

Evaluating Centric Diatom Diversity in San Francisco Bay with Scanning Electron Microscopy

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ABSTRACT

Since September 2015, research has been conducted at the University of San Francisco (USF) to study planktonic diatoms in San Francisco Bay. Planktonic diatoms are one of the greatest contributors to the biodiversity in estuary systems. Due to their primary position in the food chain, changes in planktonic diatom communities will affect marine organisms at higher trophic levels. Therefore, the abundance and diversity of diatom species allows for the measurement of the health of the marine ecosystem. A previous study by Keith (2018), focused on documenting changes in species diversity over time, observing seasonal patterns in species richness as well as the effect of environmental factors such as salinity on species succession. In her work, an abundance of centric diatoms were observed, indicating their essential role in phytoplankton communities. Unfortunately, the majority of these taxa cannot be identified with light microscopy. Our ongoing study focuses upon understanding which individual species make up this group of centric diatoms. In particular, this study uses scanning electron microscopy to take images, compare and examine phenotypic characteristics between individuals in preserved samples taken from San Francisco Bay in order to distinguish and classify the individuals at a species level as well as determine relative abundance of individual species over time. By doing so, we will also be able to identify unique and new phytoplankton taxa, and contribute to a better understanding of the ecology of San Francisco Bay.

METHODS

Sample collection and processing. Samples were collected with a 64 µm mesh plankton net near the Golden Gate Bridge, San Francisco (Figure 1). The field samples were preserved in 50% ethanol, rinsed in deionized water, and then treated with hot nitric/sulfuric acid to remove the organic material. Since the frustules (walls) of diatoms are made of silica (glass), these remain intact and cleared of cell debris.

Taxonomic identification. Centric diatoms were initially examined under the light microscope, but it was not possible to identify many of the cells down to the species level. Scanning electron microscopy (SEM) is now being used to allowed a more detailed view at a higher magnification (Figure 2). SEM data will also be used to calculate the relative abundance of each species over time.

