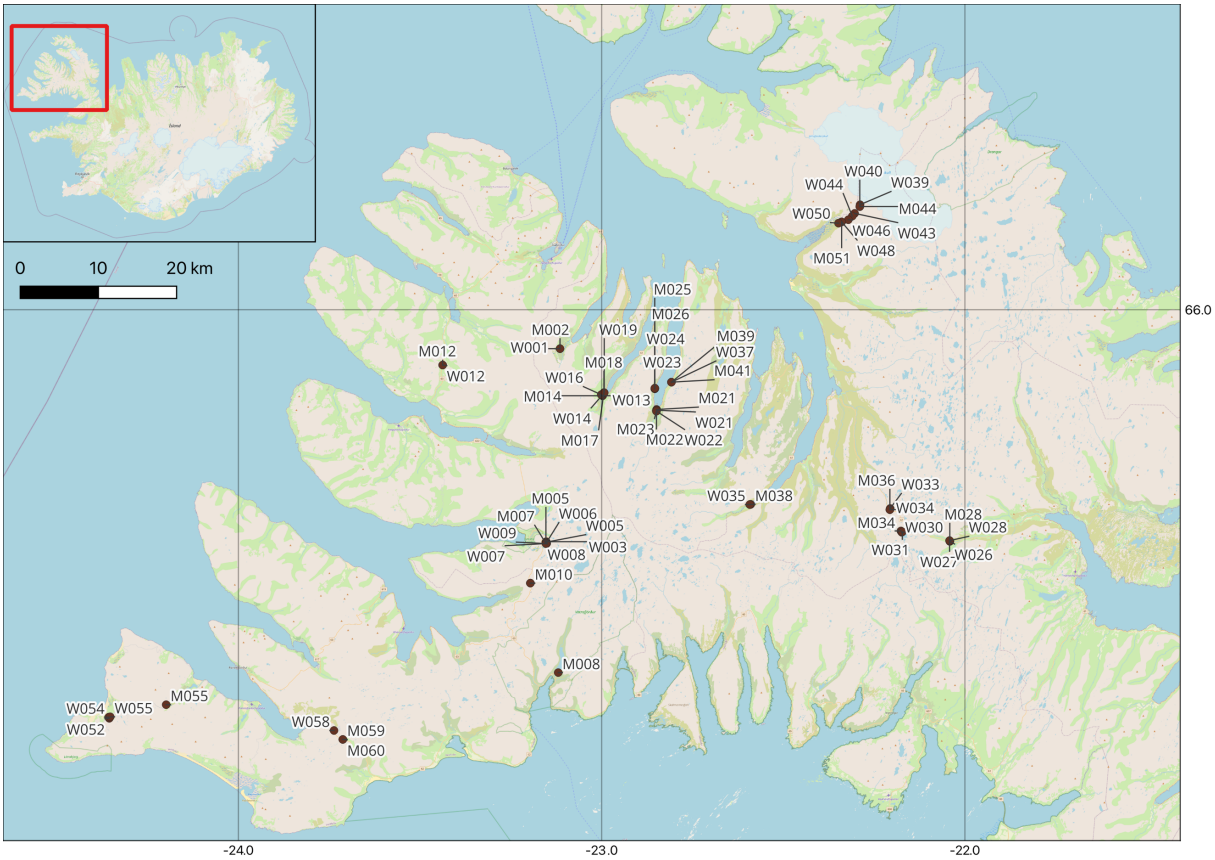



*Figure 2: map of the Westfjords indicating the position of all samples used in this study. The inset map shows Iceland with the location of the Westfjords.*

### 2.2.2. Sample Preparation

Diatom samples for light microscopic observations were prepared following the (adapted) method described by van der Werff (1955), a standard preparation technique that has been used in the Phycology lab of Meise Botanic Garden for the past 20 years. Small subsamples were cleaned by the addition of 37% $H_2O_2$ and subsequently heated to 80°C for two hours. During the heating process, distilled water was systematically added to prevent the samples from boiling dry. The reaction was completed by the addition of $KMnO_4$. The formation of black deposition following $KMnO_4$ addition was removed by dripping small amounts of HCl and $H_2O_2$ on the formed black deposition. Afterwards the samples were centrifuged (3 times 10 minutes at 3700 x g) and subsequently diluted with distilled water to avoid excessive diatom valve concentrations on the slide. Microscopic slides were made by adding a minimum of three

droplets of the cleaned diatom slurry on a cover slip with a thin layer of distilled water. The number of added droplets depends on the containing diatom concentration and was regularly checked prior to the mounting of the slides. An excessive diatom concentration on the slides hinders correct diatom identifications and observations. Slides were dried at a temperature of 40°C until all water was vaporised, and afterwards mounted into permanent microscopic slides using the specialised mounting resin Naphrax with a refraction index of 1.70 (Brunel Microscopes Ltd, Kington Langley/Chippenham, Wiltshire, United Kingdom). Slides were then dried in the dark for at least 3 weeks to allow the Naphrax resin to harden completely. Raw material, cleaned diatom samples, and microscopic slides are conserved at the BR-collection of Meise Botanic Garden (Belgium).

### 2.2.3. Microscopical observations

In total, 62 samples were included in the quantitative analyses. Of these, 50 samples were counted and identified by the author, while 12 river samples were previously counted by an intern at Meise Botanic Garden as part of a short research internship. To minimise potential operator effects, all counts and taxonomic identifications from these 12 samples were critically reviewed by the author prior to inclusion in the dataset, and taxonomic nomenclature was standardised according to the conventions applied throughout this study. The resulting permanent slides were analysed using an Olympus BX53 microscope at 1000x magnification (UPlan FL N 100x oil objective, N.A. 1.30), equipped with Differential Interference Contrast (Nomarski) optics and the Olympus UC30 Imaging System, connected to the CellSens Standard Microscope Imaging Software. During the analysis, multiple micrographs were taken from the different taxa to get an overview of the morphological variability of the encountered taxa. A voucher flora based on all these micrographs was assembled to represent all observed taxa per sample using adobe photoshop 27.8.0 version. For each slide, exactly 400 diatom valves were identified and enumerated on random transects to get a representative idea of the species richness and composition. A minimum count of approximately 400 diatom valves per sample is widely accepted as providing a representative estimate of relative taxon abundances for ecological and biomonitoring applications. Although the optimal counting effort depends on species richness and the abundance distribution of taxa, studies comparing different counting efforts have shown that increases beyond 300–500 valves generally produce only minor improvements in community estimates (Battarbee, 1986; Pappas & Stoermer, 1996; Prygiel et al., 2002). Broken valves of raphid diatoms were only counted when the central area (both central raphe endings visible) was present. For araphids and centric diatoms more than half of

the valve were counted. Following the quantitative count, each slide was examined for an additional 30 minutes to record taxa that were not encountered during the standard 400-valve count. These qualitative observations were used to improve the inventory of taxa present in the study area and to better document rare species that may have been missed during the quantitative enumeration procedure. Appendix E (Tables E1 and E2) presents the complete counting data, as well as the additional taxa recorded during the supplementary 30-minute survey.

Taxa were identified based on the morphological species concept, using distinct morphological features visible in the light microscope. The identification of smaller taxa was verified using scanning electron microscopy observations. For this, part of the prepared diatom suspension was filtered through 5-µm Isopore™ polycarbonate membrane filters (®Merck Millipore). After air–drying, pieces of the filters were affixed on aluminium stubs and sputter-coated with a 15-nm-thick platinum-palladium layer using a JFC-2300HR Sputter Coater. Stubs were subsequently examined using a JEOL-JSM-7100F field emission scanning electron microscope at 2 kV and a working distance of 4 mm.

### 2.2.4. Taxonomic identification

Diatom taxa were identified to the lowest taxonomic level possible using a combination of light microscopy and, where necessary, scanning electron microscopy observations. Identifications were based on morphological characteristics of the valves and were made using the relevant taxonomic literature and identification manuals (see Appendix A1 for a complete list of references).

The term “taxon" is used throughout this study rather than the term “species”, as the identified diatom entities include species and varieties (‘var.’), but also taxa with uncertainty in their identifications. For the latter taxa I used taxonomic abbreviations. The abbreviation ‘cf.’ (confer) indicates a questionable identification, whereas ‘s.l. ‘(sensu lato) refers to a taxon in a broad sense, and *incerta sedis* used for a taxon for which the identification upon genus level was not possible based on the currently available literature.

I initially performed all taxonomic identifications, but afterwards all identifications were subsequently verified together with my supervisor, using the assembled voucher flora and representative micrographs of all recorded taxa. This verification procedure ensured the most correct application of current taxonomic concepts.

When necessary, my identifications were compared with the original (usually type) material to confirm the taxonomic identities. Meise Botanic Garden (BR, Belgium) hosts the Van Heurck diatom collection, one of the most important diatom collections worldwide containing more than 2000 type materials. Moreover, intensive links exist between Meise Botanic Garden and other large collections in Europe such as the Natural History Museum (BM, London, UK), the Grunow collection in Vienna (W, Austria), the Foged and Østrup collection in Copenhagen (C, Denmark) and the Hustedt collection in Berlin (B, Germany), facilitating the exchange of type material between these institutes. This thesis could benefit from this exchange and allowed me to work with this historical material for taxonomic comparisons.

## 2.3. Statistical analyses

All statistical analyses were carried out in R version 4.9.6 (R Core Team, 2023) using the package vegan (Oksanen et al., 2025). Observed species richness was analysed with the Chao1 and Chao2 estimators, which provide estimates of true taxonomic richness by accounting for rare and potentially undetected taxa. Chao1 is based on abundance data, whereas Chao2 uses presence–absence information. These estimators were used to assess the completeness of the observed taxonomic richness and to evaluate how well the sampled diatom assemblages represent the diatom flora of the study area. To improve estimates of total taxonomic richness, taxa recorded during the additional qualitative slide examination were incorporated into the species richness dataset. Taxa that were observed but not encountered during the standard valve count were added as presence records with an abundance value of 1. This approach allowed these rare taxa to be included in species accumulation curves and in the Chao1 and Chao2 richness estimations, which require integer abundance data. The resulting dataset therefore combined quantitative count data with supplementary presence records to provide a more complete representation of the regional diatom flora. Diversity was further quantified using the Shannon–Wiener diversity index (H′), while Hill's evenness index was calculated to evaluate the distribution of abundances among taxa within samples.

To assess whether community composition differed significantly among groups, a PERMANOVA based on Bray–Curtis dissimilarities was performed. In PERMANOVA, significant results may reflect either differences in the location of group centroids within multivariate community space or differences in the dispersion of samples around those centroids. To distinguish between these possibilities, the homogeneity of multivariate

dispersions was evaluated using PERMDISP, implemented through the betadisper function. This analysis assesses whether observed differences in community composition are attributable to shifts in group centroids rather than differences in within-group variability (Anderson & Walsh, 2013). Non-metric multidimensional scaling (NMDS) was used to visualize patterns in diatom community composition among samples. NMDS is an unconstrained ordination technique that represents the dissimilarities between samples in a reduced number of dimensions while preserving the rank order of pairwise distances. Bray-Curtis dissimilarities calculated from Hellinger-transformed species abundance data were used as input. Samples with more similar diatom assemblages are plotted closer together in ordination space, whereas samples with more distinct assemblages are positioned further apart. The quality of the ordination was evaluated using the stress value.

To explore variation in diatom community composition, a Detrended Correspondence Analysis (DCA) was performed. Prior to the ordination analysis, rare taxa with a total abundance of fewer than 10 valves across all samples were excluded, as such taxa contribute little to the overall community structure and may introduce noise into the analyses. Species assemblages were further examined through hierarchical cluster analysis based on Bray-Curtis dissimilarities using the average linkage method. DCA was used to summarise patterns in species composition and to visualize the major gradients underlying community variation among samples. The length of the ordination axes is expressed in standard deviation (SD) units, with larger values indicating greater species turnover along the gradient.

## 2.4. Use of artificial intelligence

In this study generative artificial intelligence (AI) tools were used exclusively to assist with language editing, including improving the grammar and structure. AI tools were not used for literature retrieval, data collection or analysis, scientific interpretation, or the generation of original scientific content. The ideas, interpretations, conclusions, and scientific arguments presented in this thesis reflect the author's own understanding, critical assessment, and evaluation of the consulted sources.

# 3. Results

## 3.1. Taxon composition analysis

A final selection of 62 samples (out of a total of 120 samples) from the Westfjords have been examined, of which 25 samples were labelled as moss samples and 37 as aquatic samples (Table C1 in Appendix C). Since all samples contained a sufficient number of diatom valves for a reliable assessment (i.e., at least 400 countable valves per slide), all selected samples have been included in the analyses.

In total, 317 taxa (including species, varieties and forms) belonging to 65 genera were recorded during the counts, based on a total valve count of 24.800 individuals (Table B1 in Appendix B). An extra 86 taxa were observed during the additional scanning of the slides following the counts, adding also an extra 6 genera to the total number of genera. Of all recorded taxa, 294 were identified up to species (or infraspecific) level. The identification of an additional 43 taxa remained uncertain resembling known taxa and these were designated using the qualifiers cf., or s.l. Sixty-six taxa could only be identified to the genus level and were therefore denoted by the genus name followed by "sp." When multiple unidentified taxa occurred within the same genus, they were separated using numerical suffixes (e.g. *Staurosirella* sp1). The identity of one taxon could not be identified at any taxonomic level and was therefore provisionally designated as "*incerta sedis*". A complete list of all recorded taxa is given in Appendix B (Table B1). Appendix D, Figures D8–D34 show part of the encountered taxa. Taxa only observed outside the diatom counts are excluded from all further numerical analyses and discussions, except the Chao analyses.

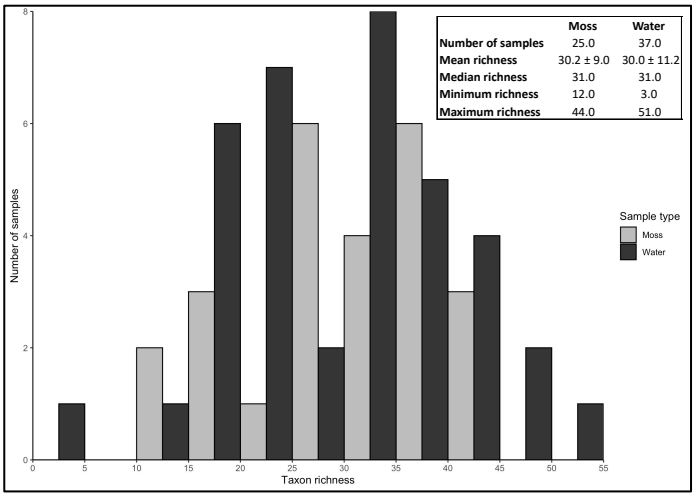



*Figure 3: Distribution of the taxon richness per sample, grouped per sample type (moss vs water). Only taxa observed during counts are taken into consideration. The inset data show the mean, median and maximum/minimum richness per group*

Taxon richness varied considerably among samples, ranging from 3 to 51 taxa for the complete sample set. Figure 3 shows the distribution of the samples based on taxon richness for the two main sample groups (moss vs aquatic). Based on median (31 taxa) and mean richness (30 taxa), no difference could be observed between both groups of samples, although aquatic samples tend to present a higher maximum (51 vs 44 in moss

samples). Most aquatic samples contained between 15 and 45 taxa, whereas moss samples mostly ranged from 25 to 35 taxa.

Species richness estimator (Chao1) based on abundance data suggested that approximately 502 taxa occur in the study area, indicating that approximately 80% of the estimated diversity was captured during the survey. Incidence-based estimates were substantially higher (Chao2 = 548 taxa), suggesting that a substantial part of the flora was not recorded, which is already demonstrated by the fact that 86 taxa were only observed during the extra scanning of the slides and analysis of the taken photographs. Species richness estimates differed between water and moss samples. In the water samples, 331 taxa were observed during the survey. Species richness estimates based on abundance data suggested that approximately 387 taxa occur in these habitats (Chao1 = 387), indicating that approximately 86% of the estimated diversity was captured during sampling. Incidence-based estimates were substantially higher (Chao2 = 429 taxa). A comparable pattern was observed in the moss samples, 271 taxa were observed in the moss samples, while the species richness estimates based on abundance data suggested that approximately 356 taxa occur in moss habitats (Chao1 = 356), indicating that approximately 76% of the estimated diversity was captured during sampling. Incidence-based estimates were slightly lower (Chao2 = 354 taxa). In both water and moss samples, the difference between observed and estimated richness indicates the presence of a substantial number of rare taxa that were either not encountered during sampling or occurred in only a few samples. Species accumulation curves are shown in Figure 4.

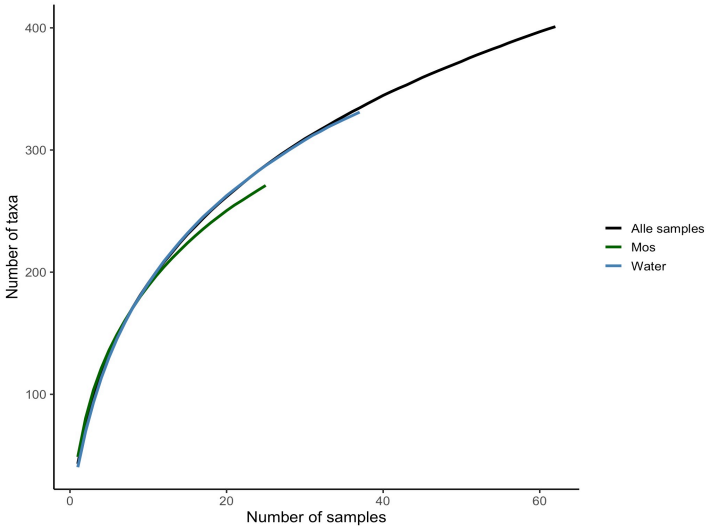



*Figure 4: Accumulation curve of all encountered taxa.*

Most taxa were restricted to a limited number of samples. Figure 5 shows that more than 60% of all taxa are considered rare in the survey and occurred in less than 5% of the analysed samples, with less than 10% of the taxa in 6–10% and 10–15%, etc. Very few taxa (< 5%) were found in 50% or more of all investigated samples. The diatom flora was dominated by a limited number of species-rich genera (Figure 6). The genus *Eunotia* was the most diverse, containing

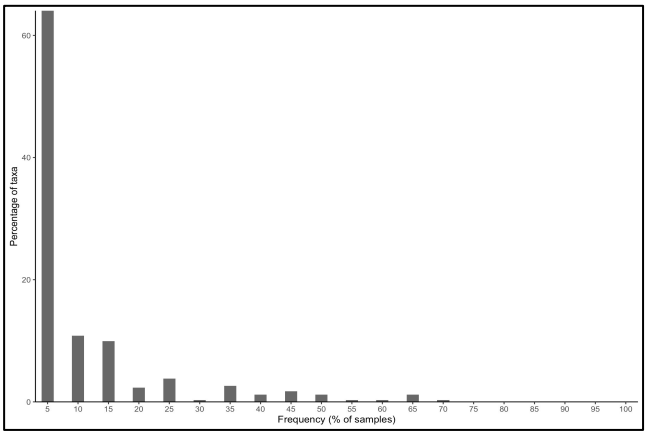



*Figure 5: Frequency classes of taxa occurring in the analysed samples (e.g. 5 indicates 1–5% of all samples).*

(21 taxa), and *Nitzschia* (15 taxa). Other species-rich genera included *Staurosira* (14 taxa), 35 taxa, followed by the genera *Pinnularia* (25 taxa), *Gomphonema* (25 taxa), *Psammothidium* *Chamaepinnularia* (11 taxa), *Encyonema* (11 taxa), *Staurosirella* (11taxa), and *Humidophila* (10 taxa). Based on valve abundance, *Meridion* was the most abundant genus, accounting for 9.6% of all counted valves. Other dominant genera include *Eunotia* (8.6%), *Staurosira* (7.8%), *Fragilaria* (6.6%), *Psammothidium* (6.0%), *Odontidium* (5.4%), *Stauroforma* (4.9%), *Aulacoseira* (4.7%), *Achnanthidium* (4.6%) and *Planothidium* (4.2%). Together, these ten genera comprised a substantial proportion of the total valve counts across all samples (62.4 %). On the contrary, the remaining 56 genera account for almost 70.5% of all observed taxa. Marked differences were observed between taxonomic richness and abundance (Figure 6). While *Eunotia* and *Psammothidium* were both species-rich and highly abundant, genera such as *Pinnularia* and *Gomphonema* contained numerous taxa (25 taxa) but on the contrary contributed relatively little to the total valve count (2.3% and 1.6%, respectively). In contrast, genera such as *Meridion* and *Odontidium* exhibited low taxonomic richness (two and one taxa, resp.) but high abundances (9.6% and 5.4, resp.).

The most abundant taxon in the dataset is *Meridion circulare* (Greville) C.Agardh (almost 9.0% of all counted valves), followed by *Staurosira ambigua* E.Morales et al.(6.0%), *Odontidium mesodon* (Ehrenberg) Kützing (5.3%) and *Aulacoseira alpigena* (Grunow) Krammer (4.0%). Other abundant taxa included *Achnanthidium minutissimum* (Kützing) Czarnecki (3.5%), *Fragilaria* sp1 (3.0%), *Stauroforma exiguiformis* (Lange-Bertalot) R.J.Flower et al. (2.9%), *Fragilaria* sp3 (2.7%), *Sellaphora nigri/atomoides*

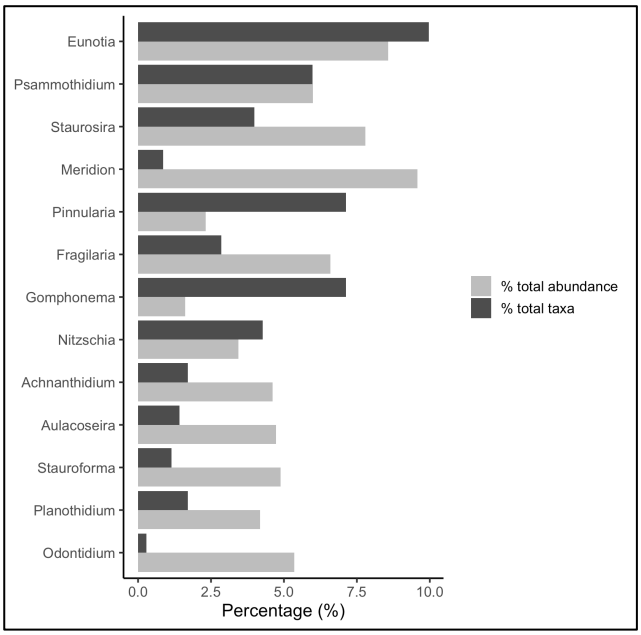



*Figure 6: Comparison of the proportional contribution of selected genera to total taxonomic richness (% total taxa) and total valve abundance (% total abundance).*

complex (2.2%), and *Planothidium lanceolatum* (Brébisson) Lange-Bertalot (2.0%) (Table 1). The five most abundant taxa accounted for almost 28% of all counted valves, with an additional 12% for the next five most abundant taxa, indicating that the community composition was dominated by a small number of taxa. Although *Eunotia* was the most species-rich genus, none of the composing species reached high individual abundances. This pattern indicates high species richness but moderate dominance, with abundance being distributed across a large number of taxa rather than concentrated in only a few dominant species. In contrast, genera such as *Meridion*, *Odontidium* and *Aulacoseira* were represented by relatively few taxa but achieved high abundances due to the dominance of individual species.

*Table 1: Summary of the 20 most abundant taxa observed in this survey. The table indicates both the % of all counted valves and the % occurrences in the samples.*

| Taxon | % of counted valves | % occurrence in samples |
|---|---|---|
| *Meridion circulare* | 8.9 | 59.7 |
| *Staurosira ambigua* | 6.0 | 43.5 |
| *Odontidium mesodon* | 5.4 | 61.3 |
| *Aulacoseira alpigena* | 4.0 | 54.8 |
| *Achnanthidium minutissimum* | 3.5 | 46.8 |
| *Fragilaria* sp1 | 3.0 | 69.4 |
| *Stauroforma exiguiformis* | 2.9 | 41.9 |
| *Fragilaria* sp3 | 2.7 | 45.2 |
| *Sellaphora nigri/atomoides* complex | 2.2 | 46.8 |
| *Planothidium lanceolatum* | 2.0 | 41.9 |
| *Stauroforma* cf. *subsalina* | 1.9 | 12.9 |
| *Planothidium boyei* | 1.9 | 41.9 |
| *Tabellaria flocculosa* | 1.8 | 61.3 |
| *Eunotia curtagrunowii* | 1.8 | 30.6 |
| *Frustulia crassinervia* | 1.7 | 32.3 |
| *Nitzschia perminuta* | 1.7 | 62.9 |
| *Psammothidium helveticum* | 1.6 | 41.9 |
| *Psammothidium acidoclinatum* | 1.4 | 41.9 |
| *Humidophila perpusilla* | 1.2 | 61.3 |
| *Chamaepinnularia mediocrisis* | 1.2 | 22.6 |

Several taxa observed during the survey could not be identified with certainty using all currently available literature. Despite detailed analysis using light microscopy and scanning electron microscopy observations, a number of populations could not be assigned to any of the described species. A selection of taxa are illustrated in Figure 7. Some of these taxa likely represent species new to science, whereas others require additional morphological and ultrastructural investigations before their taxonomic status can be resolved. Further work, including detailed morphometric analyses, additional SEM observations and comparison with type material, will

be necessary to clarify their identities. During the course of this thesis, one taxon collected in the Westfjords was formally described as a new species, *Planothidium islandicum* Van de Vijver, Coomans & Pottiez (Van de Vijver et al., 2025[a]), following the guidelines of the International Code for Botanical Nomenclature (Turland et al., 2025). Two other, previously described, taxa required further taxonomic treatment to assure their taxonomic status. For both of them, the original type material was investigated. A first taxon, *Achnanthes boyei* Østrup was

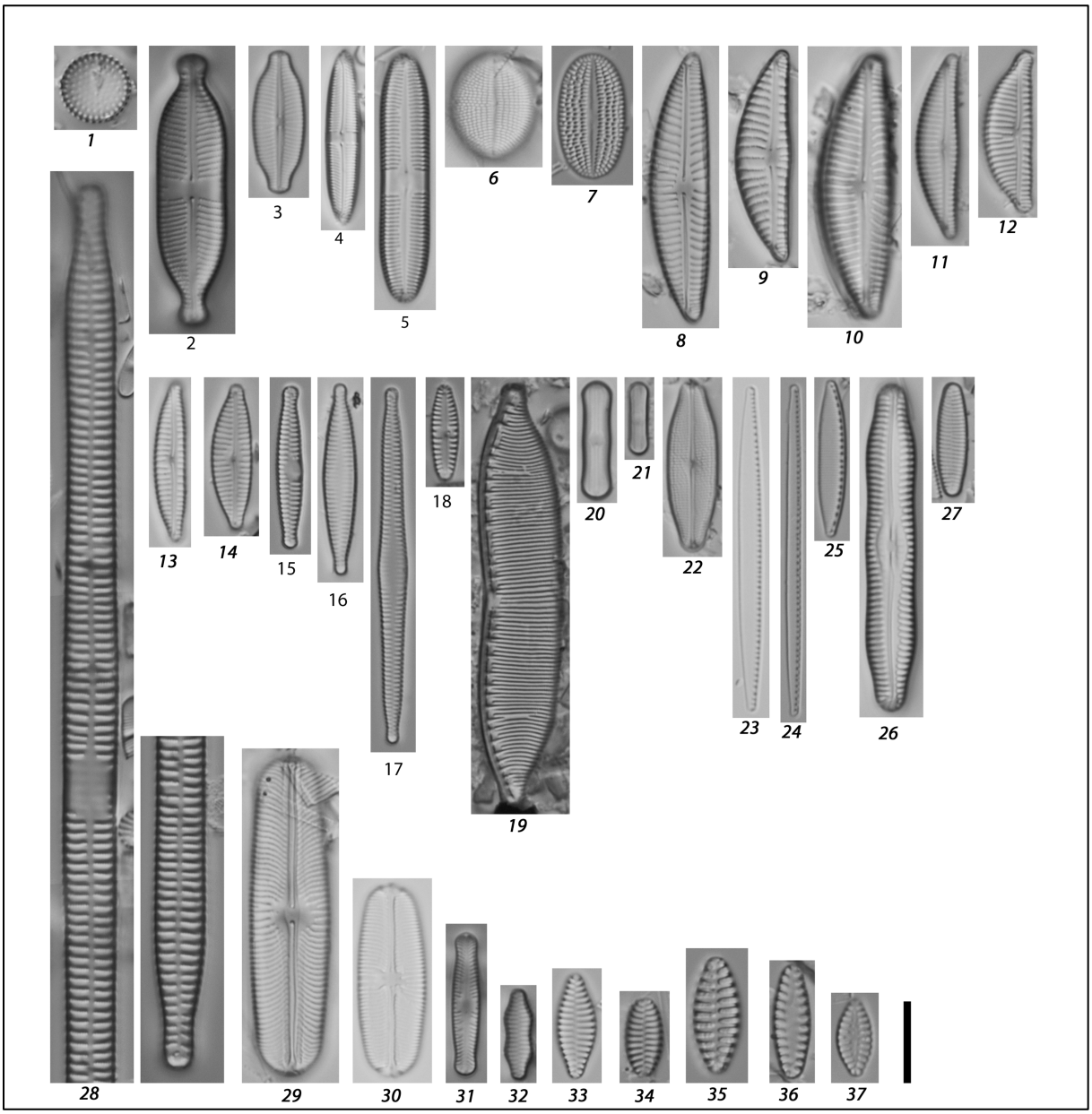


*Figure 7: LM images of several unidentified taxa (1000x). 1)* Aulacoseira *sp. 1, 2)* Placoneis *sp., 3)* incerta sedis, *4)* Caloneis *sp. 1, 5)* Caloneis *sp. 3., 6)* Cocconeis *sp. 1, 7)* Cocconeis *sp. 2, 8)* Encyonema *sp. 1, 9)* Encyonema *sp. 2, 10)* Encyonema *sp. 3, 11)* Encyonema *sp. 4, 12)* Encyonema *sp. 5, 13)* Encyonopsis *sp. 1, 14)* Encyonopsis *sp. 2, 15)* Fragilaria *sp. 1, 16)* Fragilaria *sp. 2, 17)* Fragilaria *sp. 3, 18)* Gomphonema *cf.* angustum *19)* Hantzschia *sp. 2, 20)* Humidophila *sp. 1, 21)* Humidophila *sp. 2, 22)* Neidium *sp. 1, 23)* Nitzschia *sp. 1, 24)* Nitzschia *cf.* incognita, *25)* Nitzschia *cf.* perminuta, *26)* Pinnularia *sp. 3., 27)* Stauroforma *cf.* subsalina, *28)* Ulnaria *sp., 29)* Sellaphora *sp. 1, 30)* Sellaphora *sp. 2, 31)* Sellaphora *cf* seminulum, *32)* Staurosira *sp. 1, 33)* Staurosira *sp. 2, 34) Staurosirella sp. 1, 35) Staurosirella sp. 2, 36) Staurosirella sp. 3, 37) Staurosirella sp. 4. Scale bar = 10 µm*

originally described from Iceland and previously considered a younger synonym of *P. lanceolatum* (Van de Vijver et al., 2019). A reanalysis of the type material retrieved from the diatom collection in Copenhagen, showed that the taxon presented all morphological features of the genus *Planothidium*. A fairly large population was recorded during the current survey and allowed for a more detailed analysis, indicating sufficient differences to split the taxon from *P. lanceolatum,* contradicting the conclusions in Van de Vijver et al. (2019). Therefore, the taxon was subsequently transferred to the genus *Planothidium* as a separate species *Planothidium boyei* (Østrup) Van de Vijver, Coomans, Pottiez & C.E.Wetzel (Van de Vijver et al., 2025[b]). Secondly, the morphology and taxonomic concept of *Eunotia incisa* W.Smith were reassessed using historical type material collected from the Mull deposit (Hebrides, Scotland, UK) present in the collection of Meise Botanic Garden, resulting in the designation of an epitype and a refined species description (Van de Vijver et al. 2026[a]).

## 3.2. Diatom community analysis

### 3.2.1. Differences between water and moss samples

The PERMANOVA analysis revealed a significant difference in diatom community composition between moss and water samples ($R^2 = 0.030$, $p = 0.014$). However, multivariate dispersions also differed significantly between the two groups ($p = 0.007$), suggesting that the

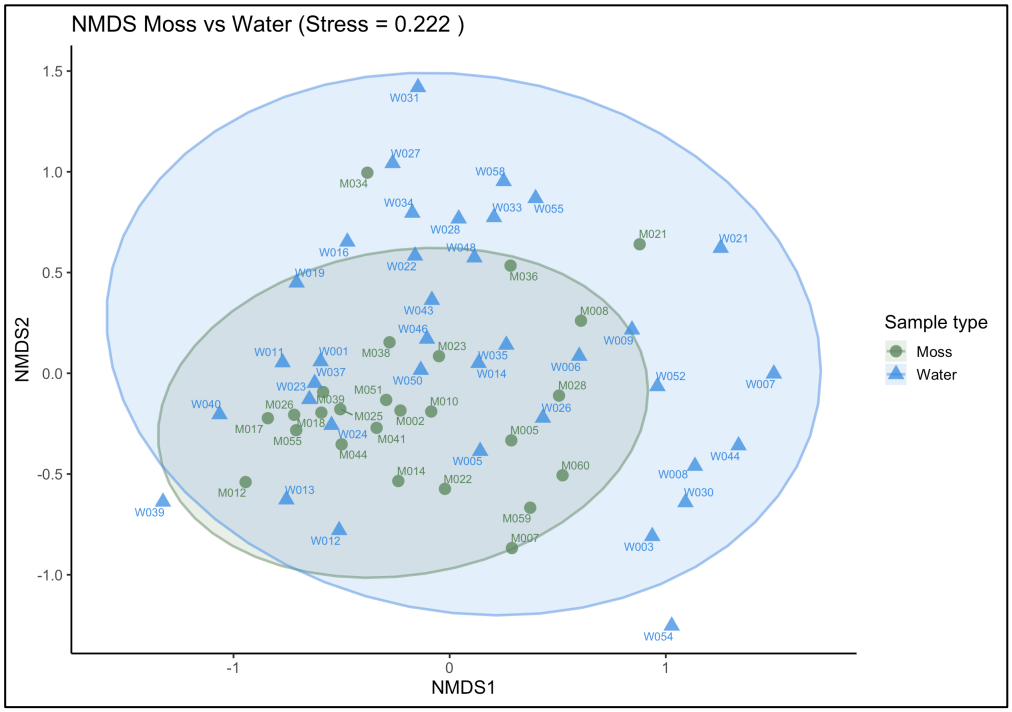



*Figure 8: Non-metric multidimensional scaling (NMDS) ordination based on Bray-Curtis dissimilarities of Hellinger-transformed diatom assemblage data from moss and water samples. Circles are Moss samples (M) and triangles indicate water samples (W).*

observed differences may partly reflect variation in within-group dispersion rather than differences in community composition alone (Figure 8).

The NMDS ordination revealed a partial separation between moss and water samples, while substantial overlap between the two groups indicated that many diatom taxa were shared across habitats. Several water samples were positioned within the moss ordination space. This pattern may be related to the proximity of these sampling sites to mosses or other vegetation, potentially resulting in the presence of epiphytic diatom taxa in the water samples. Water samples exhibited greater dispersion in ordination space, suggesting higher variability in community composition than moss samples (Figure 8).

Diatom community composition differed significantly among habitat types ($R^2 = 0.240$, $p < 0.001$). Moreover, multivariate dispersions were also significantly different among habitat types ($p < 0.001$). Although habitat type explained a significant proportion of the variation in community composition, considerable overlap among habitats remained visible in the NMDS ordination (Figure 9). Therefore, the PERMANOVA results should be interpreted with caution, as part of the observed community differentiation may be attributable to differences in dispersion among habitat types. In contrast, no significant differences in diatom community composition were detected among moss species ($R^2 = 0.745$, $p = 0.120$). Furthermore, a permutation test for homogeneity of multivariate dispersions showed no significant differences

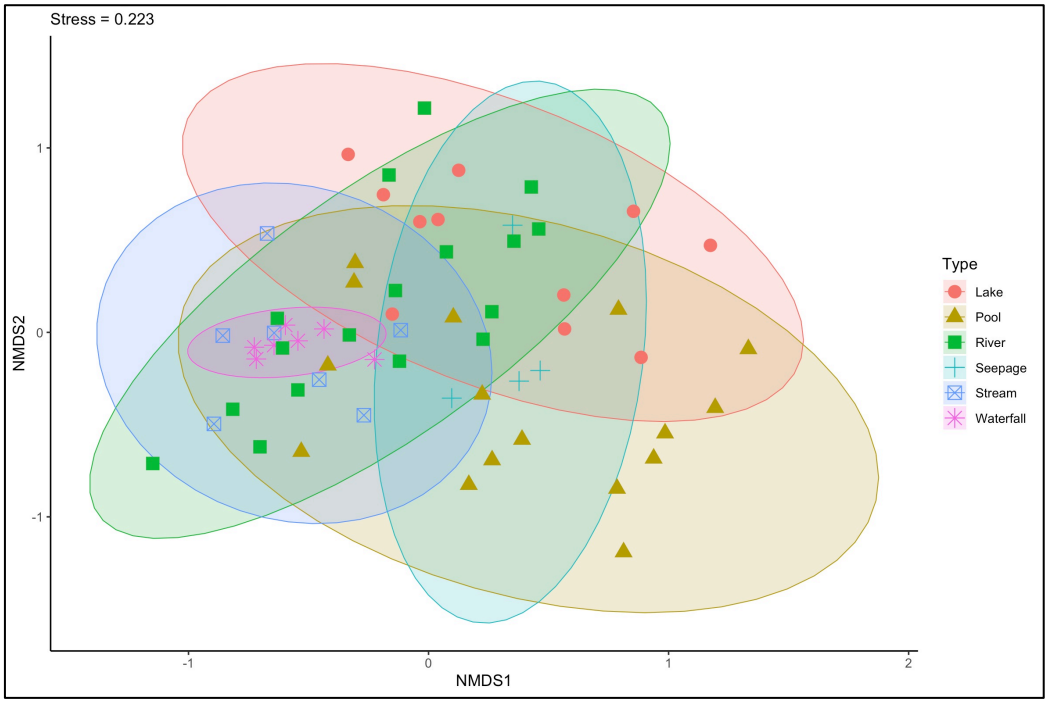



*Figure 9: Non-metric multidimensional scaling (NMDS) ordination based on Bray-Curtis dissimilarities of Hellinger-transformed diatom assemblage data from water samples. Circles are Lake samples, triangles are pool samples, squares are River samples, crosses are seepage samples, a cross in a square are stream samples, and stars are waterfall samples.*

in dispersion among moss species (p = 0.153). This indicates that the non-significant PERMANOVA result was not confounded by differences in within-group dispersion (Appendix D Figure D1). Similarly, diatom community composition did not differ significantly among F-classes ($R^2$ = 0.159, p = 0.583). Multivariate dispersions were likewise not significantly different among F-classes (p = 0.989), confirming that the absence of compositional differences was not influenced by variation in within-group dispersion (Appendix D Figure D2).

### 3.2.2. Diatom communities in the Westfjords

#### *3.2.2.1. Overall dataset*

Using different multivariate techniques, it was possible to group the analysed samples in different groups, representing different diatom communities. The first and second DCA axes explained 6.4% and 5.2% of the total variation in species composition, respectively, with a further 7.4% explained by the third and fourth axes combined. Although these percentages are relatively low, such values are common in ecological community datasets due to the large number of rare taxa and zero values present in species matrices (Stevenson et al., 1991). The length of the first DCA axis was 4.70 standard deviation units. The initial ordination revealed four clear outlier samples. These samples were characterised by a highly distinct species composition compared to the other samples, and the presence of several taxa that were largely

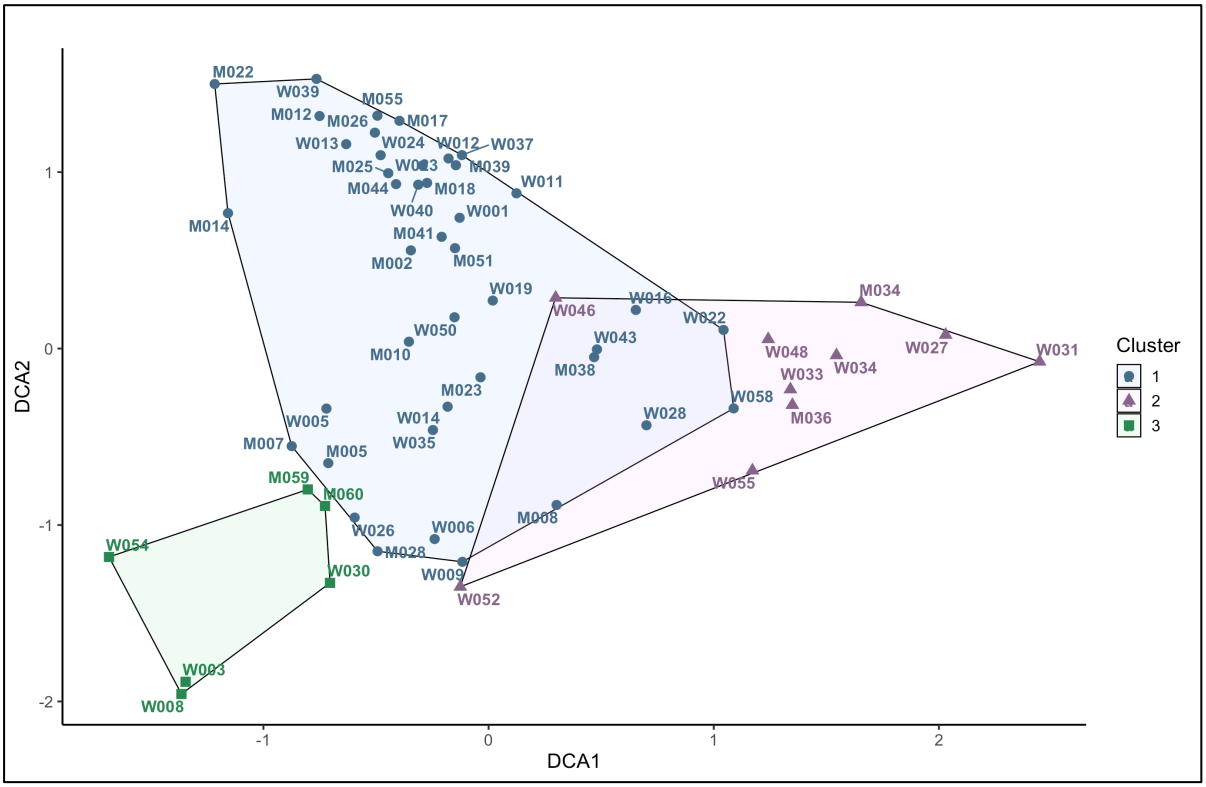



*Figure 10: Detrended correspondence analysis (DCA) ordination of diatom assemblages after removal of outlier samples. Samples are grouped into three clusters (1, 2 and 3) based on cluster analysis. Symbols and colours indicate cluster membership, while shaded polygons represent the convex hull enclosing samples belonging to the same cluster.*

absent or occurred only very sporadically in the remaining dataset. Because these outliers obscured the overall patterns in community composition, they were excluded from subsequent

*Table 2: Summary of the principal taxa in the three main assemblages, based on the cluster analysis. Symbols indicate the mean overall abundance of the taxa in each cluster. Legend: ■ = >10%, ● = 5–10%, ○ = 2.5–5%, + = 1-2.5%, · = <1%.*

| Taxon | Cluster 1 | Cluster 2 | Cluster 3 |
|---|---|---|---|
| *Meridion circulare* | ■ | · | ○ |
| *Staurosira ambigua* | ● | · | |
| *Odontidium mesodon* | ● | · | |
| *Aulacoseira alpigena* | ○ | ○ | · |
| *Fragilaria* sp. 1 | ○ | + | |
| *Fragilaria* sp. 3 | ○ | + | |
| *Planothidium lanceolatum* | ○ | | |
| *Planothidium boyei* | ○ | · | |
| *Sellaphora nigri/atomoides* complex | ○ | + | · |
| *Tabellaria flocculosa* | + | + | · |
| *Eunotia zackenbergensis* | + | | |
| *Achnanthidium modestiforme* | + | | |
| *Fallacia vitrea* | + | | |
| *Stauroforma exiguiformis* | + | ● | · |
| *Stauroforma cf subsalina* | + | ● | |
| *Pseudostaurosira opacolineata* | · | ● | |
| *Staurosira false venter* | · | ○ | |
| *Fragilaria cf amphicephaloides* | · | ○ | |
| *Pseudostaurosira pseudoconstruens* | · | ○ | · |
| *Psammothidium levanderi* | · | ○ | |
| *Psammothidium didymum* | | + | |
| *Staurosira* sp.3 | · | + | |
| *Psammothidium marginulatum* | · | + | |
| *Staurosirella jonssoniana* | · | + | · |
| *Psammothidium subatomoides* | · | + | |
| *Rossithidium pusillum* | · | + | |
| *Pseudostaurosira* false *microstriata* | | + | |
| *Nitzschia hantzschiana* | · | + | |
| *Eunotia curtagrunowii* | · | · | ■ |
| *Psammothidium helveticum* | · | · | ● |
| *Frustulia crassinervia* | + | · | ● |
| *Achnanthidium minutissimum* | ○ | ● | ● |
| *Psammothidium acidoclinatum* | + | · | ○ |
| *Eunotia nymanniana* | · | | ○ |
| *Pinnularia peracuminata* | · | · | ○ |
| *Eunotia islandica* | · | · | ○ |
| *Humidophila perpusilla* | + | · | + |
| *Nitzschia perminuta* | · | · | + |
| *Chamaepinnularia mediocrisis* | + | · | + |
| *Psammothidium daonense* | · | · | + |
| *Eunotia bilunaris* | · | | + |
| *Psammothidium* sp. | · | · | + |
| *Eunotia minor* | + | · | + |
| *Eunotia bidens* | · | | + |

analyses to improve the interpretation of ecological gradients and cluster structure among the remaining samples. Following the removal of the outliers, the DCA ordinations revealed three

distinct sample clusters. The separation among clusters occurred mainly along the first ordination axis, indicating substantial differences in diatom community composition (Figure 10).

Three major assemblages were distinguished based on the cluster analysis (Figure 10) and reflect marked differences in taxon composition between the clusters (Table 2). Cluster 1, the largest assemblage, contained 42 of the 62 samples and corresponded to the blue cluster shown in Figure 10. It was characterised by the dominance of *Meridion circulare* (12.49%), *Staurosira ambigua* (8.64%), *Odontidium mesodon* (7.88%), *Aulacoseira alpigena* (4.95%), *Fragilaria sp. 1* (4.17%) and *Fragilaria sp. 3* (3.73%). Samples assigned to this assemblage originated predominantly from rivers, including all samples collected from waterfalls.

