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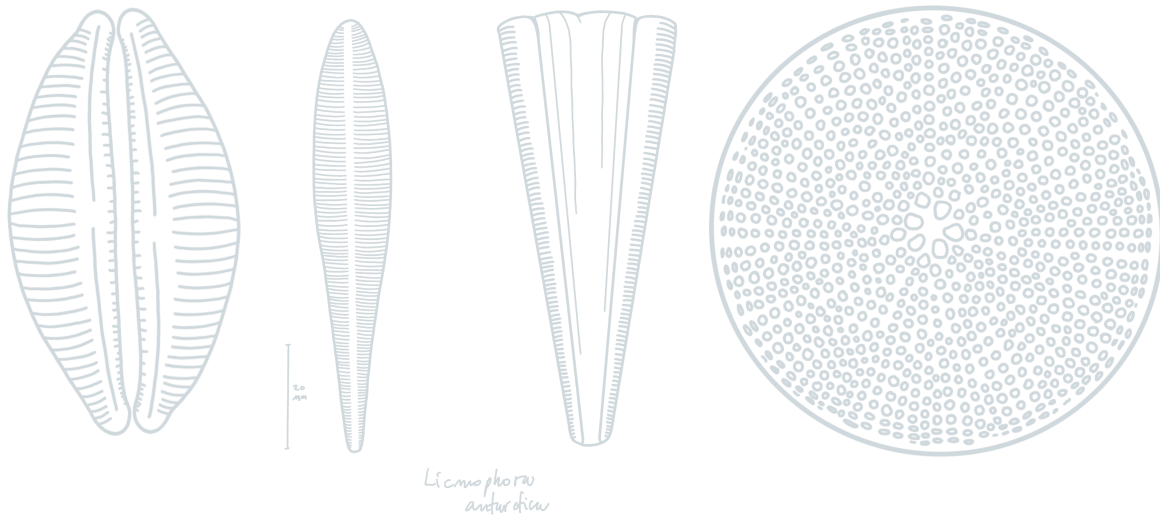
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Science goes on vacation: A book for travelers discovering Antarctica's microscopic forest

Capstone Project
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MAS MBC Program
October 2020



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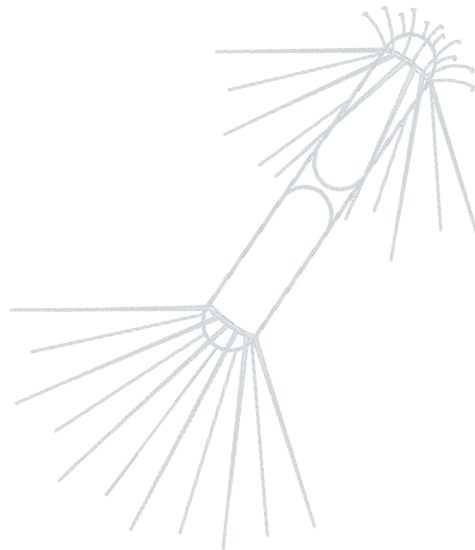
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ABSTRACT

Antarctica is one of the fastest warming regions in the world. More than eight out of ten of the glaciers that line the Western Antarctic Peninsula are in retreat, having impacts at local and global scales. Documenting these changes over time and in expansive areas can be challenging due to the harsh environmental conditions and the associated costs of explorations in remote locations. It also can be hard for people to understand how they are connected to the ocean and to realize that their daily life decisions might affect places like Antarctica that seem so far away.

Luckily, citizen science, also known as participatory science, provides an opportunity to tackle these challenges together. FjordPhyto is a citizen science program from the Vernet Laboratory that works to understand polar fjords through community efforts. It is a voluntary partnership among scientists and travelers visiting Antarctica on tourism vessels, who contribute by taking phytoplankton samples and registering oceanographic information. By participating in programs like this, travelers gain a better sense of the place they are visiting and its threats.