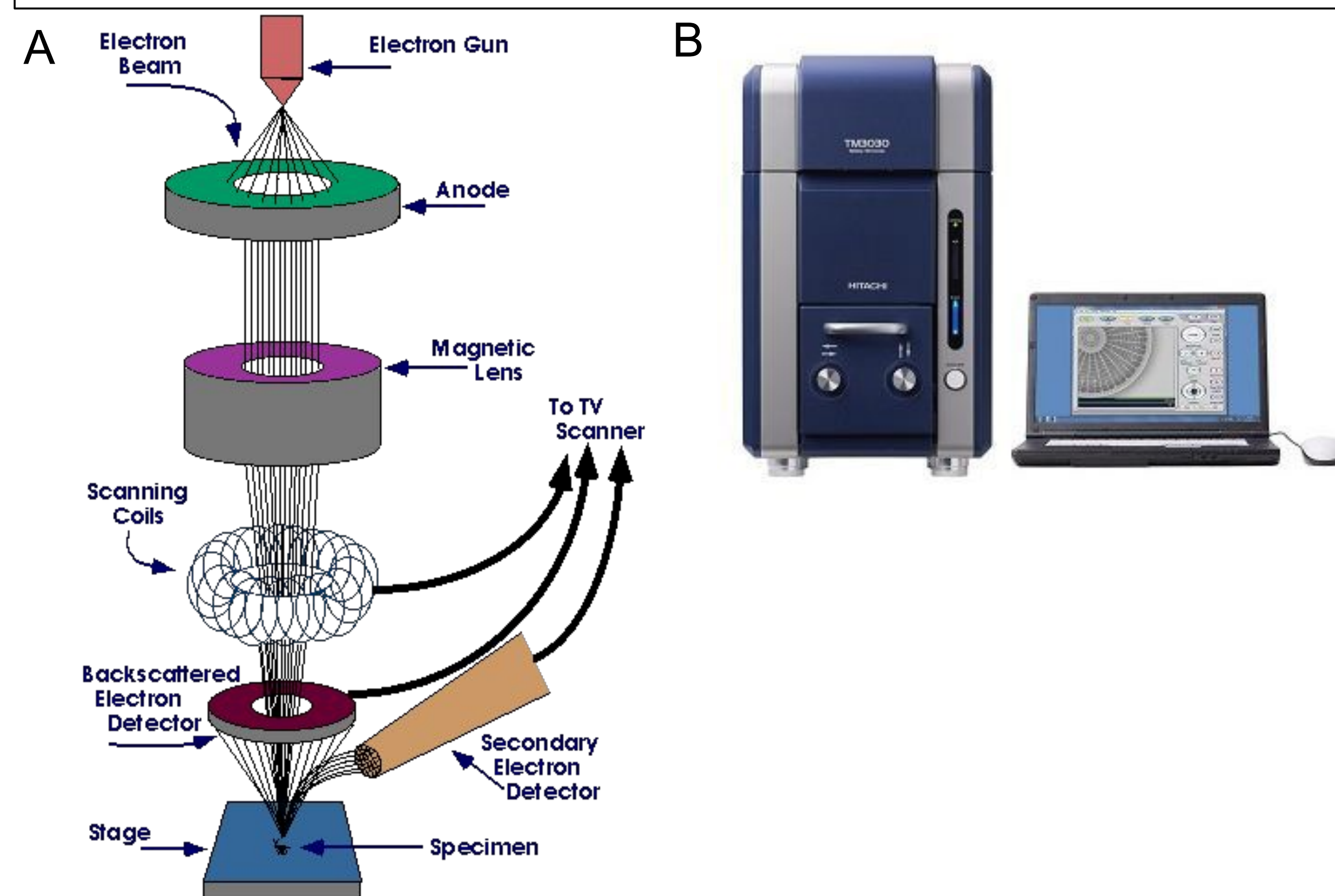


Figure 2. Scanning electron microscopy (SEM) A) Schematic of how the SEM works (image from https://www.gt-ind.com.sg/services_sem.html). B) The Hitachi TM3030 SEM at USF (image from https://www.hitachi-hightech.com/eu/product_detail/?pn=em-tm3030&version=).

ACKNOWLEDGEMENTS

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Figure 1. The sampling location: Torpedo Wharf, Fort Point and Gulf of the Farallones Visitor Center (NOAA), San Francisco (Google Maps).

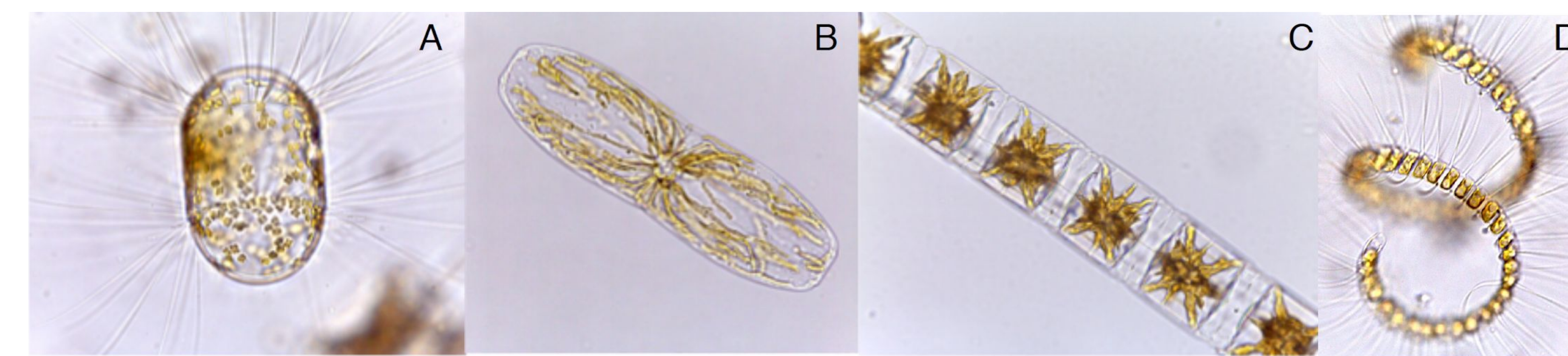


Figure 3. (A-D) Cells viewed at magnification of 400x with light microscopy (Keith 2018) A) *Corethron hystrix* collected 3/30/17, B) *Tropidoneis antarctica* collected 10/8/15, C) *Lithodesmium undulatum* collected 1/31/17, D) *Chaetoceros debilis* collected 2/26/17