Cluster 2 (pink cluster in Figure 10) was mainly composed of lake and larger pool samples. The assemblage was dominated by *Stauroforma exiguiformis* (8.75%), *Stauroforma cf. subsalina* (Grunow) Van de Vijver et al. (5.93%), *Pseudostaurosira opacolineata* (Lange-Bertalot) M.L.García & Maidana (5.25%), *Staurosira 'false' venter* (4.18%) and *Fragilaria cf. amphicephaloides* Lange-Bertalot (3.48%). Cluster 3 (green cluster in Figure 10) is the smallest of the three clusters and is comprised exclusively of pool samples, dominated *by Eunotia curtagrunowii* Nörpel-Schempp & Lange-Bertalot (16.79%), *Psammothidium helveticum* (Hustedt) Bukhtiyarova & Round (9.29%), *Frustulia crassinervia* (Brébisson) Lange-Bertalot & Krammer (8.54%), *Achnanthidium minutissimum* (6.58%), *Psammothidium acidoclinatum* (Lange-Bertalot) Lange-Bertalot (3.92%) and *Eunotia nymanniana* Grunow (3.71%).

Numerical characteristics of the three clusters are summarised in Table 3. Cluster 2 exhibited the highest richness (38.8 taxa per sample), diversity (H′ = 2.95) and evenness (0.50), indicating the most diverse assemblages in the dataset. Cluster 3 showed intermediate values for all diversity metrics, whereas Cluster 1 was characterised by a lower diversity (H′ = 2.31) and evenness (0.39) despite a relatively high mean taxon richness (30.0 taxa per sample).

*Table 3: overview of the mean taxon richness, mean evenness, mean diversity, range (max-min of taxa per sample) and median of taxa per sample in each of the three assemblages.*

| Parameter | Cluster 1 | Cluster 2 | Cluster 3 |
|---|---|---|---|
| Mean Richness | 30 ± 10 | 38.8 ± 5.2 | 23.7 ± 3.6 |
| Mean diversity | 2.31 ± 0.69 | 2.93 ± 0.22 | 2.4 ± 0.38 |
| Mean evenness | 0.39 ± 0.12 | 0.49 ± 0.05 | 0.48 ± 0.14 |
| Maximum richness | 51 | 47 | 27 |
| Minimum richness | 3 | 32 | 17 |
| Median | 31.0 | 37.5 | 24.5 |

### *3.2.2.2. Detailed analysis of Cluster 1*

Cluster 1 contained the majority of the samples. As in the initial analysis a clear pattern could not be identified within this cluster, a separate DCA only analysing the samples of cluster 1 was conducted to investigate patterns within this group in greater detail. The initial ordination of this subset revealed two samples that each formed a distinct group, clearly separated from the main sample assemblage. The first sample (M022) was characterised by a very high abundance of *Eunotia zackenbergensis* Goeyers et al. (70% of all counted valves), this sample was taken from a moss (*Sphagnum girgensohnii*) next to a large lake. The second sample (W009), taken from a small, shallow pool with a grass and sedge vegetation, is dominated by *Aulacoseira alpigena* (83%). As both samples clearly obscured the interpretation of community patterns among the remaining samples, they were excluded from subsequent analyses. Following their removal, two well-defined subclusters could be distinguished within the ordination space (Figure 11). The principal taxa characterising each subcluster are summarised in Table 4.

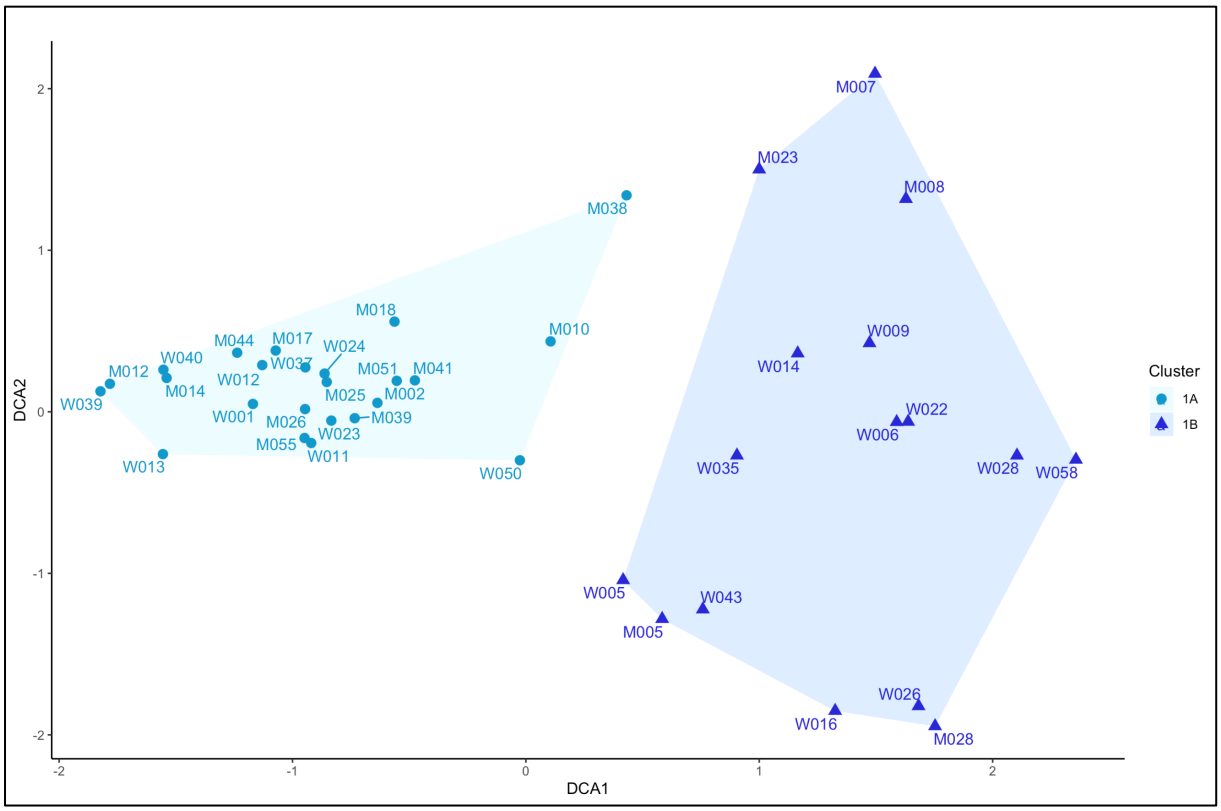



*Figure 11: Detrended Correspondence Analysis (DCA) of the Cluster 1 samples following the removal of the outlier samples M022 and W009. Two distinct subclusters (1A and 1B) can be distinguished. Shaded polygons represent the convex hulls encompassing samples assigned to each cluster.*

*Table 4: Summary of the principal taxa in the two subclusters, based on the cluster analysis. Symbols indicate the mean overall abundance of the taxa in each cluster. Legend: ■ = >10%, ● = 5–10%, ○ = 2.5–5%, + = 1-2.5%, · = <1%.*

| Taxon | Cluster 1A | Cluster 1B |
|---|---|---|
| *Meridion circulare* | ■ | + |
| *Staurosira ambigua* | ■ | · |
| *Odontidium mesodon* | ■ | ○ |
| *Fragilaria* sp1 | ● | ○ |
| *Planothidium lanceolatum* | ● | · |
| *Sellaphora nigri/atomoides* complex | ○ | · |
| *Planothidium boyei* | ○ | · |
| *Stauroforma cf subsalina* | + | + |
| *Nitzschia hantzschiana* | + | · |
| *Hygropetra balfouriana* | + | · |
| *Fragilariforma virescens* | + | · |
| *Meridion constrictum* | + | · |
| *Humidophila machalovae* | + | |
| *Achnanthidium minutissimum* | · | ● |
| *Fragilaria* sp3 | + | ● |
| *Stauroforma exiguiformis* | · | ○ |
| *Tabellaria flocculosa* | · | ○ |
| *Achnanthidium modestiforme* | · | ○ |
| *Chamaepinnularia mediocris* | | ○ |
| *Fallacia vitrea* | | ○ |
| *Aulacoseira alpigena* | ○ | ○ |
| *Rossithidium kriegeri* | | ○ |
| *Frustulia crassinervia* | · | ○ |
| *Kobayasiella parasubtilissima* | | + |
| *Brachysira microcephala* | | + |
| *Psammothidium helveticum* | · | + |
| *Psammothidium acidoclinatum* | · | + |
| *Aulacoseira westfjordensis* | · | + |
| *Rossithidium pusillum* | · | + |
| *Brachysira confusa* | · | + |
| *Humidophila perpusilla* | + | + |
| *Encyonema lunatum* | · | + |
| *Eunotia minor* | · | + |
| *Eunotia nymanniana* | · | + |
| *Gomphonema bozenae* | · | + |
| *Nitzschia perminuta* | · | + |

Subcluster 1A (Light blue, circles in Figure 11) was located on the negative side of the DCA1 axis and around the centre of the DCA2 axis. This group consisted primarily of fast-flowing river and waterfall samples and was dominated by *Meridion circulare* (21.1%), *Staurosira ambigua* (14.8%), *Odontidium mesodon* (11.95%), *Fragilaria sp. 1* (5.4%), *Planothidium lanceolatum* (5.1%), the *Sellaphora nigri/atomoides complex* (4.3%), and *Planothidium boyei* (4.3%). Subcluster 1B (Dark blue, triangles in Figure 11) was positioned on the positive side of

the DCA1 axis and was more broadly distributed along the DCA2 axis. This subcluster consisted mainly of samples originating from braided, often slow-flowing rivers and seepage habitats. The dominant taxa were *Achnanthidium minutissimum* (7.30%), *Fragilaria sp. 3* (6.4%), *Stauroforma exiguiformis* (5.0%), *Tabellaria flocculosa* (Roth) Kützing (4.2%), *Achnanthidium modestiforme* (Lange-Bertalot) Van de Vijver (3.8%), and *Chamaepinnularia mediocris* (Krasske) Lange-Bertalot (3.4%).

Numerical characteristics of the two subclusters are summarised in Table 5. Subcluster 1B exhibited the highest richness (31.1 taxa per sample), diversity (H′ = 2.60) and evenness (0.45), whereas Subcluster 1A was characterised by lower richness (24.0 taxa per sample), lower diversity (H′ = 2.10) and a less even distribution of abundances among taxa (evenness = 0.39). The observed richness ranged from 3 to 45 taxa in Subcluster 1A and from 19 to 43 taxa in Subcluster 1B.

*Table 5: overview of the mean taxon richness, mean evenness, mean diversity, range (max-min of taxa per sample) and median of taxa per sample in each of the two subclusters.*

| **Parameter** | **Cluster 1A** | **Cluster 1B** |
|---|---|---|
| Mean Richness | 24 ± 9.6 | 31.1 ± 7 |
| Mean diversity | 2.1 ± 0.72 | 2.6 ± 0.34 |
| Mean evenness | 0.4 ± 0.12 | 0.45 ± 0.08 |
| Maximum richness | 45 | 43 |
| Minimum richness | 3 | 19 |
| Median | 34 | 31.5 |

# 4. Discussion

## 4.1. Species diversity

The present study demonstrates that the Westfjords harbour a remarkably species-rich diatom flora. Based on only 62 analysed samples, a total of 317 taxa belonging to 65 genera were recorded during the routine valve counts, while an additional 86 taxa were detected during supplementary microscopic examinations. Species accumulation curves and Chao richness estimators further suggest that the actual diversity of the region is substantially higher than that observed in the present survey.

The only large-scale study specifically focusing on Icelandic diatoms is that of Foged (1974), who reported 708 taxa based on 70 samples collected from across the entire island of Iceland. Remarkably, the Westfjords were not included in that survey. The substantially larger geographic extent of Foged's study encompassed a broader range of environmental conditions and habitat types than those covered in the present study, which likely contributed to the higher number of recorded taxa. Other investigations by Foged further emphasised the high diversity of northern diatom floras. In Peary Land, North Greenland, Foged (1955) examined material from a broad array of habitat types, including soil, mosses, swamps, pools, lakes, springs, rivers, streams, and waterfalls. Although no overall species total was explicitly reported, the study highlighted the large ecological diversity of Arctic freshwater diatom communities. On the more northern Svalbard archipelago, Foged (1964) examined 209 samples from western Spitsbergen and Prins Karls Forland, including freshwater ponds and lakes, humid soils and terrestrial mosses and reported 572 diatom taxa, making it one of the most extensive inventories of the Svalbard freshwater flora at the time. In Southwest Greenland, Foged (1973) recorded 725 taxa, including 465 freshwater and 260 brackish or marine taxa, from approximately 30 sampling localities representing lakes, ponds, springs, rivers, and coastal environments. For comparison, Lange-Bertalot et al. (2017) list more than 800 commonly found species in their monograph on benthic diatoms of Central Europe and in 1996, Lange-Bertalot & Metzeltin observed 502 different diatom taxa in one (!) sample from the Finnish lake Julma Ölkky (Lange-Bertalot & Metzeltin, 1996).

Direct comparisons among these studies should, however, be interpreted with caution. Taxonomic concepts have changed considerably over time. Most historical investigations were conducted using relatively broad species concepts, whereas the present study adopted a finer taxonomic resolution. Consequently, a single taxon recognised in older studies may today be split into several distinct species. For instance in the genera *Stauroneis* and *Brachysira*, recent

revisions of populations in northern Europe including the Arctic, showed that far more species are present than previously thought (Van de Vijver et al., 2004, 2005, 2021a, 2021b, 2022). Force-fitting, the practice of applying species names of an already-known (usually European or North American) species to specimens from a geographically distant region (Tyler, 1996), increased the incorrect assessment of diatom floras, and hence a false image of biodiversity. Differences in species richness therefore reflect not only ecological and biogeographical patterns, but also variation in sampling effort, habitat coverage, and taxonomic methodology.

The high diversity observed in the present study also supports the proposition that remote regions such as the Westfjords remain insufficiently explored and may represent important reservoirs of undocumented biodiversity. Despite the limited geographic extent of the current study and the analysis of 'only' 62 samples, a highly diverse flora could be identified in the Westfjords, suggesting that additional sampling of such underrepresented regions and habitats would likely reveal even higher levels of diversity, as has been shown in the above-mentioned larger-scale Arctic surveys. The Westfjords are characterised by pronounced habitat heterogeneity, comprising a mosaic of rivers, waterfalls, lakes, pools and moss habitats, thereby providing a wide range of different ecological niches for diatoms. Kahlert et al. (2022) explicitly point out that comprehensive assessments of contemporary diatom distributions across the Arctic remain scarce, largely because of the lack of routine monitoring over the enormous geographical area. This had already been discussed by Zgrundo et al. (2017) who found 96 taxa in only 25 samples, illustrating how additional sampling of poorly explored regions can substantially increase knowledge of diatom diversity. Such geographical gaps can lead to what is called the "Wallacean shortfall", the incomplete knowledge of species distributions resulting from uneven sampling effort (Bini et al., 2006; Hortal et al., 2015). For diatoms, this problem could be at the base of our incomplete biogeographic knowledge. Not only are diatoms not always that easy to identify, often requiring a profound taxonomic expertise and high-levelled observation techniques, many regions are poorly sampled. Rare species most likely require a higher sampling effort before their distribution becomes apparent. A good example is *Staurosira ambigua*, a species that was originally described from Alaska having a conspicuous morphology, rarely observed in the genus *Staurosira* (i.e., a doubling of the areolae in the striae, visible only using SEM). For a long time the species was considered to be a north American endemic (Morales et al., 2010[a]), till I found several (larger) populations in the Westfjords.

A particularly striking feature of the dataset is the very high proportion of rare taxa. More than 60% of all recorded taxa occurred in fewer than 5% of the analysed samples, whereas only a

limited number of taxa were widespread throughout the study area. Such a frequency distribution is characteristic of many diatom communities, but may also reflect strong habitat differentiation, with numerous taxa restricted to specific environmental conditions (Vanormelingen et al., 2008). This observation is consistent with the concept of environmental filtering, whereby local environmental conditions determine which species are able to establish and persist within a given habitat (Soininen, 2007). The large number of rare taxa may additionally explain why the Chao estimators predicted substantially much higher richness values than those directly observed during the survey. The genus-level analysis further revealed that taxonomic richness and abundance were not necessarily correlated. *Eunotia* was the most species-rich genus, comprising 35 taxa, followed by *Pinnularia*, *Gomphonema,* and *Psammothidium*. Despite their high species richness, these genera did not dominate the flora when based on the total valve abundance. Conversely, genera such as *Meridion* and *Odontidium* were represented by only one or a few taxa but contributed disproportionately to total abundance as a result of the dominance of individual species. This pattern reflects a common characteristic of diatom assemblages, whereby overall diversity is supported by a large number of taxa occurring at low abundances, while a relatively small number of species account for the majority of counted individuals (Nemergut et al., 2013).

Another important outcome of this study is the considerable number of taxa that could not be identified with complete certainty, despite detailed examinations using light microscopy and, where possible, scanning electron microscopy. Moreover, one taxon collected during this survey was formally described as a new species, *Planothidium islandicum*, while the study also contributed to taxonomic revisions of *Planothidium boyei* and *Eunotia incisa*. In addition, a second species, *Aulacoseira westfjordensis* Van de Vijver et al., had already been described in 2025 (Van de Vijver et al., 2025[d]), highlighting further the uniqueness of this region. These findings directly reflect the taxonomic challenges associated with diatoms and support the growing body of evidence indicating that broad, traditional species concepts frequently underestimate the true extent of diatom diversity. The presence of multiple potentially undescribed or poorly understood taxa suggests that the Icelandic diatom flora remains incompletely characterised and that further taxonomic research remains essential.

## 4.2. Diatom communities

### 4.2.1. Differences between moss and water communities

The comparison between moss and aquatic samples indicated a significant difference in diatom community composition according to the PERMANOVA analysis. However, the significant dispersion test demonstrated that within-group variability also differed between both sample types. Consequently, the observed PERMANOVA result cannot be attributed exclusively to differences in species composition, as part of the detected variation may arise from differences in multivariate dispersion. The NMDS ordination supports this interpretation, showing a substantially greater spread of aquatic samples, whereas moss samples form a relatively compact and homogeneous cluster. This pattern suggests higher beta diversity among aquatic communities and indicates that the observed PERMANOVA result is partly influenced by differences in dispersion. However, given the relatively high stress value, the ordination may not fully capture the multivariate relationships among samples. The overlap observed in the NMDS ordination may be explained by the close spatial association between aquatic habitats and bryophytes in the Westfjords. Many water samples were collected in direct proximity to mosses or submerged moss vegetations, allowing epiphytic taxa to become incorporated into the aquatic samples and thereby increasing similarity between both habitat types.

A similar pattern was observed for the comparison among aquatic habitat types. Diatom community composition differed significantly among habitat categories, but multivariate dispersions were likewise significantly different. The NMDS ordination revealed substantial overlap between habitat types, indicating only limited separation of diatom assemblages based on habitat category. Nevertheless, differences in within-group dispersion were apparent, with pools, lakes, and seepages exhibiting greater variability in community composition than streams and waterfalls. Consequently, part of the significant PERMANOVA result is likely attributable to differences in multivariate dispersion rather than exclusively to differences in community composition. Furthermore, the relatively high NMDS stress value suggests that the two-dimensional ordination should be interpreted with caution, as it may not fully represent the multivariate relationships among samples. Therefore, although habitat type appears to influence diatom assemblage composition, the ecological interpretation of these patterns should remain cautious.

In contrast, no significant differences in diatom community composition were detected among moss species. The absence of significant differences was not associated with unequal dispersions, indicating that differences in within-group variability did not obscure a potential

ecological signal. A possible explanation for the lack of significance is the limited replication within individual moss species. Eighteen moss species were represented by only twenty-five analysed samples, resulting in several species being represented by a single sample. Considering that twenty-seven moss species were collected across the complete survey, with only a small number occurring repeatedly, the statistical power to detect species-specific patterns was likely limited. Future studies including a larger number of replicate samples per bryophyte species could provide a more robust assessment of the influence of bryophyte identity on diatom community composition. Previous studies have shown that bryophyte morphology can influence the structure of associated diatom assemblages (Knapp & Lowe, 2009).

Similarly, no significant differences were observed between moisture classes (F-classes) and the dispersions were also non-significant, indicating that the absence of differences was not influenced by unequal within-group variability. Several studies have reported compositional shifts in diatom communities along moisture gradients (Chen et al., 2012; Kopalová et al, 2014; Chattová et al., 2021; Goeyers et al., 2022), suggesting that hydrological conditions play a key role in structuring terrestrial and semi-terrestrial assemblages. The lack of such a pattern in the present study may be related to the relatively limited number of samples within individual moisture classes, which may have reduced the statistical power to detect more subtle ecological differences.

### 4.2.2. Diatom communities of the Westfjords of Iceland

The cluster analysis revealed three distinct diatom assemblages within the Westfjords. These assemblages showed no clear association with the measured environmental variables, as the observed ranges of pH, conductivity, temperature and altitude largely overlapped among clusters. Instead, the resulting groups corresponded closely to habitat type, suggesting that habitat characteristics such as hydrological regime and flow conditions may represent the principal drivers of community differentiation.

The first cluster was dominated by *Meridion circulare, Staurosira ambigua* and *Odontidium mesodon*. The predominance of these taxa is consistent with the habitat composition of this assemblage, as all dominant species are typically associated with running freshwater habitats, such as streams, rivers and spring-fed systems (Lowe, 1974; Patrick & Reimer, 1966; Morales et al., 2010[a]; Lange-Bertalot et al., 2017). Their occurrence therefore supports the interpretation of Cluster 1 as a characteristic lotic assemblage. The overall taxonomic composition of Cluster 1 suggests that continuous water movement and high oxygen availability are likely

important ecological characteristics shared by many of the river and waterfall sites assigned to this cluster. In addition to the dominant taxa, several species were almost exclusively restricted to this cluster, including *Planothidium lanceolatum, Achnanthidium modestiforme* and *Fallacia vitrea*. Most of these taxa are commonly reported from oligotrophic freshwater environments, with *P. lanceolatum* and *A. modestiforme* being particularly associated with running-water habitats (Lange-Bertalot, 1999; Van de Vijver et al., 2008, 2013). Although *Fallacia vitrea* is more frequently reported from oligotrophic lakes and peat-influenced waters (Østrup, 1901; Le Cohu & Azémar, 2010), the samples with its highest abundances in the Westfjords were collected from a pool dominated by a *Sphagnum* and sedge vegetation, and from a broad stream.

The second cluster was primarily characterised by the dominance of *Stauroforma exiguiformis*, *S.* cf. *subsalina* and *Pseudostaurosira opacolineata*. *Stauroforma exiguiformis* and *P. opacolineata* have been reported from dystrophic lakes in Canada and Scandinavia (Lange-Bertalot & Metzeltin, 1996; Witon et al., 2004). Their dominance within Cluster 2 therefore suggests the presence of a community adapted to relatively stable standing-water environments. Special attention should be given to *Stauroforma cf. subsalina*, one of the dominant taxa within this assemblage. The observed populations closely resemble *S. subsalina* morphologically, but their identification remains uncertain. *S. subsalina* has traditionally been associated with brackish habitats (Stabell, 1981), a preference that was also reflected in the accompanying flora of the historical material examined during the recent revision of the genus *Stauroforma* (Van de Vijver et al., 2026[b]). In contrast, none of the samples assigned to Cluster 2 showed indications of elevated salinity, nor did the associated diatom assemblages resemble typical brackish-water floras. The populations encountered in the present study might represent a morphologically similar but taxonomically unresolved freshwater taxon. Heudre et al. (2017, p. 266) analysed the diatom flora of the Lac de Gérardmer in France and found the same taxon to be abundant in their samples, identifying it provisionally as *Stauroforma* sp. The investigated glacial lake in the Vosges shows similar ecological conditions as the Westfjord localites. As long as its taxonomic status remains unclear, little can be said about its ecological preferences, and its abundance within Cluster 2 should not be used for ecological interpretation of the assemblage. In addition to the dominant taxa, the assemblage was characterised by various *Psammothidium* taxa and small araphid taxa, including *Pseudostaurosira pseudoconstruens* (Marciniak) D.M.Williams & Round, *Staurosirella jonssoniana* Van de Vijver & Iris Hansen, and *Pseudostaurosira* 'false' *microstriata*. Many of these taxa were largely confined to Cluster 2 and occurred only sporadically in the other assemblages. *Psammothidium* species are frequently

reported from oligotrophic, cold-water environments, including nutrient-poor lakes and weakly buffered freshwater habitats, often associated with rocky or sandy substrates (Round & Bukhtiyarova, 1996; Lange-Bertalot & Metzeltin, 1996; Enache et al., 2013). Similarly, small araphid taxa are common components of benthic communities in clear oligotrophic waters (Morales et al., 2010[b]; Van de Vijver et al., 2026[b]). The combined occurrence of these taxa therefore suggests that Cluster 2 represents a community associated with oligotrophic freshwater environments. Although the majority of samples assigned to this cluster originated from lakes and larger pools, three river samples were also included in this assemblage. The common factor among all these samples, was their locality. Sixty percent of all samples were collected on the Steingrímsfjarðarheiði plateau, a prominent, high-altitude mountain pass in the southern Westfjords of Iceland, reaching an elevation of 440 meters a.s.l. The plateau is crossed by the coastal Route 61 (Djúpvegur), connecting the town of Hólmavík in the east with the northern and western fjords leading towards Ísafjörður, the main town in the Westfjords. Two other samples (W052 & W055) were collected from lakes on a high plateau under similar conditions near Latraberg. The samples are all dominated by an abundance of small araphid taxa. These taxa were consistently present in almost all investigated Steingrímsfjarðarheiði plateau samples but were likewise also common in the remaining Cluster 2 localities, but on the other hand largely absent from the other assemblages. This pattern suggests that the composition of Cluster 2 is determined less by the distinction between running and standing waters and more by a shared set of ecological conditions favouring these oligotrophic small araphid communities. Small araphid taxa from the genera *Staurosira*, *Staurosirella* and *Pseudostaurosira* are frequently associated with early-successional, unstable, disturbed, cold, shallow and/or low-productivity environments (Lotter & Bigler, 2000; Weckström et al., 2023).

The third cluster was dominated by *Eunotia curtagrunowii*, *Psammothidium helveticum*, and *Frustulia crassinervia*. These taxa are generally associated with oligotrophic, weakly disturbed freshwater environments, including springs, streams, and peatlands, suggesting that this cluster represents relatively pristine, but nevertheless already developed freshwater conditions (Lange-Bertalot & Metzeltin, 1996; Bukhtiyarova & Round, 1996; Cantonati et al., 2012; Lange-Bertalot et al., 2017; Mašić, 2020) in contrast to cluster 2 that could be considered more pioneer habitats. The third cluster was further characterised by the presence of numerous *Eunotia* taxa, typically dominating oligotrophic to dystrophic freshwater habitats, such as humic, *Sphagnum*-rich peatland environments, including bog pools, seepages, and waters draining peat bogs (Lange-Bertalot et al., 2011). In contrast, most samples assigned to Cluster 3 originated from

pools situated in tundra and bryophyte-rich grassland vegetation rather than from clearly defined peatland habitats. Therefore, the assemblage is interpreted primarily as a community associated with oligotrophic freshwater pools, while local organic enrichment and peat influence may have contributed to the occurrence of several characteristic taxa.

Four samples (M021, W021, W007, and W044) occupied isolated positions in the ordination and were therefore identified as outliers. Their separation from the main dataset was caused by highly distinctive species compositions that were not observed in the remaining samples.
Samples M021 and W021 formed a small assemblage dominated by *Eunotia incisa* and *Eunotia mucophila*. Both samples originated from the Mjólfjörðurdal area, but since other samples were collected in the same region that did not show similar assemblages, it indicates that local habitat conditions rather than geographical proximity are more likely responsible for the observed community composition. It is, however, unclear what might have influenced this community as no apparent abiotic differences could be found between the two samples and the others. Samples W007 and W044 are presented as outliers, characterised by high abundances of *Nitzschia perminuta* Grunow, *Brachysira confusa* Van de Vijver et al., and *B. decipiens* (A.Cleve) Van de Vijver & Kusber. The latter species was only recorded in W007 and contributed substantially to the unique character of this assemblage. The combined occurrence and high abundance of these taxa, which were absent or only rarely encountered in the remaining samples, resulted in a community composition that clearly differed from the rest of the dataset.
Following the removal of these samples from the analysis, considerable variation remained within Cluster 1, prompting a more detailed analysis of this assemblage. This revealed two additional outlier samples (M022 and W009), each characterised by the overwhelming dominance of a single taxon (M022 dominated by *Eunotia zackenbergensis*, W009 by *Aulacoseira alpigena*). The strong dominance of these species produced diatom compositions that differed substantially from the remaining river and waterfall communities and justified their exclusion from the final ordination.

As Cluster 1 contained the majority of the samples, encompassing a broad range of running water habitats, a separate ordination analysis was performed to investigate in greater detail the variation within this assemblage. This analysis revealed two distinct subclusters, corresponding to differences in hydrological conditions and habitat structure.
Subcluster 1A remained characterised by the same dominant taxa that defined Cluster 1 as a whole, indicating that it represents the core flowing-water assemblage within the dataset. The

prevalence of waterfall and fast-flowing river samples, together with the dominance of taxa typically associated with turbulent lotic environments, suggests a strong affinity with habitats exposed to high flow velocities and continuous water movement. The cluster also contained a number of additional taxa, *Humidophila mochalovae* (Potapova) Goeyers et al., *Nitzschia hantzschiana* Rabenhorst, *Hygropetra balfouriana* (Grunow) Krammer & Lange-Bertalot, *Fragilariforma virescens* (Ralfs) D.M.Williams & Round and *Meridion constrictum* Ralfs, either absent from or only sporadically recorded in the other subcluster. This pattern further supports the distinct ecological character of Subcluster 1A, suggests environmental conditions favouring species adapted to more dynamic and oxygen-rich habitats. In contrast, Subcluster 1B had high abundances of *Achnanthidium minutissimum*, *Fragilaria* sp. 3 and *Stauroforma exiguiformis*. *Achnanthidium minutissimum* is a widespread freshwater taxon that occurs in a broad range of habitats, including streams, rivers, lakes and epiphytic communities (Lange-Bertalot et al., 2017). However, recent taxonomic and molecular studies have demonstrated that *A. minutissimum* represents a complex of multiple closely related species and lineages with distinct ecological preferences. As a result, ecological interpretations based solely on light-microscopic identifications should be treated with caution (Potapova & Hamilton, 2007; Lange-Bertalot et al., 2017; Pinseel et al., 2017). As *Fragilaria* sp. 3 could not be matched with any currently described species and is likely new to science, ecological information from the literature is not available. Nevertheless, its consistent occurrence within this assemblage suggests an association with habitats characterised by lower flow velocities than those represented in Subcluster 1A. Additional sampling and taxonomic investigation will be required to confirm this ecological preference. *Stauroforma exiguiformis* is a benthic, colony-forming diatom with a circumboreal distribution that has been reported from a wide range of freshwater habitats, indicating a relatively broad ecological amplitude (Van de Vijver et al., 2025[c]). In addition, Subcluster 1B contained several taxa that were absent from Subcluster 1A, including *Chamaepinnularia mediocris, Fallacia vitrea, Rossithidium kriegeri* (Krasske) Bahls, *Kobaysiella parasubtilissima*, and *Brachysira microcephala* (Grunow) Compère, indicating a partially distinct species composition and further supporting the ecological differentiation of this assemblage (Lange-Bertalot & Metzeltin, 1996; Antoniades et al., 2008; Van de Vijver et al., 2021). Together, these patterns suggest that Subcluster 1B represents the lower-energy end of the flowing-water gradient identified within Cluster 1, as the assemblage was primarily associated with braided and slow-flowing rivers, as well as seepage habitats.

# 5. Conclusion

This study represents the first comprehensive investigation of freshwater diatom communities in the Westfjords of Iceland and demonstrates that the region harbours a remarkably rich and diverse diatom flora. A total of 403 taxa were recorded, including numerous rare species, while species richness estimators indicated that the actual diversity is likely substantially higher than currently documented. These findings highlight the Westfjords as an important reservoir of freshwater diatom biodiversity, suggesting that significant portions of the regional flora remain undiscovered.

The analyses revealed clear differences in community composition among habitats, although these patterns were partly influenced by differences in within-group variability. Habitat characteristics, particularly hydrological conditions, appeared to be more important in structuring diatom assemblages than the measured environmental variables, as distinct communities were associated with flowing-water habitats, oligotrophic lakes and pools, and a characteristic pool assemblage characterised by abundant *Eunotia* and *Psammothidium* taxa. Within flowing-water habitats, additional differentiation reflected variation in flow regime and habitat structure.

The study also highlights the still incomplete state of taxonomic knowledge of Icelandic diatoms. Several populations could not be identified with certainty, one taxon was formally described as a new species (*Planothidium islandicum*), and the collected material contributed to ongoing taxonomic revisions. These findings suggest that a considerable proportion of Iceland's freshwater diatom diversity remains poorly understood and that further taxonomic investigations are required.

Overall, the results demonstrate that the freshwater habitats of the Westfjords support highly diverse and ecologically differentiated diatom communities. Continued floristic surveys, combined with detailed ecological and taxonomic studies, will be essential for improving our understanding of Icelandic diatom biodiversity and the environmental factors shaping these communities. Beyond documenting regional biodiversity, this study provides an important baseline for future ecological and biogeographical research in Iceland. As freshwater ecosystems in northern regions are expected to experience increasing environmental change, a thorough understanding of present-day diatom diversity and distribution patterns will be essential for monitoring future ecological responses and conserving aquatic biodiversity.

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# Appendix

## Appendix A: Literature used for identifications

### Appendix A1: Literature used for diatom identifications

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# Appendix B: List of taxa

*Table B1: List of diatom taxa recorded in the samples. Relative abundances are expressed as the percentage of all counted valves. Taxa for which no abundance value is provided were observed during scanning of the slide but were not encountered during the formal count.*

| ***Taxa*** | **Relative abundance** |
|---|---|
| *Achnanthes carissima* Lange-Bertalot | 0.02 |
| *Achnanthes coarcata* (Brébisson) Grunow | 0.04 |
| *Achnanthidium minutissimum* (Kützing) Czarnecki | 3.50 |
| *Achnanthidium modestiforme* (Lange-Bertalot ) Van de Vijver | 1.10 |
| *Achnanthidium nolii* (O.Bock & W.Bock) Lange-Bertalot | 0.00 |
| *Achnanthidium* sp. 1 | 0.00 |
| *Achnanthidium* sp. 2 | 0.00 |
| *Achnanthidium tropicocatenatum* Marquardt, C.E.Wetzel & Ector | 0.01 |
| *Adlafia bryophila* (J.B.Petersen) Lange-Bertalot | 0.36 |
| *Adlafia detenta* (Hustedt) Heudre, C.E.Wetzel & Ector | |
| *Adlafia minuscula* (Grunow) Lange-Bertalot | 0.10 |
| *Adlafia suchlandtii* (Hustedt) Monnier & Ector | 0.26 |
| *Amphora copulate* (Kützing) Schoeman & R.E.M.Archibald | 0.00 |
| *Amphora inariensis* Krammer | 0.07 |
| *Amphora lange-bertalotii* var. *tenuis* Levkov & Metzeltin | 0.01 |
| *Amphora parallelistriata* Manguin & de Reviers | 0.01 |
| *Amphora pediculus* (Kützing) Grunow | 0.01 |
| *Aulacoseira alpigena* (Grunow) Krammer | 3.96 |
| *Aulacoseira italica* (Ehrenberg) Simonsen | 0.06 |
| *Aulacoseira nivalis* (W.Smith) J.English & Potapova | 0.13 |
| *Aulacoseira* sp. | 0.47 |
| *Aulacoseira westfjordensis* Van de Vijver, L.Willems & Pottiez | 0.10 |
| *Brachysira confusa* Van de Vijver, R.L.Albert, B.Kennedy & Kusber | 1.04 |
| *Brachysira decipiens* (A.Cleve) Van de Vijver & Kusber | 0.32 |
| *Brachysira elisabethiana* Van de Vijver, C.E.Wetzel & Ector | 0.00 |
| *Brachysira louiseboydiana* Goeyers, Van de Vijver & Verleyen | 0.06 |
| *Brachysira microcephala* (Grunow) Compère | 0.65 |
| *Brachysira neoexilis* Lange-Bertalot | 0.07 |
| *Brachysira zellensis* (Grunow) Round & D.G.Mann | 0.01 |
| *Caloneis* sp. | 0.02 |
| *Caloneis* sp. 1 | 0.08 |
| *Caloneis* sp. 4 | 0.10 |
| *Caloneis tenuis* (W.Gregory) Krammer | 0.24 |
| *Caloneis undulata* Meister | |
| *Cavinula cocconeiformis* (W.Gregory) D.G.Mann & Stickle | 0.25 |
| *Cavinula jaernefeltii* (Hustedt) D.G.Mann & Stickle | 0.01 |

*Table B1 – continued.*

| ***Taxa*** | **Relative abundance** |
|---|---|
| *Cavinula mollicula* (Hustedt) Lange-Bertalot | 0.06 |
| *Cavinula pseudoscutiformis* (Hustedt) D.G.Mann & Stickle | 0.12 |
| *Cavinula pusio* (Cleve) Lange-Bertalot | 0.01 |
| *Cavinula variostriata* (Krasske) D.G.Mann & Stickle | 0.28 |
| *Chamaepinnularia begeri* (Krasske) Lange-Bertalot | 0.28 |
| *Chamaepinnularia* cf. *hassiaca* | |
| *Chamaepinnularia evanida* (Hustedt) Lange-Bertalot | 0.16 |
| *Chamaepinnularia gandrupii* (J.B.Petersen) Lange-Bertalot & Krammer | 0.01 |
| *Chamaepinnularia hassiaca* (Krasske) Cantonati & Lange-Bertalot | 0.03 |
| *Chamaepinnularia krookii* (Grunow) Lange-Bertalot & Krammer | 0.01 |
| *Chamaepinnularia mediocris* (Krasske) Lange-Bertalot | 1.19 |
| *Chamaepinnularia obsoleta* (Hustedt) C.E.Wetzel & Ector | 0.08 |
| *Chamaepinnularia* sp. 1 | 0.03 |
| *Chamepinnularia soehrensis* (Krasske) Lange-Bertalot & Krammer | 0.01 |
| *Cocconeis fetscheriana* Stancheva | 0.02 |
| *Cocconeis scutellum* Ehrenberg | |
| *Cocconeis* sp. 1 | 0.06 |
| *Cocconeis* sp. 2 | 0.02 |
| *Cosmioneis pusilla* (W.Smith) D.G.Mann & Stickle | |
| *Craticula acidoclinata* Lange-Bertalot & Metzeltin | |
| *Cymbella* cf. *cymbiformis* | |
| *Cymbella* cf. *vulgata* | |
| *Cymbella cymbiformis* C.Agardh | 0.00 |
| *Cymbella excisiformis* Krammer | 0.05 |
| *Cymbella lange-bertalotii* Krammer | |
| *Cymbella* sp. | |
| *Cymbopleura apiculata* Krammer | |
| *Cymbopleura naviculiformis* (Auerswald) Krammer | 0.04 |
| *Cymbopleura subcuspidata* (Krammer) Krammer | |
| *Denticula kuetzingii* Grunow | 0.04 |
| *Diatoma tenuis* C.Agardh | 0.04 |
| *Diatomella balfouriana* Greville | 0.12 |
| *Dickieia tackei* (Hustedt) E.J.Cox | 0.02 |
| *Diploneis calcifuga* Lange-Bertalot & Fuhrmann | 0.12 |
| *Diploneis dilatatafalsa* Lange-Bertalot & Fuhrmann | 0.00 |
| *Diploneis ovalis* (Hilse) Cleve | 0.00 |
| *Diploneis* sp. | |
| *Diploneis ultimathule* Lange-Bertalot & Fuhrmann | 0.03 |

*Table B1 – continued.*

| ***Taxa*** | **Relative abundance** |
|---|---|
| *Encyonema brevicapitatum* Krammer | 0.02 |
| *Encyonema cespitosum* Kützing | |
| *Encyonema elginense* (Krammer) D.G.Mann | 0.23 |
| *Encyonema jemtlandicum* Krammer | |
| *Encyonema lunatum* (W.Smith) Van Heurck | 0.95 |
| *Encyonema minutum* complex (Hilse) D.G.Mann | 0.10 |
| *Encyonema neogracile* Krammer | 0.11 |
| *Encyonema norvegicum* (Grunow) Mayer | |
| *Encyonema pergracile* Krammer | 0.01 |
| *Encyonema silesiacum* (Bleisch) D.G.Mann | 0.33 |
| *Encyonema silesiacum* s.l. | 0.07 |
| *Encyonema simile* Krammer | 0.02 |
| *Encyonema* sp. 1 | 0.03 |
| *Encyonema* sp. 2 | |
| *Encyonema* sp. 3 | |
| *Encyonema* sp. 4 | |
| *Encyonema* sp. 5 | |
| *Encyonema vulgare* Krammer | 0.02 |
| *Encyonopsis cesatii* (Rabenhorst) Krammer | 0.01 |
| *Encyonopsis* cf. *descripta* | 0.03 |
| *Encyonopsis* cf. *tavirana* | 0.06 |
| *Encyonopsis falaisensis* (Grunow) Krammer | 0.31 |
| *Encyonema gaeumanii* (F.Meister) Krammer | 0.03 |
| *Encyonopsis grunowii* Krammer | 0.02 |
| *Encyonopsis* sp. 1 | 0.06 |
| *Encyonopsis* sp. 2 | 0.02 |
| *Encyonopsis subminuta* Krammer & E.Reichardt | 0.01 |
| *Epithemia adnata* (Kützing) Brébisson | 0.12 |
| *Epithemia argus* (Ehrenberg) Kützing | |
| *Epithemia sorex* Kützing | 0.01 |
| *Eucocconeis* sp. | 0.03 |
| *Eunotia arcus* Ehrenberg | 0.03 |
| *Eunotia bidens* Ehrenberg | 0.17 |
| *Eunotia bigibboidea* Lange-Bertalot & Witkowski | |
| *Eunotia bilunaris* (Ehrenberg) Schaarschmidt | 0.33 |
| *Eunotia botuliformis* F.Wild, Nörpel-Schempp & Lange-Bertalot | 0.13 |
| *Eunotia* cf. *ambivalens* | |
| *Eunotia* cf. *arcus* | 0.04 |

*Table B1 – continued.*

| ***Taxa*** | **Relative abundance** |
|---|---|
| *Eunotia* cf. *zackenbergensis* | 0.08 |
| *Eunotia curtagrunowii* Nörpel-Schempp & Lange-Bertalot | 1.81 |
| *Eunotia diadema* Ehrenberg | 0.01 |
| *Eunotia exigua* (Brébisson) Rabenhorst | 0.05 |
| *Eunotia glacialispinosa* Lange-Bertalot & Cantonati | 0.01 |
| *Eunotia groenlandica* Nörpel-Schempp & Lange-Bertalot | 0.06 |
| *Eunotia implicata* Nörpel-Schempp, Lange-Bertalot & Alles | 0.10 |
| *Eunotia incisa* W.Smith | 0.95 |
| *Eunotia islandica* Østrup | 0.40 |
| *Eunotia metamonodon* Lange-Bertalot | 0.02 |
| *Eunotia minor* (Kützing) Grunow | 0.88 |
| *Eunotia mucophila* (Lange-Bertalot, Nörpel-Schempp & Alles) Lange-Bertalot | 0.86 |
| *Eunotia neocompacta* S.Mayama | 0.01 |
| *Eunotia neocompacta* var. *vixcompacta* Lange-Bertalot | 0.01 |
| *Eunotia neoscandinavica* Lange-Bertalot & Witkowski | 0.04 |
| *Eunotia nymanniana* Grunow | 0.77 |
| *Eunotia papiliofalsa* Lange-Bertalot | |
| *Eunotia paratridentula* Lange-Bertalot & Kulikovskiy | 0.27 |
| *Eunotia praerupta* Ehrenberg | 0.01 |
| *Eunotia pseudogroenlandica* Lange-Bertalot & Tagliaventi | 0.13 |
| *Eunotia* sp. 1 | 0.01 |
| *Eunotia* sp. 2 | 0.04 |
| *Eunotia* sp. 3 | 0.01 |
| *Eunotia tetradon* Ehrenberg | 0.02 |
| *Eunotia triodon* Ehrenberg | 0.01 |
| *Eunotia valida* Hustedt | 0.18 |
| *Eunotia zackenbergensis* Goeyers, Van de Vijver & Lange-Bertalot | 1.13 |
| *Fallacia vitrea* (Østrup) D.G.Mann | 1.15 |
| *Fragilaria* cf. *acerosa* | 0.05 |
| *Fragilaria* cf. *amphicephaloides* | 0.75 |
| *Fragilaria* sp. 1 | 3.23 |
| *Fragilaria* sp. 2 | 0.75 |
| *Fragilaria* sp. 3 | 1.80 |
| *Fragilariforma undata* (W.Smith) Heudre, C.E.Wetzel & Ector | |
| *Fragilariforma virescens* (Ralfs) D.M.Williams & Round | 0.79 |
| *Frustulia crassinervia* (Brébisson) Lange-Bertalot & Krammer | 1.73 |
| *Frustulia saxonica* Rabenhorst | 0.20 |
| *Frustulia vulgaris* (Thwaites) De Toni | 0.09 |

*Table B1 – continued.*

| ***Taxa*** | **Relative abundance** |
|---|---|
| *Gedaniella* sp. | |
| *Geissleria acceptata* (Hustedt) Lange-Bertalot & Metzeltin | 0.02 |
| *Geissleria* cf. *similis* | 0.02 |
| *Geissleria schoenfeldii* (Hustedt) Lange-Bertalot & Metzeltin | |
| *Geissleria similis* (Krasske) Lange-Bertalot & Metzeltin | 0.01 |
| *Genkalia digituloides* (Lange-Bertalot) Lange-Bertalot & Kulikovskiy | |
| *Genkalia digitulus* (Hustedt) Lange-Bertalot & Kulikovskiy | 0.01 |
| *Gomphonema acuminatum* Ehrenberg | 0.02 |
| *Gomphonema acutuisculum* (O.Müller) A.Cleve | |
| *Gomphonema angusticephalum* E.Reichardt & Lange-Bertalot | 0.02 |
| *Gomphonema bozenae* Lange-Bertalot & EReichardt | 0.42 |
| *Gomphonema brebissonii* Kützing | 0.02 |
| *Gomphonema calcifugum* Lange-Bertalot & EReichardt | 0.01 |
| *Gomphonema* cf. *angustatum* | 0.03 |
| *Gomphonema* cf. *pseudotenellum* | 0.10 |
| *Gomphonema* cf. *sacrophagus* | 0.01 |
| *Gomphonema commutatum* Grunow | 0.16 |
| *Gomphonema coronatum* Ehrenberg | |
| *Gomphonema duplipunctatum* Lange-Bertalot & E.Reichardt | 0.19 |
| *Gomphonema exilissimum* (Grunow) Lange-Bertalot & E.Reichardt | 0.04 |
| *Gomphonema hebridense* W.Gregory | 0.04 |
| *Gomphonema innocens* E.Reichardt | 0.01 |
| *Gomphonema lapponicum* (A.Cleve) A.Cleve | 0.15 |
| *Gomphonema montanum* (Schumann) Grunow | 0.03 |
| *Gomphonema parvulius* (Lange-Bertalot & E.Reichardt) Lange-Bertalot & E.Reichardt | |
| *Gomphonema productum* (Grunow) Lange-Bertalot & E.Reichardt | 0.01 |
| *Gomphonema reichardtii* Lange-Bertalot | 0.00 |
| *Gomphonema* sp. 1 | 0.23 |
| *Gomphonema* sp. 2 | 0.01 |
| *Gomphonema* sp. 3 | 0.00 |
| *Gomphonema* sp. 4 | 0.04 |
| *Gomphonema* sp. 5 | |
| *Gomphonema subclavatum* (Grunow) Grunow | 0.02 |
| *Gomphonema subtile* Ehrenberg | |
| *Halamphora dusenii* (Brun) Levkov | |
| *Halamphora oligotraphenta* (Lange-Bertalot) Levkov | 0.02 |
| *Hannaea arcus* (Ehrenberg) R.M.Patrick | 0.35 |
| *Hannaea linearis (*Holmboe) Álvarez-Blanco & S.Blanco | 0.32 |