This Capstone Project was conceived to enrich the traveler's experiences and create a product that could help connect more people with the Southern Ocean. It is part of a larger endeavor to produce and publish a bilingual phytoplankton identification book for non-scientific audiences, highlighting the different groups found at the Western Antarctic Peninsula and the collaborative science value. Besides serving as a consultation book for tourists and citizen scientists in the field, it aims to surprise people, inspire them, reinforce their explorer's spirit, and communicate the microscopic forests' relevance in the Antarctic ecosystems.

KEYWORDS

[FjordPhyto](#), Identification Book, Antarctic, Phytoplankton, Citizen Science

BACKGROUND – WHAT IS THE CONTEXT

The Western Antarctic Peninsula is the fastest warming area in Antarctica, causing accelerated melting of its millions-of-years-old ice. Over 87% of its ocean-terminating glaciers have retreated in the last 50 years.¹ As a consequence of this melting, more land-ice and meltwater reach the ocean, changing the conditions under which organisms are adapted to live. There is no consensus yet on how biological communities will respond. However, changes in phytoplankton assemblages can be expected and with that impacts on higher trophic levels on Antarctic waters and beyond.²

Despite researchers exploring the relationship of the Antarctic plankton with different variables like salinity, stratification, temperature, nutrients, lithogenic materials, among others,^{3, 4, 5} there is still plenty of work to do, and several nearshore (coastal) areas remain relatively unexplored. This is not surprising, since the Antarctic is the coldest, the windiest, and the driest continent, while at the same time containing 85% of the world's ice.⁶

¹ Cook, A.J., P.R. Holland, M.P. Meredith, T. Murray, A. Luckman, and D.C. Vaughan. 2016. Ocean forcing of glacier retreat in the Western Antarctic Peninsula. *Science* 353 (6296):283–286. <https://doi.org/10.1126/science.aae0017>.

² Moline, M.A., H. Claustre, T.K. Frazer, O. Schofield, and M. Vernet. 2004. Alteration of the food web along the Antarctic Peninsula in response to a regional warming trend. *Global Change Biology* 10(12):1,973–1,980. <https://doi.org/10.1111/j.1365-2486.2004.00825.x>.

³ Hernando, M., I.R. Schloss, G. Malanga, G.O. Almandoz, G.A. Ferreyra, M.B. Aguiar, and S. Puntarulo. 2015. Effects of salinity changes on coastal Antarctic phytoplankton physiology and assemblage composition. *Journal of Experimental Marine Biology and Ecology* 466:110–119. <https://doi.org/10.1016/j.jembe.2015.02.012>.

⁴ Dierssen, H.M., R.C. Smith, and M. Vernet. 2002. Glacial meltwater dynamics in coastal waters west of the Antarctic peninsula. *Proceedings of the National Academy of Sciences of the United States of America* 99(4):1,790–1,795. <https://doi.org/10.1073/pnas.032206999>.

⁵ Fuentes, V., Alurralde, G., Meyer, B., Aguirre, G., Canepa, A., Wölfel, A., Hass, H., Williams, G., and I. Schloss. 2016. Glacial melting: An overlooked threat to Antarctic krill. *Scientific Reports*. 6. 10.1038/srep27234.

⁶ Instituto Antártico Chileno. 2018. Enciclopedia Visual Antártica. Ograma impresiones. 148 pages.

Regardless of its remoteness and the harsh environmental conditions, Antarctic tourism is an increasing activity. Specifically, for ship-based tourism, 55,614 visitors were registered making landings the last austral summer (2019-2020).⁷ These tourism vessels cover hundreds of nautical miles, repeatedly during a five months season.