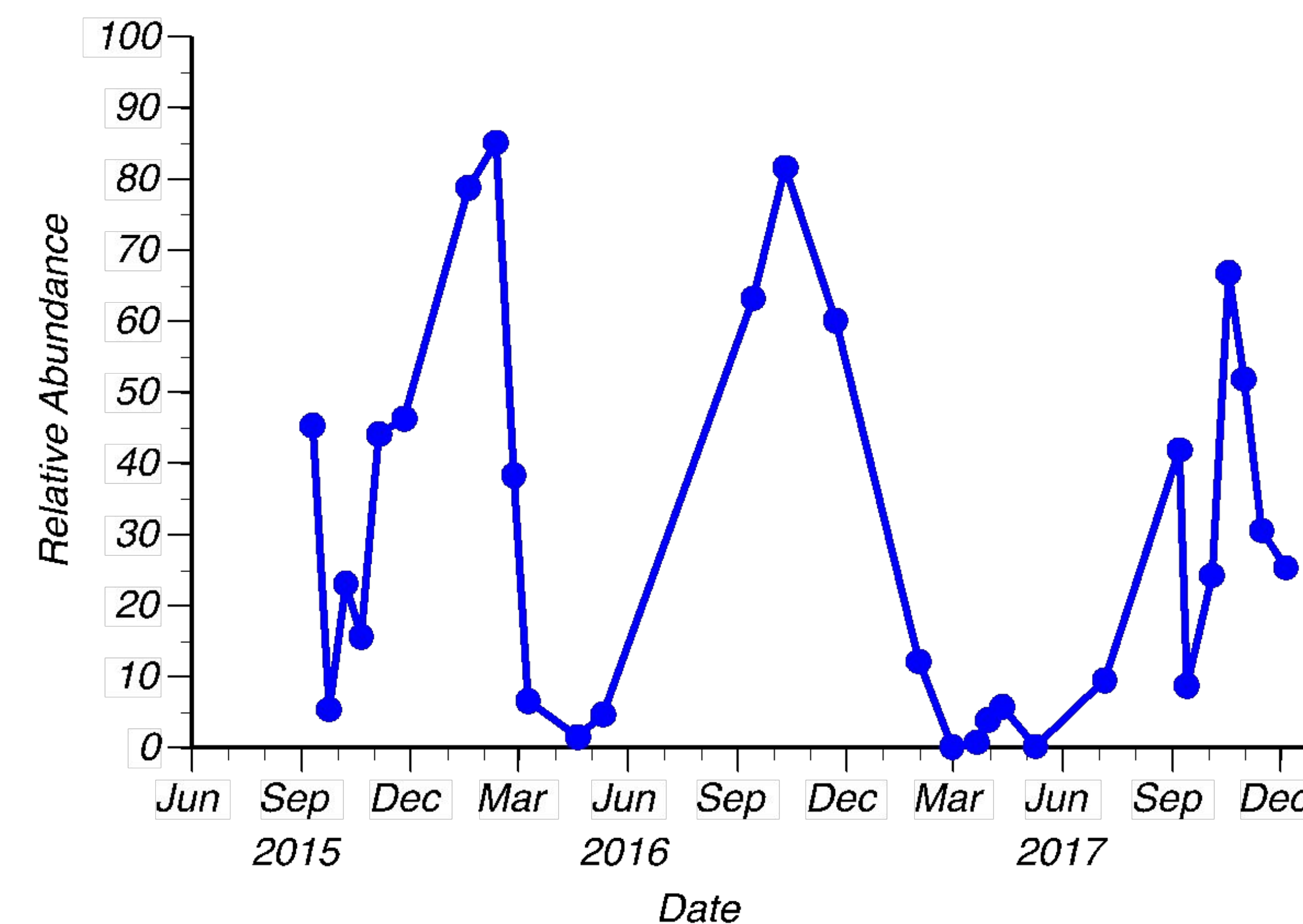


Figure 4. Relative abundance of unidentified centric diatoms in San Francisco Bay from Sept 2015 to Dec 2017 (Keith 2018).