*Table B1 – continued.*

| ***Taxa*** | **Relative abundance** |
|---|---|
| *Hantzschia abundans* Lange-Bertalot | |
| *Hantzschia amphioxys* (Ehrenberg) Grunow | |
| *Hantzschia calcifuga* E.Reichardt & Lange-Bertalot | 0.02 |
| *Hantzschia* sp. 1 | 0.04 |
| *Hantzschia* sp. 2 | 0.01 |
| *Humidophila arctica* (Lange-Bertalot & Genkal) R.L.Lowe & al. | 0.03 |
| *Humidophila contenta* (Grunow) R.L.Lowe et al. | 0.45 |
| *Humidophila eldfjalli* Furey, Manoylov & R.L.Lowe | 0.01 |
| *Humidophila flotowii* (Grunow) R.L.Lowe et al. | 0.00 |
| *Humidophila gallica* (W. Smith) R.L.Lowe, Kociolek, Q.You, Q.Wang & J.G.Štěpánek | 0.31 |
| *Humidophila laevissima* (Cleve) R.L.Lowe & al. | 0.29 |
| *Humidophila mochalovae* (Potapova) Goeyers, Van de Vijver & Sabbe | 0.44 |
| *Humidophila paracontenta* var. *magisconcava* (Lange-Bertalot) R.L.Lowe & al. | |
| *Humidophila perpusilla* (Grunow) R.L.Lowe et al. | 1.25 |
| *Humidophila schmassmannii* (Hustedt) Buczkó & Wojtal | 0.36 |
| *Humidophila* sp. 1 | 0.02 |
| *Humidophila* sp. 2 | |
| *Hygropetra balfouriana* (Grunow) Krammer & Lange-Bertalot | 0.75 |
| *incerta sedi* | 0.02 |
| *Karayevia laterostrata* (Hustedt) Bukhtiyarova | 0.00 |
| *Karayevia nitidiformis* (Lange-Bertalot) Bukhtiyarova | |
| *Karayevia suchlandtii* (Hustedt) Bukhtiyarova | |
| *Kobayasiella parasubtilissima* (H.Kobayasi & T.Nagumo) Lange-Bertalot | 0.99 |
| *Krasskella kriegeriana* (Krasske) R.Ross & P.A.Sims | 0.24 |
| *Lindavia antiqua* (W.Smith) Nakov, Guillory, M.L.Julius, E.C.Theriot & A.J.Alverson | |
| *Liparogyra spinosa* (W.Smith) Danz & Kociolek | 0.03 |
| *Luticola* cf. *aequalis* | |
| *Luticola* cf. *ignorata* | |
| *Luticola frequentissima* Levkov, Metzeltin & A.Pavlov | 0.13 |
| *Luticola* sp. | 0.02 |
| *Meridion circulare* (Greville) C.Agardh | 8.90 |
| *Meridion constrictum* Ralfs | 0.65 |
| *Microcostatus naumannii* (Hustedt) Lange-Bertalot | 0.02 |
| *Microcostatus zackenbergensis* Van de Vijver, Beyens & Iserentant | 0.00 |
| *Muelleria linearis* (O. Müller) Frenguelli | |
| *Nanofrustulum cataractarum* (Hustedt) C.E.Wetzel, E.Morales & Ector | |
| *Nanofrustulum fogedii* Van de Vijver, Beauger, Pottiez & C.E.Wetzel | 0.00 |
| *Nanofrustulum* sp. | 0.00 |

*Table B1 – continued.*

| ***Taxa*** | **Relative abundance** |
|---|---|
| *Navicula angusta* W.Smith | 0.18 |
| *Navicula* cf. *tenelloides* | 0.02 |
| *Navicula cryptotenella* Lange-Bertalot | 0.06 |
| *Navicula exilis* Kützing | 0.22 |
| *Navicula hanseatica* Lange-Bertalot & Stachura | 0.00 |
| *Navicula heimansioides* Lange-Bertalot | 0.00 |
| *Navicula pseudobryophila* Hustedt | |
| *Navicula radiosa* Kützing | 0.07 |
| *Navicula rhynchocephala* Kützing | 0.00 |
| *Navicula slesvicensis* Grunow | |
| *Neidium affine* (Ehrenberg) Pfitzer | 0.01 |
| *Neidium ampliatum* s.l. | 0.01 |
| *Neidium bisulcatum* (Lagerstedt) Cleve | 0.05 |
| *Neidium longiceps* (W.Gregory) R.Ross | |
| *Neidium septentrionale* A.Cleve | |
| *Neidium* sp. 1 | 0.02 |
| *Neidium* sp. 2 | 0.00 |
| *Neidium* sp. 3 | 0.00 |
| *Neidium* sp. 4 | 0.00 |
| *Neidium* sp. 5 | 0.02 |
| *Nitzschia alpinobacillum* Lange-Bertalot | 0.17 |
| *Nitzschia bryophila* (Hustedt) Hustedt | 0.23 |
| *Nitzschia* cf. *incognita* | 0.19 |
| *Nitzschia* cf. *perminuta* | 0.02 |
| *Nitzschia dissipata* (Kützing) Rabenhorst | 0.01 |
| *Nitzschia gandersheimiensis* Krasske | |
| *Nitzschia hantzschiana* Rabenhorst | 0.91 |
| *Nitzschia perminuta* Grunow | 1.69 |
| *Nitzschia pura* Hustedt | 0.03 |
| *Nitzschia radicula* Hustedt | |
| *Nitzschia soratensis* E.Morales & M.L.Vis | 0.02 |
| *Nitzschia* sp. 1 | 0.00 |
| *Nitzschia subtilis* (Kützing) Grunow | 0.14 |
| *Nitzschia valdestriata* Aleem & Hustedt | 0.03 |
| *Nupela impexiformis* (Lange-Bertalot) Lange-Bertalot | |
| *Odontidium hyemale* (Roth) Kützing | |
| *Odontidium mesodon* (Ehrenberg) Kützing | 5.35 |
| *Pinnularia biceps* W.Gregory | 0.01 |

*Table B1 – continued.*

| ***Taxa*** | **Relative abundance** |
|---|---|
| *Pinnularia borealis* Ehrenberg | 0.24 |
| *Pinnularia* cf. *isselana* | |
| *Pinnularia* cf. *subanglica* | 0.01 |
| *Pinnularia* cf. *subpulchra* | 0.12 |
| *Pinnularia* cf. *viridiformis* | |
| *Pinnularia decrescens* (Héribaud) F.W.Mills | |
| *Pinnularia divergens* W.Smith | 0.03 |
| *Pinnularia frequentis* Krammer | 0.00 |
| *Pinnularia intermedia* (Lagerstedt) Cleve | 0.20 |
| *Pinnularia lunata* Krammer & Lange-Bertalot | |
| *Pinnularia microstauron* var. *rostrata* Krammer | 0.02 |
| *Pinnularia nodosa* (Ehrenberg) W.Smith | 0.00 |
| *Pinnularia obscura* Krasske | 0.02 |
| *Pinnularia parvulissima* Krammer | |
| *Pinnularia peracuminata* Krammer | 0.43 |
| *Pinnularia pseudodivergentissima* Van de Vijver, A.Moravcová, Kusber & J.Neustupa | 0.17 |
| *Pinnularia rhombarea* Krammer | 0.04 |
| *Pinnularia rumrichiae* Krammer | |
| *Pinnularia septentrionalis* Krammer | |
| *Pinnularia sinistra* Krammer | 0.35 |
| *Pinnularia* sp. 1 | 0.03 |
| *Pinnularia* sp. 2 | |
| *Pinnularia* sp. 3 | |
| *Pinnularia* sp. 4 | |
| *Pinnularia* sp. 5 | |
| *Pinnularia* sp. 6 | |
| *Pinnularia stomatophora* (Grunow) Cleve | 0.04 |
| *Pinnularia subanglica* Krammer | 0.01 |
| *Pinnularia subcapitata* W.Gregory | 0.02 |
| *Pinnularia subgibba* Krammer | 0.01 |
| *Pinnularia sylvatica* Petersen | 0.44 |
| *Pinnularia viridiformis* Krammer | 0.09 |
| *Pinnularia viridiformis* var. *minor* Krammer | 0.11 |
| *Placoneis amphibola* (Cleve) E.J.Cox | 0.11 |
| *Placoneis navicularis* (Ehrenberg) E.J.Cox | 0.02 |
| *Placoneis* sp. | 0.03 |
| *Planothidium boyei* (Østrup) Van de Vijver, Coomans, Pottiez & C.E.Wetzel | 1.86 |
| *Planothidium fragilarioides* (J.B.Petersen) Round & Bukhtiyarova | |

*Table B1 – continued.*

| ***Taxa*** | **Relative abundance** |
|---|---|
| *Planothidium holstii* (Cleve) Lange-Bertalot | 0.00 |
| *Planothidium islandicum* Van de Vijver, Coomans & Pottiez | 0.13 |
| *Planothidium lanceolatum* (Brébisson ex Kützing) Lange-Bertalot | 2.04 |
| *Planothidium* sp. | 0.14 |
| *Planothidium victorii* Novis, Braidwood & Kilroy | 0.01 |
| *Psammothidium acidoclinatum* (Lange-Bertalot) Lange-Bertalot | 1.35 |
| *Psammothidium altaicum* (V.S.Poretzky) Bukhtiyarova | 0.02 |
| *Pseudostaurosira brevistriata* (Grunow) D.M.Williams & Round | 0.06 |
| *Psammothidium* cf. *frigidum* | 0.03 |
| *Psammothidium* cf. *kryophilum* | |
| *Psammothidium* cf. *marginulatum* | 0.70 |
| *Psammothidium* cf. *sacculum* | 0.31 |
| *Psammothidium daonense* (Lange-Bertalot) Lange-Bertalot | 0.20 |
| *Psammothidium didymium* (Hustedt) Bukhtiyarova & Round | 0.40 |
| *Psammothidium helveticum* (Hustedt) Bukhtiyarova & Round | 1.64 |
| *Psammothidium kuelbsii* (Hustedt) Bukhtiyarova & Round | 0.00 |
| *Psammothidium levanderi* (Hustedt) Bukhtiyarova & Round | 0.50 |
| *Psammothidium perpusillum* (Østrup) Lange-Bertalot | 0.06 |
| *Psammothidium rossii* (Hustedt) Bukhtiyarova & Round | 0.01 |
| *Psammothidium scoticum* (Flower & V.J.Jones) Bukhtiyarova & Round | 0.01 |
| *Psammothidium* sp. 1 | |
| *Psammothidium* sp. 2 | 0.26 |
| *Psammothidium subatomoides* (Hustedt) Bukhtiyarova & Round | 0.35 |
| *Psammothidium ventrale* (Krasske) Bukhtiyarova & Round | 0.06 |
| *Pseudostaurosira* cf. *alvareziae* | 0.03 |
| *Pseudostaurosira* 'false' *microstriata* | 0.26 |
| *Pseudostaurosira microstriata* (Marciniak) Flower | 0.06 |
| *Pseudostaurosira opacolineata* (Lange-Bertalot) M.L.García & Maidana | 1.05 |
| *Pseudostaurosira pseudoconstruens* (Marciniak) D.M.Williams & Round | 0.60 |
| *Pseudostaurosira robusta* (Fusey) D.M.Williams & Round | 0.00 |
| *Reimeria sinuata* (W.Gregory) Kociolek & Stoermer | 0.11 |
| *Rhopalodia gibba* (Ehrenberg) O.Müller | 0.08 |
| *Rhopalodia musculus* (Kützing) O.Müller | |
| *Rhopalodia rupestris* (W.Smith) Krammer | 0.18 |
| *Rossithidium kriegeri* (Krasske) Bahls | 0.73 |
| *Rossithidium petersenii* (Hustedt) Round & Bukhtiyarova | 0.55 |
| *Rossithidium pusillum* (Grunow) Round & Bukhtiyarova | 0.81 |
| *Sellaphora absoluta* (Hustedt) Wetzel, Ector, Van de Vijver, Compère & D.G.Mann | 0.02 |

*Table B1 – continued.*

| ***Taxa*** | **Relative abundance** |
|---|---|
| *Sellaphora* cf. *arvensis* | |
| *Sellaphora* cf. *pupula* | |
| *Sellaphora* cf. *seminulum* | |
| *Sellaphora* cf. *vitabundicta* | 0.02 |
| *Sellaphora laevissima* (Kützing) D.G.Mann | 0.02 |
| *Naviculadicta litos* (Hohn & Hellerman) | 0.02 |
| *Sellaphora medioconvexa* (Hustedt) C.E.Wetzel | 0.01 |
| *Sellaphora nigri/atomoides* complex | 2.24 |
| *Sellaphora seminulum* (Grunow) D.G.Mann | 0.17 |
| *Sellaphora* sp. 1 | 0.00 |
| *Sellaphora* sp. 2 | |
| *Skabitschewskia oestrupii* (A.Cleve) Kulikovskiy & Lange-Bertalot | 0.01 |
| *Skabitschewskia peragalloi* (Brun & Héribaud) Kulikovskiy & Lange-Bertalot | |
| *Stauroforma* cf. *inermis* | 0.11 |
| *Stauroforma* cf. *subsalina* | 1.92 |
| *Stauroforma exiguiformis* (Lange-Bertalot) R.J.Flower, V.J.Jones & Round | 2.79 |
| *Stauroneis agrestis* J.B.Petersen | |
| *Stauroneis amphicephala* Kützing | 0.02 |
| *Stauroneis angustilancea* Lange-Bertalot & Metzeltin | |
| *Stauroneis borrichii* (J.B.Petersen) J.W.G.Lund | |
| *Stauroneis* cf. *heinii* | |
| *Stauroneis* cf. *jarensis* | |
| *Stauroneis* cf. *neohyalina* | |
| *Stauroneis* cf. *subgracilis* | |
| *Stauroneis gracilis* Ehrenberg | |
| *Stauroneis leguminopsis* Lange-Bertalot & Krammer | |
| *Stauroneis neohyalina* Lange-Bertalot & Krammer | |
| *Stauroneis producta* Grunow | |
| *Stauroneis reichardtii* Lange-Bertalot, Cavacini, Tagliaventi & Alfinito | 0.02 |
| *Stauroneis siberica* (Grunow) Lange-Bertalot & Krammer | |
| *Stauroneis smithii* Grunow | |
| *Stauroneis* sp. 1 | |
| *Stauroneis* sp. 2 | |
| *Staurosira ambigua* E.Morales, Edlund & Spaulding | 6.10 |
| *Staurosira cf binodis* | 0.00 |
| *Staurosira cf triundulata* | 0.00 |
| *Staurosira construens* Ehrenberg | 0.13 |
| *Staurosira construens* var. *venter* (Ehrenberg) P.B.Hamilton | 0.04 |

*Table B1 – continued.*

| ***Taxa*** | **Relative abundance** |
|---|---|
| *Staurosira* 'false' *venter* | 0.78 |
| *Staurosira neoproducta* (Lange-Bertalot) Chudaev & Gololobova | 0.01 |
| *Staurosira* 'small' *venter* | 0.20 |
| *staurosira* sp. 1 | 0.01 |
| *Staurosira* sp. 2 | 0.11 |
| *Staurosira* sp. 3 | 0.40 |
| *Staurosira tabellaria* (W.Smith) Leuduger-Fortmorel | 0.00 |
| *Staurosirella binodiformis* Van de Vijver | 0.15 |
| *Staurosirella* cf. *lapponica* | 0.05 |
| *Staurosirella jonssoniana* Van de Vijver & Iris Hansen | 0.45 |
| *Staurosirella pavinensis* Tahri, Van de Vijver & Beauger | 0.09 |
| *Staurosirella* sp. 1 | 0.21 |
| *Staurosirella* sp. 2 | |
| *Staurosirella* sp. 3 | 0.15 |
| *Staurosirella* sp. 4 | |
| *Surirella amphioxys* W.Smith | 0.00 |
| *Surirella roba* Leclercq | 0.01 |
| *Surirella* sp. 1 | |
| *Surirella terricola* Lange-Bertalot & E.Alles | 0.01 |
| *Tabellaria fenestrate* (Lyngbye) Kützing | 0.01 |
| *Tabellaria flocculosa* (Roth) Kützing | 1.83 |
| *Tetracyclus emarginatus* (Ehrenberg) W.Smith | |
| *Tryblionella angustata* W.Smith | 0.04 |
| *Ulnaria* sp. | 0.24 |
| *Ulnaria ulna* (Nitzsch) Compère | 0.01 |

# Appendix C: List of samples and sample information

*Table C1. Sampling information and environmental variables for all samples included in this study. Details include the sampling date, locality, geographic coordinates, habitat and sample descriptions, moss species, moisture class (F), altitude, pH, conductivity, and temperature.*

| Sample Number | Date | Locality | coordinates | region description | sample description | Moss species | F | altitude (m) | pH | conduction (µS/m) | temperature (°C) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **ICE23-M-002** | 7.VI.2023 | Valagil River | 65°57'23.2"N 23°06'52.4"W | river flowing rapidly over rocks, forming the Valagil waterfall | mosses (FII) on the waterline, constantly submerged at the waterfall | *Scorpidium scorpioides* | 2 | 38 | 6.02 | 279 | 9.3 |
| **ICE23-M-005** | 8.VI.2023 | Dinjandisheidi | 65°44'19.48"N 23°09'12.15"W | seepage area with running water. Runs through mosses and grasses in Tundra | mosses submerged in a small pool (20x20cm) (FI) was recently covered with snow | *Scapania paludicola* | 1 | 352 | 5.95 | 59 | 2.3 |
| **ICE23-M-007** | 8.VI.2023 | Dinjandisheidi | 65°44'13.95 N 23°09'11.20" W | small pool with shallow bed, elongated with elevated rock edges. Grass and sedge vegetation in pool. Bed is sand and silt | *Sphagnum* (FIV) on the shore of a pool | *Sphagnum* cf *warnstorfii* | 4 | 332 | 5.4 | 56 | 5.1 |
| **ICE23-M-008** | 8.VI.2023 | Dinjandisheidi | 65°35'27.91 N 23°07'10.10 W | lake in wetland with birch forest, running through sedge vegetation. Along the shore *Eleocharis*, crowberry and *Sphagnum* | sphagnum (FIII) | *Sphagnum subnitens* | 3 | 4 | 6.25 | 63 | 8.5 |
| **ICE23-M-010** | 8.VI.2023 | Dinjandisheidi | 65°41'33.07" N 23°11'46.12" W | river on a plateau, fast-flowing through moss and sedge vegetation, bed contains gravel and stones | (FV) mosses on the edge | *Straminergon stramineum* | 5 | 385 | 6.05 | 35 | 3.3 |
| **ICE23-M-012** | 8.VI.2023 | Vestfjardarvegur | 65°56'17.17" N 23°26'15.53 W | fast-flowing stream along the mountainside, a lot of mosses along the edge. Stream over gravel and stones. Little side stream with a small waterfall at the end | moss vegetation (FIII) along slope with streaming water | *Bryum pseudotriquetrum* | 3 | 232 | 6.38 | 66 | 3.8 |

*Table C1 – continued.*

| Sample Number | Date | Locality | coordinates | region description | sample description | Moss species | F | altitude (m) | pH | conduction (µS/m) | temperature (°C) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **ICE23-M-014** | 9.VI.2023 | Vestfjordheidi | 65°54'13.23" N 22° 59'50.46" W | valley to Sudavik Fjord, wide vallley with large waterfalls at the edges. Mountainvalley with Willow and crowberry. Braided streams with plenty of mosses. | sample of Moss (FV) at the edge | *Hylocomium splendens* | 5 | 15 | 6.62 | 35 | 7.9 |
| **ICE23-M-017** | 9.VI.2023 | Hestfjord dal | 65°54'24.76" N 22°59'37.85 W | small stream almost at the end of the valley. Shallow and fast-flowing. Partly with stones and naked bottom, partly with long moss strands | mosses (FII) long strands under water, fast-flowing | *Fontinalis antipyretica* | 2 | 3 | 6.09 | 42 | 5.5 |
| **ICE23-M-018** | 9.VI.2023 | Hestfjord dal | 65°54'25.66" N 22°59'37.38" | stream in valley, through sedge area. *Caltha palustris* on the edge. Mosses and stones in water with a fair amount of silt | sample from mosses in water (FI) | *Scorpidium scorpioides* | 1 | 1 | 6.7 | 48 | 6.5 |
| **ICE23-M-021** | 9.VI.2023 | Mjolfjord dal | 65°53'17.63" N 22°50'54.52 W | other fjord, away from Sudavik. A large and deep lake with silt on the bottom, mosses and grasses at raised edge. | mosses at the edge partly under water (FII) | *Polytrichum commune* | 2 | 5 | 5.35 | 60 | 12.8 |
| **ICE23-M-022** | 9.VI.2023 | Mjolfjord dal | 65°53"14.73"N 22°50'56.40" W | lake with sedge and permanent water. Next to a large lake. In water fine algal mosses. | *Sphagnum* on shore (FIV) | *Sphagnum girgensohnii* | 4 | 0 | 5.48 | 85 | 17.2 |

*Table C1 – continued.*

| Sample Number | Date | Locality | coordinates | region description | sample description | Moss species | F | altitude (m) | pH | conduction (µS/m) | temperature (°C) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **ICE23-M-023** | 9.VI.2023 | Mjolfjord dal | 65°53'11.01" N 22° 50'56.71" W | wide, slow-streaming river over red stone bottom in the stream some mosses under water. Stream is clear but no acceleration. | *Sphagnum* (FIV) on edge | *Sphagnum teres* | 4 | 0 | 5.98 | 35 | 11 |
| **ICE23-M-025** | 9.VI.2023 | Djupvegur Molfjördur | 65°54'41.38" N 22°51'13.16" W | road between 2 fjords. Edge with +/- 500m waterfalls. Falling down from a height of 3m. Wall covered with mosses. Water flows through everywhere. Often some patches of green algae | mosses (FIII) of splash zone next to stream | *Scapania* cf. *irrigua* | 3 | 5 | 5.77 | 52 | 7.5 |
| **ICE23-M-026** | 9.VI.2023 | Djupvegur Molfjördur | 65°54'43.68" N 22°51'12.53" W | same place as W023, +/- 100m further. Bigger waterfall with a high discharge. Completely through mosses surrounded. Below there is a river formed | sample of mosses (FII) in the stream channel | Mixed mosses | 2 | 5 | 5.95 | 56 | 6.6 |
| **ICE23-M-028** | 10.VI.2023 | Steingrimsfjardar heidi | 65°44'23.17" N 22°02'28.94" W | stream that flows next to the road, fast-flowing, meltwater, shallow. Solid bottom with mosses and green algae. Seepage appears between rocks on the slope. | mosses (FII) out of seepage | Mixed mosses | 2 | 251 | 6.15 | 57 | 7.3 |
| **ICE23-M-034** | 10.VI.2023 | Steingrimsfjardar heidi | 65°45'05.28" N 22°10'33.68" W | large lake, bottom out of stones and silt layer. Edges moss tundra vegetation, *Cinclidium* and sedges. | *Philonotis* in lake (FI) | *Fontinalis antipyretica* | 1 | 402 | 6.27 | 32 | 6.3 |
| **ICE23-M-036** | 10.VI.2023 | Steingrimsfjardar heidi | 65°46'31.80" N 22°12'23.27" W | large lake at edge of the road. In moss and sedge vegetation. Some stream. Bottom with large stones | mosses (FVI) in tundra at the lake | *Sanionia uncinata* | 6 | 330 | 6.08 | 52 | 6.3 |

*Table C1 – continued.*

| Sample Number | Date | Locality | coordinates | region description | sample description | Moss species | F | altitude (m) | pH | conduction (µS/m) | temperature (°C) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **ICE23-M-038** | 11.VI.2023 | XXXX | 65°46'53.26"N 22°35'22.45"W | pool with flow, 2m wide, shallow with mosses and green algae. | mos (FI) floating in water and under water | *Fontinalis antipyretica* | 1 | 1 | 6.17 | 50 | 7.8 |
| **ICE23-M-039** | 11.VI.2023 | Skötufjordur | 65°55'08.09"N 22°48'28.24"W | fjord with waterfalls at the edge. Waterfall flows over mosses. At the base a small stream with dune, silt and mosses | mosses (FII) at base in fast flowing water | Unkown moss species | 2 | 15 | 6.54 | 69 | 8.4 |
| **ICE23-M-041** | 11.VI.2023 | Skötufjordur | 65°55'08.09"N 22°48'28.24"W | fjord with waterfalls at the edge. Waterfall flows over mosses. At the base a small stream with dune, silt and mosses | mosses (FIV) in spat zone, no flowing water. | *Bryum pseudotriquetrum* | 4 | 13 | 6.54 | 69 | 8.4 |
| **ICE23-M-044** | 11.VI.2023 | Kaldalon | 66°06'54.24"N 22°17'21.13"W | sample +/- 300m further than w039. fast-flowing river from the slope side through moss vegetation. Fine brown silt and algae in current | mosses (FIII) on the edge of little stream, water flows under | *Bryum pseudotriquetrum* | 3 | 51 | 6.83 | 29 | 8.5 |
| **ICE23-M-051** | 11.VI.2023 | Kaldalon | 66°05'52.85"N 22°20'21.27"W | river that is flowing into a lake over rocks and mosses. Fast-flowing | mosses (FI) from river | *Brachythecium rivulare* | 1 | 6 | 6.88 | 66 | 9.2 |
| **ICE23-M-055** | 11.VI.2023 | Latraberg | 65°33'16.59"N 24°11'55.82"W | descent of the plateau. Large waterfall with a lot of mosses. A small stream flows out and forms a little pool. | mosses (FI) from a waterfall of several meters high | *Hygrohypnum* cf. *ochraceum* | 1 | 134 | 6.83 | 80 | 5.3 |
| **ICE23-M-059** | 11.VI.2023 | Kleifaheidi | 65°30'54.17" N 23°42'45.06"W | large pool (25x15m) probably with melt water. Bottom of mosses, grasses and stones. | mosses (FI) submerged | *Cephaloziella* cf. *divaricata* | 1 | 389 | 6.56 | 109 | 7.3 |
| **ICE23-M-060** | 11.VI.2023 | Kleifaheidi | 65°30'54.17" N 23°42'45.06"W | large pool (25x15m) probably with melt water. Bottom of mosses, grasses and stones. | mosses (FIII) at outflow of pool, slow current | *Sanionia uncinata* | 3 | 389 | 6.56 | 109 | 7.3 |
| **ICE23-W-001** | 7.VI.2023 | Valagil River | 65°57'23.2"N 23°06'52.4"W | flowing rapidly over rocks, forming the Valagil waterfall | Sample from the bottom of a pool formed by the river. Pebbles and fine gravel on the bottom. | | | 38 | 6.02 | 279 | 9.3 |

*Table C1 – continued.*

| Sample Number | Date | Locality | coordinates | region description | sample description | Moss species | F | altitude (m) | pH | conduction (µS/m) | temperature (°C) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **ICE23-W-003** | 8.VI.2023 | Dinjandisheidi | 65°44'21,67"N 23°09'09.12"W | tundra with rocks, scattered patches of moss vegetation. Little pools through which the water flows. shallow pools with moss vegetation and grasses on the bottom, full vegetation at the edge | A scraping sample from the bottom | | | 339 | 5.3 | 53 | 6 |
| **ICE23-W-005** | 8.VI.2023 | Dinjandisheidi | 65°44'19.48"N 23°09'12.15"W | seepage area with running water. Runs through mosses and grasses in Tundra | moss-covered bottom with silt. Scraping of some mosses | | | 352 | 5.95 | 59 | 2.3 |
| **ICE23-W-006** | 8.VI.2023 | Dinjandisheidi | 65°44'16.66"N 23°09'9.11" W | lake partly covered with ice. Large and elongated (25x10m). Very deep (bed couldn't be seen) | scraping sample of bottom with gravel, lays between 2 edges of rocks, snow on 1 side | | | 334 | 5.48 | 30 | 3 |
| **ICE23-W-007** | 8.VI.2023 | Dinjandisheidi | 65°44'14.34" 23°09'5.81 W | little pool (10x8m) with bed of rocks | scraping sample between pebbles and stones | | | 332 | 5.52 | 45 | 7.1 |
| **ICE23-W-008** | 8.VI.2023 | Dinjandisheidi | 65°44'14.34" 23°09'5.81 W | bed of slippy substrate | little pool +/- 5m of lake with | | | 332 | 5.9 | 184 | 5.9 |
| **ICE23-W-009** | 8.VI.2023 | Dinjandisheidi | 65°44'13.95 N 23°09'11.20" W | small pool with shallow bed, elongated with elevated rock edges. Grass and sedge vegetation in pool. Bed of sand and sediment | scraping sample of bottom in a small stream | | | 332 | 5.4 | 56 | 5.1 |
| **ICE23-W-011** | 8.VI.2023 | Dinjandisheidi | 65°41'33.07" N 23°11'46.12" W | river on a plateau, fast-flowing through moss and sedge vegetation, bed of gravel and stones | scraped of stones with fine silt | | | 385 | 6.05 | 35 | 3.3 |
| **ICE23-W-012** | 8.VI.2023 | Vestfjardarvegur | 65°56'17.17" N 23°26'15.53 W | fast-flowing stream along the mountainside, a lot of mosses along the edge. Stream over gravel and stones. Little side stream with a small waterfall at the end | gravel and sediment from little pool | | | 232 | 6.38 | 66 | 3.8 |

*Table C1 – continued.*

| Sample Number | Date | Locality | coordinates | region description | sample description | Moss species | F | altitude (m) | pH | conduction (µS/m) | temperature (°C) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **ICE23-W-013** | 9.VI.2023 | Vestfjordheidi | 65°54'13.23" N 22° 59'50.46" W | valley to Sudavik Fjord, wide vallley with large waterfalls at the edges. Mountainvalley with Willow and crowberry. Braided streams with plenty mosses. | scraping sample of rocky riverbed with many patches of algae | | | 15 | 6.62 | 35 | 7.9 |
| **ICE23-W-014** | 9.VI.2023 | Vestfjordheidi | 65°54'14.74 N 22°59'55.34" W | Depression in rocks. Water in two pools, sample taken from smaller pool. | scraping sample from pool with mud and moss fragment | | | 15 | 5.99 | 148 | 7.2 |
| **ICE23-W-016** | 9.VI.2023 | Hestfjord dal | 65°54'17.52" N 23°00'4.14" w | very wide river from big waterfall and fast-flowing above rocks | scraping sample from slower flowing water. | | | 22 | 6.16 | 19 | 6.4 |
| **ICE23-W-019** | 9.VI.2023 | Hestfjord dal | 65°54'25.58" N 22°59'34.18" W | small stream small +/- 30cm wide. Shallow, flowing, sedges along the edge, mosses in the water. Clear presence of slime | sample of slime in little stream | | | 2 | 5.91 | 97 | 9.8 |
| **ICE23-W021** | 9.VI.2023 | Mjolfjord dal | 65°53"14.73" N 22°50'56.40" W | lake with sedge and permanent water. Next to a large lake. In water fine algal mosses. | algal muck from between sedges. | | | 0 | 5.48 | 85 | 17.2 |
| **ICE23-W-022** | 9.VI.2023 | Mjolfjord dal | 65°53'11.01" N 22° 50'56.71" W | wide, slow-streaming river over red stone bottom in the stream some mosses under water. Stream is clear but no acceleration. | scraping sample of red bottom | | | 0 | 5.98 | 35 | 11 |
| **ICE23-W-023** | 9.VI.2023 | Djupvegur Molfjördur | 65°54'41.38" N 22°51'13.16" W | road between 2 fjords. Edge with +/- 500m waterfalls. Falling down from a height of 3m. Wall covered with mosses. Water flows through everywhere. Often some patches of green algae | slime algae | | | 5 | 5.77 | 52 | 7.5 |
| **ICE23-W-024** | 9.VI.2023 | Djupvegur Molfjördur | 65°54'43.68" N 22°51'12.53" W | same place as W023, +/- 100m further. Bigger waterfall with a high discharge. Completely through mosses surrounded. Below there is a river formed | scraping sample out of the river | | | 5 | 5.95 | 56 | 6.6 |

*Table C1 – continued.*

| Sample Number | Date | Locality | coordinates | region description | sample description | Moss species | F | altitude (m) | pH | conduction (µS/m) | temperature (°C) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **ICE23-W-026** | 10.VI.2023 | Steingrimsfjardar heidi | 65°44'23.17" N 22°02'28.94" W | stream that flows next to the road, fast-flowing, meltwater, shallow. Solid bottom with mosses and green algae. Seepage appears between rocks on the slope. | sample of silt of seepage | | | 251 | 6.15 | 57 | 7.3 |
| **ICE23-W-027** | 10.VI.2023 | Steingrimsfjardar heidi | 65°44'26.00" N 22°02'31,44" W | large river, fast-flowing over blocks of rocks. Occasional mosses on rocks. At edge seepages | scraping samples out of the river | | | 244 | 6.3 | 34 | 8.5 |
| **ICE23-W-028** | 10.VI.2023 | Steingrimsfjardar heidi | 65°44'26.00" N 22°02'31,44" W | large river, fast-flowing over blocks of rocks. Occasional mosses on rocks. At edge seepages | scraping sample of seepage | | | 244 | 6.39 | 109 | 8.4 |
| **ICE23-W-030** | 10.VI.2023 | Steingrimsfjardar heidi | 65°45'00.08" N 22°10'25.90" W | moss tundra with pools. Partly of meltwater, bottom mostly with mosses, grasses and gravel. Shallow zone. | sample of the ground of a pool | | | 410 | 6.12 | 50 | 5.4 |
| **ICE23-W-031** | 10.VI.2023 | Steingrimsfjardar heidi | 65°45'01.65" N 22°10'19.66" W | river on plateau where the other road continues. Very fast-flowing above rocks. every stone is coated with fine silt. | Scraped off with a toothbrush, just after the fast-flowing section. | | | 403 | 6.14 | 28 | 6.4 |
| **ICE23-W-033** | 10.VI.2023 | Steingrimsfjardar heidi | 65°46'36.48" N 22°12'20.55" W | same plateau 5km further, large river, fast-flowing and shallow. Stones covered with silt. | scraping sample of river stones, fine silt | | | 370 | 6.76 | 40 | 6.4 |
| **ICE23-W-034** | 10.VI.2023 | Steingrimsfjardar heidi | 65°46'31.80" N 22°12'23.27" W | large lake at edge of the road. In moss and sedge vegetation. Some flow. Bottom with large stones | scraping sample of stones in lake | | | 330 | 6.08 | 52 | 6.3 |
| **ICE23-W-035** | 10.VI.2023 | XXXX | 65°46'52.55" N 22°35'31.83" W | fjord next to plateau. Very wide valley with a lot of braided rivers. Vegetation: willow, sedge, crowberry and mosses. Small stream over vegetation, possible meltwater. | scraping sample of stones in small river | | | 0 | 6.07 | 44 | 7.7 |

*Table C1 – continued.*

| Sample Number | Date | Locality | coordinates | region description | sample description | Moss species | F | altitude (m) | pH | conduction (µS/m) | temperature (°C) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **ICE23-W-037** | 11.VI.2023 | Skötufjordur | 65°55'08.09" N 22°48'28.24" W | fjord with waterfalls at the edge. Waterfall flows over mosses. At the base a small stream with dune, silt and mosses | scraping sample of silt on stones in small river on the base. | | | 15 | 6.55 | 69 | 10.3 |
| **ICE23-W-039** | 11.VI.2023 | Kaldalon | 66°07'01.82" N 22°17'18.55" W | sample +/- 200m further than w038. fast-flowing shallow river on stones and rocks. In river algae in the current. Slightly milky water flowing from a large snowfield | scraping sample of algae of the bottom | | | 54 | 6.9 | 15 | 7.6 |
| **ICE23-W-040** | 11.VI.2023 | Kaldalon | 66°06'54.24" N 22°17'21.13" W | sample +/- 300m further than w039. fast-flowing river from the slope side through moss vegetation. Fine brown silt and algae in current | scraping sample of silt out of the bed | | | 51 | 6.83 | 29 | 8.5 |
| **ICE23-W-043** | 11.VI.2023 | Kaldalon | 66°06'27.09" N 22°18'12.50" W | fast-flowing very shallow, braided river. Flows over stones and rocks. Occasionally moss patches. | scraping sample of fast-flowing part. Fine silt on stones | | | 23 | 6.89 | 29 | 9.2 |
| **ICE23-W-044** | 11.VI.2023 | Kaldalon | 66°06'16.10" N 22°18'35.74" W | Still pool among rocks and willow vegetation. On bottom a thick layer of plant material. Probably melt water. Plants on bottom sediment (silt) | scraping sample of sediment (silt) | | | 15 | 6.81 | 46 | 14.7 |
| **ICE23-W-046** | 11.VI.2023 | Kaldalon | 66°06'01.58" N 22°19'15.24" W | series of small pools where water flows through. Still water in pools. Surrounded by vegetation, on bed fine red silt. | scraping sample of red silt | | | 10 | 6.4 | 58 | 12 |
| **ICE23-W-048** | 11.VI.2023 | Kaldalon | 66°05'52.85" N 22°20'21.27" W | almost at end moraine, between 2 lakes, lake 100mx10, very shallow, stones on the bottom with silt. | scraping sample of stones | | | 6 | 6.42 | 66 | 11.2 |
| **ICE23-W-050** | 11.VI.2023 | Kaldalon | 66°05'47.84" N 22°20'52.30" W | fast-flowing stream with next to it a smaller stream (20cm wide). Stream is shallow over stone, the small stream is shallow and over silt. | scraping sample from stream, pebbles with silt | | | 4 | 6.64 | 64 | 9 |

*Table C1 – continued.*

| Sample Number | Date | Locality | coordinates | region description | sample description | Moss species | F | altitude (m) | pH | conduction (µS/m) | temperature (°C) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **ICE23-W-052** | 11.VI.2023 | Latraberg | 65°32'20.66" N 24°21'19.66" W | plateau with tundra, here and there lakes and pools. Large lake (30x8m), quite deep in moss tundra. Stones with silt on the bottom | scraping sample from stones in lake | | | 93 | 6.52 | 90 | 10.1 |
| **ICE23-W-054** | 11.VI.2023 | Latraberg | 65°32'25.59" N 24°21'24,84" W | temporary pool on grassland. A lot of grasses in water and on the bottom, stone-poor | scraping sample out of grass vegetation on bottom | | | 88 | 6.82 | 99 | 10.7 |
| **ICE23-W-055** | 11.VI.2023 | Latraberg | 65°32'26.94" N 24°21'10.11" W | large lake, 100x50m, quite deep. Bottom with rocks, stones and grasses. Vegetation with crowberry, butterwort, *Polygonum*, grasses and mosses, very few *Sphagnum*. | scraping sample of stones from bottom | | | 8 | 6.63 | 109 | 10.7 |
| **ICE23-W-058** | 11.VI.2023 | Kleifaheidi | 65°31'30.82" N 23°44'12.05" W | fast-flowing river at the statue. Flows over stones, mosses on stones. | scraping sample of stones in current | | | 331 | 6.57 | 47 | 7.4 |

# Appendix D: Images & Figures

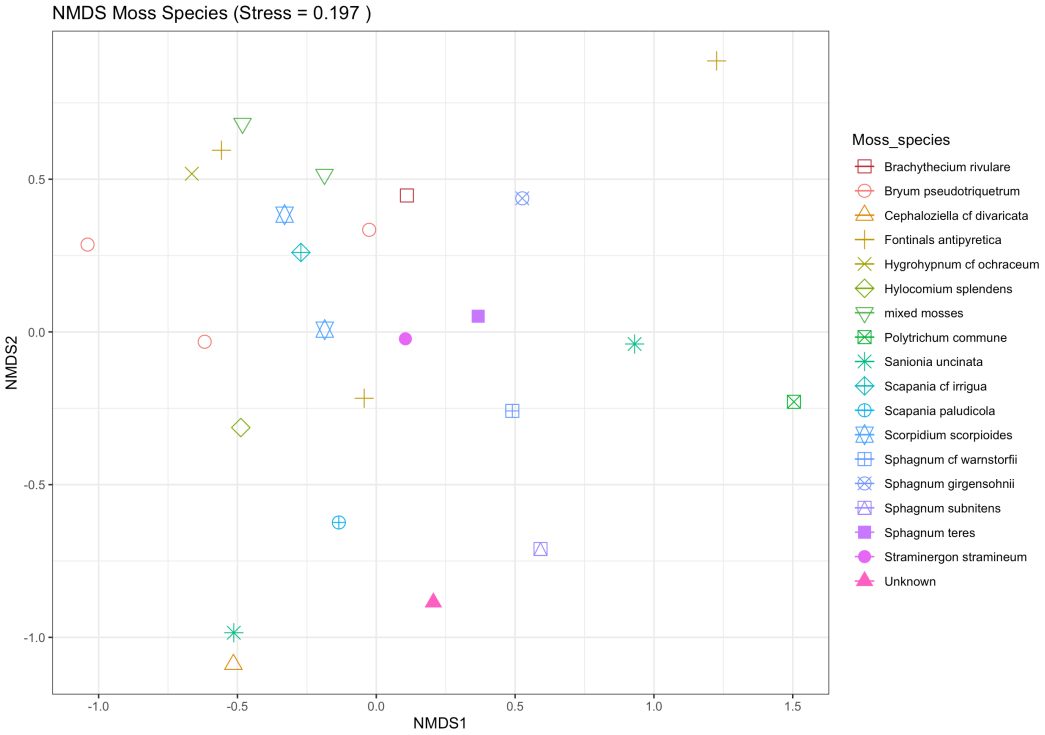



*Figure D1: Non-metric multidimensional scaling (NMDS) ordination of diatom communities associated with different moss species. Each point represents a sample and symbols indicate the moss species on which the sample was collected. The ordination is based on Bray-Curtis dissimilarities.*

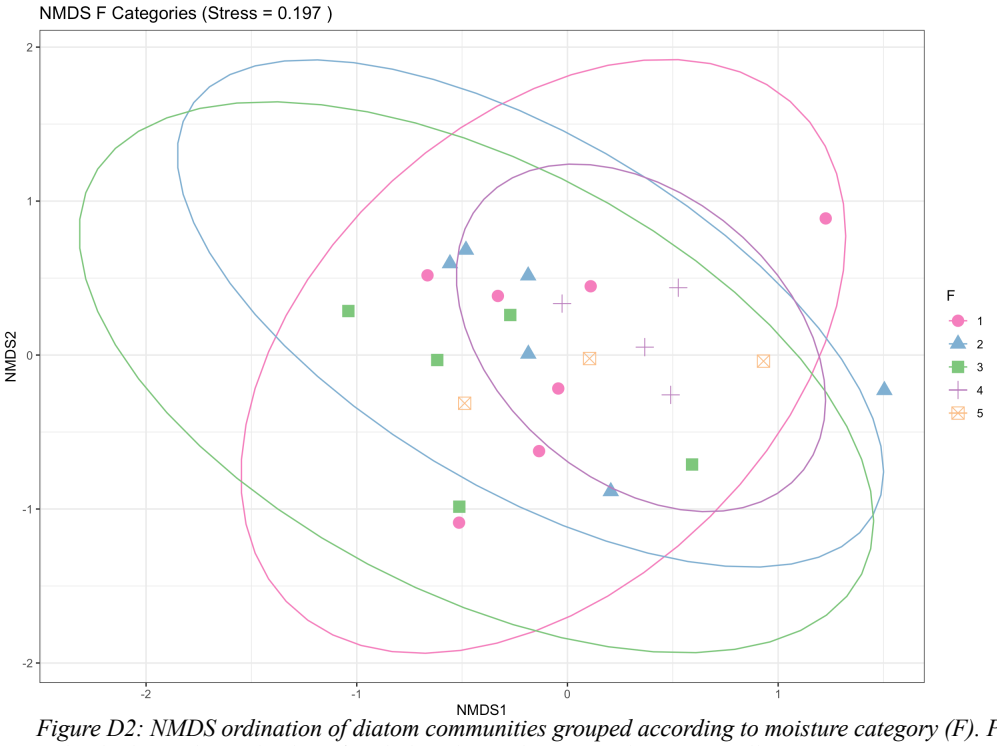



*Figure D2: NMDS ordination of diatom communities grouped according to moisture category (F). Points represent individual samples and colours/symbols indicate the assigned category. Ellipses represent 95% confidence intervals around group centroids.*

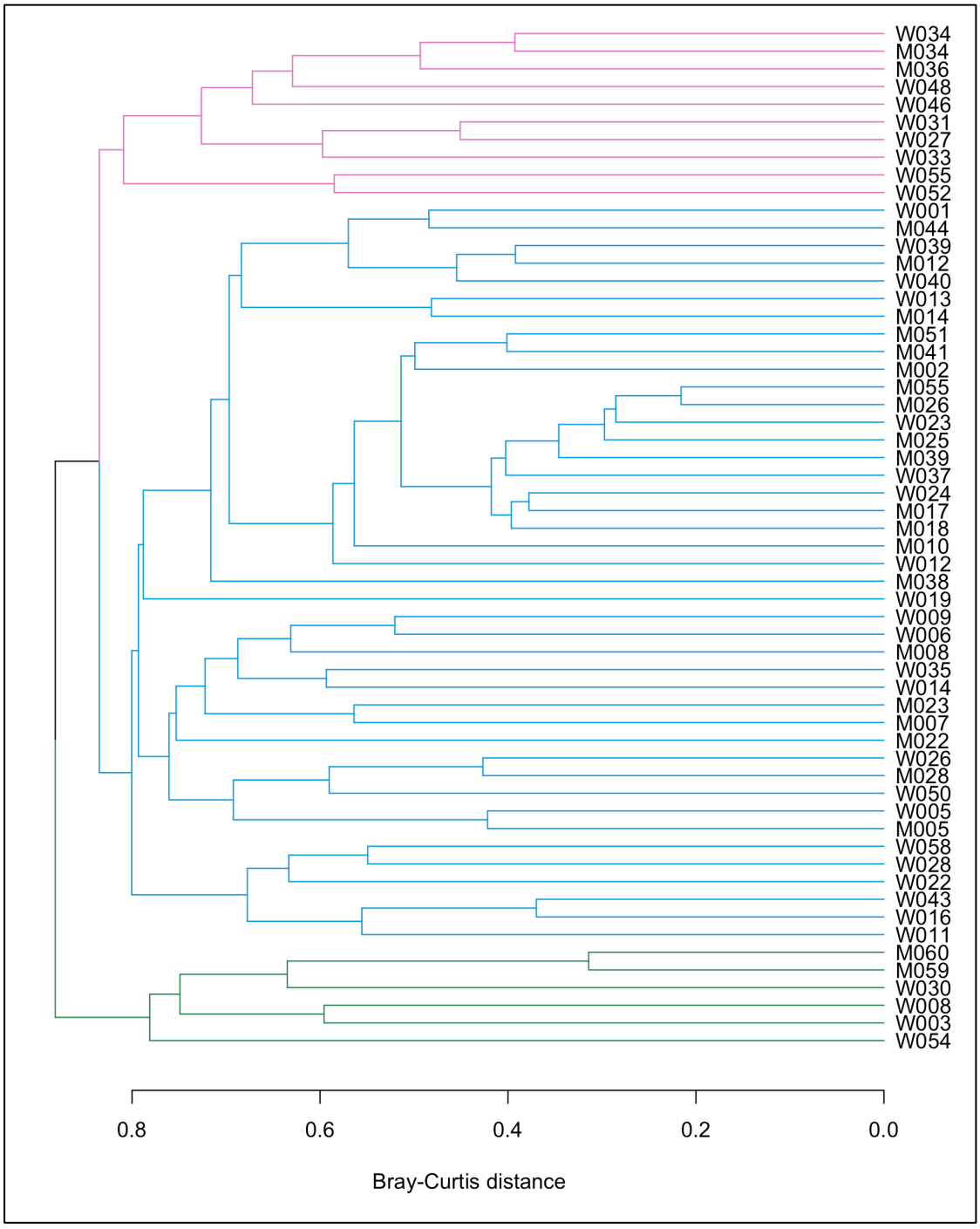



*Figure D3: Hierarchical clustering of diatom assemblages based on Bray-Curtis dissimilarity after exclusion of outlier samples. Three groups were identified (clusters 1, 2 and 3), represented by coloured branches. Branch lengths reflect the degree of dissimilarity between samples.*