Seeing this growing industry as an opportunity for a partnership that would allow sampling over a larger temporal and spatial extent and engage travelers with science, in 2016, the Vernet Laboratory from the Scripps Institution of Oceanography started a collaborative science program called [FjordPhyto](#). As most citizen science programs, FjordPhyto is about the power of a non-scientific multitude in which everyone contributes a small part to scientific endeavors. Since its beginning, more than 300 samples have been collected from 19 locations with more than 3000 travelers. By collecting samples, the staff and the travelers on Antarctic tour vessels help scientists to understand phytoplankton communities' succession in polar fjords. At the same time, the program provides them an enriching experience of learning more about science in polar environments.^{8,9}

Even though no formal studies have been conducted researching the impact of the FjordPhyto program on the staff and travelers, several examples illustrate how on-board citizen science programs can enhance the knowledge and stewardship capacity of cruise passengers regarding the Arctic.¹⁰ A study conducted on Arctic expedition cruise ships showed that, after participating of on-board educational programs, travelers

⁷ IAATO. 2019. IAATO Data and Statistics. <https://iaato.org/information-resources/data-statistics/> Reviewed on September 17th, 2020.

⁸ Mascioni, M., G.O. Almandoz, A.O. Cefarelli, A. Cusick, M.E. Ferrario, and M. Vernet. 2019. Phytoplankton composition and bloom formation in unexplored nearshore waters of the Western Antarctic Peninsula. *Polar Biology* 42:1,859-1,872, <https://doi.org/10.1007/s00300-019-02564-7>.

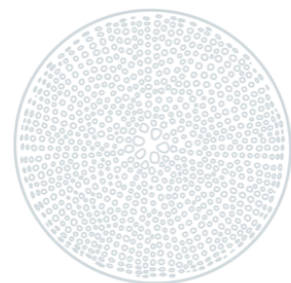
⁹ Cusick, A. M., Gilmore, R., Bombosch, A., Mascioni, M., Almandoz, G. O., and M. Vernet. 2020. Polar tourism as an effective research tool. *Oceanography*, 33(1), 50-61.

¹⁰ Taylor A., Barðadóttir Þ., Auffret S., Bombosch A., Cusick A., Falk E. and A. Lynnes A. 2019. Arctic expedition cruise tourism and citizen science: a vision for the future of polar tourism. *Journal of Tourism Futures*. DOI 10.1108/JTF-06-2019-0051.

reported a greater appreciation for the wilderness of the Arctic, a greater concern for the environment, and a desire to donate (time/money) for environmental protection or to vote for representatives who support the same cause.¹¹

This Capstone Project was conceived thinking about creating more experiences that help connect people with the Southern Ocean and considering that recently several of the vessels participating on the FjordPhyto project have microscopes available for their passengers. The idea was to create a book that could serve as an identification guide and consultation book for the staff and Antarctic travelers, surprise people with the diversity and beauty of the phytoplankton, inspire them to get involved in science, and communicate the key role of these microscopic creatures in the Antarctic ecosystems.

Because producing and publishing a book is a large endeavor that requires more time than the available for this Capstone Project, a humbler goal was defined. The objective was **to define the structure, create the content, and propose the layout of an identification Antarctic phytoplankton book** that contributes to enriching tourists' experiences traveling to the Antarctic, and which simultaneously compiles updated scientific information about the phytoplankton genera recorded at the Western Antarctic Peninsula.



¹¹ Manley, B., Elliot, S. and S. Jacobs. 2017. Expedition cruising in the Canadian Arctic: visitor motives and the influence of education programming on knowledge, attitudes, and behaviours. Resources, Vol. 6 No. 3, pp. 23-44, doi: 10.3390/resources6030023.

METHODOLOGY - WHAT WAS THE PROCESS?

The creative process started with an extensive review of books and identification guides that exist, concerning phytoplankton and other living groups, including terrestrial plants and animals. Publications from different languages and designed for diverse audiences were considered to identify different styles and layout options. A scientific literature review was conducted in parallel, focused specifically on publications about the Antarctic, climate change, and its impacts on polar biological communities.

