Conference Abstract

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Phytoplankton Under Pressure - The Role of Environmental Drivers in Parasitism

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Phytoplankton Under Pressure - The Role of Environmental Drivers in Parasitism

Martyna Budziak[1*], Doris Ilicic[2], Hans-Peter Grossart[2,3], Wojciech Krztoń[1], Edward Walusiak[1], Janusz Fyda[4], Elżbieta Wilk-Woźniak[1]

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Fungal parasitism is attracting growing attention in phytoplankton ecology because of its outstanding importance for aquatic food webs and energy cycling. However, relatively few studies have addressed baseline data on occurrence and environmental factors associated with chytrid parasite infections in natural ecosystems. This work provides insights into occurrence, prevalence, and dynamics of parasitic infections by studying three shallow, freshwater bodies during the growing season over a period of six years. Data were collected each year from April to October, monthly or fortnightly from a central point of each waterbody from 2019 to 2024. Chytrids were detected in each of the studied waterbodies, infecting species of green algae, diatoms, and cyanobacteria. General linear model (GLM) indicated that major factors driving the occurrence of chytrid infections were water temperature, nitrates, phosphates and pH. However, recurring and prevalent infections were observed in only one waterbody, which is classified as a natural, undisturbed aquatic ecosystem. The recorded infection prevalence (IPC) ranged between 0% and 20%, while the mean infection severity remained low throughout the study. Infections were highest in summer (June-August) and were most prominent during cyanobacterial blooms, although the most infected group of phytoplankton was green algae (*Desmodesmus* spp.). GLM revealed a significantly positive correlation between IPC and water temperature, precipitation and cyanobacterial bloom. Overall, our results demonstrate that a combination of abiotic and biotic parameters drives the occurrence of parasitic infection more than just indicated by the magnitude of the prevalence alone.