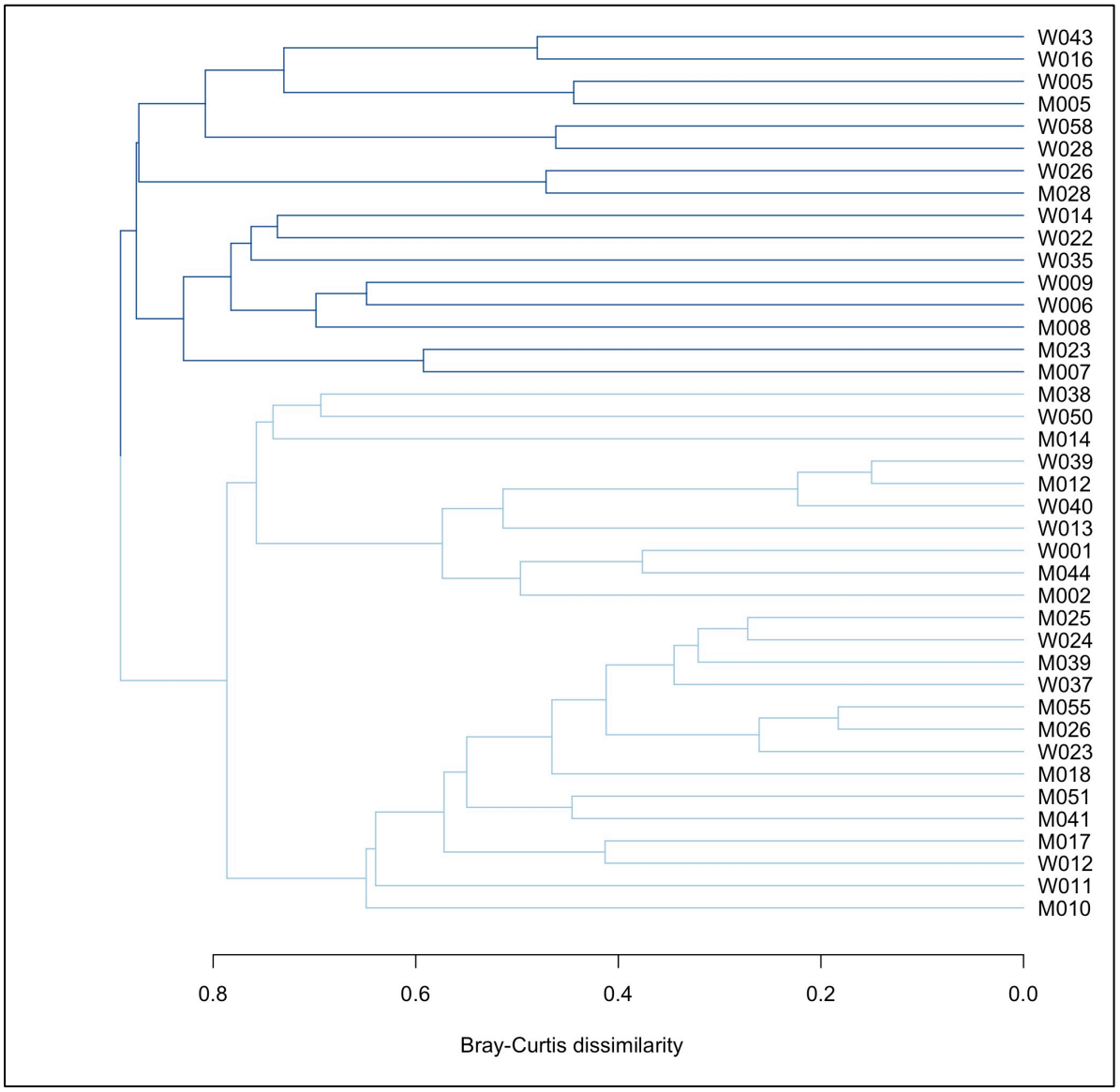



*Figure D4: Hierarchical clustering of diatom assemblages based on Bray-Curtis dissimilarity after exclusion of outlier samples. Two subgroups were identified (subclusters 1A and 1B), represented by coloured branches (Light blue and dark blue). Branch lengths reflect the degree of dissimilarity between samples.*

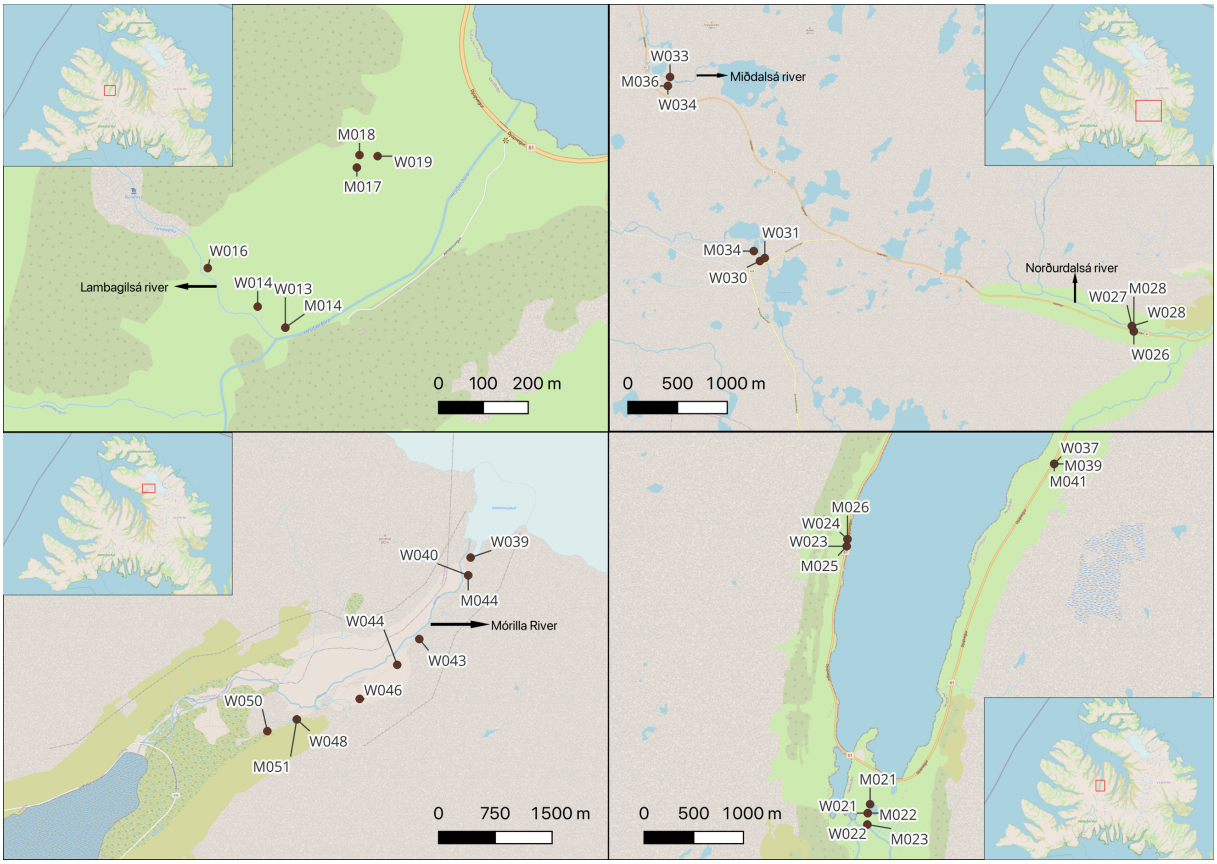



*Figure D5: Detailed maps of four sampling site clusters in the Westfjords, Iceland. Sampling locations situated in close proximity are shown together and labelled according to their sample code. The rivers associated with each cluster are indicated where applicable. Insets show the position of each cluster within the study area.*




*Figure D6. Representative examples of four habitat types sampled in this study: (a) seepage, (b) stream, (c) pool, and (d) moss. The white sample bottle used for collecting the samples is visible in each photograph. River and waterfall habitats, which were also sampled, are not shown.*

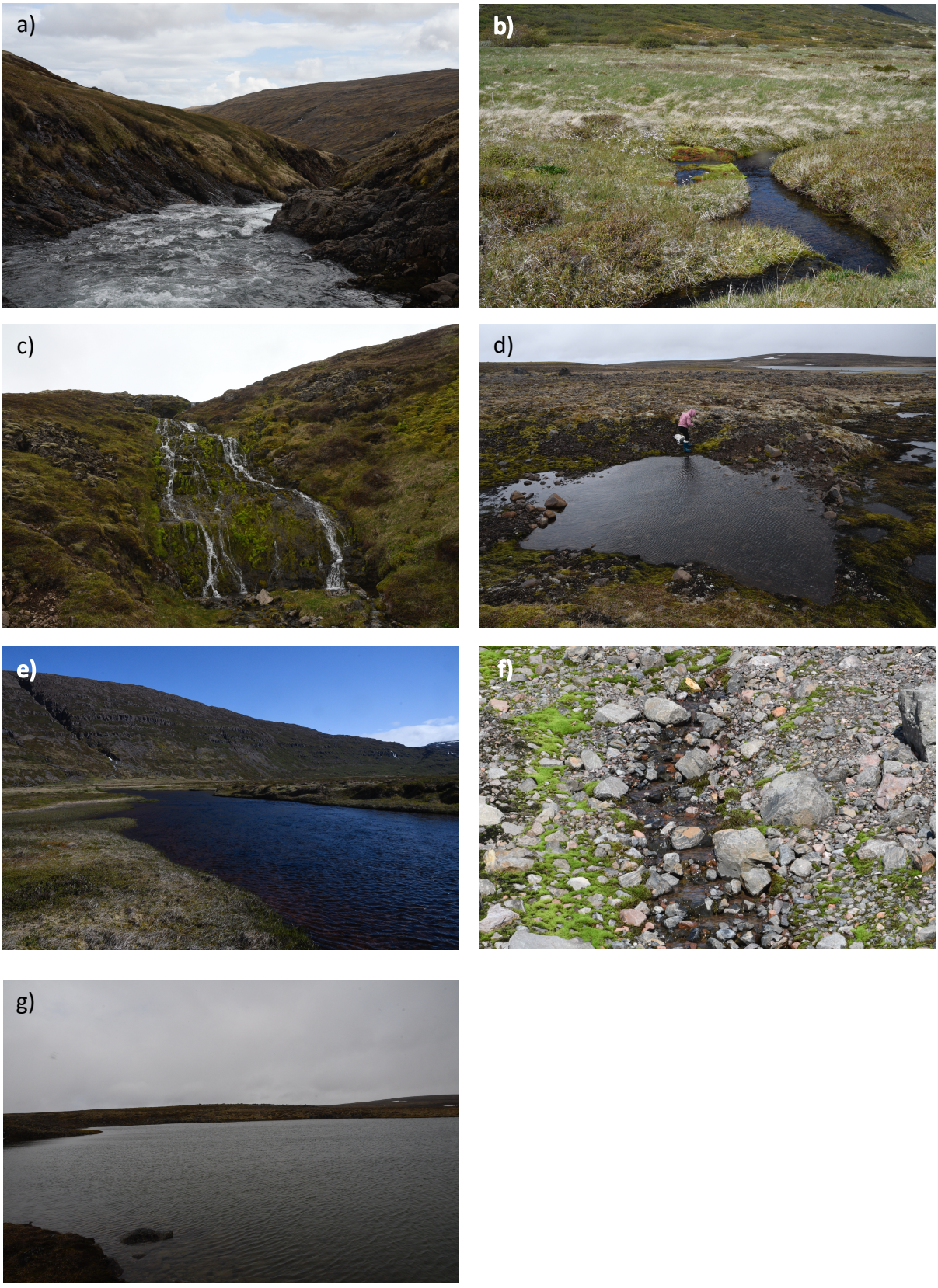



*Figure D7: Representative examples of the seven habitat types sampled in the Westfjords, Iceland: a) fast-flowing-river, b) stream, c) waterfall, d) pool, e) slow flowing river, f) seepage, and g) lake.*

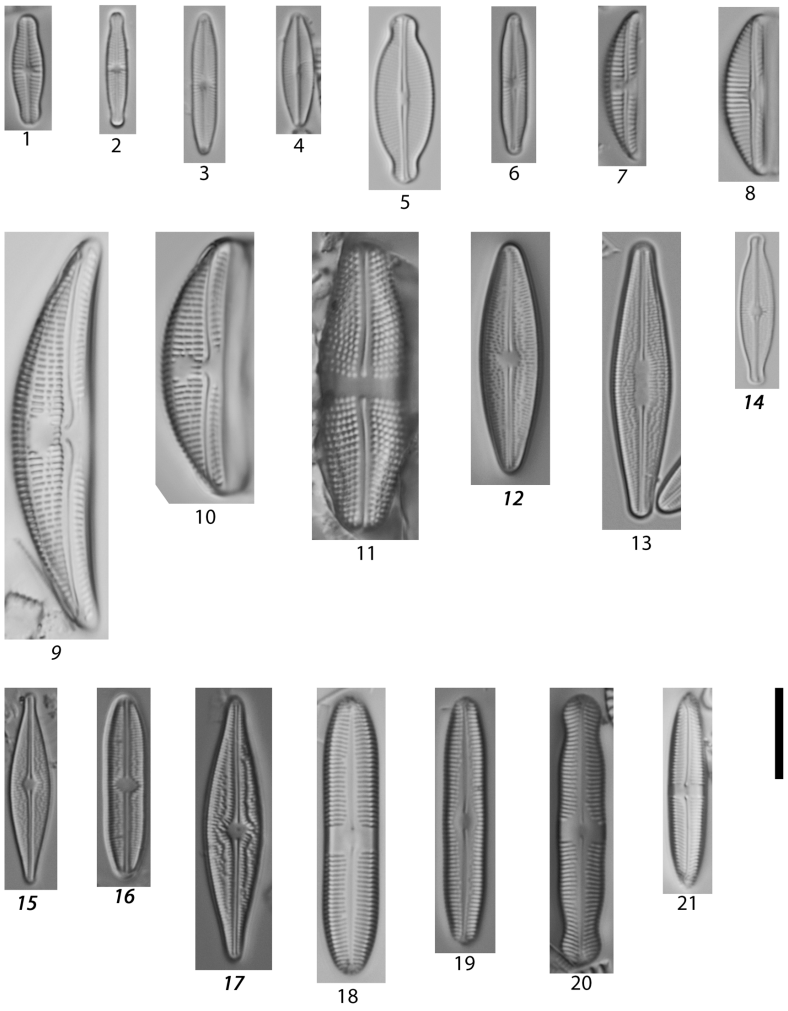



*Figure D8: LM images of observed taxa in this study (1000x). 1)* Achnanthidium modestiforme*, 2)* Achnanthidium minutissimum*, 3)*Adlafia suchlandtii*, 4)* Adlafia minuscula*, 5)* Adlafia detenta*, 6)* Adlafia bryophila*, 7)* Amphora inariensis*, 8)* Amphora parallelistriata*, 9)* Amphora lange-bertalotii*, 10)* Amphora copulata *11)* Achnanthes coarcata*, 12)* Brachysira confusa*, 13)* Brachysira decipiens*, 14)* Brachysira neoexilis*, 15)* Brachysira microcephala*, 16)* Brachysira zellensis*, 17)* Brachysira elisabethiana*, 18)* Caloneis *sp.3, 19)* Caloneis tenuis*, 20)* Caloneis undulata*, 21)* Caloneis *sp1. Scale bar = 10 µm*

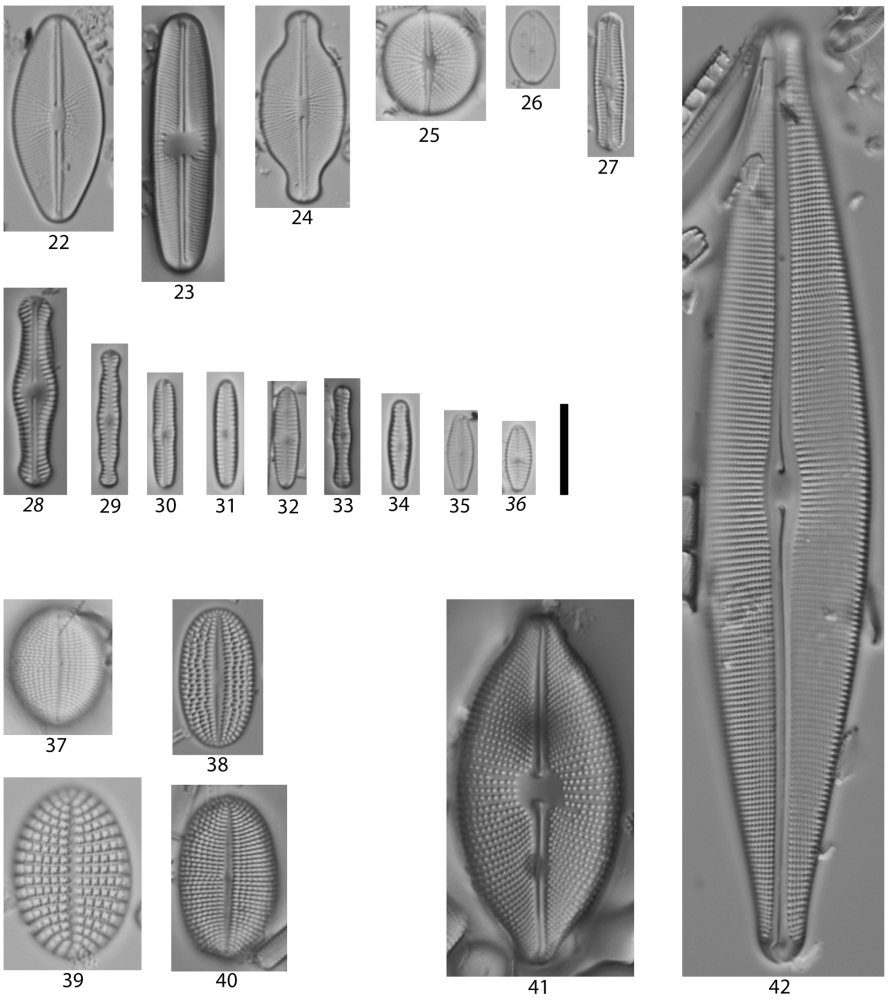



*Figure D9: LM images (1000x) 22)* Cavinula cocconeiformis, *23*) Cavinula variostriata, *24)* Cavinula pusio, *25)* Cavinula pseudoscutiformis, *26)* Cavinula mollicula, *27)* Chamaepinnularia grandrupii, *28)* Chamaepinnularia krookii, *29)* Chamaepinnularia soehrensis, *30)* Chamaepinnularia mediocris, *31)* Chamaepinnularia begeri, *32)* Chamaepinnularia *sp. 1, 33)* Chamaepinnularia *cf.* hassiaca, *34)* Chamaepinnularia hassiaca, *35)* Chamaepinnularia evanida, *36)* Chamaepinnularia obsoleta, *37)* Cocconeis *sp. 1, 38)* Cocconeis *sp. 2, 39)* Cocconeis scutellum, *40)* Cocconeis fetcheriana, *41)* Cosmioneis pussila, *42)* Craticula acidoclinatum. *Scale bar = 10µm.*

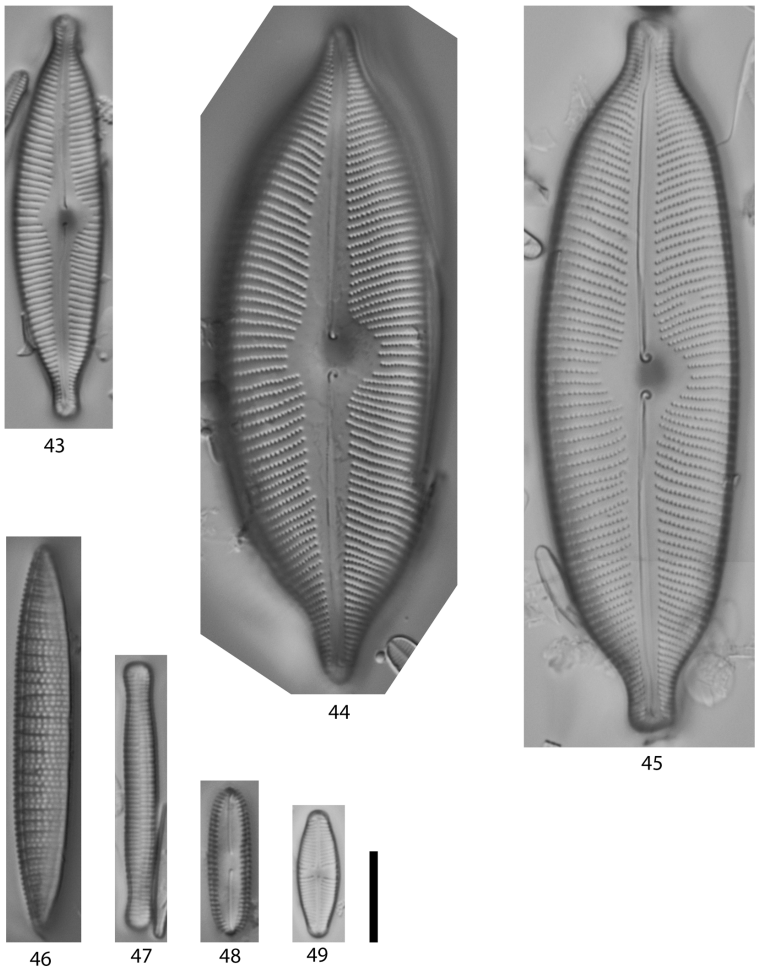



*Figure D10: LM images (1000x). 43)* Cymbopleura naviculiformis*, 44)* Cymbopleura apiculatea*, 45)* Cymbopleura subcuspidata*, 46)* Denticula kuetzingii*, 47)* Diatoma tenuis*, 48)*Diatomella balfouriana*, 49)* Dickieia tackei*.*
*Scale bar = 10µm.*

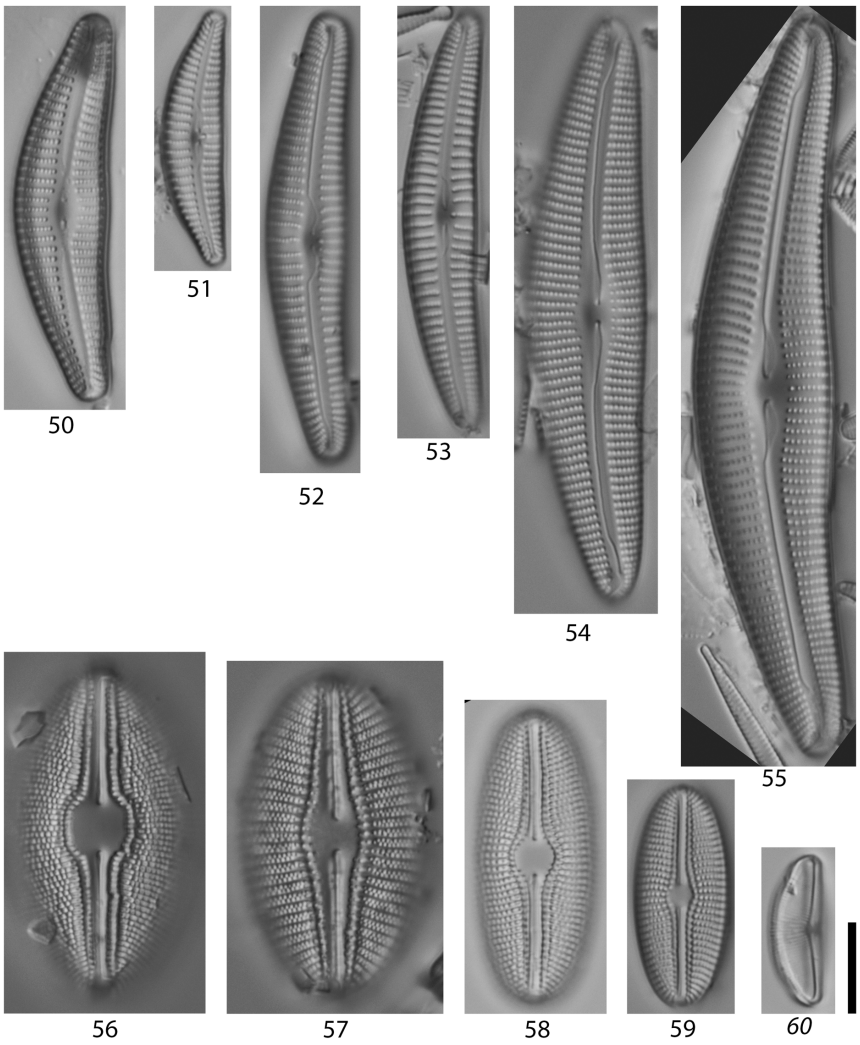



*Figure D11: LM images (1000x). 50)* Cymbella *cf.* cymbiformis, *51)* Cymbella excisiformis, *52)* Cymbella *sp., 53)* Cymbella *cf. vulgata, 54)* Cymbella cymbiformis, *55)* Cymbella lange-bertalotii, *56)* Diploneis ovalis, *57)* Diploneis dilatatafalsa, *58)* Diploneis ultimathule, *59) Diploneis* calcifuga, *60)* Eucocconeis *sp. Scale bar = 10µm.*

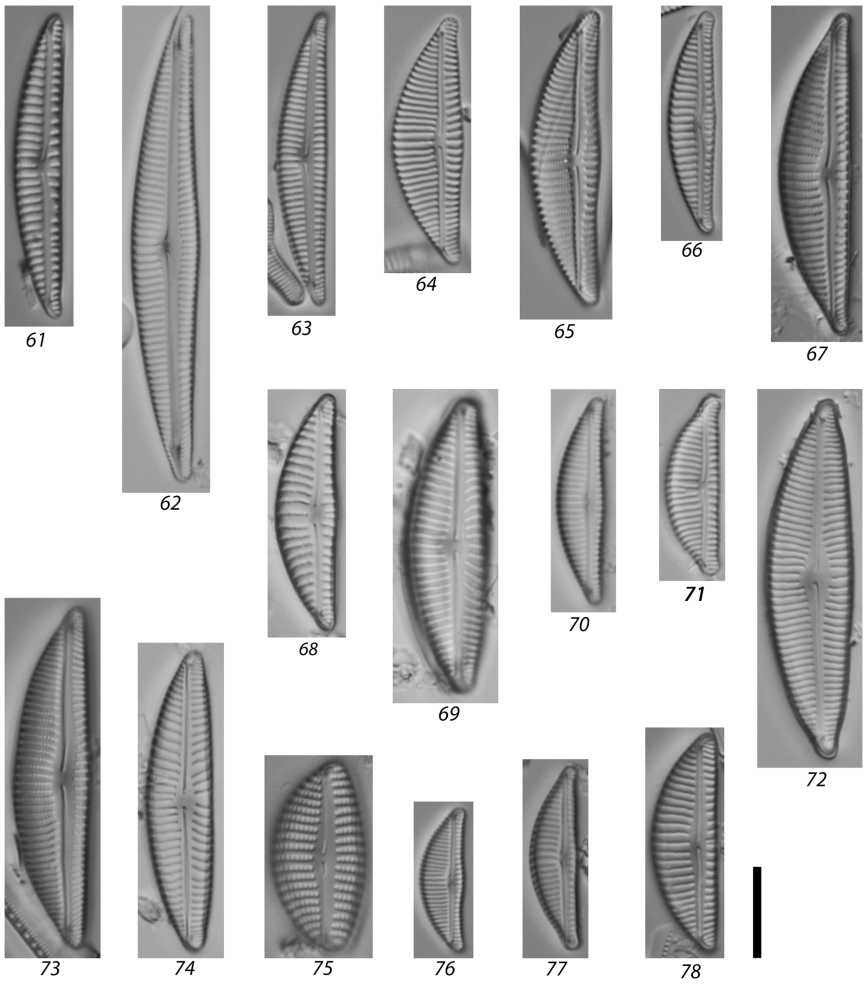



*Figure D12: LM images (1000x). 61)* Encyonema lunatum, *62)* Encyonema pergracile, *63)* Encyonema neogracile, *64)* Encyonema silesiacum, *65)* Encyonema vulgare, *66)* Encyonema simile, *67)* Encyonema jemtlandicum, *68)* Encyonema *sp. 2, 69)* Encyonema *sp. 3, 70)* Encyonema *sp. 4, 71)* Encyonema *sp. 5, 72)* Encyonema elginense, *73)* Encyonema *norvegicum, 74)* Encyonema *sp. 1, 75)* Encyonema cespitosum, *76)* Encyonema minutum, *77)* Encyonema brevicapitatum, *78)* Encyonema silesiacum *s.l. Scale bar = 10µm.*

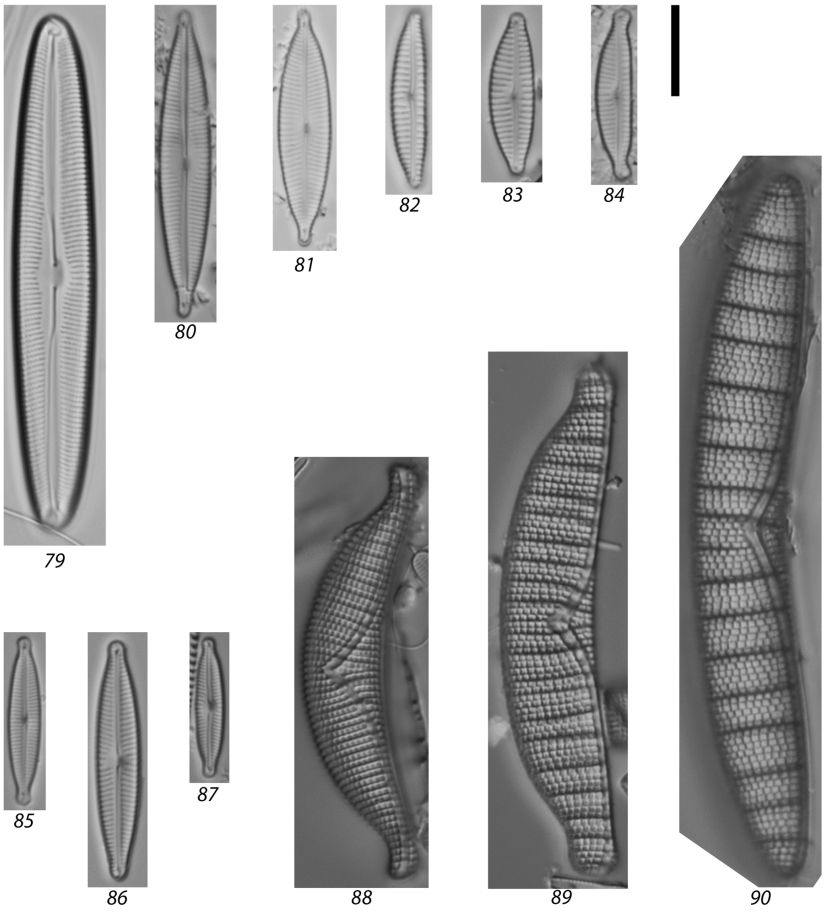



*Figure D13: LM images (1000x). 79)* Encyonopsis grunowii, *80)* Encyonopsis cesatii, *81)* Encyonopsis *cf* descripta, *82)* Encyonopsis *sp. 1, 83)* Encyonopsis *sp. 2, 84)* Encyonema gaeumanii, *85*) Encyonopsis subminuta, *86)* Encyonopsis falaisensis, *87)* Encyonopsis *cf* tavirana, *88)* Epithemia sorex, *89*) Epithemia adnata, *90)* Epithemia argus. *Scale bar = 10µm.*

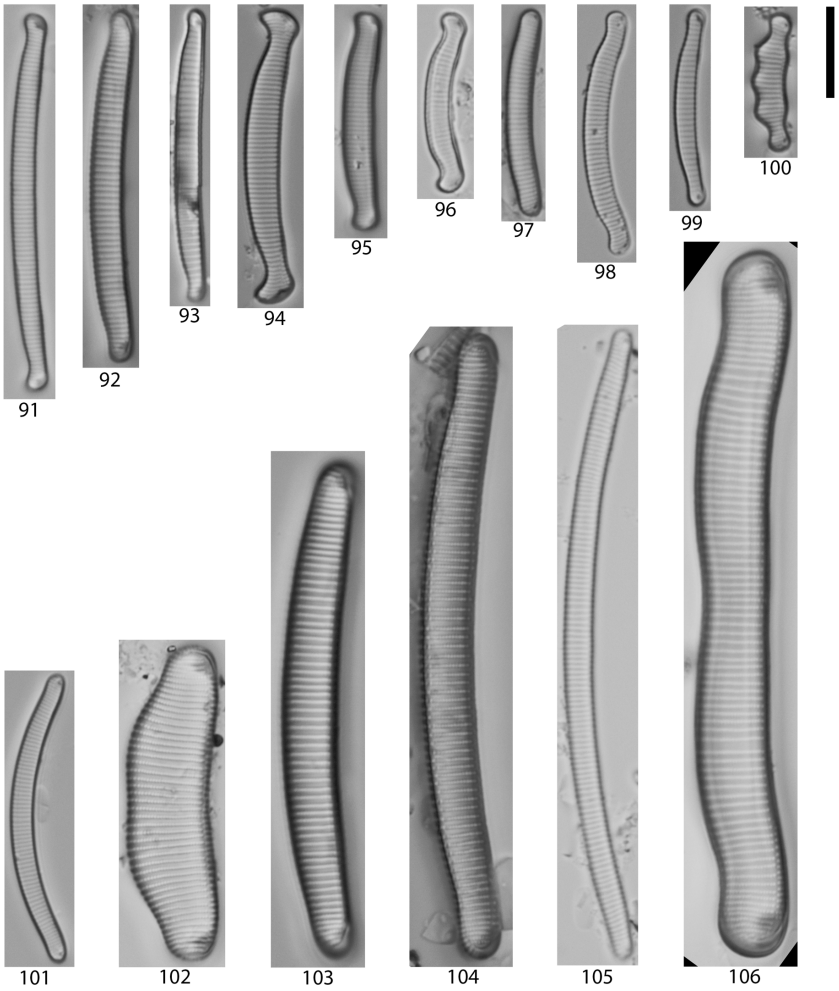



*Figure D14: LM images (1000x). 91)* Eunotia zackenbergensis*, 92)* Eunotia *cf* zackenbergensis*, 93)* Eunotia groenlandica*, 94)* Eunotia neocompacta*, 95)* Eunotia neocompacta *var.* vixcompacta*, 96)* Eunotia exigua*, 97)* Eunotia botuliformis*, 98)* Eunotia nymanniana*, 99)* Eunotia pseudogroenlandica*, 100)* Eunotia paratridentula*, 101)* Eunotia mucophila*, 102)* Eunotia *sp. 2, 103)* Eunotia valida*, 104)* Eunotia glacialispinosa*, 105)* Eunotia bilunaris*, 106)* Eunotia neoscandinavia*. Scale bar = 10 µm.*

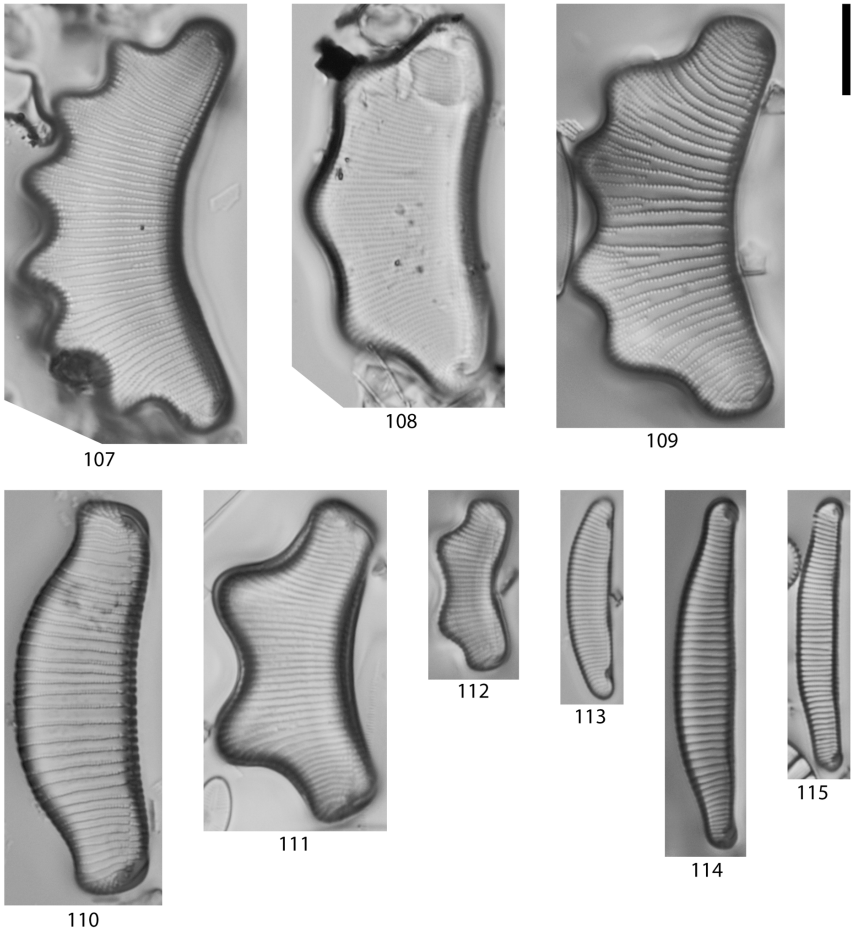



*Figure D15: LM images (1000x). 107)* Eunotia diadema*, 108)* Eunotia triodon*, 109)* Eunotia tetradon*, 110)* Eunotia praerupta*, 111)* Eunotia bigibboidea*, 112)* Eunotia papiliofalsa*, 113)* Eunotia incisa*, 114)* Eunotia minor*, 115)* Eunotia implicata*. Scale bar = 10 µm.*

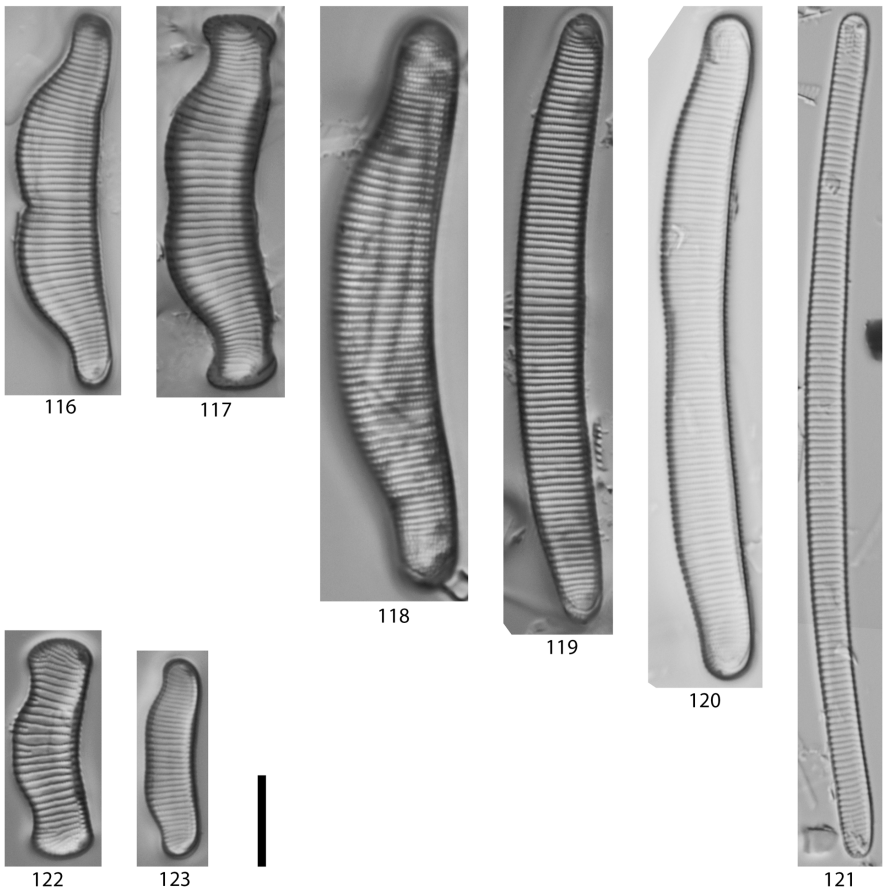



*Figure D16: LM images (1000x). 116)* Eunotia islandicum*, 117)* Eunotia bidens*, 118)* Eunotia metamonodon*, 119)* Eunotia *sp. 3, 120)* Eunotia *sp. 1, 121)* Eunotia *cf* ambivalens*, 122)* Eunotia curtagrunowii*, 123)* Eunotia arcus*. Scale bar = 10 µm.*

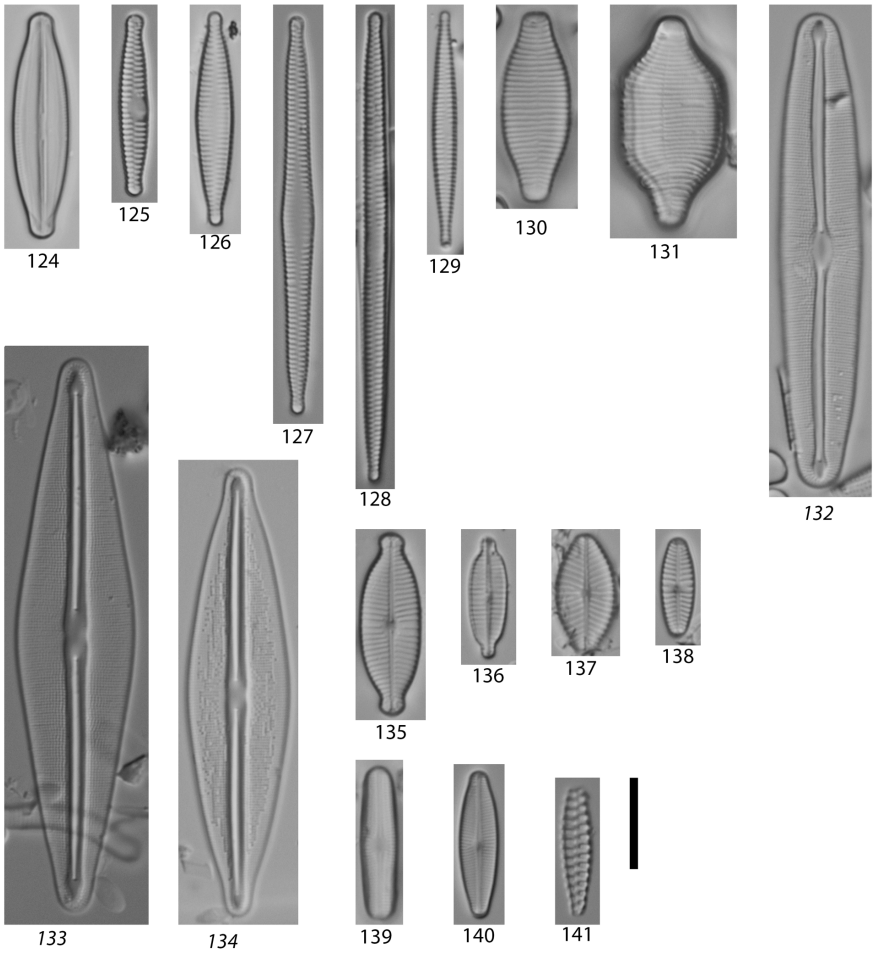



*Figure D17: LM images (1000x). 124)* Fallacia vitrea, *125)* Fragilaria *sp. 1, 126)* Fragilaria *sp. 2 127)* Fragilaria *sp.3, 128)* Fragilaria *cf.* amphicephaloides, *129)* Fragilaria *cf.* acerosa, *130)* Fragilariforma virescens, *131)* Fragilariforma undata, *132)* Frustulia vulgaris, *133)* Frustulia saxonica, *134)* Frustulia crassinervia, *135)* Geissleria similis, *136)* Geissleria *cf.* similis, *137)* Geissleria schoenfeldii, *138)* Geissleria acceptata, *139)* Genkalia digituloides, *140)* Genkalia digitulus, *141)* Gedaniella *sp. Scale bar = 10 µm.*

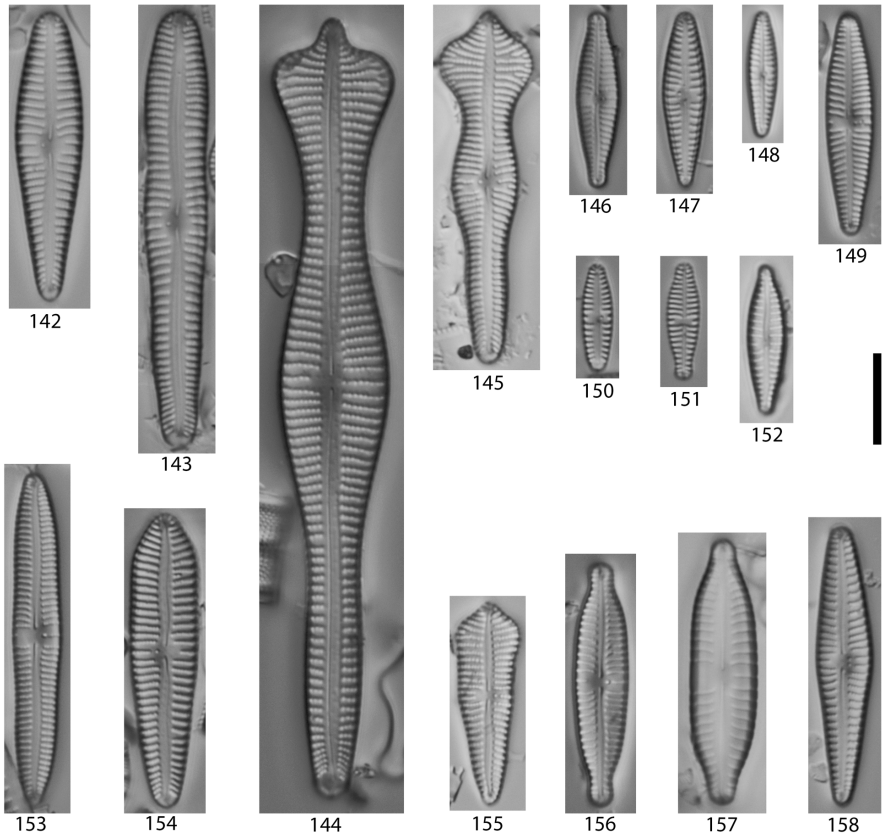



*Figure D18: LM images (1000x). 142)* Gomphonema commutatum*, 143)* Gomphonema montanum*, 144)* Gomphonema coronatum*, 145)* Gomphonema acuminatum*, 146)* Gomphonema *sp. 5, 147)* Gomphonema *sp. 2, 148)* Gomphonema *sp. 3, 149)* Gomphonema *sp. 1, 150)* Gomphonema *cf.* angustum*, 151)* Gomphonema calcifugum*,152)* Gomphonema parvulius*, 153)* Gomphonema hebridense*, 154)* Gomphonema brebissonii*, 155)* Gomphonema angusticephalum*, 156)* Gomphonema productum*, 157)* Gomphonema reichardtii*, 158)* Gomphonema duplipunctatum*. Scale bar = 10 µm.*