Subsequently, the content and structure of the book were defined. In conjunction with the FjordPhyto team members input, the most relevant information to include in the introductory chapter and which organisms should be presented on the identification pages was determined. The decision regarding how many details were ideal per each genus was also discussed with the group. In general terms, all the process was highly collaborative. Weekly meetings were held with the chair of the Capstone Committee and with a graphic designer,

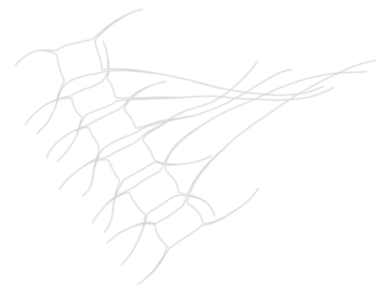
Considering there are approximately one hundred species of diatoms registered for the Western Antarctic Peninsula, we decided to structure the book around genera instead of species. All the phytoplanktonic groups found in the samples collected by the citizen scientists participating in the program were included. The updated and reviewed list was provided by Martina Mascioni, a researcher member and taxonomist of the FjordPhyto team based on Argentina.



Once the general structure was defined, the process of writing, drawing, and selecting pictures took place. For the writing phase, essential books^{12,13} were used in addition to specialized literature, composed mainly by peer-reviewed papers. The phytoplankton illustrations were sketched first on paper and from different angles. After that, they were digitally redrawn and composed on watercolor backgrounds. The pictures were selected from the repositories of Allison Cusick (mostly Antarctic landscapes and citizen scientists sampling the Southern Ocean) and Martina Mascioni (mainly phytoplankton images, taken under scanning electron and light microscopes).

During the same period, and with the support of Ingrid Céspedes, a graphic designer, the book's graphic style was defined, the book's layout was made, and the illustrations for the introductory pages were created. These last drawings were done by the graphic designer under the direction of the Capstone lead and the review of the FjordPhyto team.

Throughout the development of this project, the FjordPhyto team realized the necessity of having a logo for their diverse outreach materials and academic activities. Responding to that, and despite not being part of the original goals of this Capstone Project, I decided to include the development of a brand identity for FjordPhyto, defining a color palette, font, and a family of logos for the project.



¹² **Tomas, C. 1995.** Identifying Marine Phytoplankton. Academic Press. 858 pages.

¹³ **Scott, F. J and H.J. Marchan, 2005.** Antarctic Marine Protists. Australian Biological Resources Study. Australian Antarctic Division. 563 pages.

RESULTS - WHAT WAS DONE?

A. THE BOOK

1. General aspects

The book resulted in a visual product dominated by images, including pictures, watercolor drawings, and digital illustrations. It also includes poems, quotations, and testimonials from travelers who have participated in the FjordPhyto project, creating connections among people and these tiny creatures.

This book is the first book directed toward non-scientist audiences that compiles morphological, biological, and ecological information of the Western Antarctic Peninsula's phytoplankton genera. Even though researchers can enjoy the book, it was written for a wider audience. All the texts are short, avoid scientific jargon, and give the reader contextualized information. The book was created as a bilingual product (English/Spanish) because although the Antarctic tour industry is international, the main gateway is through South America, specifically from Argentina and Chile.

The book is structured in seven chapters. Three are introductory, and three are exclusively for phytoplanktonic groups (diatoms, dinoflagellates, and small flagellates plus cyanobacteria). The last chapter is for commonly found zooplankton representatives in the phytoplankton samples.

Two chapters were developed in detail for this Capstone Project, the diatom chapter, and one of the introductory chapters. The following pages present part of the content of the book, in low resolution. All the pictures, texts, and illustrations have copyright, and its reproduction or distribution is not allowed at this moment. The conditions might change once the book is published.

2. Introductory chapter - The journey begins here

The introductory chapter covers a diverse range of topics, all of them chosen to provide the reader context. Its pages present information regarding the location, who eats whom, the phytoplankton superpowers, how Antarctica is changing and what the community is doing through collaborative science.