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PREVIOUS WORK

Previously, Keith (2018) studied the seasonal occurrences of phytoplankton species in the San Francisco Bay and many taxa were easy to identify under light microscopy (Figure 3). However, a number of centric diatoms could not be taxonomically separated, so were lumped into one group. She found that during winter unidentified centric diatoms account for up to 80% of cells present, making these taxa an important component of the Bay ecosystem (Figure 4). Our aim is to characterize the different species of these centric diatoms using SEM.

WHY DIATOMS?

Diatoms are single-celled algae covered with intricate designs of silica glass. These are important organisms as they produce $\geq 50\%$ of the oxygen we breathe, serve as important energy sources for the aquatic food chain system, and are one of the most diverse protist groups to have existed. Since 71% of the Earth is covered in water, it is important to understand the health condition of these marine ecosystems. Diatoms are good indicators for assessing and monitoring aquatic systems.

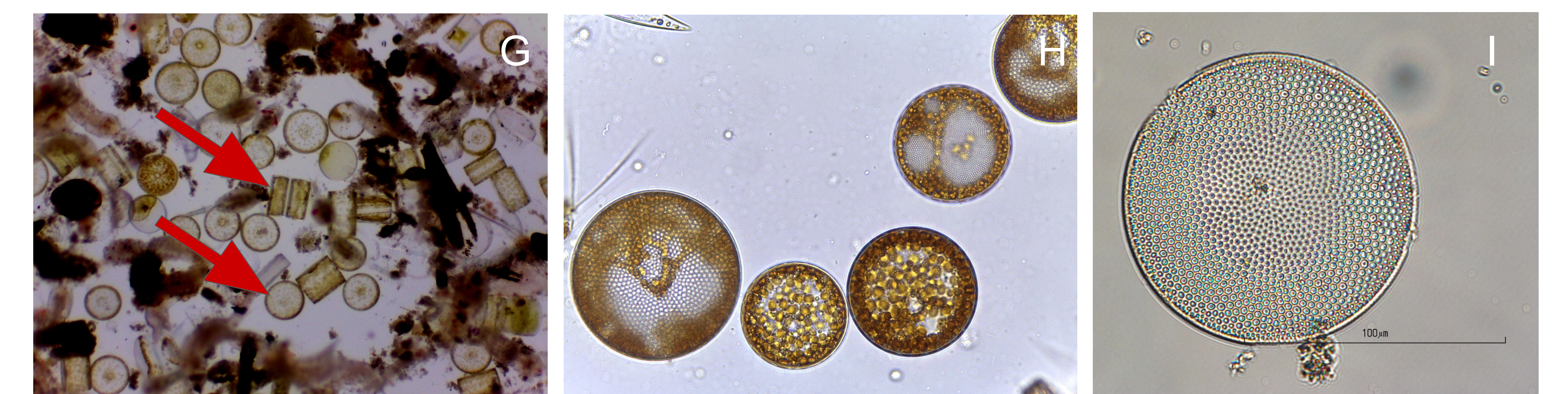
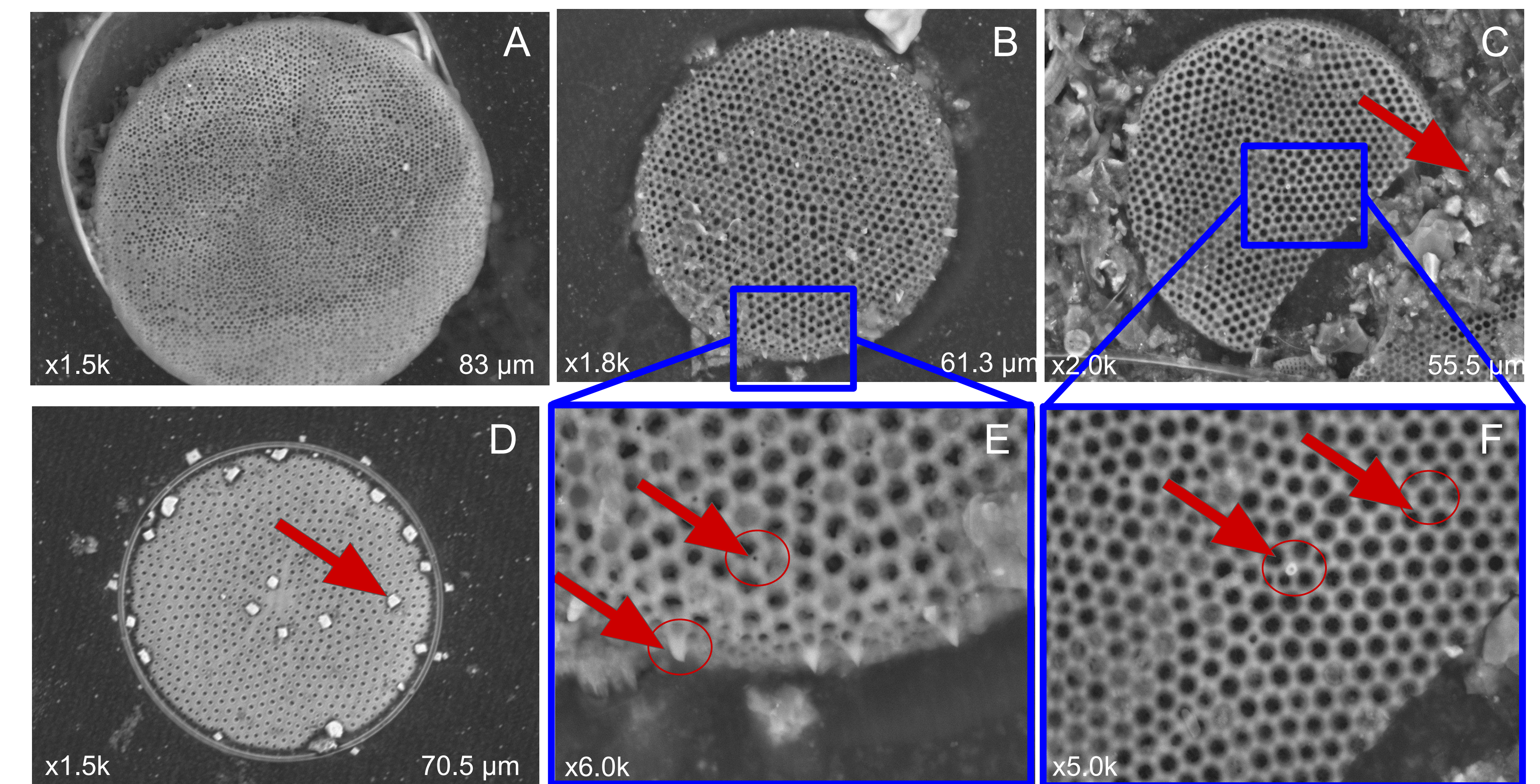


Figure 5. Centric diatoms viewed with SEM (A-F) and light microscopy (G-L) at varying magnifications. Diameter of diatoms measured in micrometers (µm). A) dense honeycomb valve pattern. B) porous honeycomb valve pattern. C) broken centric diatom surrounded by sand grains. D) internal valve face with radial, single areolae and sand grains. E) higher magnification view of B shows pores and spines. F) higher magnification view of C shows honeycomb pattern and single labiate process. G) Valve (round) and girdle (rectangular) views. H) Examples of different sizes and patterns. I) "clean" valve (frustule). J-L) valve pattern obscured by chloroplasts.