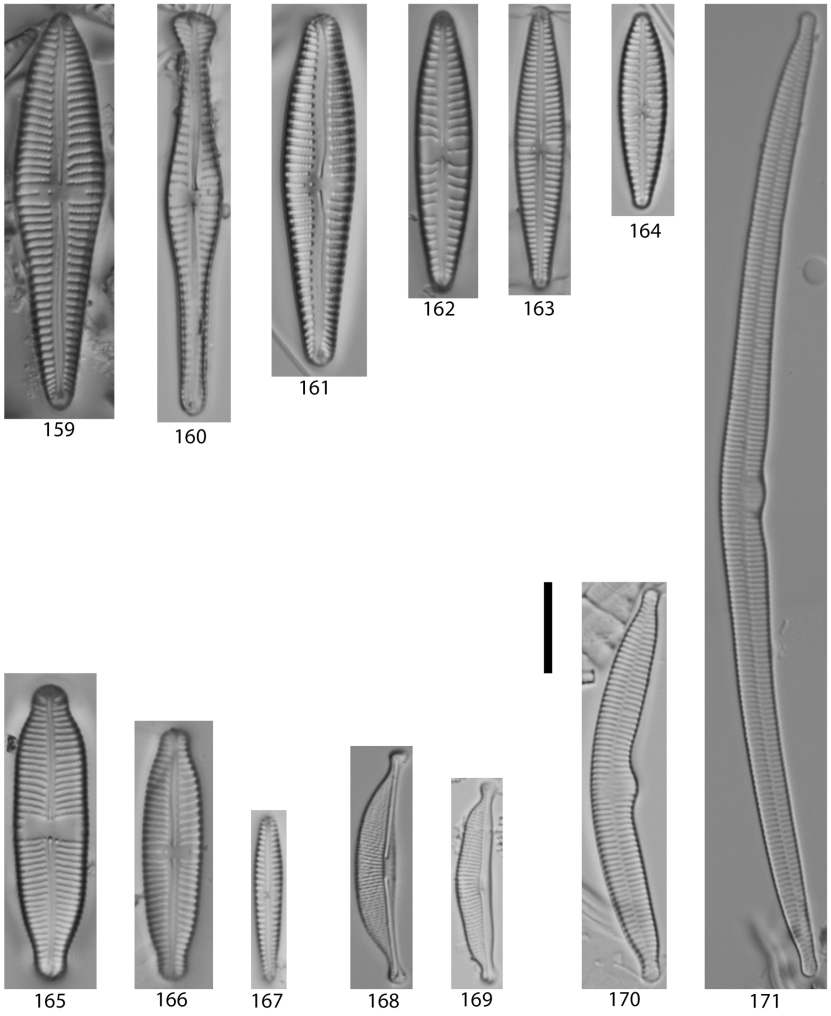



*Figure D19: LM images (1000x). 159)* Gomphonema acutuisculum*, 160)* Gomphonema subtile*, 161)* Gomphonema subclavatum*, 162)* Gomphonema bozenae*, 163)* Gomphonema exillissimum*, 164)* Gomphonema *sp. 4, 165)* Gomphonema lapponicum*, 166)* Gomphonema *cf.* sacropphagus*, 167)* Gomphonema *cf.* pseudotenellum*, 168)* Halamphora oligotaphenta*, 169)* Halamphora dusenii*, 170)* Hannaea arcus*, 171)* Hannaea linearis*. Scale bar = 10 µm.*

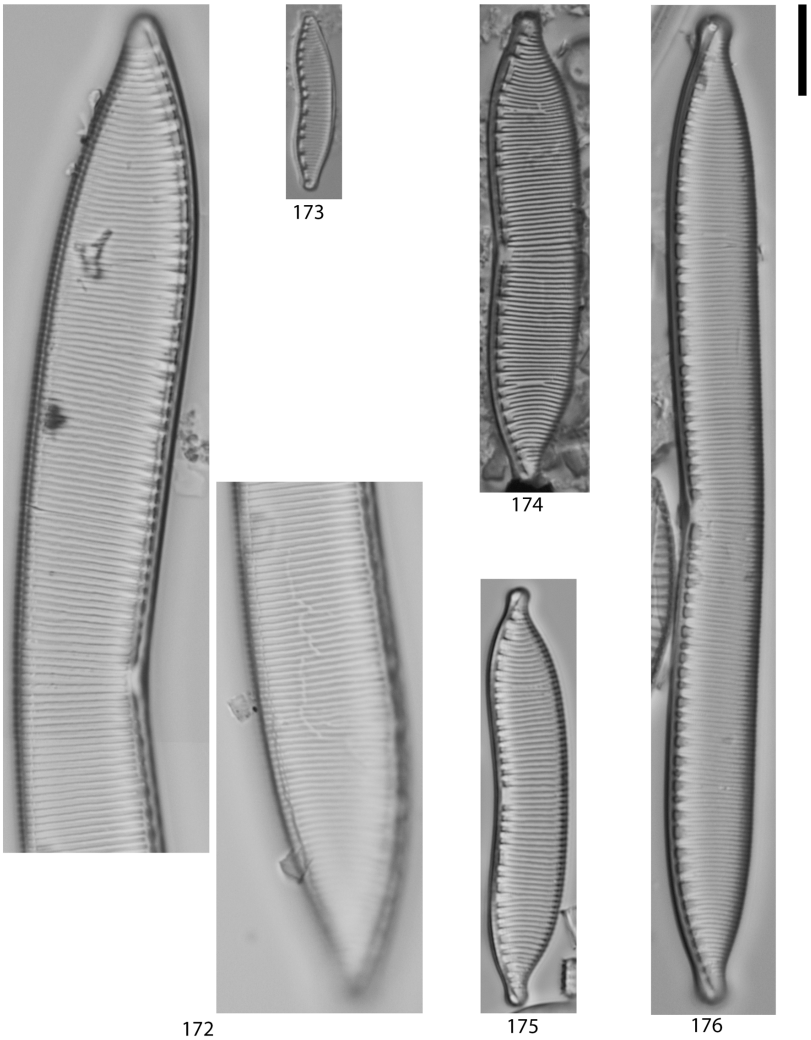



*Figure D20: LM images (1000x). 172)* Hantzschia *sp. 1, 173)* Hantzschia amphioxys*, 174)* Hantzschia *sp. 2, 175)* Hantzschia abundans*, 176)* Hantzschia calcifuga*. Scale bar = 10 µm.*

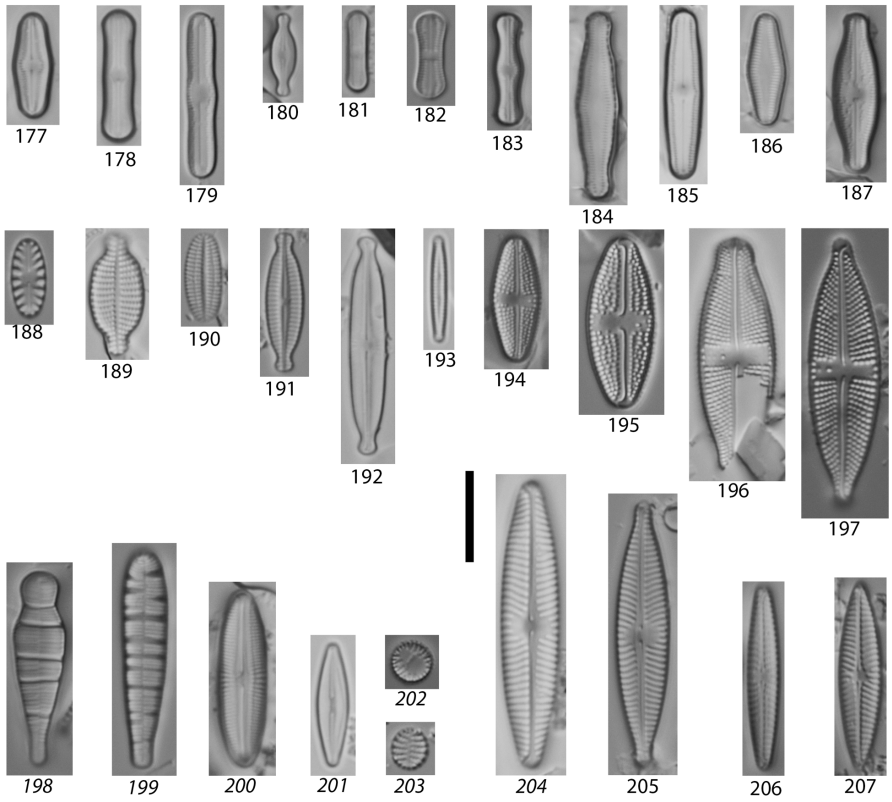



*Figure D21: LM images (1000x). 177)* Humdiphila perpusilla, *178)* Humdiphila contenta, *179)* Humidophila *sp. 1, 180)* Humidophila schmassmannii, *181)* Humdiphila *sp. 2, 182)* Humdiphila paracontenta *var.* magisconcava, *183)* Humdiphila eldfjalii, *184)* Humdiphila laevissima, *185)* Humdiphila arctica, *186)* Humdiphila gallica, *187)* Humdiphila mochalovae, *188)* Hygropetra balfouriana, *189)* Karayevia laterostrata, *190)* Karayevia suchlandtii, *191)* Karayevia nitidiformes, *192)* Kobaysiella parasubtilissima, *193)* Krasskella kriegeriana, *194)* Luticola frequentissima, *195)* Luticola *cf.* aequalis, *196)* Luticola *sp., 197)* Luticola *cf.* ignorata, *198)* Meridion constrictum, *199)* Meridion circulare, *200)* Muelleria linearis, *201)* Microstatus naumannii, *202)* Nanofrustulum cataractarum, *203)* Nanofrustulum *sp., 204)* Navicula angusta, *205)* Navicula exilis, *206)* Navicula *cf.* tenelloides, *207)* Navicula cryptotenella. *Scale bar = 10 µm.*

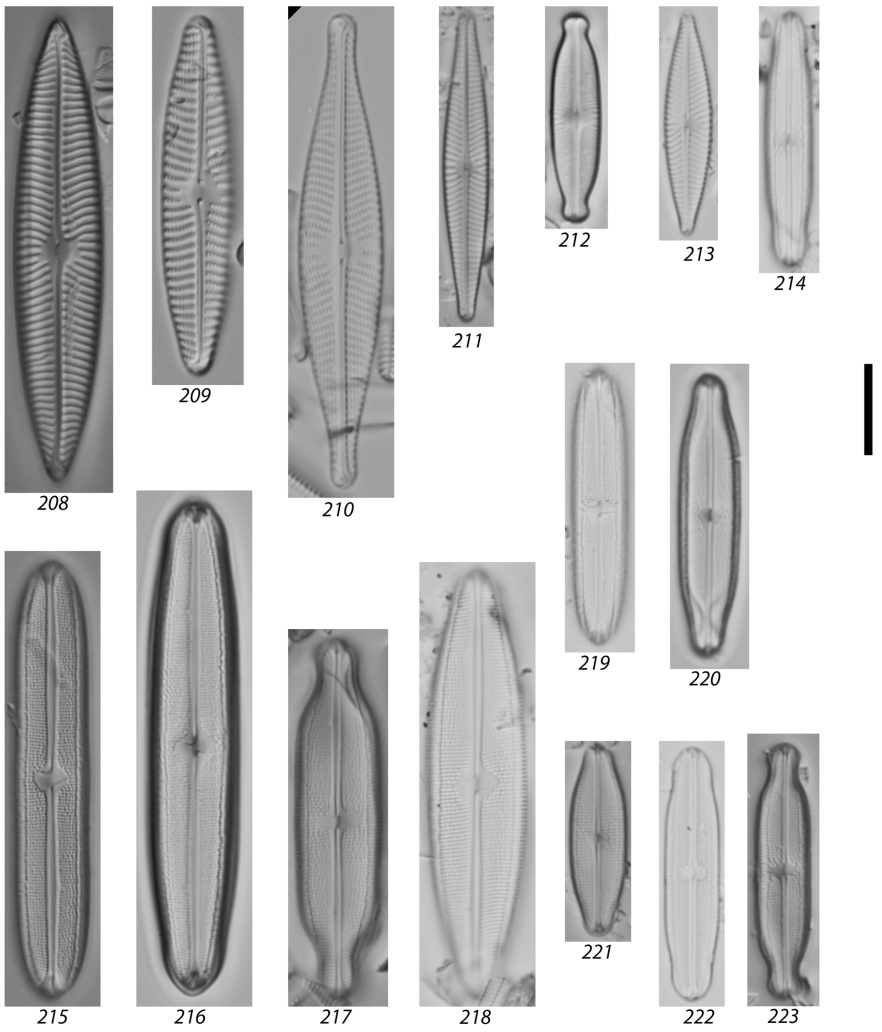



*Figure D22: LM images (1000x). 208)* Navicula radiosa*, 209)* Navicula slesvicensis*, 210)* Navicula rhynchocephala*, 211)* Navicula heimansoides*, 212)* Navicula pseudobryophila*, 213)* Navicula hanseatica*, 214)* Neidium septentrionale*, 215)* Neidium bisulcatum*, 216)* Neidium ampliatum *s.l., 217)* Neidium affine*, 218)* Neidium *sp. 4, 219)* Neidium *sp. 3, 220)* Neidium *sp. 2, 221)* Neidium *sp. 1, 222)* Neidium longiceps*, 223)* Neidium *sp. 5. Scale bar = 10 µm.*

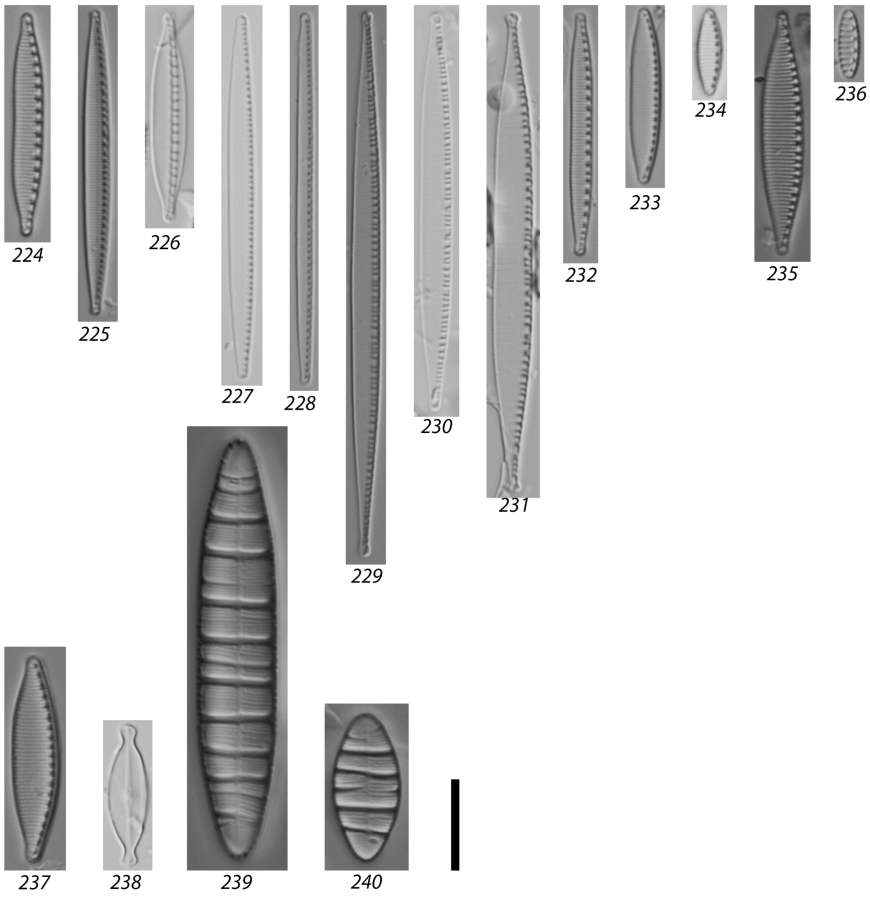



*Figure D23: LM images (1000x). 224)* Nitzschia hantzschiana, *225)* Nitzschia radicula, *226)* Nitzschia dissipata, *227)* Nitzschia *sp. 1, 228)* Nitzschia *cf.* incognita, *229)* Nitzschia subtilis, *230)* Nitzschia pura, *231)* Nitzschia gandersheimiensis, *232)* nitzschia perminuta, *233)* Nitzschia *cf.* perminuta, *234)* Nitzschia soratensis, *235)* Nitzschia alpinobacillum, *236)* Nitzschia valdestriata, *237)* Nitzschia bryophila, *238)* Nupela impexiformis, *239)* Odontidium hyemale, *240)* Odonotidium mesodon. *Scale bar = 10 µm.*

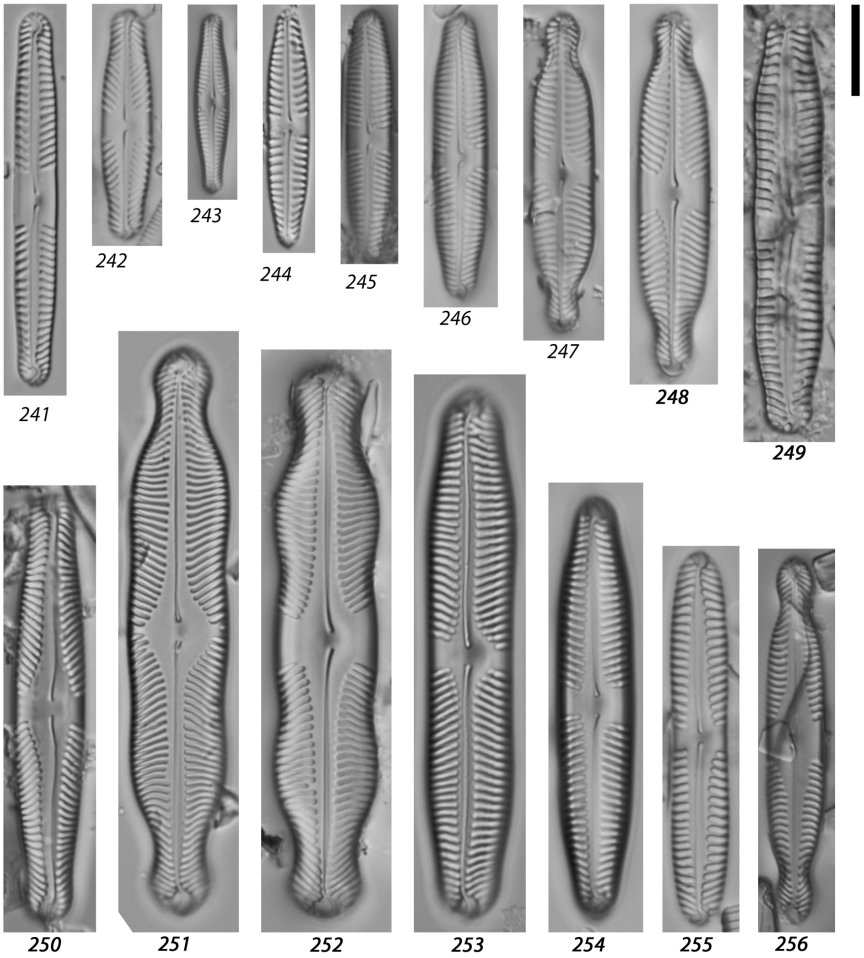



*Figure D24: LM images (1000x). 241)* Pinnularia sinistra*, 242)* Pinnularia Pseudodivergentissima*, 243)* Pinnularia sylvatica*, 244)* Pinnularia obscura*, 245)* Pinnularia *sp. 6, 246)* Pinnularia microstauron *var.* rostrata*, 247)* Pinnularia subanglica*, 248)* Pinnularia *cf.* subanglica*, 249)* Pinnularia nodosa*, 250)* Pinnularia lunata*, 251)* Pinnularia biceps*, 252)* Pinnularia septentrionalis*, 253)* Pinnularia rhombarea*, 254)* Pinnularia *sp. 5, 255)* Pinnularia *sp.1, 256)* Pinnularia rumrichae. *Scale bar = 10 µm.*

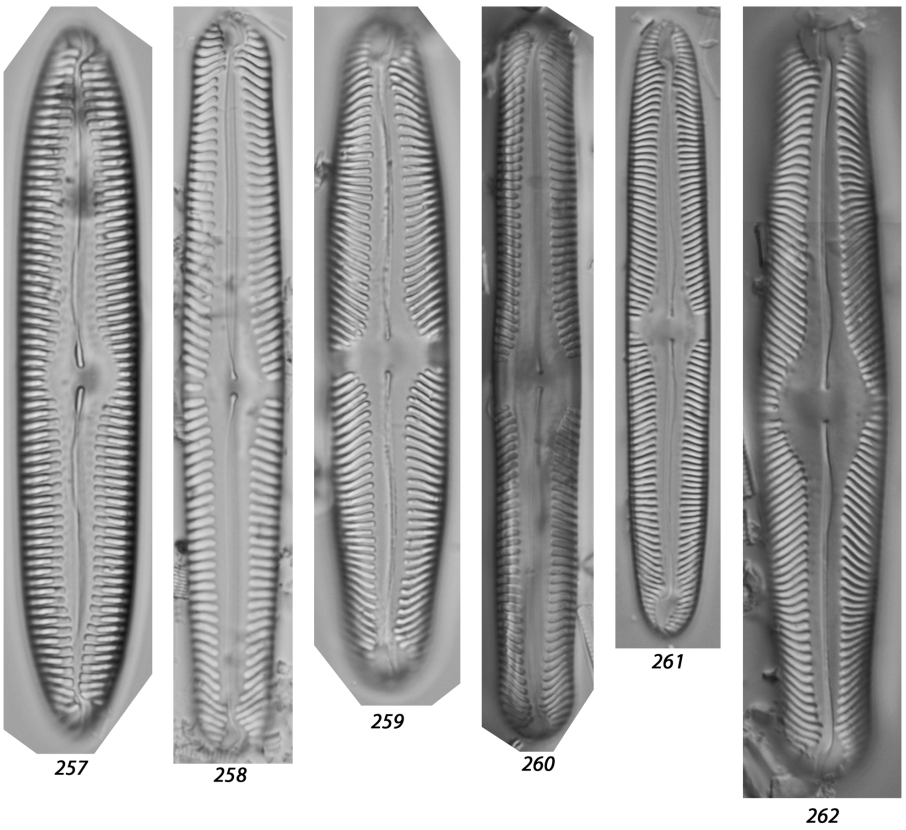



*Figure D25: LM images (1000x). 257)* Pinnularia peracuminata*, 258)* Pinnularia parvulissima*, 259)* Pinnularia divergens*, 260)* Pinnularia subgibba*, 261)* Pinnularia Stomatophora*, 262)* Pinnularia decresens*. Scale bar = 10 µm.*

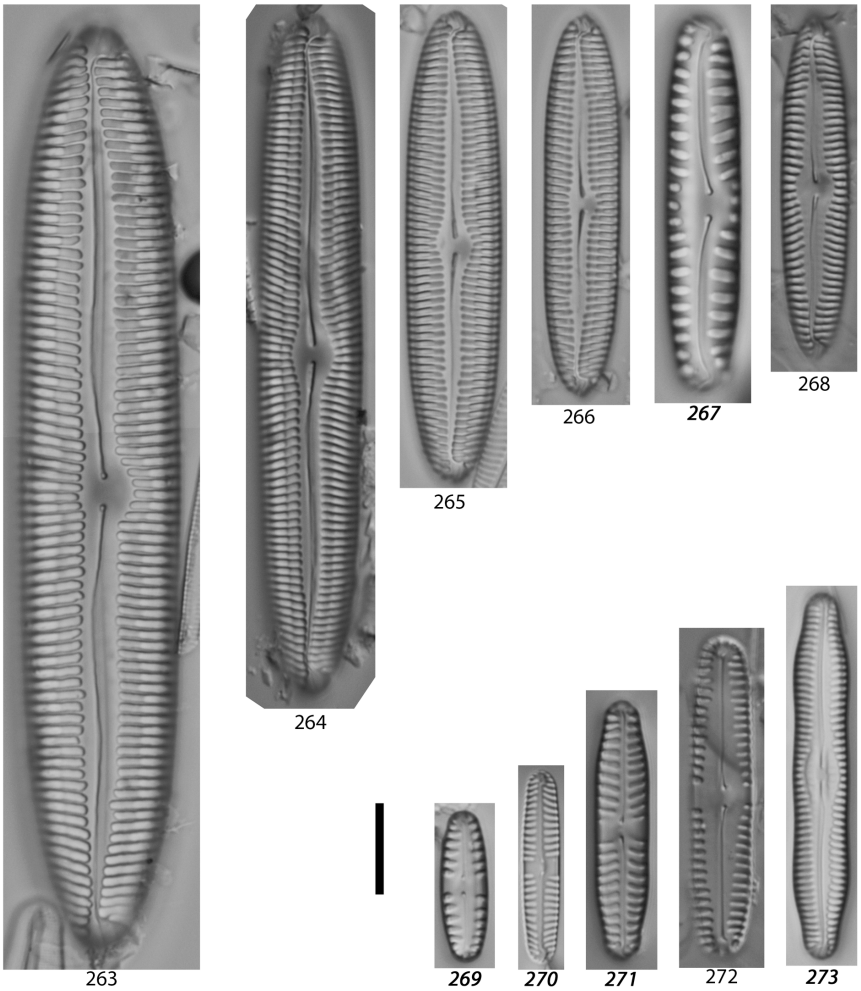



*Figure D26: LM images (1000x). 263)* Pinnularia viridiformis*, 264)* Pinnularia *cf.* viridiformis*, 265)* Pinnularia viridiformis *var.* minor*, 266)* Pinnularia Frequentis*, 267)* Pinnularia borealis*, 268)* Pinnularia *cf.* isselana*, 269)* Pinnularia *cf.* subpulchra*, 270)* Pinnularia *sp. 2, 271)* Pinnularia *sp. 4, 272)* Pinnularia intermedia*, 273)* Pinnularia *sp. 3. Scale bar = 10 µm.*

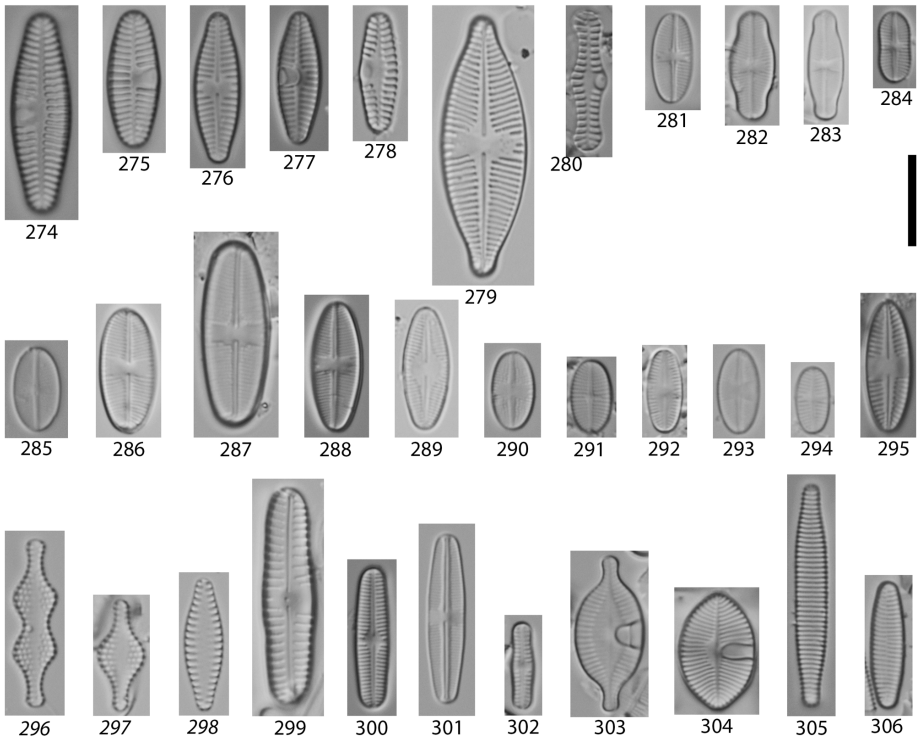



*Figure D27: LM images (1000x). 274)* Planothidium lanceolatum, *275)* Planothidium boyei, *276)* Planothidium islandicum, *277)* Planothidium victorii, *278)* Planothidium *sp.*, *279)* Planothidium holstii, *280)*Planothidiun fragilariodes *281)* Psammothidium acidoclinatum, *282)* Psammothidium ventrale, *283)* Psammothidium perpusillum, *284)* Psammothidium didymium, *285)* Psammothidium kuelbsii, *286)* Psammothidium daonense, *287)* Psammothidium helveticum, *288)* Psammothidium *cf.* kryophilum, *289)* Psammothidium *cf.*marginulatum, *290)* Psammothidium subatomoides, *291)* Psammothidium levanderi, *292)* Psammothidium scoticum, *293)* Psammothidium *s. p1*, *294)* psammothidium *cf.* sacculum, *295)* Psammothidium *sp. 2*, *296)* Pseudostaurosira robustra, *297)* Pseudostaurosira pseudoconstruens, *298)* Pseudostaurosira opacolineata, *299)* Reimeria sinuata, *300)* Rossithidium pusillum, *301)* Rossithidium petersenii, *302)* Rossithidium kriegeri, *303)* Skabitschewskia peragalloi, *304)* Skabitschewskia oestrupii, *305)* Stauroforma exiguiformis, *306)* Stauroforma *cf.* subsalina. *Scale bar = 10 µm.*

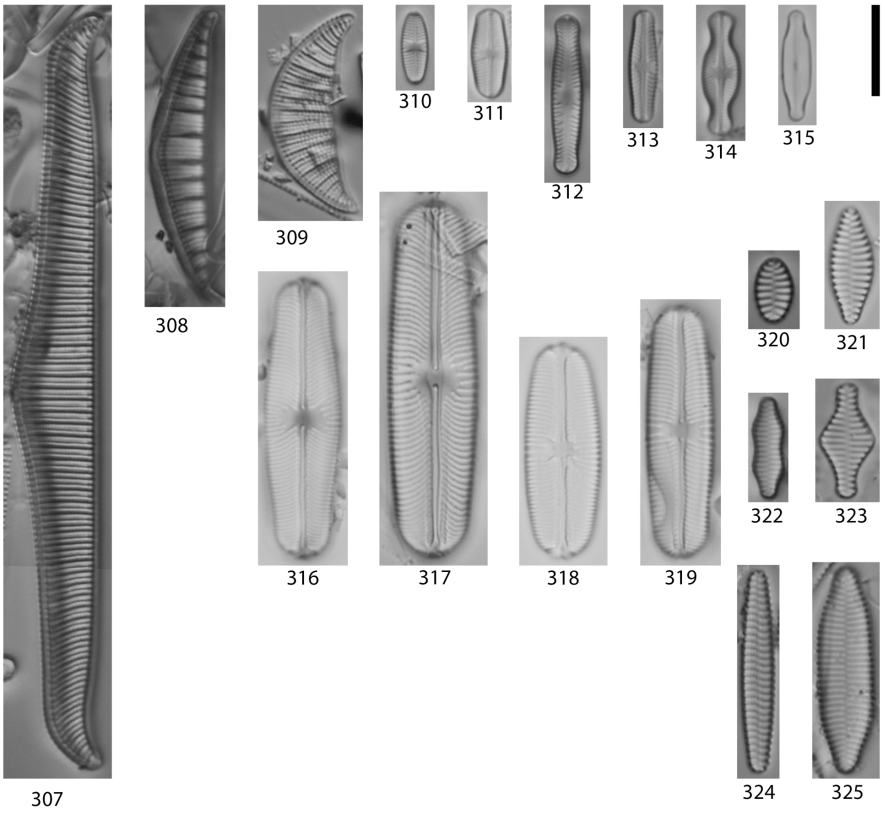



*Figure D28: LM images (1000x). 307)* Rhopalodia gibba, *308)* Rhopalodia rupestris, *309)* Rhopalodia musculus, *310)* Sellaphora nigri/atomoides *complex, 311)* Sellaphora *cf.* vitabundicta, *312)* Sellaphora *cf.* seminulum, *313)* Sellaphora seminulum, *314)* Sellaphora medioconvexa, *315)* Sellaphora *cf.* arvensis, *316)* Sellaphora *cf.* pupula *317)* Sellaphora *sp. 1, 318)* Sellaphora *sp. 2, 319) Sellaphora* laevissima, *320)* Staurosira ambigua, *321)* Staurosira *sp. 2, 322)* Staurosira *sp. 1, 323)* Staurosira construens, *324)* Staurosira *sp. 3, 325)* Staurosira neoproducta. *Scale bar = 10 µm.*

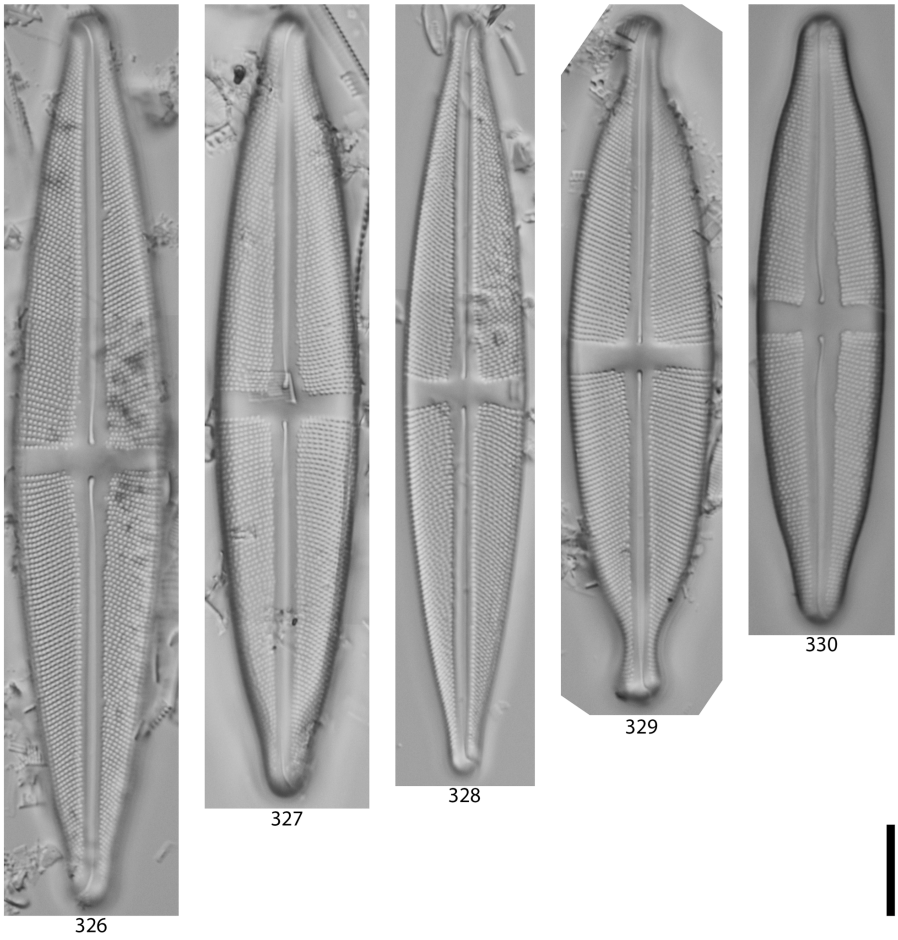



*Figure D29: LM images (1000x). 326)* Stauroneis *sp. 1, 327)* Stauroneis *sp. 2, 328)* Stauroneis angustilancea*, 329)* Stauroneis amphicephala*, 330)* Stauroneis *cf.* subgracilis*. Scale bar = 10 µm.*

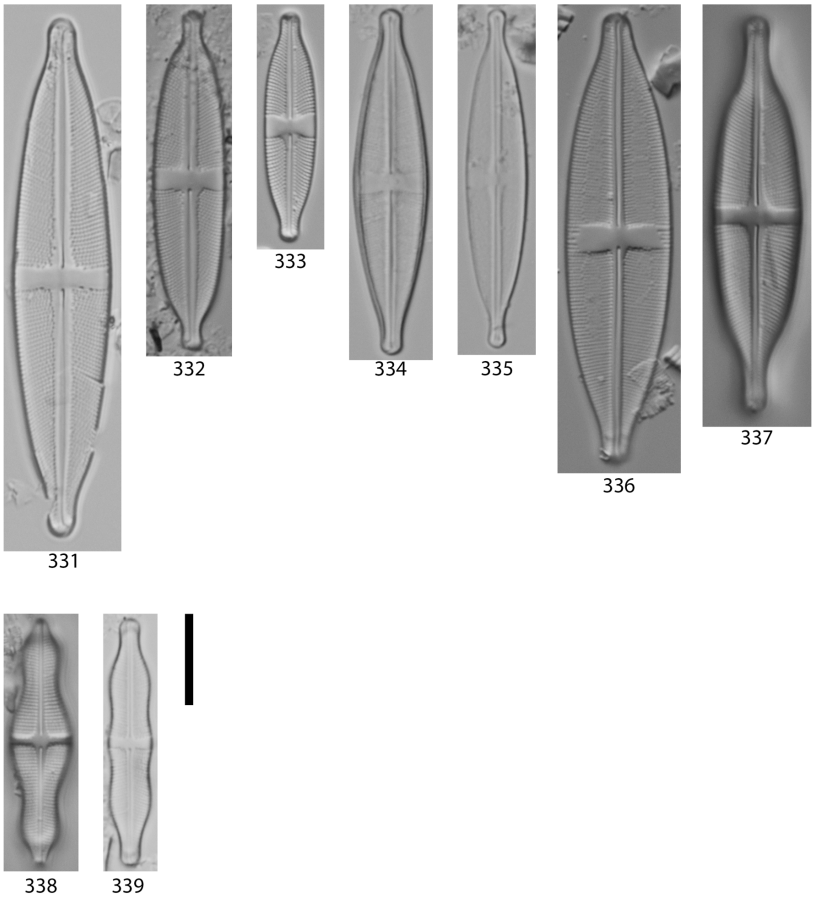



*Figure D30: LM images (1000x). 331)* Stauroneis *cf* jarensis*, 332)* Stauroneis reichardtii*, 333)* Stauroneis agrestris*, 334)* Stauroneis*. cf.* neohyalina*, 335)* Stauroneis neohyalina*, 336)* Stauroneis siberica*, 337)* Stauroneis producta*, 338)* Stauroneis smithii*, 339)* Stauroneis leguminopsis*. Scale bar = 10 µm.*

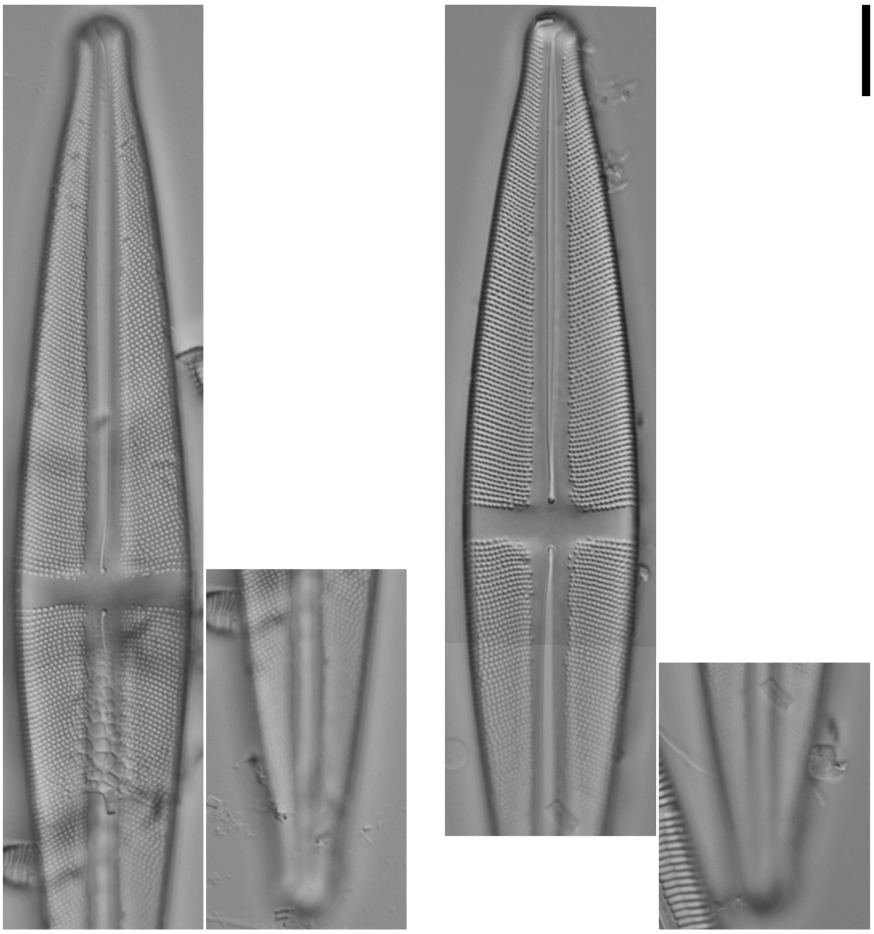



*Figure D31: LM images (1000x). 340)* Stauroneis *cf.* heinii*, 341)* Stauroneis gracilis*. Scale bar = 10 µm.*

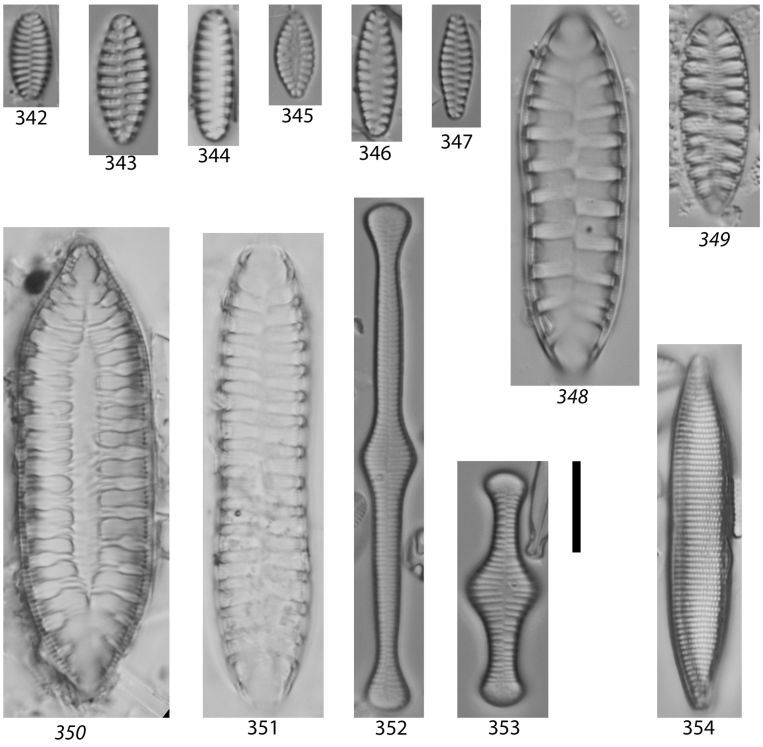



*Figure D32: LM images (1000x). 342)* Staurosirella *sp. 1, 343)* Staurosirella *sp. 2, 344)* Staurosirella *cf.* lapponica*, 345)* Staurosirella *sp. 4, 346)* Staurosirella *sp. 3, 347)* Staurosirella. jonssoniana*, 348)* Surirella roba*, 349)* Surirella terricola*, 350)* Surirella amphioxys*, 351)* Surirella *sp. 1, 352)* Tabellaria fenestrata*, 353)* Tabellaria flocculosa*, 354)* Tryblionella angustata. *Scale bar = 10 µm.*

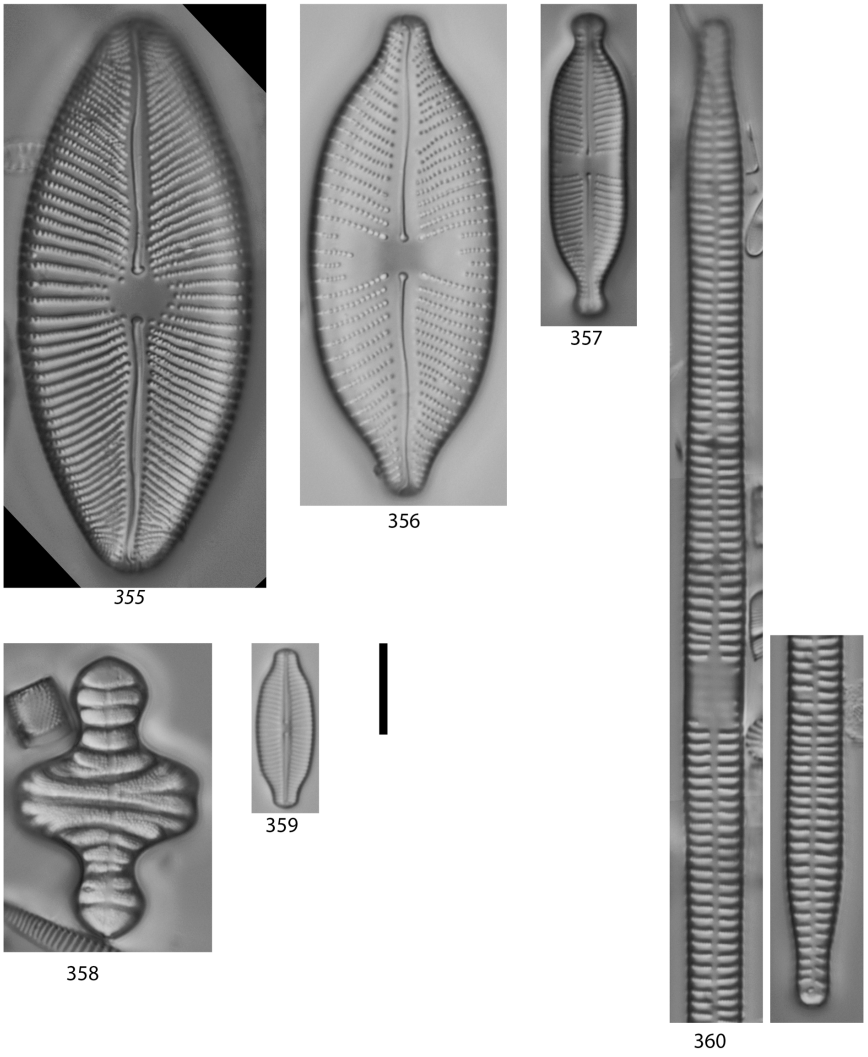



*Figure D33: LM images (1000x). 355)* Placoneis navicularis*, 356)* Placoneis amphibola*, 357)* Placoneis *sp. 358)* Tetracyclus emarginatus*, 359)* incerta sedis*, 360* Ulanria *sp. Scale bar = 10 µm.*