Figure 1. Cover page of the introductory chapter

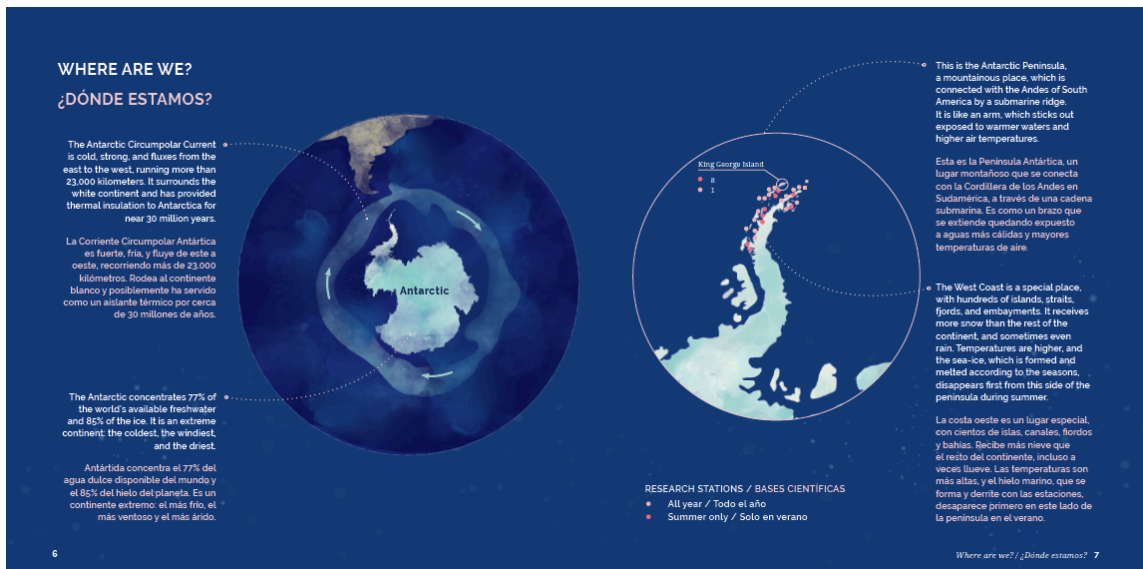


Figure 2. Introductory chapter: Where are we?

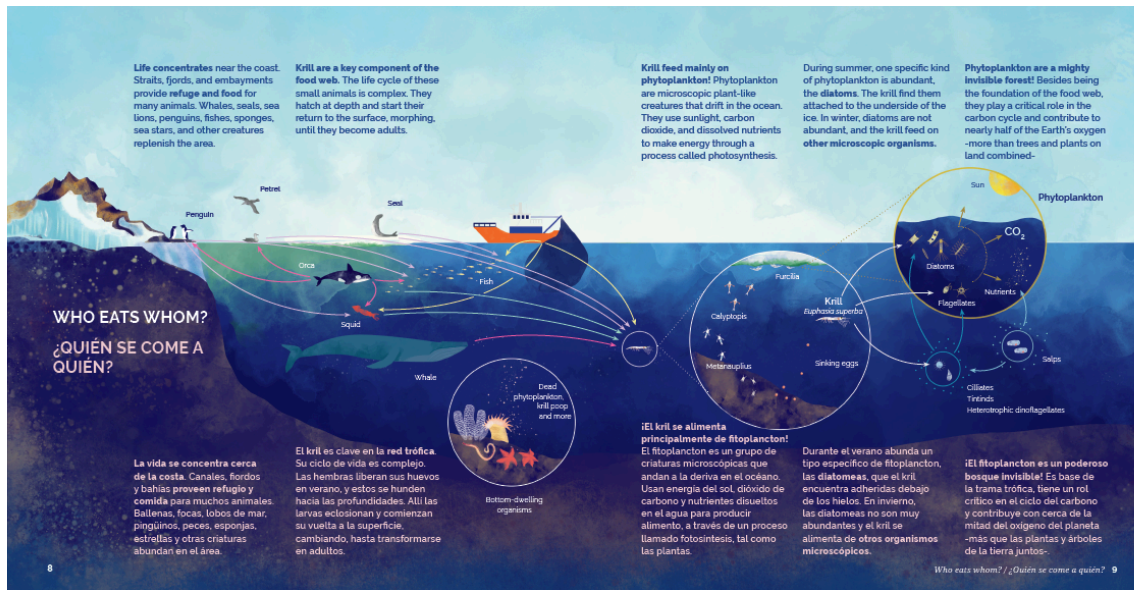


Figure 3. Introductory chapter: Who eats whom?