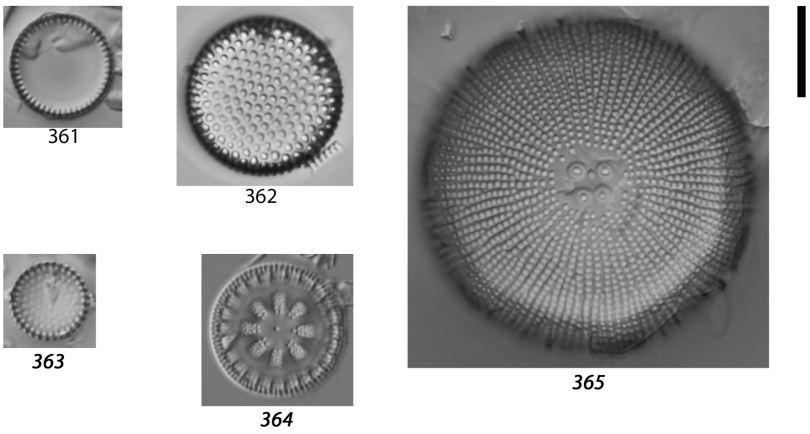



*Figure D34: LM images (1000x). 361)* Aulacoseira alpigena*, 361)* Aulacoseira nivalis, *363)* Aulacoseira *sp., 364)* Lindavia antiqua, *365)* Lyparogyra spinosa*. Scale bar = 10 µm.*

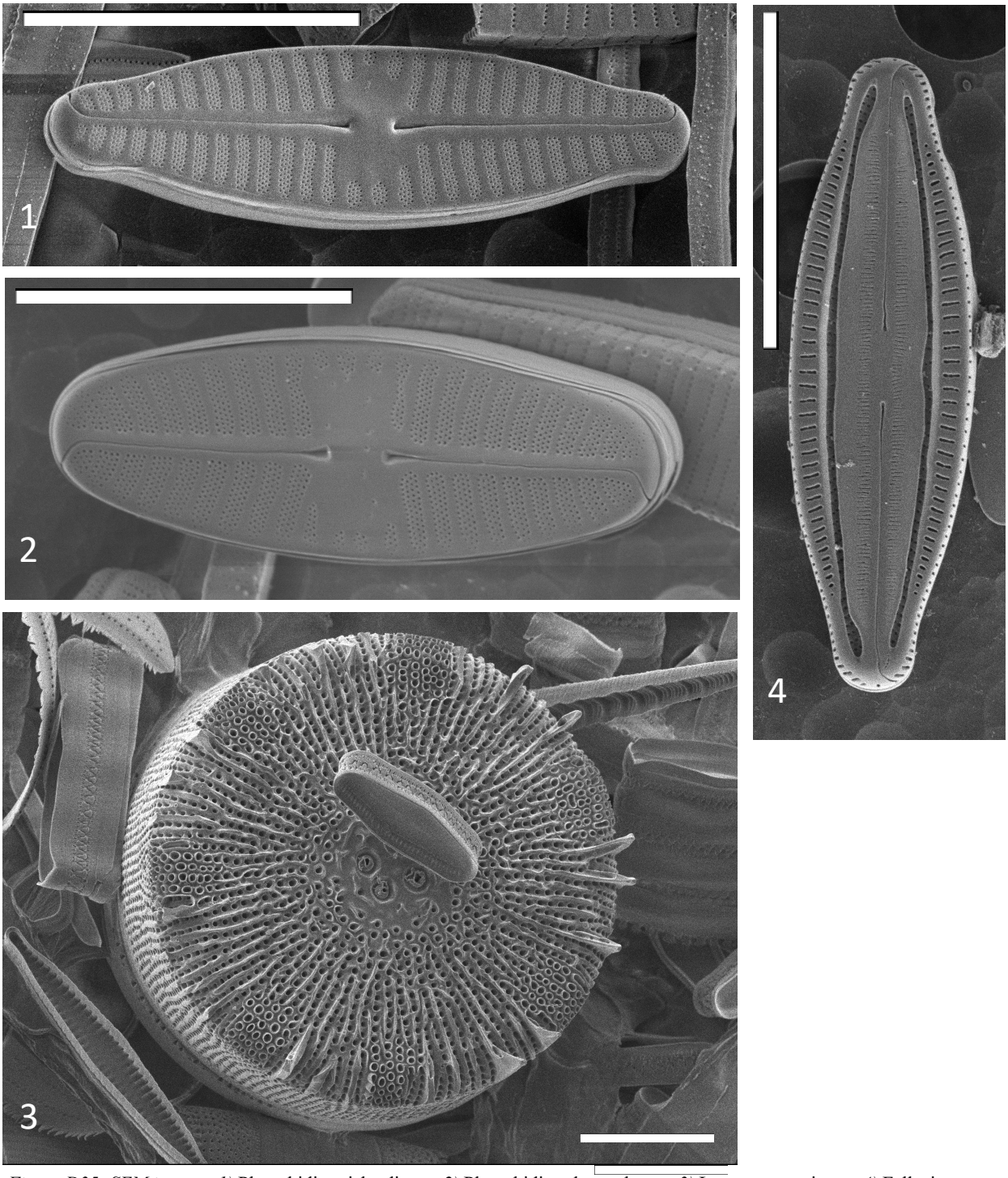



*Figure D35: SEM images. 1)* Planothidium islandicum*, 2)* Planothidium lanceolatum*, 3)* Lyparogyra spinosa*, 4)* Fallacia vitrea*. Scale bar = 10 µm.*

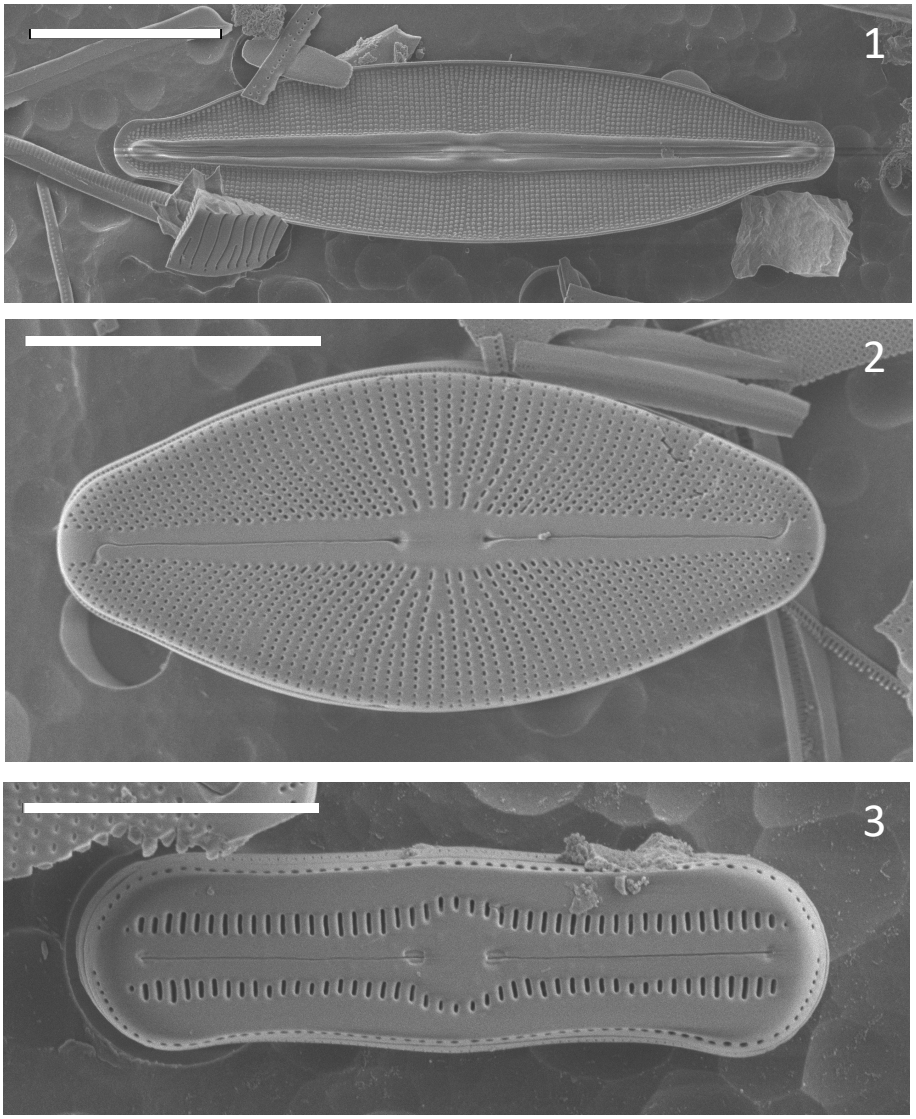



*Figure D36: SEM images. 1)* Frustulia saxonica*, 2)* Cavinula cocconeisformis*, 3)* Humidophila contenta*. Scale bar = 10 µm.*

# Appendix E: Counts

*Table E1: Diatom counts for all moss samples included in this study. An asterisk (*) indicates that the taxon was observed in the sample but was not included in the valve count.*

| | M002 | M005 | M007 | M008 | M010 | M012 | M014 | M017 | M018 | M021 | M022 | M023 | M025 | M026 | M028 | M034 | M036 | M038 | M039 | M041 | M044 | M051 | M055 | M059 | M060 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Achnanthes carissima* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Achnanthes coarcata* | | | | * | | | | | | | | | | | | | | * | | | | | | 1 | 9 |
| *Achnanthidium minutissimum* | | 3 | | 8 | | | | * | 1 | | * | 8 | | | 9 | 4 | 4 | * | | | 4 | | | 53 | 92 |
| *Achnanthidium modestiforme* | | | | | | | * | * | 5 | | * | | 3 | | 102 | | | | | | | 3 | | | |
| *Achnanthidium nolii* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Achnanthidium* sp. 1 | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Achnanthidium* sp. 2 | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Achnanthidium tropicocatenatum* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Adlafia bryophila* | 2 | | | | | * | | | | | | | | | | | | 3 | | 13 | * | * | | | |
| *Adlafia detenta* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Adlafia minuscula* | | | | | 2 | | * | 1 | 2 | | | | | | 2 | | | | | | 1 | | | | |
| *Adlafia suchlandtii* | | 7 | | | | 1 | 1 | 1 | 2 | | | * | * | * | * | * | | | 1 | 7 | * | 2 | * | | |
| *Amphora copulate* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Amphora inariensis* | | | | | | | | 2 | | | | | | | | | | | 1 | * | | * | * | | |
| *Amphora lange-bertalotii* var. *tenuis* | | | | | | | | * | | | | * | | | | | | | | | | | | | |
| *Amphora parallelistriata* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Amphora pediculus* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Aulacoseira alpigena* | 3 | * | 1 | 9 | 42 | | 3 | * | 80 | 38 | 9 | 69 | 26 | 3 | 2 | 49 | 24 | 31 | 17 | 16 | 1 | 19 | | | |
| *Aulacoseira italica* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Aulacoseira nivalis* | | 1 | | | | | | | | 10 | 3 | * | | | | * | | | | | | | | | |
| *Aulacoseira* sp. | | | | | | | | * | | | | | | | | | | | | | | | | | |
| *Aulacoseira westfjordensis* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Brachysira confusa* | 3 | 5 | 1 | 24 | * | | | | * | | | * | | | | | 1 | * | | * | * | | | | |
| *Brachysira decipiens* | | | | | | | | | | | | | | | | | | | * | | | | | | |
| *Brachysira elisabethiana* | | | | | | | | | | | | * | | | | | | | | | * | | | | |
| *Brachysira louiseboydiana* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Brachysira microcephala* | | 2 | | | | | | | | | | * | | | | | * | * | | | | | | | |
| *Brachysira neoexilis* | | | | 9 | | | | | | | | | | | | | | | | | | | | | |

*Table E1 – continued.*

| | M002 | M005 | M007 | M008 | M010 | M012 | M014 | M017 | M018 | M021 | M022 | M023 | M025 | M026 | M028 | M034 | M036 | M038 | M039 | M041 | M044 | M051 | M055 | M059 | M060 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Brachysira zellensis* | | | | | | | | | | | | * | | | | | | | | 1 | | | | | |
| *Caloneis* sp. | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Caloneis* sp.1 | | | | | | | | | | | | | | | | * | | | | | | | | | |
| *Caloneis* sp.4 | | | | | | | | | | | | * | | | 14 | | | | | | | | | | |
| *Caloneis tenuis* | | * | | 4 | | 1 | * | | * | | | | * | | 2 | | | 1 | 1 | 4 | * | * | | 1 | 1 |
| *Caloneis undulata* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Cavinula cocconeiformis* | * | * | | 1 | | | | | | | | * | | | 2 | | | * | | * | 2 | * | | 4 | 5 |
| *Cavinula jaernefeltii* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Cavinula mollicula* | | | | | | | | | | | | | | | | 5 | | * | | | | | | | |
| *Cavinula pseudoscutiformis* | | | | | | | | | | | | | | | | 5 | 2 | * | | | | | | | |
| *Cavinula pusio* | | | | | | | | | | | | | | | | 2 | | | | | | | | | |
| *Cavinula variostriata* | 3 | | 2 | 3 | 2 | | * | | | | | * | * | | 13 | * | | * | * | 10 | * | 8 | | | |
| *Chamaepinnularia begeri* | | | | | | | | | | | | | | | 8 | * | 6 | | | | | | | | |
| *Chamaepinnularia* cf. *hassiaca* | | | | | | | | | | | | * | | | | | | | | | | | | | |
| *Chamaepinnularia evanida* | 3 | 26 | | | | | | | | | | | | | | | | | | | | | | | |
| *Chamaepinnularia gandrupii* | | | | | | | | | | | | | | | | | | | | | | 2 | | | |
| *Chamaepinnularia hassiaca* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Chamaepinnularia krookii* | | | | 1 | | | | | | | | * | | | | * | * | | | | * | | | | |
| *Chamaepinnularia mediocris* | | 1 | 43 | 9 | * | | * | | * | | 8 | 40 | | | | | | | | | | 1 | | | |
| *Chamaepinnularia obsoleta* | | 20 | | | | | | | | | | | | | | | | | | | | | | | |
| *Chamaepinnularia* sp. 1 | | | | | | | | | | 8 | | | | | | | | | | | | | | | |
| *Chamepinnularia soehrensis* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Cocconeis fetscheriana* | | | | | | | | | | | | * | | | | | | | 2 | 2 | | | * | | |
| *Cocconeis scutellum* | | | | | | | | | | | | | | | | | | | | * | | | | | |
| *Cocconeis* sp. 1 | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Cocconeis* sp. 2 | | | | | | | | | | | | | | | | | | | | * | | 2 | * | | |
| *Cosmioneis pusilla* | | | | | | | | | | * | | * | | | | | | | | | | | | | |
| *Craticula acidoclinata* | | | | | | | | | | | | * | | | | | | * | | | | | | | |
| *Cymbella* cf. *cymbiformis* | | | | | | | | | | | | | | | | | | | | | | | * | | |
| *Cymbella* cf. *vulgata* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Cymbella cymbiformis* | | | | | | | | | | * | | | | | | | | 1 | | | | | | | |

*Table E1 – continued.*

| | M002 | M005 | M007 | M008 | M010 | M012 | M014 | M017 | M018 | M021 | M022 | M023 | M025 | M026 | M028 | M034 | M036 | M038 | M039 | M041 | M044 | M051 | M055 | M059 | M060 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Cymbella excisiformis* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Cymbella lange-bertalotii* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Cymbella* sp. | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Cymbopleura apiculata* | | | | | | | | | | | | * | | | | | | | | | | | | | |
| *Cymbopleura naviculiformis* | | | | * | | | | | | | | * | | | | * | | * | | * | | | | | |
| *Cymbopleura subcuspidata* | | | | * | | | | | | | | | | | | | | | | | | | | | |
| *Denticula kuetzingii* | 10 | | | | | | | | | | | | | | | | | | | | | | | | |
| *Diatoma tenuis* | | | | | | | | | | | | * | | | | | | | | | | | | | |
| *Diatomella balfouriana* | | | | 2 | | | | | | | | * | * | | | | | | 2 | 2 | | 4 | | | |
| *Dickieia tackei* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Diploneis calcifuga* | 1 | | | * | | * | | | | * | | * | * | | 12 | | | | 2 | 5 | * | * | * | | |
| *Diploneis dilatatafalsa* | | | | | | | | | | 1 | | | | | | | | | | | | | | | |
| *Diploneis ovalis* | | | | 1 | | | | | | | | * | | | | | | | | | | | | | |
| *Diploneis* sp. | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Diploneis ultimathule* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Encyonema brevicapitatum* | | | | | | | | | | | | | | | | | | 1 | | | * | | | | |
| *Encyonema cepitosum* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Encyonema elginense* | | | | | | | | | | 22 | 1 | | | | | | | | | | | | | | |
| *Encyonema jemtlandicum* | | | | | | | | | | | | | | | | | | | | | | * | | | |
| *Encyonema lunatum* | | 23 | 5 | | 19 | | 1 | | * | | | * | | | 4 | * | | * | | 3 | * | 1 | | | |
| *Encyonema minutum* complex | 1 | | | | 2 | | * | * | 2 | | | | | | | * | * | * | | | | | * | | |
| *Encyonema neogracile* | | | | | | | | | * | | | * | | | | | | * | | | | | | | |
| *Encyonema norvegicum* | | * | | | | | | | | | | | | | | | | | | | | | | | |
| *Encyonema pergracile* | | | | 1 | | | | | | | | | | | | | | | | | | | | | |
| *Encyonema silesiacum* | 1 | | 1 | | 3 | * | * | 10 | * | | | * | 8 | 8 | | | * | * | 6 | 3 | * | * | * | | |
| *Encyonema silesiacum* s.l. | 4 | | | 2 | | | 2 | | | | | | | | | * | | | 4 | | 2 | | | | |
| *Encyonema simile* | | | | | | | | | | | | 2 | | | | * | | | | 1 | * | * | | | |
| *Encyonema* sp. 1 | | | | | | | | | | | | | | | | | | | | * | | | | | |
| *Encyonema* sp. 2 | | | | | | | | | | | | | | | | | | | | | * | | | | |
| *Encyonema* sp. 3 | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Encyonema* sp. 4 | * | | | | | | | | | | | | | | | | | | | | | | | | |

*Table E1 – continued.*

| | M002 | M005 | M007 | M008 | M010 | M012 | M014 | M017 | M018 | M021 | M022 | M023 | M025 | M026 | M028 | M034 | M036 | M038 | M039 | M041 | M044 | M051 | M055 | M059 | M060 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Encyonema* sp. 5 | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Encyonema vulgare* | | | | | | | | 3 | | | | | | | | | | | | | | | | | |
| *Encyonopsis cesatii* | | | | | | | | | | | | | | | | | | * | | | | | | | |
| *Encyonopsis* cf. *descripta* | | | | | | | | | | | | | | | | * | | | | | | | | | |
| *Encyonopsis* cf. *tavirana* | * | | | | | | | | | | | * | | | | | | | | | | | | | |
| *Encyonopsis falaisensis* | * | 2 | | 3 | | | | | | | | * | | | 10 | | | | | | * | 2 | | | |
| *Encyonema gaeumanii* | | 1 | | | | | | | | | | * | | | * | * | | * | | | * | | | | |
| *Encyonopsis grunowii* | | | | * | | | | | | | | * | | | | | | * | | | | | | | |
| *Encyonopsis* sp. 1 | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Encyonopsis* sp. 2 | | | | | | | | | | 3 | * | | | | | | | | | | | | | | |
| *Encyonopsis subminuta* | | | | | | | | | | | | | | | | | | * | | | * | * | | | |
| *Epithemia adnata* | | | | | | | | | | * | | * | | | 29 | | 1 | | | | | | | | |
| *Epithemia argus* | | | | | | | | | | | | | | | | | | | * | * | | | | | |
| *Epithemia sorex* | | | | * | | | | | | | | * | | | | | | | | | | | | | |
| *Eucocconeis* sp. | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Eunotia arcus* | | | * | | | | * | | | | | | | | | | | | | | | | | | * |
| *Eunotia bidens* | | 1 | | | | | 2 | | | | | | | | * | * | | * | | | | | | | 1 |
| *Eunotia bigibboidea* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Eunotia bilunaris* | * | | | | | | * | * | * | | | * | 3 | 4 | 2 | * | | | * | * | * | 2 | * | | |
| *Eunotia botuliformis* | | 1 | | | | | | | | | | | | | 10 | | | | | | | | | | |
| *Eunotia* cf. *ambivalens* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Eunotia* cf. *arcus* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Eunotia* cf. *zackenbergensis* | | | | | | | | | | | 19 | | | | | | | | | | | | | | |
| *Eunotia curtagrunowii* | | 1 | 2 | 2 | | * | 8 | | | 6 | | * | | | * | * | 1 | * | * | | | | | 74 | 52 |
| *Eunotia exigua* | | 2 | | | | | | | | | | | | | 5 | | | | | | | | | | |
| *Eunotia glacialispinosa* | | | | | | | 1 | | * | | | * | 1 | * | | | * | | | | | | | | |
| *Eunotia groenlandica* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Eunotia implicata* | | | | 1 | * | | * | | 5 | | | 3 | | | | 1 | | | | | | | | | |
| *Eunotia incisa* | 1 | | * | 12 | * | | | | * | 169 | 3 | * | | | | * | | | | | * | 1 | | | |
| *Eunotia islandica* | 3 | * | | | | | 3 | | | | | | | | | | | 6 | | | 1 | | | 15 | 9 |
| *Eunotia metamonodon* | | | | | | | | | | | | | | | | | | | | | | | | | |

*Table E1 – continued.*

| | M002 | M005 | M007 | M008 | M010 | M012 | M014 | M017 | M018 | M021 | M022 | M023 | M025 | M026 | M028 | M034 | M036 | M038 | M039 | M041 | M044 | M051 | M055 | M059 | M060 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Eunotia minor* | 9 | 2 | | | 3 | | * | 10 | 7 | 5 | | 5 | 3 | 11 | | * | | 4 | 4 | 2 | 2 | 2 | 10 | 33 | 6 |
| *Eunotia mucophila* | | | | | | | | | | 6 | | | | | | | | | | | | | | 3 | |
| *Eunotia neocompacta* | | | | | | | | | | | 1 | | | | | | | | | | | | | | |
| *Eunotia neocompacta* var. *vixcompacta* | | | | | | | | | | 2 | | | | | | | | | | | | | | | |
| *Eunotia neoscandinavica* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Eunotia nymanniana* | | | 13 | 27 | 8 | | 4 | | | | | 48 | * | | | | | 2 | * | * | | | | 7 | 45 |
| *Eunotia papiliofalsa* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Eunotia paratridentula* | * | | | 1 | 1 | | | * | 2 | | | * | | | | * | | 8 | | | * | | | | |
| *Eunotia praerupta* | | * | | | | | | | * | | | * | | | | | | | | | | | | | |
| *Eunotia pseudogroenlandica* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Eunotia diadema* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Eunotia* sp. 1 | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Eunotia* sp. 2 | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Eunotia* sp. 3 | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Eunotia tetradon* | | | | * | | | | | * | | | * | | | | * | | | | | | | | | |
| *Eunotia triodon* | | | | 1 | | | | | | | | | | | | | | | | | | | | | |
| *Eunotia valida* | | | | 1 | | | | | | | | 2 | | | | | | | 2 | | | | | 7 | |
| *Eunotia zackenbergensis* | | | 1 | | | | | | | | 280 | | | | | * | | | | | | | | | |
| *Fallacia vitrea* | | | 113 | 17 | | | | | | | | 71 | | | | | | | | | | | | | |
| *Fragilaria* cf. *acerosa* | | | | | | | | | * | | | 5 | | | | | | | | | 1 | | | | |
| *Fragilaria* cf. *amphicephaloides* | | | | | | | | | | | | * | | | | | | 2 | | 9 | | | | | |
| *Fragilaria* sp.1 | 30 | 7 | | 6 | 24 | | 11 | 28 | 60 | 1 | 5 | 40 | 20 | 24 | 1 | 5 | 7 | 52 | 21 | 8 | 51 | 40 | 2 | * | |
| *Fragilaria* sp. 2 | 1 | | | | | | | | | | | | | | | | | | * | 3 | | 18 | | | |
| *Fragilaria* sp. 3 | 6 | 91 | | | | | | * | | | 1 | | 15 | 4 | 14 | 5 | 8 | | 45 | | | | 37 | | |
| *Fragilariforma virescens* | | | * | | | | | | * | | | | | | | 27 | | * | 26 | | | | | | |
| *Fragilariforma undata* | | | | | | | | | | | | * | | | | | | | | | | | | | |
| *Frustulia crassinervia* | | 33 | 1 | 7 | 9 | | | | | | | * | | | 19 | * | | | | | * | | | | |
| *Frustulia saxonica* | | | | | | | | | | 9 | * | | | | | | | | | | | | | | |
| *Frustulia vulgaris* | * | 5 | | | | * | | | | | | * | | | 2 | | | * | | | * | | | | |
| *Gedaniella* sp. | | | | | | | | | | | | * | | | | | | | | | | | | | |
| *Geissleria acceptata* | | | | | | | | | | | | | | | | | | | | | | | | | |

*Table E1 – continued.*

| | M002 | M005 | M007 | M008 | M010 | M012 | M014 | M017 | M018 | M021 | M022 | M023 | M025 | M026 | M028 | M034 | M036 | M038 | M039 | M041 | M044 | M051 | M055 | M059 | M060 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Geissleria* cf. *similis* | | | | | | | | | | | | | | | | | | | | | | | | | * |
| *Geissleria schoenfeldii* | | | | | | | | | | | | | | | | * | | | | | | | | | |
| *Geissleria similis* | | | | | | | | | | | | | | | | 3 | | | | | | | | | |
| *Genkalia digitulus* | | | | | * | | | | | | | | | | | 1 | | | | | | | | | |
| *Genkalia digituloides* | | | | | * | | | | | | | | | | | | | | | | | | | | |
| *Gomphonema acuminatum* | | | | | | | | | | | | * | | | | | | | | | | | | | |
| *Gomphonema acutuisculum* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Gomphonema angusticephalum* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Gomphonema bozenae* | | | | 3 | | | | | * | | | * | | | | | | 2 | * | | 3 | | | | |
| *Gomphonema brebissonii* | | | | | | | | | | | | 1 | | | | 1 | | 3 | | | | | | | |
| *Gomphonema calcifugum* | 3 | | | | | | | | | | | * | | | | | | | | | | | | | |
| *Gomphonema* cf. *angustatum* | | | | | | | 2 | * | | | | 1 | 2 | | | | | | * | | | | | | |
| *Gomphonema* cf. *pseudotenellum* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Gomphonema* cf. *sacrophagus* | | | | | | | 2 | * | | | | | | | | | | | | | | | | | |
| *Gomphonema commutatum* | 4 | | | * | * | * | 5 | 1 | * | | | | 2 | * | 4 | | | | | 2 | * | | * | | |
| *Gomphonema coronatum* | | | | * | | | | | | | | * | | | | | | | | | | | | | |
| *Gomphonema duplipunctatum* | | 4 | | | | | 4 | | * | | | * | | * | 2 | | | 2 | * | * | 2 | | * | | 2 |
| *Gomphonema exilissimum* | | | | | | | | | | | | | | | | | | * | | | | | | | |
| *Gomphonema hebridense* | | | | 2 | 1 | | | | | | | * | | * | 2 | | | * | | * | | | | | |
| *Gomphonema innocens* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Gomphonema lapponicum* | | | | * | | | | | | | | * | | | | | | | | | | | | 12 | 5 |
| *Gomphonema montanum* | | | | | | | | | | | | | 2 | | | | | 2 | | | 3 | | | | |
| *Gomphonema parvulius* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Gomphonema productum* | | | | | | | | | | | | | | | * | | | | | | | | | | |
| *Gomphonema reichardtii* | | | | * | | | | | | | | * | | | | | * | | | | | | | | |
| *Gomphonema* sp. 1 | | | | | | | * | | | | | * | | | | 2 | * | 2 | | | | 2 | | 18 | 6 |
| *Gomphonema* sp. 2 | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Gomphonema* sp. 3 | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Gomphonema* sp. 4 | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Gomphonema* sp. 5 | | | | | | | | | | | | * | | | | | | | | | | | | | |
| *Gomphonema subclavatum* | * | | | | | | * | 1 | | | | | | | | | | | 2 | | | 2 | 1 | | |

*Table E1 – continued.*

| | M002 | M005 | M007 | M008 | M010 | M012 | M014 | M017 | M018 | M021 | M022 | M023 | M025 | M026 | M028 | M034 | M036 | M038 | M039 | M041 | M044 | M051 | M055 | M059 | M060 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Gomphonema subtile* | | | | * | | | | | | | | * | | | | | | | | | | | | | |
| *Halamphora dusenii* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Halamphora oligotaphenta* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Hannaea arcus* | * | | | | | | | 1 | * | | | * | * | 9 | | | | | * | 1 | 1 | * | * | | |
| *Hannaea linearis* | | | | | | | | | | | | * | | | | | | | | | | * | | | |
| *Hantzschia abundans* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Hantzschia amphioxys* | | | | | | | | | | | | | | | | | | | | | * | | | | * |
| *Hantzschia calcifuga* | | | | | | * | | | | | | | | | | | | | | * | | | | | |
| *Hantzschia* sp. 1 | | | | | | | | | | | | | | | | | | | | | * | | | | |
| *Hantzschia* sp. 2 | | | | | | | | | | | | * | | | 2 | | | | | | | | | | |
| *Humidophila arctica* | | | | | | | 4 | | | | 2 | | | | | | | | | | | | | | |
| *Humidophila contenta* | 4 | 1 | 1 | * | 1 | | | | | | | | 1 | | * | * | 1 | 1 | | * | * | 2 | | | 8 |
| *Humidophila eldfjalli* | | | | | | | | | | | | | | | | | | | | | | | | 3 | |
| *Humidophila flotowii* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Humidophila gallica* | | | | | | | 37 | 1 | 4 | | | | | * | | | | | * | | | | | | 3 |
| *Humidophila laevissima* | | | | | | | 46 | | * | | 1 | * | | * | | | | | | | | | | 3 | |
| *Humidophila mochalovae* | | | | | | | 110 | | | | | | | | | | | | | | | | | | |
| *Humidophila paracontenta var. magisconcava* | | | | | | | | | | | | | | | | | | | | * | | | | | |
| *Humidophila perpusilla* | 10 | 23 | | 3 | 1 | 1 | 18 | 3 | * | | 1 | 1 | 9 | 3 | 4 | | 2 | 11 | | 10 | | 2 | 6 | 21 | 37 |
| *Humidophila schmassmannii* | | | 1 | * | | | | * | 3 | | 1 | 3 | | | | 1 | | 1 | | | | | * | | |
| *Humidophila* sp. 1 | | | | | | | | | | | | | | | | | | | | * | | | | | |
| *Humidophila* sp. 2 | * | | | | | | | | | | | | | | | | | | | | | | | | |
| *Hygropetra balfouriana* | 12 | | * | | | | | | 1 | | 1 | 1 | 6 | | | | | | 1 | 46 | 2 | 32 | * | | * |
| *Karayevia laterostrata* | | | | | | | | | | | | * | | | | | | | | | | | | | |
| *Karayevia nitidiformis* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Karayevia suchlandtii* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Kobayasiella parasubtilissima* | | 1 | 121 | 2 | 22 | | | | | | 1 | 13 | | | 1 | * | | | | | | | | | |
| *Krasskella kriegeriana* | | | | | | | | | | | | | | | 7 | | | | | | * | | | | |
| *Lindavia antiqua* | | | | | | | | | | | | | | | | | * | | | | | | | | |
| *Liparogyra spinosa* | | | | | | | 5 | | | | | | * | | | | | | | * | | | * | | 1 |
| *Luticola* cf. *aequalis* | | | | | | * | | | | | | | | | | | | | | | | | | | * |

*Table E1 – continued.*

| | M002 | M005 | M007 | M008 | M010 | M012 | M014 | M017 | M018 | M021 | M022 | M023 | M025 | M026 | M028 | M034 | M036 | M038 | M039 | M041 | M044 | M051 | M055 | M059 | M060 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Luticola* cf. *ignorata* | | | | | | | | | | | | | | | | | | | | | | | | | * |
| *Luticola frequentissima* | * | | | | | | | | | | 1 | | | | * | | | | | | * | | | 8 | 22 |
| *Luticola* sp. | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Meridion circulare* | 76 | | | * | 19 | 332 | 54 | * | 11 | | | 10 | 26 | 20 | 7 | | 2 | 44 | 10 | 4 | 145 | 43 | 22 | 47 | 39 |
| *Meridion constrictum* | 4 | | 5 | | 6 | 4 | 2 | * | 3 | | | 2 | 2 | * | | | 2 | | * | * | | | | | |
| *Microcostatus naumanii* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Microcostatus zackenbergensis* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Muelleria linearis* | | | | | | | | | | | | | | | | | | | | | * | | | | |
| *Nanofrustulum cataractarum* | | | | | | | | | | | | * | | | | | | | | | | | | | |
| *Nanofrustulum fogedii* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Nanofrustulum sp* | | | | | | | | | | 1 | | | | | | | | | | | | | | | |
| *Navicula angusta* | | 2 | | 1 | 7 | | * | | | | | * | | | 1 | | | | | | * | | | | |
| *Navicula* cf. *tenelloides* | | | | | | | | | | | | | | | 2 | | | | | | | | | | |
| *Navicula cryptotenella* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Navicula exilis* | 4 | | 1 | 2 | 3 | 3 | | | | | | * | * | * | 8 | * | | * | * | * | * | 3 | | | |
| *Navicula hanseatica* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Navicula heimansoides* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Navicula pseudobryophila* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Navicula radiosa* | | | | | | | | | * | | * | * | | | * | * | * | * | * | * | * | 4 | | | |
| *Navicula rhynchocephala* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Navicula slesvicensis* | | | | | | | * | | | | | | | | | | | | | | | | | | |
| *Neidium affine* | | | | | | | | | | | | | | | | * | | | | | | | | | |
| *Neidium ampliatum* s.l. | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Neidium bisulcatum* | | 5 | | | | | | | | | | * | | | | 2 | | | | | * | * | | | |
| *Neidium longiceps* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Neidium septentrionale* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Neidium* sp. 1 | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Neidium* sp. 2 | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Neidium* sp. 3 | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Neidium* sp. 4 | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Neidium* sp. 5 | | | | | | | | | | 6 | | | | | | | | | | | | | | | |

*Table E1 – continued.*

| | M002 | M005 | M007 | M008 | M010 | M012 | M014 | M017 | M018 | M021 | M022 | M023 | M025 | M026 | M028 | M034 | M036 | M038 | M039 | M041 | M044 | M051 | M055 | M059 | M060 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Nitzschia alpinobacillum* | | | | | 2 | | | 2 | | | | | | | | 2 | 4 | | | 3 | | | | | |
| *Nitzschia bryophila* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Nitzschia* cf. *incognita* | | | | | | | | * | | | 1 | | | 1 | | | | | * | 18 | | 4 | | | |
| *Nitzschia* cf. *perminuta* | | | | | | | | | | | | | | | | 3 | | | | | | | | | |
| *Nitzschia dissipata* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Nitzschia gandersheimiensis* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Nitzschia hantzschiana* | * | | | | 58 | * | 8 | 2 | 1 | | | 4 | 5 | * | 13 | | | 5 | 2 | 30 | 5 | 7 | 1 | | |
| *Nitzschia perminuta* | 10 | 4 | 1 | 7 | 12 | | 1 | | 1 | | 3 | 3 | 1 | * | | | | 2 | 1 | 15 | 1 | 6 | 3 | | 1 |
| *Nitzschia pura* | | | | | | | | | | | | | | | | 4 | | | | | | | | | |
| *Nitzschia radicula* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Nitzschia soratensis* | | | | | | | | | | | | | | | | | | | * | | | | | | |
| *Nitzschia* sp. 1 | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Nitzschia subtilis* | | | | 1 | | | | | | | | | | | | | | 4 | 4 | | | | | | |
| *Nitzschia valdestriata* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Nupela impexiformis* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Odontidium hyemale* | | | | | | | | * | | | | | | | | | | | | | | | | | |
| *Odontidium mesodon* | 44 | 52 | | | 18 | 8 | 1 | 30 | 38 | | 1 | 7 | 77 | 169 | | * | | 5 | 91 | 31 | 6 | 26 | 155 | | |
| *Pinnularia biceps* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pinnularia borealis* | | * | 2 | | | | 4 | | | | | | | | 2 | | 3 | | | | | | | 23 | 5 |
| *Pinnularia* cf. *subanglica* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pinnularia* cf. *subpulchra* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pinnularia* cf. *viridiformis* | | | | | | | | | | | | | | | | | | | | | | * | | | |
| *Pinnularia* cf. *isselana* | | | | | | | * | | | | | | | | | | | | | | | | | | |
| *Pinnularia decrescens* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pinnularia divergens* | | | 3 | | 1 | | | | | | | * | | | | | * | | | | | * | | | |
| *Pinnularia frequentis* | | | | 1 | | | | | | | | | | | | | | | | | | | | | |
| *Pinnularia intermedia* | | | | | | | | | | | | | | | | | | | | | | | | 13 | 12 |
| *Pinnularia lunata* | | | | | | | | | | | | | | | | | | | | | * | | | | |
| *Pinnularia microstauron* var. *rostrata* | | | | 4 | | | | | | | | * | | | | | | | | | | | | | |
| *Pinnularia nodosa* | | | | | | | | | | | | | | | | | | | | | * | | | | |
| *Pinnularia obscura* | | | 1 | | | | | | | | | | | | | | | | | | | | | 4 | |

*Table E1 – continued.*

| | M002 | M005 | M007 | M008 | M010 | M012 | M014 | M017 | M018 | M021 | M022 | M023 | M025 | M026 | M028 | M034 | M036 | M038 | M039 | M041 | M044 | M051 | M055 | M059 | M060 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Pinnularia paravulissima* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pinnularia peracuminata* | | | 19 | | | | | | | | | | | 3 | | | | | | 1 | | | | | |
| *Pinnularia pseudodivergentissima* | | 8 | 5 | | 13 | | | | | | | * | | | | | | | | | | | | 2 | * |
| *Pinnularia rumrichiae* | | | | | | | | | | | | * | | | | | | | | | | | | | |
| *Pinnularia rhombarea* | | | | | | | | | | | 9 | | | | | | | | | | | | | | |
| *Pinnularia septentrionalis* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pinnularia sylvatica* | | 38 | | | 2 | | | | | | | * | * | | 2 | * | * | * | | | | | | | |
| *Pinnularia sinistra* | | 6 | * | | 17 | * | 2 | * | 1 | | 2 | * | | | 2 | * | | | | * | * | | | | 5 |
| *Pinnularia* sp. 1 | | | | * | 1 | | | | | | | | | | 4 | | | | | | | | | | |
| *Pinnularia* sp. 2 | | | | | | | | | | | | | | | | | | | | | * | | | | |
| *Pinnularia* sp. 3 | | | | | | | | | | | | | | | | | | | | * | | | | | |
| *Pinnularia* sp. 4 | | | | | | | | | | | | | | | | | | | | * | | | | | |
| *Pinnularia* sp. 5 | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pinnularia* sp. 6 | | | | | | | | | | | | | | | * | | | | | | | | | | |
| *Pinnularia stomatophora* | | | | | | | 2 | | | | | 2 | | | | | | | | | | | | | |
| *Pinnularia subanglica* | | | | | | | | | | | | | | | | * | | | | | | | | | |
| *Pinnularia subcapitata* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pinnularia subgibba* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pinnularia viridiformis* | | | | | | | | | | | 10 | | | | | | | | | | | | | | |
| *Pinnularia viridiformis* var. *minor* | 2 | 2 | | | | | 1 | | | | | | | | | | | | | | | * | | | |
| *Placoneis amphibola* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Placoneis navicularis* | | | | | | | | | * | | | | | | | | | | * | | | | | | |
| *Placoneis* sp. | | | | | | | | | | | | | | | | | | | | | | | | 8 | * |
| *Planothidium boyei* | 66 | 6 | 24 | | 10 | 21 | 8 | 25 | 23 | | 8 | 1 | 27 | 17 | * | 2 | 2 | | 36 | 15 | 47 | * | 22 | | |
| *Planothidium holstii* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Planothidium islandicum* | 5 | | | | | 12 | | | | | | * | 2 | | 1 | | | | | 1 | | | | | |
| *Planothidium lanceolatum* | 16 | | | | 8 | 12 | 4 | 8 | 23 | | 3 | | 26 | 30 | | * | | | 18 | 14 | 75 | 13 | 43 | | |
| *Planothidium* sp. | | | | | | | | | | * | | | | | | | | | | | 35 | | | | |
| *Planothidium victorii* | | | | | | | | | | | | | | | | | | | | | | 2 | | | |
| *Planothidium fragilarioides* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Psammothidium acidoclinatum* | 9 | 8 | 9 | 5 | 2 | | | * | * | 25 | 5 | * | 3 | * | 6 | | 12 | | 1 | 3 | * | 4 | * | 6 | |

*Table E1 – continued.*

| | M002 | M005 | M007 | M008 | M010 | M012 | M014 | M017 | M018 | M021 | M022 | M023 | M025 | M026 | M028 | M034 | M036 | M038 | M039 | M041 | M044 | M051 | M055 | M059 | M060 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Psammothidium altaicum* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pseudostaurosira brevistriata* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Psammothidium* cf. *frigidum* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Psammothidium daonense* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Psammothidium didymum* | | | | | | | | | | | | | | | | 6 | 5 | | | | | | | | |
| *Psammothidium helveticum* | 13 | 4 | | | 5 | | 1 | | | | | * | | | 2 | * | | * | | | 1 | | | 28 | 24 |
| *Psammothidium* cf. *kryophilum* | | | | | | | | | | | | | | | | | | | | | | | | | * |
| *Psammothidium kuelbsii* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Psammothidium levanderi* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Psammothidium* cf. *marginulatum* | | | | | | | | | | | | | | | | 31 | | | | | | | | | |
| *Psammothidium perpusillum* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Psammothidium rossii* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Psammothidium* cf. *sacculum* | | | | | 5 | | | | | | | 5 | | | | | | | | | | | | | |
| *Psammothidium scoticum* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Psammothidium* sp. 2 | | | | 1 | | 1 | 1 | | | | | | | | 4 | | | | | | | | | | |
| *Psammothidium* sp. 1 | | | | | | * | * | | | | | | | | | | | | | | | | | | |
| *Psammothidium subatomoides* | | | | | | | | * | | | | | | | | | | * | | | | | | | |
| *Psammothidium ventrale* | | | | | | | | | | | | | | | | | | * | | | | | | | |
| *Pseudostaurosira* cf. *alvareziae* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pseudostaurosira* 'false' *microstriata* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pseudostaurosira microstriata* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pseudostaurosira opacolineata* | | | 14 | | | * | | | | 7 | | 8 | | | | 48 | 35 | | 4 | 3 | | | | | |
| *Pseudostaurosira pseudoconstruens* | 1 | | | 7 | | | | | | | | 2 | | | | 29 | 11 | | | | | | | | |
| *Pseudostaurosira robusta* | | | | | | | | | | | | | | | | | | | 1 | * | | | | | |
| *Reimeria sinuata* | | | | | 4 | * | | | | | | | | | | | | | | | | 2 | | | |
| *Rhopalodia gibba* | | | * | | | | | | | | | | | | | | 1 | | * | * | * | 3 | | | |
| *Rhopalodia musculus* | | | | | | | | | | | | * | | | | | | | | | | | | | |
| *Rhopalodia rupestris* | | | | | | | | | | | | | 1 | | 42 | | | | | | | | | | |
| *Rossithidium kriegeri* | | | | | | | | | | | | | | | | | | | | | 1 | | | | |
| *Rossithidium petersenii* | 4 | 1 | | | 1 | | 3 | 1 | 1 | | | | | | * | | | * | | | | 3 | | | |
| *Rossithidium pusillum* | 9 | | | 6 | | | * | * | | 1 | 2 | 4 | | | 15 | * | 5 | 2 | | | 3 | 18 | | | |

*Table E1 – continued.*

| | M002 | M005 | M007 | M008 | M010 | M012 | M014 | M017 | M018 | M021 | M022 | M023 | M025 | M026 | M028 | M034 | M036 | M038 | M039 | M041 | M044 | M051 | M055 | M059 | M060 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Sellaphora absoluta* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Sellaphora* cf. *arvensis* | | | | | | * | | | | | | | | | | | | | | | | | | | |
| *Sellaphora* cf. *pupula* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Sellaphora* cf. *seminulum* | | | | | | | | | | | | | | | | | | | | | | | * | | |
| *Sellaphora* cf. *vitabundicta* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Sellaphora laevissima* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Naviculadicta lithos* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Sellaphora medioconvexa* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Sellaphora nigri/atomoides* complex | | | 4 | | 2 | 4 | 29 | 85 | 57 | | 7 | 8 | 33 | 39 | | 2 | | | 12 | 12 | | 11 | 44 | 3 | |
| *Sellaphora seminulum* | | | | | | * | | | | | | | | | | | | | 1 | 33 | | | | | |
| *Sellaphora* sp. 1 | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Sellaphora* sp. 2 | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Skabitschewskia oestrupii* | | | | | | | | | | | | | | | | * | | | | | | | | | |
| *Skabitschewskia peragalloi* | | | | | | | | | | | | | | | | * | * | | | | | | | | |
| *Stauroforma* cf. *inermis* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Stauroforma* cf. *subsalina* | | | | 61 | | | | | | 4 | | 7 | | | | | 99 | 165 | | | | | | | |
| *Stauroforma exiguiformis* | | | | 119 | 10 | | 1 | | | | 3 | * | | | * | 34 | 56 | * | * | 4 | | 2 | | 3 | 7 |
| *Stauroneis agrestis* | | | | | | | | | | | | | | | | * | | | | | | | | | |
| *Stauroneis amphicephala* | | | | | | | | | | | | * | | | | | | | | | | | | | |
| *Stauroneis angustilancea* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Stauroneis borrichii* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Stauroneis* cf. *heinii* | | | | | | | | | | | | | | | | * | | | | | | | | | |
| *Stauroneis* cf. *neohyalina* | | | | | * | | | | | | | | | | | | | | | | | | | | |
| *Stauroneis* cf. *subgracilis* | | | | | | * | | | | | | | | | | | | | | | | | | | |
| *Stauroneis* cf. *jarensis* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Stauroneis gracilis* | | | | | | | | | | | | | | | | | | | | | | * | | | |
| *Stauroneis leguminopsis* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Stauroneis neohyalina* | * | | | | | | | | | | | | | | | | | | | | | | | | |
| *Stauroneis producta* | | | | | | | | | | | | * | | | | | | | | | | | | | |
| *Stauroneis reichardtii* | | * | | | | | | | | | | | | | * | | | | | | | | | | 2 |
| *Stauroneis siberica* | | | | | | | | | | | | | | | | * | | | | | | | | | |

*Table E1 – continued.*

| | M002 | M005 | M007 | M008 | M010 | M012 | M014 | M017 | M018 | M021 | M022 | M023 | M025 | M026 | M028 | M034 | M036 | M038 | M039 | M041 | M044 | M051 | M055 | M059 | M060 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Stauroneis smithii* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Stauroneis* sp. 1 | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Stauroneis* sp. 2 | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Staurosira ambigua* | 16 | | 6 | | 51 | * | 8 | 185 | 67 | | 4 | 7 | 95 | 41 | | | 14 | | 73 | 64 | | 98 | 49 | | |
| *Staurosira* cf. *binodis* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Staurosira* cf. *triundulata* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Staurosira construens* | | | | | | | | | | | | | | | | | 1 | | | | | | | | |
| *Staurosira construens* var. *venter* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Staurosira* 'false' *venter* | | | | | | | | | | | | | | | | 57 | 8 | 25 | | | | | | | |
| *Staurosira neoproducta* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Staurosira* 'small' *venter* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *staurosira* sp. 1 | | | | | | | | | | | | | | | | 3 | | | | | | | | | |
| *Staurosira* sp. 2 | | | | | | | | | | | | | | | | 2 | 20 | | | | | | | | |
| *Staurosira* sp. 3 | | | | 1 | | | | | | | | * | | | | 33 | | | | | | | | | |
| *Staurosira tabellariae* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Staurosirella binodiforme* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Staurosirella* cf. *lapponica* | | | | 7 | | | | | | * | | | | | | | | | | | | | | | |
| *Staurosirella jonssoniana* | | 1 | | | 2 | | | | | | | * | | | | 11 | 35 | | 1 | * | | | | | |
| *Staurosirella pavinensis* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Staurosirella* sp. 1 | | | | | | | | | | | 3 | * | | | | 16 | 21 | | | | | | | | |
| *Staurosirella* sp. 2 | | | | | | | | | | * | | | | | | | | | | | | | | | |
| *Staurosirella* sp. 3 | | | | | | | | | | | | | | | 1 | | * | | | | | | | | |
| *Staurosirella* sp. 4 | | | | | | | | | | | | * | | | | | | | | | | | | | |
| *Surirella amphioxys* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Surirella roba* | 2 | | | | | | | | | | | | | | | * | | | | | | | | | |
| *Surirella* sp. 1 | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Surirella terricola* | | | | | | | | | | | | | | | | | | | | | 1 | | | | |
| *Tabellaria fenestrata* | | | | | | | | | * | | | | | | | 2 | | | | | | * | | | |
| *Tabellaria flocculosa* | 3 | | | 15 | 1 | * | 1 | | * | 76 | 1 | 17 | | | 4 | | 7 | 12 | * | * | 3 | 3 | | | 1 |
| *Tetracyclus emarginatus* | | | | | | | | * | * | | | | | | | * | | | | | | | | | |
| *Tryblionella angustata* | | | | | | | | | * | | | * | | | | * | | * | | | | | | | |

*Table E1 – continued.*

| | M002 | M005 | M007 | M008 | M010 | M012 | M014 | M017 | M018 | M021 | M022 | M023 | M025 | M026 | M028 | M034 | M036 | M038 | M039 | M041 | M044 | M051 | M055 | M059 | M060 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Ulnaria* sp. | 2 | | | | | | | * | | | | | 1 | 14 | | 2 | | 1 | 8 | 1 | 1 | 1 | 5 | | |
| *Ulnaria ulna* | | | | | | | | | | | | | | | | | | | | | | | | | |
| *incerta sedi* | | | | | | | | | | | | | | | | | | | | | | | | | |

*Table E2: Diatom counts for all aquatic samples (seepages, streams, pools, rivers, and waterfalls) included in this study. An asterisk (*) indicates that the taxon was observed in the sample but was not included in the valve count.*

| | W001 | W003 | W005 | W006 | W007 | W008 | W009 | W011 | W012 | W013 | W014 | W016 | W019 | W021 | W022 | W023 | W024 | W026 | W027 | W028 | W030 | W031 | W033 | W034 | W035 | W037 | W039 | W040 | W043 | W044 | W046 | W048 | W050 | W052 | W054 | W055 | W058 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Achnanthes carissima* | | | | | | | | | | | | | | | | | | | 4 | | | | | | | | | | | | | | | | | | |
| *Achnanthes coarcata* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Achnanthidium minutissimum* | 2 | | * | 18 | | 12 | 6 | | | | | | | | 45 | | | 27 | 3 | 132 | * | | 9 | 3 | 30 | | | | 13 | | 15 | 39 | 8 | 80 | 1 | 70 | 168 |
| *Achnanthidium modestiforme* | | | | | | | | | | | | | 10 | | | | | 147 | | | | | | | | | | | | | | | 3 | | | | |
| *Achnanthidium nolii* | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | |
| *Achnanthidium* sp. 1 | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | |
| *Achnanthidium* sp. 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Achnanthidium tropicocatenatum* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 |
| *Adlafia bryophila* | | | | | | | | | | | | | * | | | | * | * | 2 | | | | | 2 | | | | | | 48 | 20 | | | | | | |
| *Adlafia detenta* | | | | | | | | | * | | | | | | | | | | | | | | | | | | | | | | * | | | | | | |
| *Adlafia minuscula* | | | 5 | * | | | | | | | | | * | | | | 4 | 3 | 1 | | | | | | | * | | | | | 5 | * | | | | | |
| *Adlafia suchlandtii* | | | 2 | | | | | 1 | * | 1 | | 1 | | | | * | 1 | 8 | 1 | * | | | | 1 | | 4 | | | 12 | | 3 | | 8 | | | | |
| *Amphora copulate* | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | |
| *Amphora inariensis* | | | | | | | | | 4 | | | | | | | * | 6 | | | | | | | | | 2 | | | | | 2 | * | | | | * | |
| *Amphora lange-bertalotii* var. *tenuis* | | | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | | * | | | | 2 | |
| *Amphora parallelistriata* | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | | | | | | | | | | * | |
| *Amphora pediculus* | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | | |
| *Aulacoseira alpigena* | | 1 | 6 | | | | 81 | | * | 2 | 17 | | 332 | | | 6 | 8 | | | | | | | 11 | 22 | 13 | | | | 1 | 23 | 4 | 13 | | | * | |
| *Aulacoseira italica* | | | | | | | | | | | | | | | 15 | | | | 1 | | | | | | | | | | | | | | | | | | |
| *Aulacoseira nivalis* | | | | 7 | | | | | | | 10 | | | | | | | | | | | | | * | 2 | * | | | | | | | | | | * | |
| *Aulacoseira* sp. | | | | | | | | 8 | | | | 13 | | | 81 | | 1 | | 7 | | | 6 | | | | | | | | | | | | | | | |
| *Aulacoseira westfjordensis* | | | | | | | | | | | | | | | | | | | | 6 | | | 11 | | | | | | 9 | | | | | | | | |

*Table E2 – continued.*

| | W0 01 | W0 03 | W0 05 | W0 06 | W0 07 | W0 08 | W0 09 | W0 11 | W0 12 | W0 13 | W0 14 | W0 16 | W0 19 | W0 21 | W0 22 | W0 23 | W0 24 | W0 26 | W0 27 | W0 28 | W0 30 | W0 31 | W0 33 | W0 34 | W0 35 | W0 37 | W0 39 | W0 40 | W0 43 | W0 44 | W0 46 | W0 48 | W0 50 | W0 52 | W0 54 | W0 55 | W0 58 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Brachysira confusa* | | | 11 | 36 | 131 | 1 | 9 | 2 | | | 3 | 4 | * | 3 | 1 | | | | | | 3 | | 3 | | 1 | * | | | 6 | 7 | | * | | | | | 2 |
| *Brachysira decipiens* | | | | 5 | 74 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Brachysira elisabethiana* | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | |
| *Brachysira louiseboydiana* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 16 |
| *Brachysira microcephala* | | | | 28 | | | 15 | | | | 1 | 2 | | | | | | | | 38 | | | 3 | | 3 | | | | 1 | | | 5 | | 6 | | 13 | 43 |
| *Brachysira neoexilis* | | 3 | | | | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | | | |
| *Brachysira zellensis* | | | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | | 1 | | | | | |
| *Caloneis* sp. 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | 4 | | | | |
| *Caloneis* sp. 1 | | 9 | | | | 5 | | | | | | | | | | | | 4 | | | | | | * | 1 | | | | | | | | | | | * | |
| *Caloneis* sp. 3 | | | | | | | | | | | | | * | | | | | 7 | | | | | | | | | | | | | | | | | | 3 | |
| *Caloneis tenuis* | | | | | | | | | * | | | | 2 | | | * | | 7 | | | | | 1 | | | * | | | | | * | * | 6 | 6 | 23 | | |
| *Caloneis undulata* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | |
| *Cavinula cocconeiformis* | 3 | | | * | | 8 | | | | | 1 | | | | | | | 4 | | 1 | 13 | | 2 | | * | | | | 2 | * | * | * | | 14 | | * | 1 |
| *Cavinula jaernefeltii* | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | | | | | | | |
| *Cavinula mollicula* | | | | | | | | | | | | | | | | | | | | | | | | 10 | | | | | | | | | | | | | |
| *Cavinula pseudoscutiformis* | | | | | | | | | | | | | | | | | | | 2 | | | 3 | 7 | 6 | * | | | | | | | | | | | 6 | |
| *Cavinula pusio* | | | | | | | | | | | | | | | | | | | | | | | 1 | | | * | | | | | | | | | | | |
| *Cavinula variostriata* | | | | | | * | | | * | * | 2 | | * | * | | | * | 9 | | | | | | 2 | 4 | * | | | | 4 | 2 | * | 6 | | | | |
| *Chamaepinnularia begeri* | | | | | 34 | 18 | | | | | | | | | | * | | | | | * | | | 2 | | | | | | | | | 2 | | | | |
| *Chamaepinnularia* cf. *hassiaca* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Chamaepinnularia evanida* | | | 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 4 | | | | | | |
| *Chamaepinnularia gandrupii* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Chamaepinnularia hassiaca* | | | | | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 7 | |
| *Chamaepinnularia krookii* | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | | | | | | | | | | | |
| *Chamaepinnularia mediocris* | | 38 | | 2 | | 11 | 21 | | * | | 92 | | | | | | | 2 | | | | | | | 7 | | | | | 16 | | | | 4 | | | |
| *Chamaepinnularia obsoleta* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Chamaepinnularia* sp. 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Chamepinnularia soehrensis* | | | | * | | | | | | | | | | 3 | | | | | | | | | | | | | | | | | | | | | | | |
| *Cocconeis fetscheriana* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Cocconeis scutellum* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Cocconeis* sp. 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 15 | * |

*Table E2 – continued.*

| | W0 01 | W0 03 | W0 05 | W0 06 | W0 07 | W0 08 | W0 09 | W0 11 | W0 12 | W0 13 | W0 14 | W0 16 | W0 19 | W0 21 | W0 22 | W0 23 | W0 24 | W0 26 | W0 27 | W0 28 | W0 30 | W0 31 | W0 33 | W0 34 | W0 35 | W0 37 | W0 39 | W0 40 | W0 43 | W0 44 | W0 46 | W0 48 | W0 50 | W0 52 | W0 54 | W0 55 | W0 58 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Cocconeis* sp. 2 | | | | | | | | | * | | | | | | | | | | | | | | | | | 1 | | | | | | 1 | | | | | |
| *Cosmioneis pusilla* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | | | |
| *Craticula acidoclinata* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Cymbella* cf. *cymbiformis* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Cymbella* cf. *vulgata* | | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | | | | | | | | |
| *Cymbella cymbiformis* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Cymbella excisiformis* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | 12 |
| *Cymbella lange-bertalotii* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | |
| *Cymbella* sp. | | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | | | | | | | | |
| *Cymbopleura apiculata* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Cymbopleura naviculiformis* | | | | | | | 5 | | | | | | | | | | | | | | | 2 | 2 | * | | | | | | | | | 1 | | * | |
| *Cymbopleura subcuspidata* | | | | | | | | | | | | | | | | | | | | | | | | * | | * | | | | | | | | | | * | |
| *Denticula kuetzingii* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Diatoma tenuis* | 6 | | | | | | | | | | | | | | | | | | | | | | 5 | | | | | | | | | | | | | | |
| *Diatomella balfouriana* | | | | | | | | | 2 | | | | | | | * | | | | | | | | | | 1 | | | | | | 10 | 8 | | | | |
| *Dickieia tackei* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 4 | |
| *Diploneis calcifuga* | | | | * | | | | | * | | | | | | | | | 5 | | | | | | | * | * | | | | | 1 | 3 | | | * | |
| *Diploneis dilatatafalsa* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Diploneis ovalis* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Diploneis* sp. | | | | | | | | | | | | | | | | | | | | * | | | | | | | | | | | | | | | | |
| *Diploneis ultimathule* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 8 | | |
| *Encyonema brevicapitatum* | | | | * | | | | | | | | | | | | | | | | | | | | | * | | | | | | 5 | | | | | |
| *Encyonema cepitosum* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | |
| *Encyonema elginense* | | | | | 6 | | 29 | | | | | | | | | | | | | | | | | | * | | | | | | | | | | | * | |
| *Encyonema jemtlandicum* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Encyonema lunatum* | | | 18 | 13 | 2 | 32 | 21 | | | * | | 1 | 1 | | | | | 5 | | | | | | * | 2 | 2 | | 1 | 9 | 66 | * | | 6 | | | * | |
| *Encyonema minutum* complex | | | | | | | | | | | 5 | | | | | | | | | | | | 8 | * | | | | 2 | | | 4 | | | | | * | |
| *Encyonema neogracile* | | | | * | | | | | | * | | | | 22 | | | | | | | | | | | 2 | | | | | | | | | 3 | | * | |
| *Encyonema norvegicum* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Encyonema pergracile* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | |
| *Encyonema silesiacum* | 12 | | | 3 | | | | 6 | 2 | | 4 | 1 | | | | 3 | 1 | | | | | 1 | | | * | 2 | | | 2 | | * | 3 | | | | | 2 |

*Table E2 – continued.*

| | W0 01 | W0 03 | W0 05 | W0 06 | W0 07 | W0 08 | W0 09 | W0 11 | W0 12 | W0 13 | W0 14 | W0 16 | W0 19 | W0 21 | W0 22 | W0 23 | W0 24 | W0 26 | W0 27 | W0 28 | W0 30 | W0 31 | W0 33 | W0 34 | W0 35 | W0 37 | W0 39 | W0 40 | W0 43 | W0 44 | W0 46 | W0 48 | W0 50 | W0 52 | W0 54 | W0 55 | W0 58 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Encyonema silesiacum* s.l. | | | | | | | | | | 3 | | | | | | | | | | | | | | * | | | | | | | | | | | | | |
| *Encyonema simile* | | | | | | | | | | | | | | | | | | | | | | | | * | * | | | | | | 1 | * | | | | | |
| *Encyonema* sp. 1 | | | | | | | | | | | | | | | * | | | | | 2 | | | | | | | | | | | | | | | | | 5 |
| *Encyonema* sp. 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Encyonema* sp. 3 | | | | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Encyonema* sp. 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Encyonema* sp. 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | | | | * | |
| *Encyonema vulgare* | | | | * | | | | | | | | | | | | | | 1 | | | | | | | * | | | | | | | | | | | | |
| *Encyonopsis cesatii* | | | | * | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | | | | | | |
| *Encyonopsis* cf. *descripta* | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | | | | | | 6 | | 1 | |
| *Encyonopsis* cf. *tavirana* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 14 | | | | | |
| *Encyonopsis falaisensis* | | | | 3 | 2 | 6 | * | | | | | | | | 1 | | | 9 | | 4 | | | | | | | | | 8 | | | 6 | 20 | | | |
| *Encyonema gaeumanii* | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | | | * | | | 4 | | 2 | |
| *Encyonopsis grunowii* | | | | * | 3 | * | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | * | |
| *Encyonopsis* sp. 1 | | | | * | | | 14 | | | | * | | | | | | | 1 | | | | | | | | | | | | | | | | | | | |
| *Encyonopsis* sp. 2 | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | | | | | | |
| *Encyonopsis subminuta* | | | | | | | | | | | | | | | | | | * | | | | | | | * | | | | | | | | | | | 3 | |
| *Epithemia adnata* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | |
| *Epithemia argus* | | | | | | | | | | | | | | | | | | | | | | | | | * | * | | | | | | * | | | | | |
| *Epithemia sorex* | | | | | | | | | | | | | | | | | | 3 | | | | | | | | | | | | | | * | | | | | |
| *Eucocconeis* sp. | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | 2 | 4 | | | |
| *Eunotia arcus* | | 2 | | | | | | | * | 1 | | | | | | | | | | | | | | * | | | | | | | * | | 4 | | | | |
| *Eunotia bidens* | | 2 | | | | 29 | | | | * | * | | | | | | | | | | 6 | | | * | | | | | | | | * | | | | | |
| *Eunotia bigibboidea* | | | | | | | | | | | | | | | | | | | | | * | | | | | | | | | | | | | | | | |
| *Eunotia bilunaris* | | | | | | | | | | 4 | 7 | | 1 | 5 | | 6 | * | | | | 46 | | | * | | 1 | | | | * | | * | 1 | | 1 | | |
| *Eunotia botuliformis* | | 2 | 2 | 3 | | | | | | | | | | | | | | 8 | | | | | 3 | | * | | | | 1 | | | | 2 | | | | |
| *Eunotia* cf. *ambivalens* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Eunotia* cf. *arcus* | | | | | | | | | | | | | | | 9 | | | | | | | | | | | | | | | | | | | | | | |
| *Eunotia* cf. *zackenbergensis* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Eunotia curtagrunowii* | | 16 | 6 | | 1 | 29 | * | | | * | 8 | | | | | | * | * | | | 31 | | 1 | * | 3 | | | | | * | * | * | | 5 | 201 | 2 | |
| *Eunotia exigua* | 1 | 5 | * | | | | | | | | * | | | | | | | | | | | | | | | | | | | | | | | | | | |

*Table E2 – continued.*

| | W0 01 | W0 03 | W0 05 | W0 06 | W0 07 | W0 08 | W0 09 | W0 11 | W0 12 | W0 13 | W0 14 | W0 16 | W0 19 | W0 21 | W0 22 | W0 23 | W0 24 | W0 26 | W0 27 | W0 28 | W0 30 | W0 31 | W0 33 | W0 34 | W0 35 | W0 37 | W0 39 | W0 40 | W0 43 | W0 44 | W0 46 | W0 48 | W0 50 | W0 52 | W0 54 | W0 55 | W0 58 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Eunotia glacialispinosa* | 1 | | | | | | | | | | | | | | | | * | | | | | | | | | | | | | | | | | | | | |
| *Eunotia groenlandica* | | 15 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Eunotia implicata* | | | | | | | 1 | | | | * | | 3 | | | * | | | | | | | | * | | 1 | | | | | * | | 9 | | | | |
| *Eunotia incisa* | | | | | * | | | | | | 2 | | | 41 | | | | | | | | | | * | 4 | | | | | * | | 1 | 2 | | | | |
| *Eunotia islandica* | 3 | 5 | 7 | 6 | | 18 | 2 | | | * | 1 | | | | | | | | | | 7 | | | | | | | | | | | | | 6 | 8 | * | |
| *Eunotia metamonodon* | | | | 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Eunotia minor* | * | | | 6 | | | | 1 | | | 2 | 44 | 2 | | | 4 | 3 | | | 19 | | | | * | | | | 1 | 13 | | | | 2 | | | 2 | |
| *Eunotia mucophila* | | | | 2 | | | | | | | | | | 202 | | 1 | | | | | | | | | | | | | | | | | | | | | |
| *Eunotia neocompacta* | | | | | | | | | | | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | |
| *Eunotia neocompacta* var. *vixcompacta* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Eunotia neoscandinavica* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 10 | | |
| *Eunotia nymanniana* | | | | | * | | | | | | | | | | | | | | | | 37 | | | | * | * | | | | | | | | | | |
| *Eunotia papiliofalsa* | | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | | | | | | | | |
| *Eunotia paratridentula* | | | | | | | 14 | 2 | | * | 7 | 11 | * | | 1 | | | | | | | | | * | 1 | | | | 18 | | | | 2 | | | | |
| *Eunotia praerupta* | | | | | | | | | | | 1 | | | | | | | | 1 | | | | | | | | | | | | | | | | | | |
| *Eunotia pseudogroenlandica* | | | | | | | | | | | | | | 32 | | | | | 1 | | | | | | | | | | | | | | | | | | |
| *Eunotia diadema* | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Eunotia* sp. 1 | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | 2 | | | | | | | | |
| *Eunotia* sp. 2 | | | | | | | | | | | | 6 | | | | | | | | | | | | | | | | | 1 | | | | | | 3 | | 1 |
| *Eunotia* sp. 3 | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | | | | | 1 |
| *Eunotia tetradon* | | | | | | | 4 | | | | | | * | | | | | | | | | | | * | | | | | | | | | | | | |
| *Eunotia triodon* | | | | | | | | | | | * | 1 | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Eunotia valida* | | 6 | | 6 | * | 12 | 1 | | | | 1 | | | | | | | | | | | | | | 4 | | | | | | | | | 2 | | | |
| *Eunotia zackenbergensis* | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | | | | | | | | |
| *Fallacia vitrea* | | | | 10 | 73 | | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | | |
| *Fragilaria* cf. *acerosa* | | | | | | | | | | | | | | | 2 | * | | | 1 | | | | | | | | | | 4 | | | | | | | | |
| *Fragilaria* cf. *amphicephaloides* | | | | | | | | | | | | | | | | 27 | | | 7 | | | 2 | | | | | | | | | | | | 106 | | 33 | |
| *Fragilaria* sp.1 | 37 | | 12 | 3 | | | | 43 | | 1 | 8 | | 8 | | 33 | 32 | 8 | 1 | 8 | 4 | | 11 | 6 | 7 | 24 | 12 | | 45 | | | 6 | 1 | 23 | | | | 26 |
| *Fragilaria* sp. 2 | | | | | | | | | | | 9 | 81 | | | | | 1 | | | | | | | | | | | | 73 | | | | | | | | 1 |
| *Fragilaria* sp. 3 | 4 | | 63 | 7 | | | | | | | | | 4 | | 4 | | | 5 | | 58 | | | 16 | 7 | 3 | 9 | | | | | | 7 | 21 | | | | 13 |
| *Fragilariforma virescens* | | | | | | | | | | 90 | 20 | 12 | * | | | | | | | | | | | * | | * | | | 11 | | | | 10 | | | | |

*Table E2 – continued.*

| | W0 01 | W0 03 | W0 05 | W0 06 | W0 07 | W0 08 | W0 09 | W0 11 | W0 12 | W0 13 | W0 14 | W0 16 | W0 19 | W0 21 | W0 22 | W0 23 | W0 24 | W0 26 | W0 27 | W0 28 | W0 30 | W0 31 | W0 33 | W0 34 | W0 35 | W0 37 | W0 39 | W0 40 | W0 43 | W0 44 | W0 46 | W0 48 | W0 50 | W0 52 | W0 54 | W0 55 | W0 58 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Fragilariforma undata* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Frustulia crassinervia* | 2 | 135 | 73 | 4 | 33 | 68 | 14 | | | | | 1 | | | 1 | | | 1 | | | 2 | | | * | 2 | | | | 5 | 18 | | | | 2 | | | |
| *Frustulia saxonica* | | | | 24 | | | 8 | | | | | | | 7 | | | | 2 | | | | | | | | | | | | | | | | | | |
| *Frustulia vulgaris* | | | 14 | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | 1 | | | | | |
| *Gedaniella* sp. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Geissleria acceptata* | | | | | | | | | | | | | | | | | 5 | | | | | | | | | 1 | | | | | | | | | | | |
| *Geissleria* cf. *similis* | | * | | * | | | | | | | | | | | | | | 2 | | | 3 | | | | | | | | | | | | | | | |
| *Geissleria schoenfeldii* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Geissleria similis* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Genkalia digitulus* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | 2 | |
| *Genkalia digituloides* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Gomphonema acuminatum* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 6 | |
| *Gomphonema acutuisculum* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | |
| *Gomphonema angusticephalum* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 4 | |
| *Gomphonema bozenae* | | | | | | | 6 | | | | * | | | | | | | | | 78 | 10 | | | | | * | | | | * | | | | | 2 | * | |
| *Gomphonema brebissonii* | | | | | | | | | | | * | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Gomphonema calcifugum* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Gomphonema* cf. *angustatum* | | | | | | | | | | | * | | | | | | | | | | | | | | | 3 | | | | | | | | | | | |
| *Gomphonema* cf. *pseudotenellum* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 24 | |
| *Gomphonema* cf. *sacrophagus* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Gomphonema commutatum* | | | | | | | | | | 2 | 5 | | 1 | | | | | | | | | | | | 3 | * | | | | * | | | 10 | | | | |
| *Gomphonema coronatum* | | | | * | | | | | | | * | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Gomphonema duplipunctatum* | | | 22 | | | | | | | 1 | | | | | | * | 2 | 4 | | | | | | | * | * | | 1 | | | | | | | | | |
| *Gomphonema exilissimum* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 10 | |
| *Gomphonema hebridense* | | | | * | 1 | | | | | | | | | 3 | | | | | | | | | | | | | | | | | | * | | | | | |
| *Gomphonema innocens* | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | | | | | | | | |
| *Gomphonema lapponicum* | | 1 | | 2 | * | 16 | | | | | | | | | | | | | | | | | | | * | | | | | | | | | | | | |
| *Gomphonema montanum* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | |
| *Gomphonema parvulius* | | | | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Gomphonema productum* | | | | | | | | | | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Gomphonema reichardtii* | | | | | | | | | | | * | | | | | | | | | | | | 1 | | | | | | | | | | | | | | |

*Table E2 – continued.*

| | W0 01 | W0 03 | W0 05 | W0 06 | W0 07 | W0 08 | W0 09 | W0 11 | W0 12 | W0 13 | W0 14 | W0 16 | W0 19 | W0 21 | W0 22 | W0 23 | W0 24 | W0 26 | W0 27 | W0 28 | W0 30 | W0 31 | W0 33 | W0 34 | W0 35 | W0 37 | W0 39 | W0 40 | W0 43 | W0 44 | W0 46 | W0 48 | W0 50 | W0 52 | W0 54 | W0 55 | W0 58 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Gomphonema* sp. 1 | 3 | | 4 | | | | | 1 | | | | 2 | | | 1 | 6 | | | 2 | 4 | | | * | | | | | | 3 | | | | | | | |
| *Gomphonema* sp. 2 | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Gomphonema* sp. 3 | | | | | | | | | | | | | | | | | * | | | | | | | | | | | | | * | | | | | | 1 |
| *Gomphonema* sp. 4 | | | | 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Gomphonema* sp. 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Gomphonema subclavatum* | | | | | | | | | | | * | | | | | | * | | | | | | | | | | | | | | | | | | | | |
| *Gomphonema subtile* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Halamphora dusenii* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | |
| *Halamphora oligotaphenta* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | 1 | | | | 1 | |
| *Hannaea arcus* | * | | | | | | | 1 | | | 1 | | | | 1 | 6 | 3 | | | | | | | 1 | 39 | 1 | 2 | | 16 | | | * | 2 | | | | 3 |
| *Hannaea linearis* | | | | | | | | | | | | | | | 2 | | | | 3 | | | | 28 | | | | | 6 | | | | | | | | | 40 |
| *Hantzschia abundans* | | | | | | | | | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Hantzschia amphioxys* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Hantzschia calcifuga* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 4 | | |
| *Hantzschia* sp. 1 | | | | | | | | | | | | | | | | | | 8 | | | | | | | | | | | | | | | 1 | | * | | |
| *Hantzschia* sp. 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Humidophila arctica* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | |
| *Humidophila contenta* | | 2 | * | * | 2 | 5 | | | | | 13 | | | | | * | 1 | 3 | | | 20 | | | * | 41 | * | | | | | 4 | | 1 | | | * | |
| *Humidophila eldfjalli* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Humidophila flotowii* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Humidophila gallica* | | 1 | | | | | | | | 29 | 1 | | | | | | | | | | | | | | | 1 | | | | | | | | | | | |
| *Humidophila laevissima* | | | | | | | | | | 22 | | | | | | * | 1 | | | | | | | | | | | | | | | * | | | | | |
| *Humidophila mochalovae* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Humidophila paracontenta var. magisconcava* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Humidophila perpusilla* | 3 | | 4 | | | | | 1 | * | 28 | 4 | 3 | 1 | 1 | | 1 | 2 | 9 | | 1 | | | 8 | | 49 | 5 | | | 1 | * | 3 | * | 15 | | | 4 | |
| *Humidophila schmassmannii* | | | | * | | | | | | | 1 | | 2 | | 47 | | 8 | | | | | | | | 1 | | | | | | 17 | 1 | 2 | | | | |
| *Humidophila* sp. 1 | 1 | | | | | | | | | | | 2 | | | | | | | | | | | | | | | | | 3 | | | | | | | | |
| *Humidophila* sp. 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Hygropetra balfouriana* | 7 | | 1 | | | | | | * | | 4 | | | | 2 | 1 | 3 | | | 2 | | | | | | 2 | | | 1 | | 18 | 20 | 22 | | | | |
| *Karayevia laterostrata* | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | |
| *Karayevia nitidiformis* | | | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | * | * | | | | | |

*Table E2 – continued.*

| | W0 01 | W0 03 | W0 05 | W0 06 | W0 07 | W0 08 | W0 09 | W0 11 | W0 12 | W0 13 | W0 14 | W0 16 | W0 19 | W0 21 | W0 22 | W0 23 | W0 24 | W0 26 | W0 27 | W0 28 | W0 30 | W0 31 | W0 33 | W0 34 | W0 35 | W0 37 | W0 39 | W0 40 | W0 43 | W0 44 | W0 46 | W0 48 | W0 50 | W0 52 | W0 54 | W0 55 | W0 58 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Karayevia suchlandtii* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | |
| *Kobayasiella parasubtilissima* | | | | 7 | 21 | | * | | | | | | | 49 | | | | | | | | | | * | | | | | | | 3 | | 4 | | | | |
| *Krasskella kriegeriana* | | | | 6 | 4 | | 4 | | | | | | | | | | | 4 | | | | | | | 2 | | | | | 33 | | * | | | | | |
| *Lindavia antiqua* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | |
| *Liparogyra spinosa* | | | | | | | | | | 1 | | | | | | | * | | | | | | | | | | | | | | | | | | | | |
| *Luticola* cf. *aequalis* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Luticola* cf. *ignorata* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Luticola frequentissima* | | | | | | | | | | | * | | | | | | | 1 | | | | | | | * | | | | | | 1 | | | | | | |
| *Luticola* sp. | | | | | | | | | | | | | | | | | | | | | | | | | | | | 4 | | | | | | | | | |
| *Meridion circulare* | 160 | | | | | | | 88 | 19 | 188 | 3 | | * | | 9 | 28 | 7 | 4 | 3 | | | | 1 | | 15 | 14 | 352 | 299 | 27 | | 8 | 8 | 63 | | | | |
| *Meridion constrictum* | 8 | | | | | | | 34 | * | 15 | | 3 | 9 | | | 14 | * | | | 1 | | | | | 1 | | | | 5 | 1 | 6 | 2 | 33 | | | | |
| *Microcostatus naumanii* | | 4 | | | | | | | | | * | | | | | | | | | | 1 | | | | | | | | | | | | | | | | |
| *Microcostatus zackenbergensis* | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Muelleria linearis* | | | | | | | | | | | | | | | | | | * | | | | | | | | | | | | | * | | | | | |
| *Nanofrustulum cataractarum* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Nanofrustulum fogedii* | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Nanofrustulum sp* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Navicula angusta* | | | | 5 | 1 | 19 | | | | | | | | | * | | | 3 | | | | | | 4 | | | | | | | 2 | | | | | |
| *Navicula* cf. *tenelloides* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | |
| *Navicula cryptotenella* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 14 | | | | | | |
| *Navicula exilis* | | | | | | | | 1 | | | | | | | 3 | * | 1 | 2 | | 2 | | | | 1 | 1 | 2 | | 1 | 6 | | 8 | | * | 3 | | | |
| *Navicula hanseatica* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | 1 | |
| *Navicula heimansoides* | | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | | | | | | | | |
| *Navicula pseudobryophila* | | | | | | | | | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Navicula radiosa* | | | 1 | * | | | 1 | | 3 | | | | * | | | | | 2 | | | | 2 | | * | * | * | | | | | * | 3 | 2 | | * | * | |
| *Navicula rhynchocephala* | | | | | | | | | | | | | | | | | 1 | | | | | | | | | * | | | | | | | | | | * | |
| *Navicula slesvicensis* | | | | | | | | | | | | | | | | | * | | | | | | | | | | | | | | | | | | | | |
| *Neidium affine* | | | | | | | * | | | | | | | | | | | | | | | | | * | | | | | | | | | | | | 2 | |
| *Neidium ampliatum* s.l. | | | | * | | | | | | | | | | | | | | | | | 2 | | | | | | | | | | | | | | | | |
| *Neidium bisulcatum* | | | 1 | * | 1 | | * | | | | | | | | | | | 1 | | | | | | * | | | | | | | 2 | | | | | |
| *Neidium longiceps* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | | | |

*Table E2 – continued.*

| | W0 01 | W0 03 | W0 05 | W0 06 | W0 07 | W0 08 | W0 09 | W0 11 | W0 12 | W0 13 | W0 14 | W0 16 | W0 19 | W0 21 | W0 22 | W0 23 | W0 24 | W0 26 | W0 27 | W0 28 | W0 30 | W0 31 | W0 33 | W0 34 | W0 35 | W0 37 | W0 39 | W0 40 | W0 43 | W0 44 | W0 46 | W0 48 | W0 50 | W0 52 | W0 54 | W0 55 | W0 58 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Neidium septentrionale* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | | | |
| *Neidium* sp. 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 5 | | | | | | | * | |
| *Neidium* sp. 2 | | | | * | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | |
| *Neidium* sp. 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Neidium* sp. 4 | | | | | | | | | | | | | | | | | | | | | * | | 1 | | | | | | | | | | | | | | |
| *Neidium* sp. 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Nitzschia alpinobacillum* | | | | | | | | | 7 | | | | | | | | | | | | | | | 5 | | * | | | | | | 17 | | | | * | |
| *Nitzschia bryophila* | | | | 3 | | | 4 | | 6 | | | | | | | | | | 1 | | | 2 | 8 | | * | | | | 10 | 9 | 15 | | | | | | |
| *Nitzschia* cf. *incognita* | | | | | * | | | | | | | | 2 | | | | | 3 | | | | | | | | 10 | | | | | | | | 1 | 6 | | |
| *Nitzschia* cf. *perminuta* | | | * | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | | | | | | |
| *Nitzschia dissipata* | | | | | | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Nitzschia gandersheimiensis* | | | | | | | | | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Nitzschia hantzschiana* | 2 | | | | | | | | | 2 | 1 | | * | | | | 6 | | | | | | | | | 2 | | | | | 46 | 5 | 10 | 7 | | 4 | |
| *Nitzschia perminuta* | 3 | | 3 | 14 | 2 | 7 | 6 | 2 | 24 | | | | | 13 | 1 | 2 | * | 11 | 6 | 2 | 6 | 1 | 10 | | | * | | 2 | 20 | 157 | | 7 | | 12 | 35 | * | |
| *Nitzschia pura* | | | | | | | | | | | | | | | | | | | | | | | | 4 | | | | | | | | | | | | | |
| *Nitzschia radicula* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | |
| *Nitzschia soratensis* | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | | | 2 | |
| *Nitzschia* sp. 1 | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | * |
| *Nitzschia subtilis* | | | | | | | 3 | | | | | | | | | | | | | | | | | | | | | | | | 10 | | | 6 | | 7 | |
| *Nitzschia valdestriata* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | 6 | |
| *Nupela impexiformis* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | |
| *Odontidium hyemale* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Odontidium mesodon* | 69 | | 79 | 4 | | | | 13 | 25 | 1 | 9 | 12 | * | | 1 | 153 | 89 | 1 | | 2 | | | | 1 | | 46 | 46 | 3 | 9 | | 2 | 1 | 2 | | | | |
| *Pinnularia biceps* | | | | * | * | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pinnularia borealis* | | 2 | 3 | | | | | | | | 10 | | | | | | * | 2 | | | | | | | | | | | | * | | | | | 3 | | |
| *Pinnularia* cf. *subanglica* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | |
| *Pinnularia* cf. *subpulchra* | | | | | | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 4 | 22 | | |
| *Pinnularia* cf. *viridiformis* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | | |
| *Pinnularia* cf. *isselana* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pinnularia decrescens* | | | | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pinnularia divergens* | | | | * | * | | 1 | | | | | | | | | | | | | | | | 2 | | | * | | | | | 1 | | | | | | |

*Table E2 – continued.*

| | W0 01 | W0 03 | W0 05 | W0 06 | W0 07 | W0 08 | W0 09 | W0 11 | W0 12 | W0 13 | W0 14 | W0 16 | W0 19 | W0 21 | W0 22 | W0 23 | W0 24 | W0 26 | W0 27 | W0 28 | W0 30 | W0 31 | W0 33 | W0 34 | W0 35 | W0 37 | W0 39 | W0 40 | W0 43 | W0 44 | W0 46 | W0 48 | W0 50 | W0 52 | W0 54 | W0 55 | W0 58 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Pinnularia frequentis* | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pinnularia intermedia* | | | | | | | | | | | | | | | | | * | 1 | | | | | | | 2 | 14 | | | | 4 | | | | 4 | | | |
| *Pinnularia lunata* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pinnularia microstauron* var. *rostrata* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pinnularia nodosa* | | | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | * | | | | | | |
| *Pinnularia obscura* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pinnularia paravulissima* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | |
| *Pinnularia peracuminata* | | | | | | 41 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | 40 | | |
| *Pinnularia pseudodivergentissima* | | | 5 | 2 | * | | 4 | | | | | | | | | | | 2 | | | | | | | | | | | | | | | | | | | |
| *Pinnularia rumrichiae* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pinnularia rhombarea* | | | | | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | |
| *Pinnularia septentrionalis* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | * | | | | | |
| *Pinnularia sylvatica* | | | * | | | 25 | 7 | | | | | | | | 1 | | * | 7 | | | | | | | * | | | | | 22 | | | 4 | | | | |
| *Pinnularia sinistra* | | 3 | 16 | 7 | 3 | * | 1 | | 1 | * | 3 | | | | | * | * | 5 | 1 | | 9 | | | * | | * | | | | 2 | | | | | | | |
| *Pinnularia* sp. 1 | 1 | | | | | | | | | | | | | | | | 2 | | | | | | | | | | | | | | | | | | | | |
| *Pinnularia* sp. 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | | | | | | |
| *Pinnularia* sp. 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pinnularia* sp. 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pinnularia* sp. 5 | | | | | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pinnularia* sp. 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pinnularia stomatophora* | | | | 2 | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pinnularia subanglica* | | | | | | | | | | | | | | | | | | | | | 2 | | | * | | | | | | | | | | | | | |
| *Pinnularia subcapitata* | | | | | | | | | | | | 2 | | | | | | | | | | | | | | | | | 2 | | | | | | | | 1 |
| *Pinnularia subgibba* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | |
| *Pinnularia viridiformis* | | | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 7 | | | | |
| *Pinnularia viridiformis* var. *minor* | | | 21 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | |
| *Placoneis amphibola* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 27 | | |
| *Placoneis navicularis* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 6 | | |
| *Placoneis* sp. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Planothidium boyei* | | | | * | | | | | 13 | 3 | | | | | | 16 | 29 | 6 | | | | | | 1 | | 32 | | | | | 2 | | | | | | |

*Table E2 – continued.*

| | W0 01 | W0 03 | W0 05 | W0 06 | W0 07 | W0 08 | W0 09 | W0 11 | W0 12 | W0 13 | W0 14 | W0 16 | W0 19 | W0 21 | W0 22 | W0 23 | W0 24 | W0 26 | W0 27 | W0 28 | W0 30 | W0 31 | W0 33 | W0 34 | W0 35 | W0 37 | W0 39 | W0 40 | W0 43 | W0 44 | W0 46 | W0 48 | W0 50 | W0 52 | W0 54 | W0 55 | W0 58 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Planothidium holstii* | | | | * | | | | | | | | | | | | | | | | | * | | | | | | | | | | | | | 1 | | | |
| *Planothidium islandicum* | | | | | | | | | * | | | | | | | | | | | | | | | | | 3 | | | | | 4 | | 4 | | | | |
| *Planothidium lanceolatum* | 45 | | 3 | * | | | | 81 | 4 | * | | 1 | 4 | | 5 | 8 | 12 | | | | | | | * | | 19 | * | 30 | 1 | | | | | | | | |
| *Planothidium* sp. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Planothidium victorii* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Planothidium fragilarioides* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Psammothidium acidoclinatum* | | 71 | 2 | 42 | | 17 | 35 | | 6 | | | | | | | 2 | 19 | 10 | | | | | | | | | | | | | 14 | | 11 | 8 | | | |
| *Psammothidium altaicum* | | | | | | | | | | | | | | | | | | | 2 | | | 4 | | | | | | | | | | | | | | | |
| *Pseudostaurosira brevistriata* | | | | | | | | | | | | | | | | | | | 16 | | | | | | | | | | | | | | | | | | |
| *Psammothidium* cf. *frigidum* | | | | | | | | | | | | | | | 6 | | | | | | | | 2 | | | | | | | | | | | | | | |
| *Psammothidium daonense* | | 48 | | | | | | | | | | | | | | | | | 1 | | | | | | | | | 1 | | | | | | | | | |
| *Psammothidium didymum* | | | | | | | | | | | | | | | | | | | 16 | | | 10 | 27 | 27 | | | | | | | | 9 | | | | | |
| *Psammothidium helveticum* | | 18 | | 18 | | | 2 | 9 | | | 28 | 11 | | 1 | 2 | | | 10 | 2 | | 153 | | 9 | 2 | * | | | | 42 | | | 5 | 2 | 14 | | | 1 |
| *Psammothidium* cf. *kryophilum* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Psammothidium kuelbsii* | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | |
| *Psammothidium levanderi* | 6 | | | | | | | | | | | | | | | | | | 28 | | | 8 | 32 | | | | | | 2 | | | 36 | | | | 11 | |
| *Psammothidium* cf. *marginulatum* | | | | | | | | | | | 20 | 27 | | | 7 | | | | | 12 | | | | 65 | | 7 | | | 4 | | | | | | | | |
| *Psammothidium perpusillum* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 15 | | | |
| *Psammothidium rossii* | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | | | | | | | |
| *Psammothidium* cf. *sacculum* | | | | | | | | 6 | | | 10 | 7 | | | 11 | | | | | 1 | | 5 | | | 14 | | | | 14 | | | | | | | | |
| *Psammothidium scoticum* | | | | | | | | | | | | | | | | | | | | | | | 2 | | | * | | | | | | | | | | | |
| *Psammothidium* sp. 2 | | | | | | | | | | | | | | | | | | 15 | | | 41 | | | | | | | | | | | 2 | | | | | |
| *Psammothidium* sp. 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Psammothidium subatomoides* | 4 | | | | | | | 3 | | | | | | | 1 | | | | 34 | | | 10 | 35 | | | | | | | | | | | | | | 1 |
| *Psammothidium ventrale* | | | | | | 4 | | | | | | | | | | | | | | 3 | | | 5 | | * | | | | 3 | | | | | | 1 | |
| *Pseudostaurosira* cf. *alvareziae* | | | | | | | | | | | | | | | | | | | | | | 8 | | | | | | | | | | | | | | |
| *Pseudostaurosira* 'false' *microstriata* | | | | | | | | | | | | | | | | | | | 25 | | | 40 | | | | | | | | | | | | | | |
| *Pseudostaurosira microstriata* | | | | | | | | 1 | | | | | | | | | | | | | | | 15 | | | | | | | | | | | | | | |
| *Pseudostaurosira opacolineata* | | | | | | | | | * | | | | | | | | | | 11 | | | 1 | 7 | 44 | | 4 | | | | | 34 | 41 | | | | | |
| *Pseudostaurosira pseudoconstruens* | | 1 | | | | | | | | | | | | | | | | | 8 | | | 30 | | 6 | | 1 | | | | | 13 | 29 | | | | 11 | |

*Table E2 – continued.*

| | W0 01 | W0 03 | W0 05 | W0 06 | W0 07 | W0 08 | W0 09 | W0 11 | W0 12 | W0 13 | W0 14 | W0 16 | W0 19 | W0 21 | W0 22 | W0 23 | W0 24 | W0 26 | W0 27 | W0 28 | W0 30 | W0 31 | W0 33 | W0 34 | W0 35 | W0 37 | W0 39 | W0 40 | W0 43 | W0 44 | W0 46 | W0 48 | W0 50 | W0 52 | W0 54 | W0 55 | W0 58 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Pseudostaurosira robusta* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Reimeria sinuata* | | | | * | | | | | * | | | | | | | | 19 | | | | | | | | | 2 | | | | | | | | | | | |
| *Rhopalodia gibba* | | | | | | | | | | | | | | | | | | 7 | | | | | | | | | | | | | 1 | 1 | 2 | | | 5 | |
| *Rhopalodia musculus* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Rhopalodia rupestris* | | | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | | | 1 | | | | |
| *Rossithidium kriegeri* | | | | | | | | | | | | 127 | | | 4 | | | | | | | | | | | | | | 16 | | | | | | | | 32 |
| *Rossithidium petersenii* | 4 | 7 | 1 | | | 10 | | | | | 41 | | | | | * | | | | | 3 | | 2 | | 49 | | | 1 | | | | 4 | | | | |
| *Rossithidium pusillum* | | | | | | | | | | | | | | | 28 | * | 2 | 5 | 4 | 6 | | | | 2 | | * | | 1 | | | 6 | 34 | 18 | 8 | | 18 | 3 |
| *Sellaphora absoluta* | | | | | | | | | | | | | | | | | | | 1 | | | | 4 | | | | | | 1 | | | | | | | | |
| *Sellaphora* cf. *arvensis* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Sellaphora* cf. *pupula* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | |
| *Sellaphora* cf. *seminulum* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Sellaphora* cf. *vitabundicta* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 4 | |
| *Sellaphora laevissima* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 5 | |
| *Naviculadicta lithos* | | | | | | | | | | | | | | | | | | | 4 | | | | | | | | | | | | | | | | | | |
| *Sellaphora medioconvexa* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | |
| *Sellaphora nigri/atomoides* complex | | 3 | 1 | | | | | | * | | 6 | | 3 | | | 4 | 48 | 5 | 2 | | | 4 | | 7 | * | 24 | | | | | 79 | | 9 | | | 9 | |
| *Sellaphora seminulum* | | | | | | | | | | | | | | | | 2 | 2 | | | | | | | | | * | | | | 3 | | | | | | | |
| *Sellaphora* sp. 1 | | | | | | * | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Sellaphora* sp. 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | | | |
| *Skabitschewskia oestrupii* | | | | | | | | | | | | | | | | | | | | | | | 3 | * | | | | | | | | | | | | | |
| *Skabitschewskia peragalloi* | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | | | | | | | | | |
| *Stauroforma* cf. *inermis* | | | | | | | | 4 | | | | | | | | | | | 16 | 2 | | 4 | | | | | | | 1 | | | | | | | | |
| *Stauroforma* cf. *subsalina* | | | | | | | | | | | | | | | | | | | | | | | | 43 | | | | | | | | | 1 | 37 | | 60 | |
| *Stauroforma exiguiformis* | 2 | | 2 | 13 | | | 69 | | | | 18 | | 6 | 3 | 67 | | | * | 17 | | 2 | 115 | 64 | 23 | 10 | * | | | | | 13 | 5 | | | | 23 | |
| *Stauroneis agrestis* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Stauroneis amphicephala* | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | 2 | | | | | | | 1 | |
| *Stauroneis angustilancea* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | |
| *Stauroneis borrichii* | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | |
| *Stauroneis* cf. *heinii* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Stauroneis* cf. *neohyalina* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

*Table E2 – continued.*

| | W0 01 | W0 03 | W0 05 | W0 06 | W0 07 | W0 08 | W0 09 | W0 11 | W0 12 | W0 13 | W0 14 | W0 16 | W0 19 | W0 21 | W0 22 | W0 23 | W0 24 | W0 26 | W0 27 | W0 28 | W0 30 | W0 31 | W0 33 | W0 34 | W0 35 | W0 37 | W0 39 | W0 40 | W0 43 | W0 44 | W0 46 | W0 48 | W0 50 | W0 52 | W0 54 | W0 55 | W0 58 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Stauroneis* cf. *subgracilis* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Stauroneis* cf. *jarensis* | | | | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Stauroneis gracilis* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Stauroneis leguminopsis* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | |
| *Stauroneis neohyalina* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Stauroneis producta* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Stauroneis reichardtii* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | | | | 2 | | | |
| *Stauroneis siberica* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Stauroneis smithii* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | |
| *Stauroneis* sp. 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | |
| *Stauroneis* sp. 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | |
| *Staurosira ambigua* | 2 | | | 6 | | | | 90 | 282 | | 5 | | | | * | 69 | 103 | | 29 | | | | 6 | | 2 | 137 | | | | | 1 | | | | | 3 | |
| *Staurosira* cf. *binodis* | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | |
| *Staurosira* cf. *triundulata* | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | |
| *Staurosira construens* | | | | | | | | | | | | | | | | | | | 10 | | | 22 | | | | | | | | | | | | | | | |
| *Staurosira construens* var. *venter* | | | | | | | | | | | | | 9 | | | | | | | | | | | | | | | | | | | | | | | | |
| *Staurosira* 'false' *venter* | | | | | | | | | | | | | | | | | | | | | | 36 | | 52 | | | | | | | | 14 | | | | | 1 |
| *Staurosira neoproducta* | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | | | | | | | | |
| *Staurosira* 'small' *venter* | | | | | | | | | | | | | | | | | | | 10 | | | 40 | | | | | | | | | | | | | | | |
| *staurosira* sp. 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Staurosira* sp. 2 | | | | | | | | | | | | | | | | | | | | | | | 6 | | | | | | | | | | | | | | |
| *Staurosira* sp. 3 | | | | | | | | | | | | | | | | | | | 31 | | | | | | | 1 | | | | | | 32 | | | | | |
| *Staurosira tabellariae* | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | |
| *Staurosirella binodiformis* | | | | | | | | | | | | | | | | | | | 19 | | | 19 | | | | | | | | | | | | | | | |
| *Staurosirella* cf. *lapponica* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 5 | |
| *Staurosirella jonssoniana* | | | | | | | | | | | | | | | | | | | 42 | | 1 | | 2 | 6 | | 11 | | | | | * | | | | | | |
| *Staurosirella pavinensis* | | | | | | | | | | | | | | | | | | | 12 | | | 6 | 4 | | | | | | | | | | | | | | |
| *Staurosirella* sp. 1 | | | | | | | | | | | | | | | | | | | | | 1 | | | 10 | | | | | | | | | | | | | |
| *Staurosirella* sp. 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Staurosirella* sp. 3 | | | | | | | | | | | | | | | | | | | | | | | | 33 | | | | | | | | 3 | | | | | |
| *Staurosirella* sp. 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

*Table E2 – continued.*

| | W0 01 | W0 03 | W0 05 | W0 06 | W0 07 | W0 08 | W0 09 | W0 11 | W0 12 | W0 13 | W0 14 | W0 16 | W0 19 | W0 21 | W0 22 | W0 23 | W0 24 | W0 26 | W0 27 | W0 28 | W0 30 | W0 31 | W0 33 | W0 34 | W0 35 | W0 37 | W0 39 | W0 40 | W0 43 | W0 44 | W0 46 | W0 48 | W0 50 | W0 52 | W0 54 | W0 55 | W0 58 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Surirella amphioxys* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | |
| *Surirella roba* | | | | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Surirella* sp. 1 | | | | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Surirella terricola* | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Tabellaria fenestrata* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Tabellaria flocculosa* | 2 | | 1 | 65 | 3 | | 10 | 2 | | 2 | 15 | 24 | * | 13 | 7 | | | 2 | 1 | 20 | 1 | 1 | 30 | 5 | 48 | | | | 21 | * | * | 3 | 10 | 2 | | 2 | 20 |
| *Tetracyclus emarginatus* | | | | | | | | | | | | | | | | | | | | | | | * | | | | * | | | | | | | | | | |
| *Tryblionella angustata* | | | | | | | | | | | | | | | | | | | | | | | | 2 | * | | | | | | * | 7 | | | | | |
| *Ulnaria* sp. | | | | | | | | | | | | | * | | | 9 | 2 | | | | | | | 2 | | 4 | | | | | | * | 6 | | | | |
| *Ulnaria ulna* | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| *incerta sedi* | | | | | | | | | | | | | | | | | | 5 | | | | | | | | | | | | | | | | | | | |

# Appendix F: Scientific activities during course of thesis

## Scientific publications

- Van de Vijver, B., **Coomans, A.**, & Pottiez, M. (2025). Epitypification of *Achnanthes boyei* Østrup and its transfer to the genus *Planothidium* (*Achnanthidiaceae, Bacillariophyceae*). *Notulae Algarum* 385: 1–4.