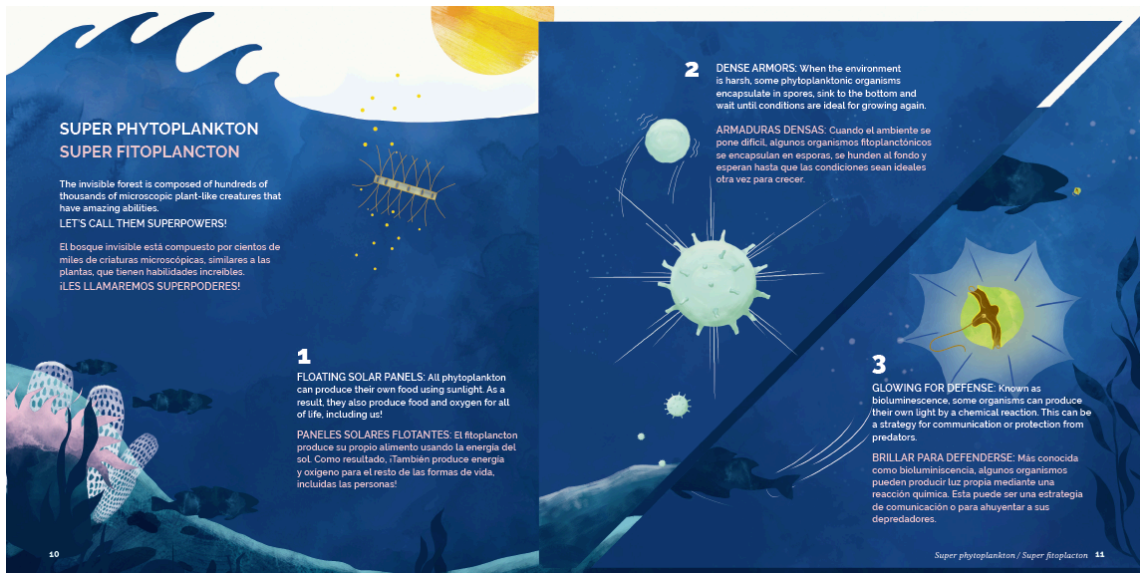


Figure 4. Introductory chapter: Super Phytoplankton

3. Identification pages – Diatoms: Glass houses

All identification pages have the same structure. Each genus is presented in a double-page setup, half blue, half light gray.

The blue side gives information about the group's morphology, using drawings and complementary texts, and symbols that give clues regarding how common the group is, its size, and its distribution. Meanwhile, the light gray page presents ecological or biological information and fun facts about the genus. The texts are secondary in visual terms, and the page is dominated by diverse pictures, showing different angles and how the group looks under different types of microscopes.

Because diatoms are a key group of the Antarctica food web, and because they are easy to find in collected phytoplankton samples, a significant proportion of the book is dedicated to this group.