- Van de Vijver, B., **Coomans, A.**, & Pottiez, M. (2025). *Planothidium islandicum* sp. nov., a new cavum-bearing *Planothidium* species from the Westfjords, northwestern Iceland (*Achnanthaceae, Bacillariophyceae*). *Phytotaxa* 731(2): 183–186. https://doi.org/10.11646/phytotaxa.731.2.9

- Van de Vijver, B., Bos, I., **Coomans, A.**, & Pottiez, M. (2026). Observations and epitypification of *Eunotia incisa* W. Gregory (*Eunotiaceae, Bacillariophyceae*). *Notulae Algarum* 427: 1–5.

## Participation in a scientific conference

- Convocatie Nederlands-Vlaamse Kring van Diatomisten (NVKD), 16–18 October 2025, Rijkswaterstaat, Lelystad, The Netherlands
- 8th Annual Meeting on Plant Ecology & Evolution (AMPEE8), 7 November 2025, Meise Botanic Garden, Meise, Belgium

# Appendix G: Published work

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## *Planothidium islandicum sp. nov.*, a new cavum-bearing *Planothidium* species from the Westfjords, northwestern Iceland (Achnanthaceae, Bacillariophyceae)

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The genus *Planothidium* Round & Bukhtiyarova ex Round (1996) was originally described in 1996 to accommodate monoraphid diatom species with multiseriate striae and long terminal raphe fissures (Round & Bukhtiyarova 1996, Morales 2006, Jahn *et al.* 2017, Wetzel *et al.* 2019). Morales (2006) proposed to subdivide the genus into four groups based on the shape and structure of the central area of the sternum valve (rapheless valve). Two of the groups present a peculiar asymmetrical structure in the central area whereas the two other groups lack this structure. One group possesses the so-called *sinus*, a shallow, rounded hyaline depression in the central area, and contains species such as *P. lanceolatum* (Brébisson ex Kützing 1846: 247) Lange-Bertalot (1999: 287). The second group also shows this depression in the central area, but the area is additionally covered by a thick, often broad silica hood, called a cavum. Typical species in this group include *P. frequentissimum* (Lange-Bertalot 1993: 4) Lange-Bertalot (1999: 282) and *P. victorii* P.M.Novis *et al.* (2012: 22).

The past 15 years, the taxonomy of the cavum-bearing group received a lot of attention from diatom taxonomists which resulted in the description of a large number of new species, split off from the catch-all species *P. frequentissimum* (Jahn *et al.* 2017, Wetzel *et al.* 2013, 2019, Marquardt *et al.* 2021, Tseplik *et al.* 2024), often based on both morphological and molecular results. The differences between the newly described species and *P. frequentissimum* are often quite subtle and include small differences in valve outline (e.g. shape of the apices), striation pattern and density, and the shape and size of the cavum hood that can be restricted to the central area or even span neighboring striae.

During a survey of the freshwater and moss-inhabiting diatom flora in rivers and lakes of the Westfjords (northwestern Iceland), a cavum-bearing *Planothidium* population was observed in a wet *Bryum pseudotriquetrum* moss sample showing some resemblance to *P. frequentissum* but having more elongated, clearly rostrate valves and a higher stria density. Following detailed scanning electron microscopy observations (such as the strongly silicified cavum hood and the number of areolae per stria), the population from Iceland could not be identified using all currently available literature and will therefore be described as a new species: *Planothidium islandicum* Van de Vijver, Coomans & Pottiez *sp. nov.*

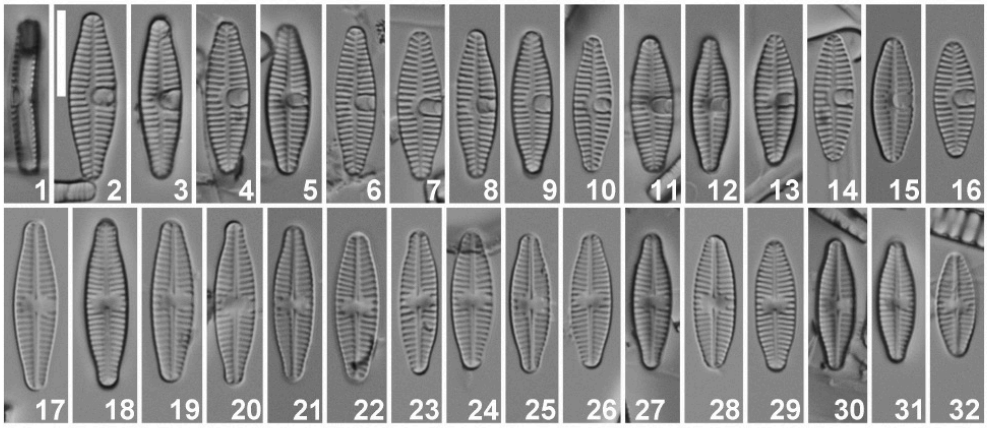
### New species description

***Planothidium islandicum* Van de Vijver, Coomans & Pottiez sp. nov. (Figs 1–32 LM, 33–42 SEM)**

Frustules in girdle view weakly bent (Fig. 1). Valves strictly lanceolate to linear-lanceolate with convex margins. Apices protracted, distinctly rostrate (Figs 2–32). Valve dimensions (n=40): length 10–20 µm, width 4.0–5.5 µm. Sternum valve (Figs 2–16, 33, 34, 37, 39–42): axial area very narrow, linear, very slightly gradually widening towards the central area. Shallow irregular depressions present in axial area along the apical axis (Fig. 33). Central area externally forming an asymmetrical rectangular fascia (Figs 33, 34) with dense pattern of shallow depressions (Fig. 33), opposite side with 2–3 slightly shortened striae (Figs 33, 34). Striae composed of 3–5 rows of small areolae, near the valve margin irregularly organised (Figs 33, 34), continuing over the mantle (Fig. 1). Internally, well developed thickened cavum with a narrow aperture towards the mantle, not extending over the adjacent striae (Figs 39–41). Sternum internally well developed with thick virgae. Striae sunken between virgae (Fig. 37). Areolae internally covered by individual hymenes (Fig. 40). Mantle striae very short, composed of two irregular rows of areolae (Fig. 42). Raphe valve (Figs 17–32, 35, 36, 38): Axial area very narrow, linear, abruptly widening at the central area (Fig. 35). Central area asymmetrical, forming a large hyaline area bordered on both side by 2–3 shortened striae (Figs 35, 36). Striae composed of 3–4 rows of equally sized, small, rounded areolae. Near the axial area, striae terminated by only 2 areolae (Figs 35–36). Depressions in axial and central area not observed (Figs 35, 36). Raphe

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branches almost straight. External central raphe endings forming expanded pores (Figs 35, 36). Terminal raphe fissures bent, continuing shortly onto the valve mantle (Fig. 35). Internally, central nodule raised, with central raphe endings indistinct, deflected into opposite sides (Fig. 38). Terminal raphe endings terminating onto almost inconspicuous helictoglossae (Fig. 38). Striae internally sunken between raised virgae (Fig. 38). Girdle composed of at least 2, possibly 3 unperforated, hyaline, open, copulae, valvocopula being the largest of all (Fig. 42).



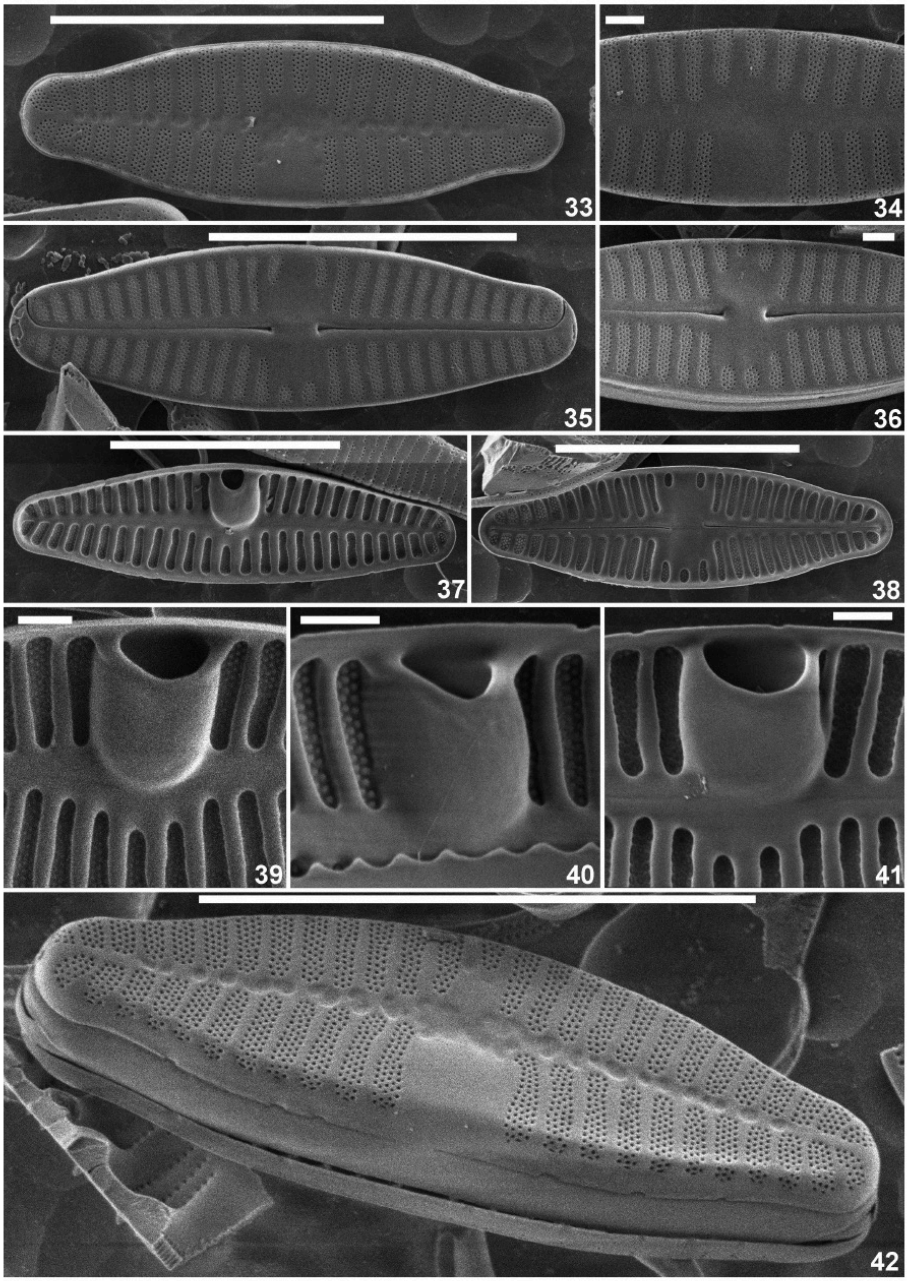

**FIGURES 1–32.** ***Planothidium islandicum*** Van de Vijver, Coomans & Pottiez, sp. nov. LM pictures taken from the holotype slide (BR-4924, Westfjords, Iceland, sample M012). Fig. 1 LM view of a frustule in girdle view. Figs 2–16. LM views of Sternum valves in a size diminution series. Figs 17–32. LM views of Raphe valves in a size diminution series. Scale bars = 10 µm.

**Type:**—ICELAND, Westfjords, along a small brook on the Vestfjarðavegur (65°56'17.17"N/ 23°26'19.93"W, alt. 232 m), sample ICE23-M012, coll. date 08.06.2023, leg. B. Van de Vijver (holotype slide BR-4924= Fig. 4, isotype slide 472, University of Antwerp, Belgium). **PhycoBank registration**: http://phycobank.org/106063.

**Etymology:**—The specific epithet "*islandicum*" refers to Iceland, the island from where the species was described.

**Ecology & associated diatom flora:**—The type population of *Planothidium islandicum* was collected from a wet *Bryum pseudotriquetrum* (Hedwig) P.Gaertner., E.Mey & Scherbius moss carpet on the border of a small stream along the Vestfjarðavegur running from the city of Ísafjörður in the northern part of the Westfjords to the small town of Þingeyri on the coast of Dýrafjörður fjord. The small stream had a high current, a pH of 6.3, and a conductivity of only 66 µS/cm. The diatom flora was dominated by *Meridion circulare* (Greville 1822: 213) C.Agardh (1831: 40), *Odontidium mesodon* (Ehrenberg 1839: 57) Kützing (1849: 12), *Planothidium* cf. *lanceolatum* and *P. boyei* (Østrup 1918: 41) Van de Vijver *et al.* (2025: 2).

**Taxonomic comments**:—The new species clearly belongs to the cavum-bearing section of the genus *Planothidum*. Several of these cavum-bearing species have a lanceolate valve outline combined with protracted, distinctly rostrate apices: *P. frequentissimum*, *P. victorii*, and *P. naradoense* R.Jahn & J.Zimmermann (in Jahn *et al.* 2017: 100). Jahn *et al.* (2017) and Wetzel *et al.* (2019) discussed the taxonomy and morphology of these rostrate *Planothidium* species. *Planothidium frequentissimum* has more rhombic-lanceolate valves with short, rostrate apices compared to *P. islandicum* that has a more narrowly lanceolate outline. This is also reflected in the length/width ratio: 3.3–3.7 in *P. islandicum* versus 2.3–2.9 in *P. frequentissimum*. *Planothidium frequentissimum* has a less robust cavum with a larger opening (see Wetzel *et al.* 2019, fig. 348) compared to *P. islandicum*. The virgae in *P. islandicum* are narrower than the rows of areolae whereas in *P. frequentissimum* the opposite can be noted (see Wetzel *et al.* 2019, figs 345–347). Although ecological preferences should not be used to discriminate diatom species, *P. frequentissimum* is usually found in more eutrophic, alkaline conditions, tolerant up to the α-mesosaprobic, even polysaprobic level, whereas based on the dominant diatom flora in the Icelandic sample, *P. islandicum* seems to prefer more oligotrophic, weakly acidic conditions. *Planothidium victorii* has a very broad opening of the cavum (Jahn *et al.* 2017, figs 342, 346, Wetzel *et al.* 2019, fig. 357), much broader than in *P. islandicum*. Moreover, *P. victorii* has a more elliptic-lanceolate valve outline with only weakly rostrate, more broadly rounded apices, contrary to *P. islandicum* with its narrowly lanceolate rostrate outline. Finally, *P. naradoense* has distinctly lanceolate valves but with only very slightly rostrate apices (Jahn *et al.* 2017, figs 351–366).




**FIGURES 33–42.** *Planothidium islandicum* Van de Vijver, Coomans & Pottiez, sp. nov. SEM pictures taken from the holotype slide (BR-4924, Westfjords, Iceland, sample M012). Fig. 33. SEM external view of a Sternum valve. Fig. 34. SEM external detail of the central area of a Sternum valve. Fig. 35. SEM external view of a Raphe valve. Fig. 36. SEM external detail of the central area of a Raphe valve. Fig. 37. SEM internal view of a Sternum valve. Fig. 38. SEM internal view of a Raphe valve. Figs 39–41. SEM internal detail of the cavum on the Sternum valve. Fig. 42. SEM external view of an entire frustule in girdle view showing the mantle striae of the Sternum valve and the girdle elements. Scale bars represent 10 µm except for Figs 34, 36 & 39–41 where scale bar = 1 µm.

Other cavum-bearing *Planothidium* species such as *P. tyushovii* Tseplik *et al.* (in Tseplik *et al.* 2024: 276) or *P. dyakonovii* Tseplik *et al.* (in Tseplik *et al.* 2024: 277), recently described from the Kamchatka Peninsula (Russia) lack the rostrate apices (Tseplik *et al.* 2024). *Planothidium incuriatum* C.E.Wetzel *et al.* (in Wetzel *et al.* 2013: 49) is much larger with a valve width of 6–7 µm (not 4.0–5.5 µm as in *P. islandicum*) and has more convex margins with a very broad, open cavum, extending over the adjacent striae, a feature not observed so far in *P. islandicum*.

## Acknowledgements

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Van de Vijver, B., Coomans, A., Pottiez, M. & Wetzel, C.E. (2025) Epitypification of *Achnanthes boyei* Østrup and its transfer to the genus *Planothidium* (Achnanthidiaceae, Bacillariophyceae). *Notulae Algarum* 385: 1–4.

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# Epitypification of *Achnanthes boyei* Østrup and its transfer to the genus *Planothidium* (*Achnanthidiaceae, Bacillariophyceae*)

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*Achnanthes boyei* Østrup (1918: 41, pl. 4: fig. 60) was described based on a sample collected from Iceland in 1914. Van de Vijver & al. (2019) analysed the original slide that Ernst Vilhelm Østrup (1845–1917) used to describe the species and proposed, based on morphometric analysis, that *Achnanthes boyei* was a heterotypic synonym of *Achnanthes lanceolatum* Brébisson ex Kützing [≡ *Planothidium lanceolatum* (Brébisson ex Kützing) Lange-Bertalot]. Unfortunately, unmounted material of *Achnanthes boyei* is no longer available, making detailed scanning electron microscopy (SEM) observations impossible. Following the publications by Jahn & al. (2017) and Cantonati & al. (2021), it became clear that SEM analysis might add crucial information to separate sinus-bearing taxa in the genus *Planothidium*.

During a survey of the freshwater and moss-inhabiting diatom flora of Westfjords Region in northwestern Iceland, a *Planothidium* population was observed in a wet *Bryum pseudotriquetrum* (Hedwig) J.R.Spence & H.P.Ramsay ex Holyoak & N.Pedersen moss sample collected in June 2023 along a small brook on the Vestfjarðavegur (65.938103°N, -23.438869°W, alt. 232 m) that showed considerable similarity in outline to the type population of *Achnanthes boyei* as described by Østrup (1918). A second *Planothidium* taxon in the sample had a different outline and axial area and was identified as *P. lanceolatum sensu stricto*. Analysis of both taxa using SEM observations indicated several morphological differences only visible in SEM such as the number of areola rows per stria and the shape of the axial and central area due to the shortening of some central striae on the sternum (= rapheless) valve.

These new observations made it necessary to revise the conclusion in Van de Vijver & al. (2019) that *Achnanthes lanceolatum* and *A. boyei* are conspecific. Here we proposed to recognise both taxa and transfer *A. boyei* to the genus *Planothidium* as *P. boyei* (Østrup) Van de Vijver, Coomans, Pottiez & C.E.Wetzel, *comb. nov*. and epitypify *P. boyei* based on a lectotype specimen from a moss sample collected in 2023. Epitypification is necessary in this instance as valuable information enabling the unambiguous separation of *P. boyei* from *P. lanceolatum* is now available. According to Art. 9.9 in the Code for Botanical Nomenclature, "an epitype is a specimen or illustration selected to serve as an interpretative type when the holotype, lectotype, or previously designated neotype, or all original material associated with a validly published name, is demonstrably ambiguous and cannot be critically identified for purposes of the precise application of the name to a taxon. Designation of an epitype is not effective unless the holotype, lectotype, or neotype that the epitype supports is explicitly cited (see Art. 9.20)" (Turland & al. 2025).


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Based on the new observations, the description provided in Van de Vijver & al. (2019) is here updated to incorporate our new information.

***Planothidium boyei*** (Østrup) Van de Vijver, Coomans, Pottiez & C.E.Wetzel, *comb. nov.* (Figs 1–41)

Basionym: *Achnanthes boyei* Østrup 1918: *Botany of Iceland*, Vol. II, Part I. No. 5.: 41, pl. 4: fig. 60.

Lectotype (**designated here**): slide K.B. 6557 (**C**, Botanical Museum in Copenhagen) made from sample 9.213.1 (Hallormsstaðaskógur National Forest, Iceland, leg. J. Boye Petersen)

Epitype (**designated here for the above lectotype** of *Achnanthes boyei* Østrup): slide **BR**-4917, (**BR**, Meise Botanic Garden); sample ICE23-M012 (Vestfjarðavegur Westfjords, Iceland, coll. date 08.vi.2023, (65.938103°N/ -23.438869°W, alt. 232 m, leg. B. Van de Vijver); a representative specimen for the epitype is shown in Fig. 5.

Registration (for the new combination): http://phycobank.org/105992

Registration (for the typification): http://phycobank.org/105993

Description: Frustules rectangular, only weakly bent in the middle, producing a concave raphe valve (Fig. 1). Valves narrowly rhombic to lanceolate, usually with inflated central part. Apices are weakly protracted, broadly rounded in smaller specimens becoming clearly protracted, rostrate in longer specimens. Smallest specimens elliptic to linear-elliptic with non-protracted, broadly rounded apices (Figs 17 & 18). Valve dimensions (n=60): length 9–29 µm, width 4–6.5 µm. Sternum (=rapheless) valve (Figs 1–18, 38, 39, 41): axial area narrow, gradually widening almost from the apices towards the central area. Central area with a large horseshoe–shaped hyaline sinus on one side showing a very distinct circular depression bordered by at least one distinctly shortened stria. The other side of the central area with several shortened striae forming a semi-lunate hyaline area. Both central and axial area with typical pattern of irregular, shallow depressions (Figs 38, 39). Striae clearly radiate in the centre, becoming even more distinctly radiate towards the apices, 13–15 in 10 µm. Striae composed of 4 rows of small areolae, the outer rows markedly larger than the inner rows. At the apices, striae only composed of 2–3 rows of areolae. Raphe valve (Figs 19–37, 40): Axial area very narrow, linear, almost not widening near the central area. Central area forming a rectangular to bow–tie shaped hyaline area, bordered on one side by 1–3 very short striae. Raphe branches straight with expanded, drop–like central raphe endings. Terminal raphe fissures unilaterally deflected. Striae radiate in the middle, becoming distinctly radiate towards the apices, 13–16 in 10 µm. Striae composed of 4 rows of equally sized areolae.

*Planothidium boyei* differs from *P. lanceolatum* in the number of areolae per stria on the sternum valve with *P. boyei* having four rows and *P. lanceolatum* only three. According to Van de Vijver & al. (2013) the type of *P. lanceolatum* is devoid of shallow depressions in the axial area but this could be an effect of erosion of the type material. The shape of the central and axial area differs in each species. In *P. boyei*, due to the distinct shortening of the striae adjacent to the sinus, the central area develops a distinctive shape not observed in *P. lanceolatum*. The semi-lunate hyaline zone on the other side of the central area in *P. boyei* is also not observed in *P. lanceolatum*. Although subtle, these differences proved in the past sufficient to separate other *Planothidium* species, separations confirmed by molecular data (cf. Jahn & al. 2017).

The *Planothidium boyei* population collected in 2023 was observed in a diatom community entirely dominated by *Meridion circulare* (Greville) C.Agardh, *Meridion constrictum* Ralfs, and *Odontidium mesodon* (Kützing) Kützing, like the community in which the type population of *Achnanthes boyei* was observed (Van de Vijver & al. 2019).


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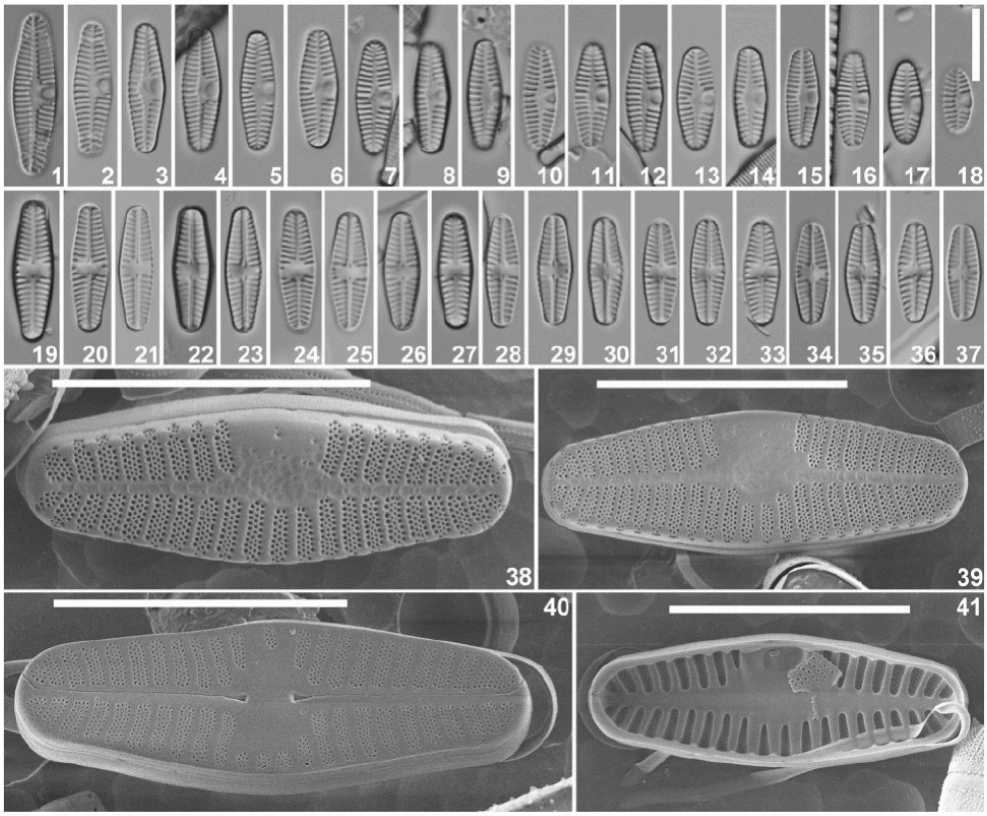
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**Figs 1–41.** ***Planothidium boyei*** (Østrup) Van de Vijver, Coomans, Pottiez & C.E.Wetzel, *comb. nov*. LM and pictures taken from the epitype slide (**BR**-4917, Vestfjarðavegur Westfjords, Iceland). **Figs 1–18.** Rapheless valves. **Figs 19–37**. Raphe valves. **Fig. 38.** SEM external view of a sternum valve in slight oblique view showing the short mantle striae. **Fig. 39.** SEM external view of the sternum valve showing the 4 rows of areolae per stria and the shallow markings in the central and axial area. Note also the shortening of the striae adjacent the sinus. **Fig. 40.** SEM external view of a raphe valve. Each stria is composed of 4 rows of areolae of equal size. **Fig. 41.** SEM internal view of a sternum valve showing the typical sinus. Scale bars = 10 µm.


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# Observations and epitypification of *Eunotia incisa* W.Gregory (*Eunotiaceae, Bacillariophyceae*)

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*Eunotia incisa* W.Gregory is a typical and often frequent constituent of the diatom floras in peat bogs and acidic environments (Lange-Bertalot & al. 2011: 121). The species was originally described in 1854 by William Gregory (1803–1858) for fossil specimens from diatomaceous material found in the famous Mull Deposit on the Island of Mull (Hebrides, Scotland) (Gregory 1854a: 96, published April 1854, although no exact date given). In the same month of 1854, Gregory (1854b:105, published April 19th 1854) also mentioned the new species in a short note on the diatoms (mainly species in the genus *Eunotia*) from a fossil deposit of Lillhaggsjön (Lapland, Sweden): "…but especially in the presence of *Eunotia incisa*, first observed by me in the Mull Earth". In Gregory (1854a: 96), William Smith (1808–1857) seemingly is indicated as the author of the species name stating: "These figures represent the new form, which Mr. Smith, to whom I pointed it out, has named *Eunotia incisa*"; however, in the figure captions, the new taxon is listed as "*Eunotia incisa*, n. sp.", clearly indicating that W.Gregory should be considered to be the author of the species. This is confirmed in Smith (1856: 101) where he listed the species as *E. incisa* W.Gregory. Gregory (1854a) added a short description and illustrated the morphological variability of the species by illustrating three valves and one frustule (Gregory 1854a: pl.4: fig. 4, here shown as Fig. 1a). One of the three valves, showing more acutely endings, is considered the most typical representative whereas one of the other figures, indicated by 'β' is described as 'variety β, with rounded apices' (Fig. 1b) and the third valve represents an intermediate form between the previous two (Fig. 1c).

**Table 1.** List of all *Eunotia incisa* slides from Mull Deposit conserved in **BM**.

| |
|---|
| BM 424 Mull deposit, Gregory 1854 |
| BM 654 Mull deposit, Dr Gregory 1854 |
| BM 821 Mull deposit, Dr Gregory 1855 |
| BM 20977 Mull deposit, Gregory |
| BM 20652 Mull deposit, WA 759 |
| BM 23601 Mull deposit, WA 759 |
| BM 23084 Mull, W.S. |
| BM 631 Mull deposit |
| BM 1615 Mull deposit |
| BM 53766 Mull |
| BM 53930 Mull |
| BM 54069 Mull |

Although the species is reported worldwide from the Arctic to the subantarctic islands (see Guiry & Guiry 2023 for details), a recent assessment of original material has not been published. A lectotype


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was designated by Bukhtiyarova (2019: 13, fig. 23, indicated by her on p. 13 as fig. 22, a lapsus) based upon one of the original Gregory figures. However she did not examine original material. A short survey of the Natural History Museum's (BM) Data Portal (https://data.nhm.ac.uk/) yields several microscopic slides of the Mull Deposit with *E. incisa* specified on the label conserved in the **BM**-collection (Table 1). Some of the slides bear the name W.Gregory on the label, others have a number referring to the Walker Arnott collection WA759, and a third category only mentions 'Mull Deposit'. Additionally, vials containing unmounted material are also conserved at **BM** (Williams, pers. comm.).

In the Walker Arnott collection, part of the Van Heurck diatom collection in **BR** (Meise Botanic Garden, Belgium), several vials, all originating from the same material collected by W. Gregory from the Mull Deposit, are conserved (samples WA28, WA29, WA757, WA758, and WA759). Additionally, an historic slide in the Van Heurck collection was made from WA758 and in the exsiccata set '*Types du Synopsis des Diatomées de Belgique'* made by Van Heurck (1882–1885), one sample, Types n°462 labelled "*Melosira distans* Kütz. var. *nivalis*", was prepared based on the same sample WA758. It is not entirely clear whether the Walker Arnott material is 100% identical to the material used by Gregory in his 1854a paper, as a date on the material is missing, although it probably is.

As the species was lectotypified based upon the original drawing by Bukhtiyarova, without having seen the original material, and in recent years, several morphological similar species have been described, such as *E. boreoalpina* Lange-Bertalot & Nörpel-Schempp (in Metzeltin & Lange-Bertalot 1998: 52), *E. incisadistans* Lange-Bertalot & Sienkiewicz (in Lange-Bertalot et al. 2011: 122, pl. 38: figs. 1–40), and *E. sedina* Lange-Bertalot & al. (2011: 215, pl. 47: figs. 1–17), a better grasp of the morphological variability of the type material of *E. incisa* is needed. Given the close morphological similarity between all these taxa in the *E. incisa* complex, we **here designate** Walker Arnott sample WA758 as epitype for the lectotypified illustration in Bukhtiyarova (2019).

***Eunotia incisa*** W.Smith ex W.Gregory (Figs 1–36).
Original description: Gregory (1854a: 96)
Lectotype (designated by Bukhtiyarova 2019: 13, fig. 23 from Gregory (not 22, as stated on p, 13): Gregory, 1854, pl IV [4]: fig. 4)
Epitype (**designated here for the above lectotype of *E. incisa***): Walker Arnott sample WA 758, Mull Deposit, leg. Dr. Gregory, **BR**. Slide **BR**-4938 was made from this sample and the epitype is represented by Fig. 5.
Registration (for the above epitypification): http://phycobank.org/107363
Further original material: **BM**-collection: see Table 1**.**
Synonyms: *Eunotia sudetica var. incisa* (W.Smith ex W.Gregory) Manguin (in Bourrelly & Manguin 1950: 169), *Eunotia veneris var. incisa* (W.Smith ex W.Gregory) A.Cleve (1953: 112)
Description: Frustules in girdle view rectangular, often weakly in the shape of a parallelogram (Fig. 1d). Valves usually heteropolar with straight ventral margin and clearly convex dorsal margin, throughout the entire cell diminution cycle. Apices distinctly flattened and elongated, acutely rounded. Valve dimensions (n=40): length 30–45 µm, width 5–6 µm. Striae parallel in the valve middle, becoming radiate towards the apices, 18–21 in 10 µm in the middle, becoming denser at the apices, up to 24 in 10 µm. Striae uniseriate, composed of very fine, rounded areolae, 35–40 in 10 µm. Areolae denser on valve mantle at apices (Fig. 35). Striae interrupted at the valve face/mantle junction by a rather narrow hyaline sternum (Fig. 31). Raphe branches short, curved and undulating, entirely located on valve mantle (Figs 31, 35). Central raphe endings located in hyaline zone, lacking bordering areolae (Fig. 32). Terminal raphe fissures short, knob-like, terminating well before the apices. Internally, central raphe endings located on weakly raised


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plate. Helictoglossae well developed, raised, located well before the apices (Figs 34, 36). Pseudosepta well developed. One rimoportula present, externally visible as large pore on the dorsal margin (Figs 33, 34, white arrows), internally well separated from the helictoglossae (Fig. 36, arrow).

The var. β as depicted in the original drawings of *E. incisa* in Gregory (1854a, our Fig. 1b) showing truncated, bluntly rounded apices was not observed in the epitype material. Lange-Bertalot et al. (2011: 120) doubted conspecificity with *E. incisa* ("4β = variety β with rounded apices appears questionable").

Typical parallelogram-like or distinctly trapezoid frustules in girdle view were not observed in the Walker Arnott material. Lange-Bertalot & al. (2011, pl. 36: fig. 34) showed one frustule with this typical frustule outline, although the frustule was not photographed in the type material. Lange-Bertalot & al. (2011: 121) gave a broader width range (3–7 µm) than observed in the epitype material. The lowest valve length (10 µm) is also much smaller than in the epitype material. Stria density, on the other hand, is comparable.

*Eunotia incisadistans* is separated from *E. incisa* in having a much lower stria density (10–14 in 10 µm versus 18–21 in 10 µm in *E. incisa*). Valves with such a low stria density have not been observed in the epitype material. *Eunotia boreoalpina* has more protracted, rostrate apices and a slightly lower stria density (13–17 in 10 µm).

David M. Williams (Natural History Museum, London, UK) is thanked for his valuable comments and his help with the search of original Mull Deposit material in the **BM** collection.

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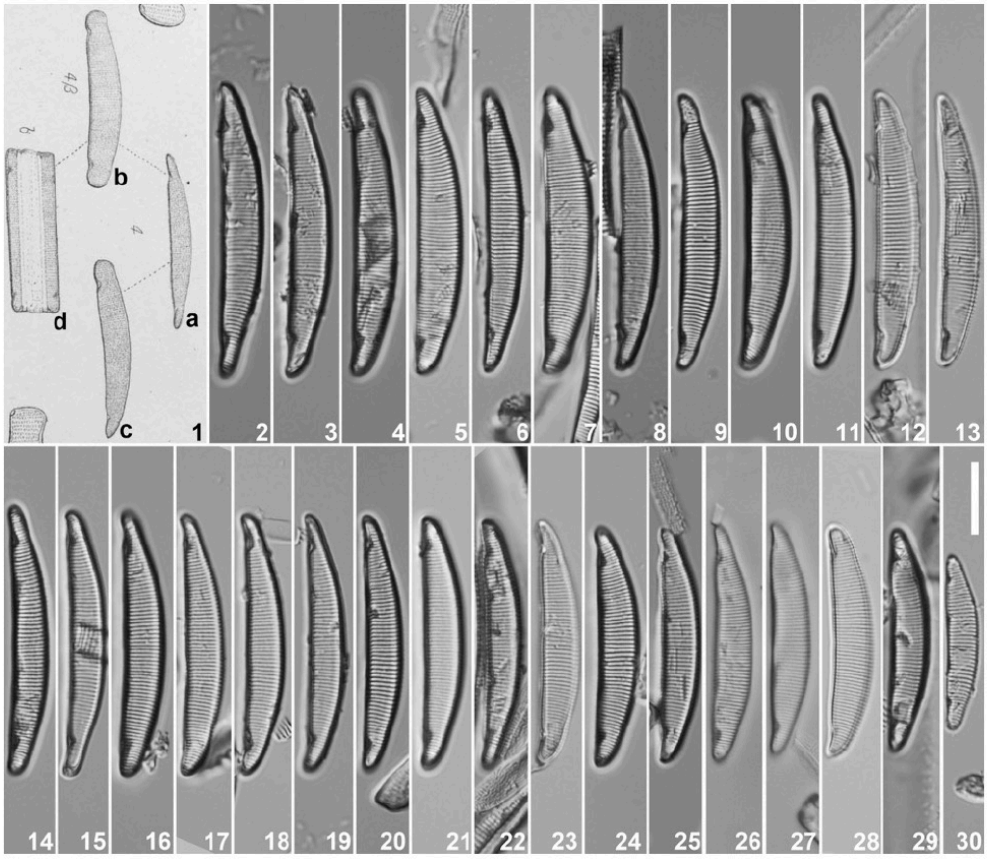
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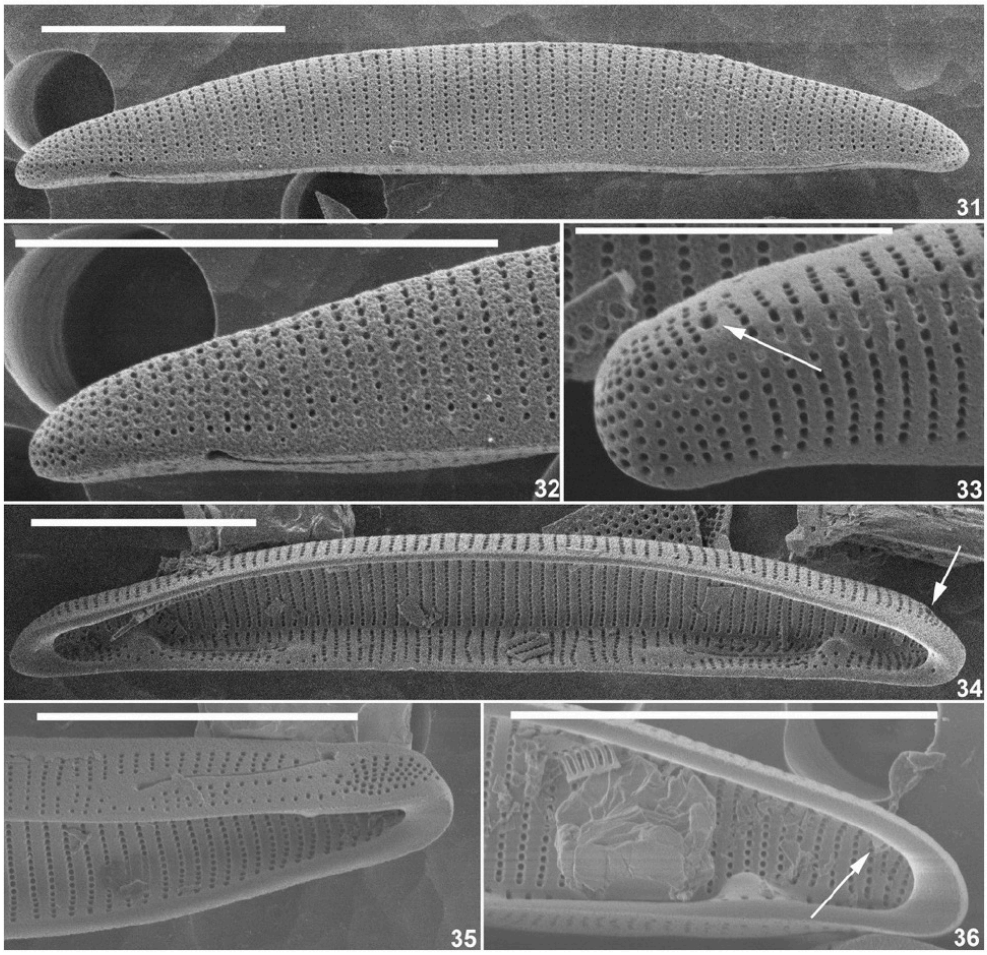
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**Figs 1–30.** ***Eunotia incisa*** W.Smith ex W.Gregory. **Fig. 1.** Original drawing of *E. incisa* from Gregory (1854, plate IV, Fig. 4). **Fig. 1a** represents the lectotype designated by Bukhtiyarova et al. (2019). **Fig. 1b.** Valve with clearly truncated, broadly rounded apices. **Fig. 1c.** Intermediate valve between a and b. **Fig. 1d.** Drawing of a frustule. **Figs 2–30.** LM pictures taken from the epitype slides (Walker Arnott WA758, Mull Deposit, Scotland, UK, **BR**- 4938. Scale bar = 10 µm.


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**Figs 31–36.** ***Eunotia incisa*** W.Smith ex W.Gregory. SEM pictures taken from the epitype slides (Walker Arnott WA758, Mull Deposit, Scotland, UK, **BR**- 4938). **Fig. 31**. External view of an entire valve. **Fig. 32**. Detail of Fig. 30 showing an enlargement of the valve apex with the raphe running on the valve mantle. **Fig. 33**. External detail of the dorsal margin showing the external rimoportula opening (white arrow). **Fig. 34**. Internal view of an entire valve. The white arrow shows the external rimoportula opening. **Fig. 35**. External view of the valve mantle showing the entire raphe branch and the more densely spaced areolae at the apex. **Fig. 36**. Internal detail of a valve apex showing the pseudoseptum and the rimoportula at the dorsal side (white arrow). Scale bars = 10 µm.


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