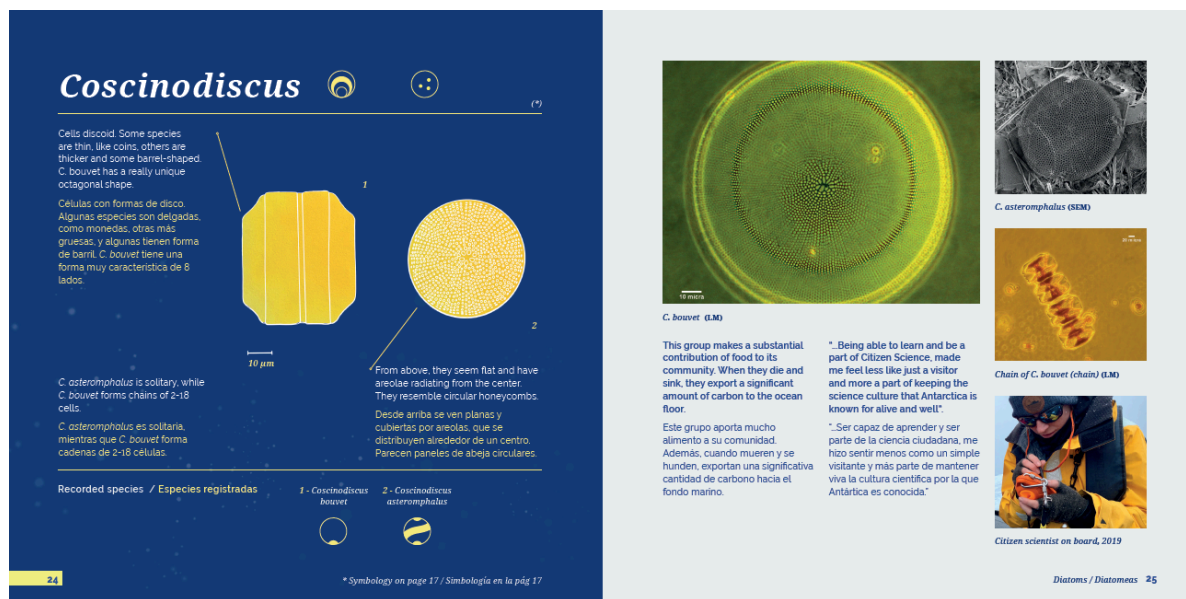


Figure 5. ID pages, Diatoms, *Coscinodiscus*

B. THE BRAND

Following a participatory process, we developed a brand identity for the FjordPhyto program. It involved identifying the key concepts and colors that represent the program according to their members, and the definition of the target audience. The creative process involved weekly review sessions with the FjordPhyto team and the graphic designer.

As a result of the process, a document with the brand guidelines was produced, including the main brand, the complementary brand, the corporate color palette, the corporate font, and examples of use. Some of these elements can be seen below.



Figure 6. The main brand with corporate colors



Figure 7. The complementary brand with alternative colors

FUTURE ACTIONS - WHAT'S NEXT?

We recently launched a fundraising campaign, and along with the FjordPhyto team, will continue to work on developing the remaining chapters of the book. Our plan is for the book to become available as soon as possible for print and distributed on the tour ships visiting the Antarctic and at local libraries in the United States, Chile, and Argentina. A simplified timeline can be seen below.

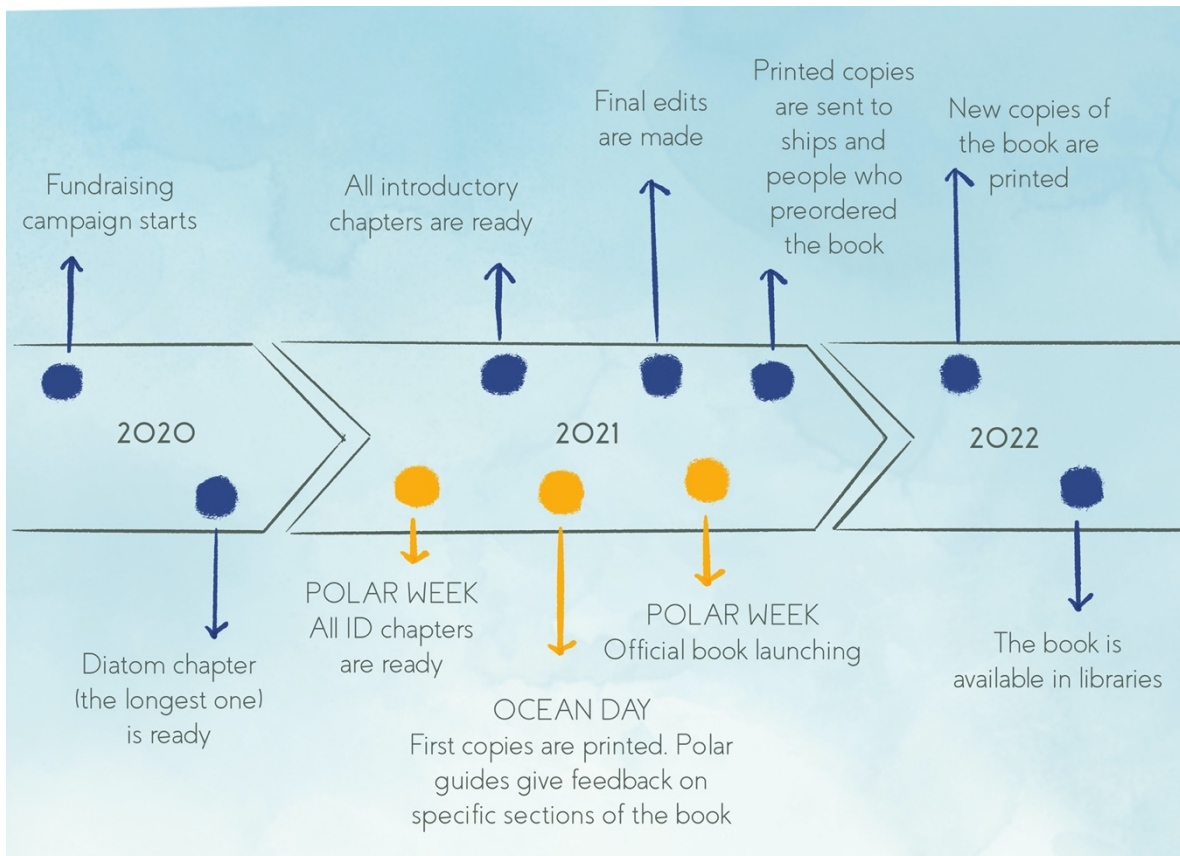


Figure 8. Book timeline

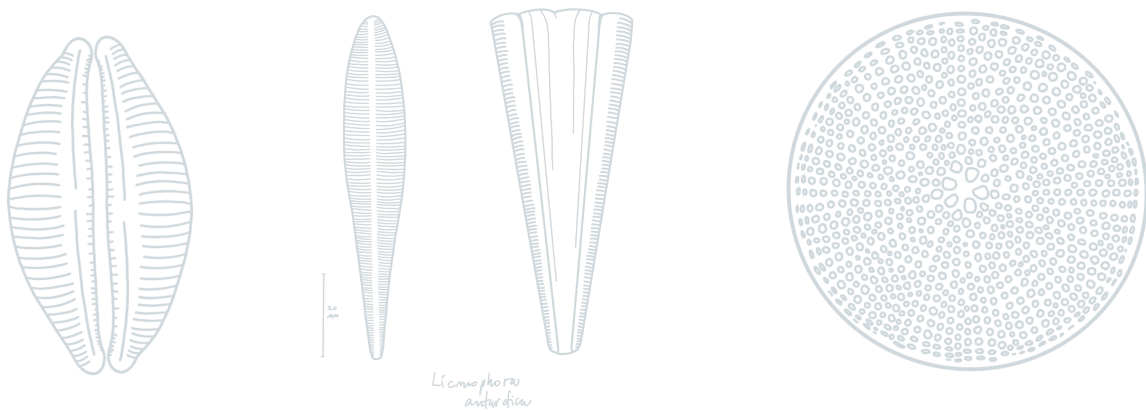
INDICATORS OF SUCCESS

As the first book about the Antarctic phytoplankton directed toward non-scientist audiences, that compiles updated information and beautiful images, we expect it to be received with enthusiasm among travelers, tour operators, and the general public interested in polar regions.

Some indicators of success considered include the extended use of the book by polar guides; an increased interest of Antarctic travelers in phytoplankton (that can be measured by change on time they spend looking through the microscope, reading books, or asking questions related to these topics); the tour operators' willingness to offer the book for sale in their onboard gift shops; the number of libraries engaged with putting the book on their shelves; and the interest in using the book as educational material by teachers and local organizations.

ACKNOWLEDGEMENTS

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