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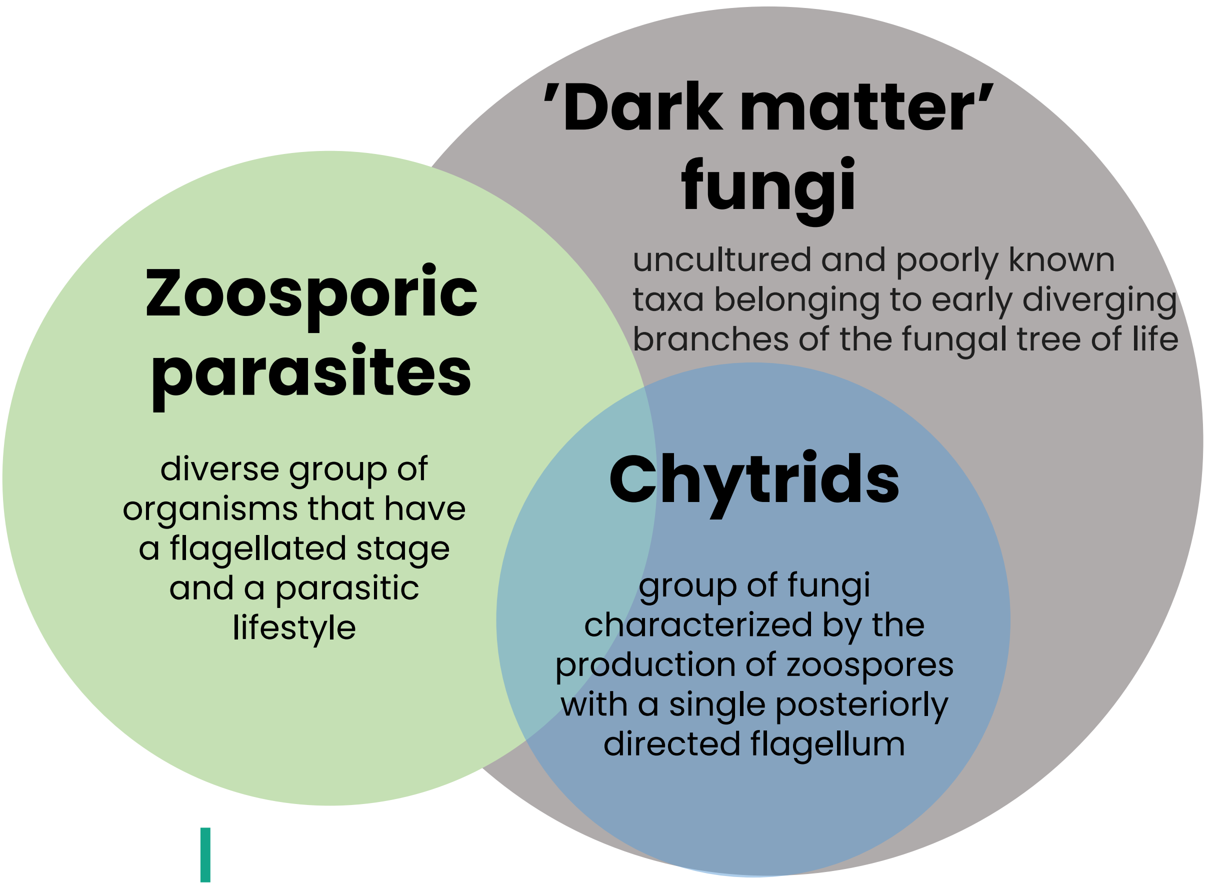
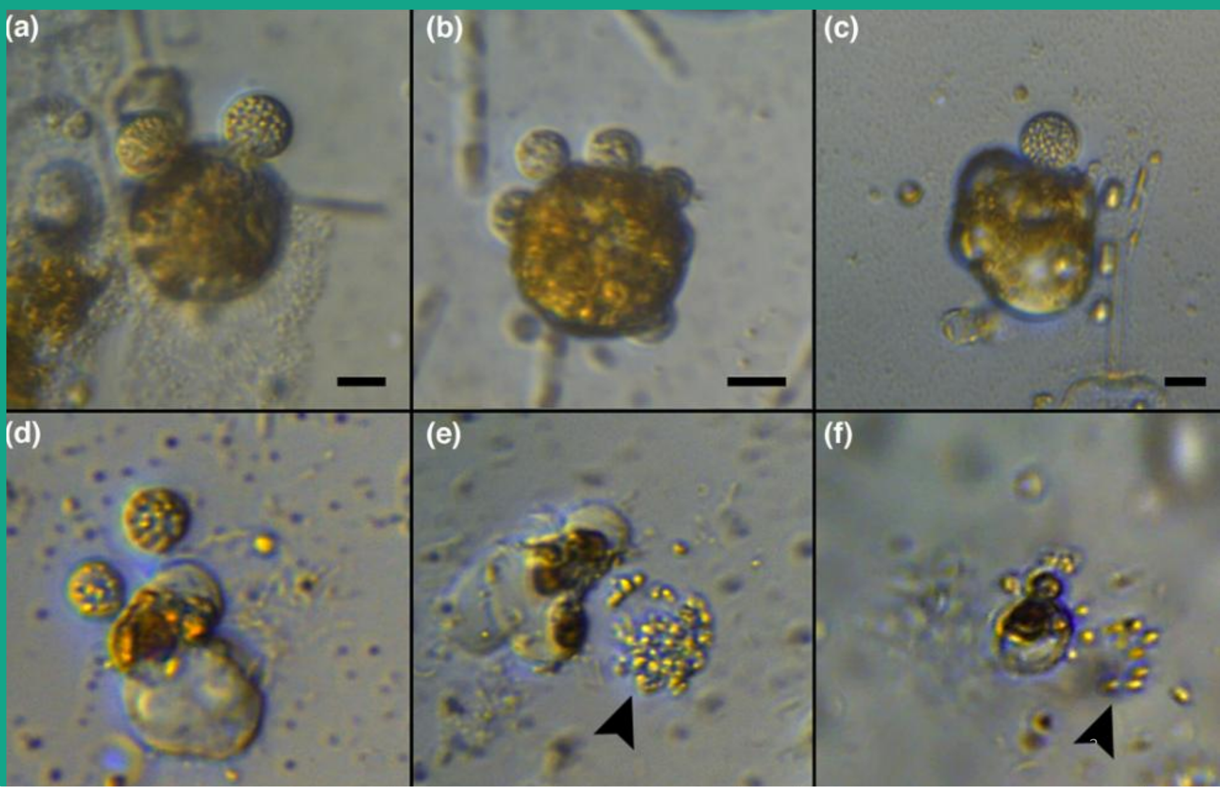
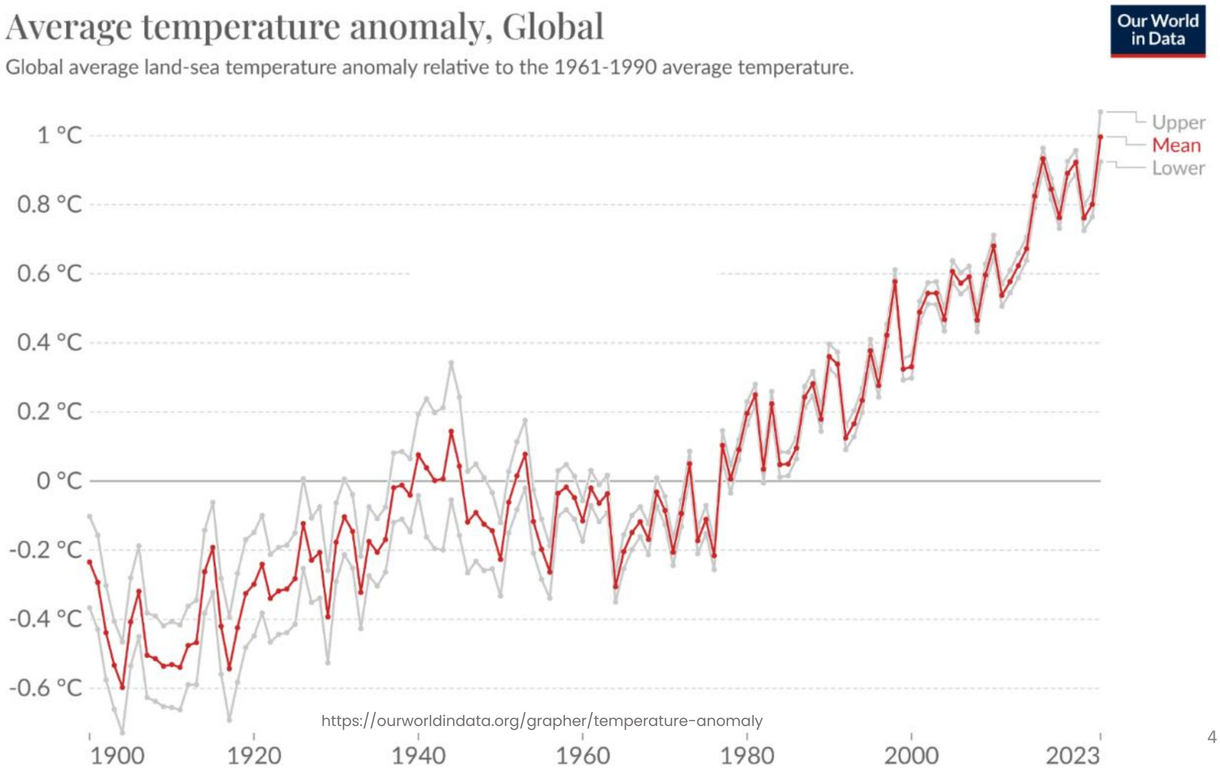

'Dark matter' fungi
uncultured and poorly known taxa belonging to early diverging branches of the fungal tree of life
Zoosporic parasites
diverse group of organisms that have a flagellated stage and a parasitic lifestyle
Chytrids
group of fungi characterized by the production of zoospores with a single posteriorly directed flagellum

Reñé et al. (2023) *Marine Ecology*



Light microscopy images of organisms observed in diatom-enriched incubations. (a–c) mature sporangia of chytrids infecting *Ditylum brightwellii*, (d) mature sporangia of chytrids infecting a *Chaetoceros affinis* cell. (e, f) chytrid zoospores emerging from chytrid sporangia (arrowheads).

Climate change - temperature



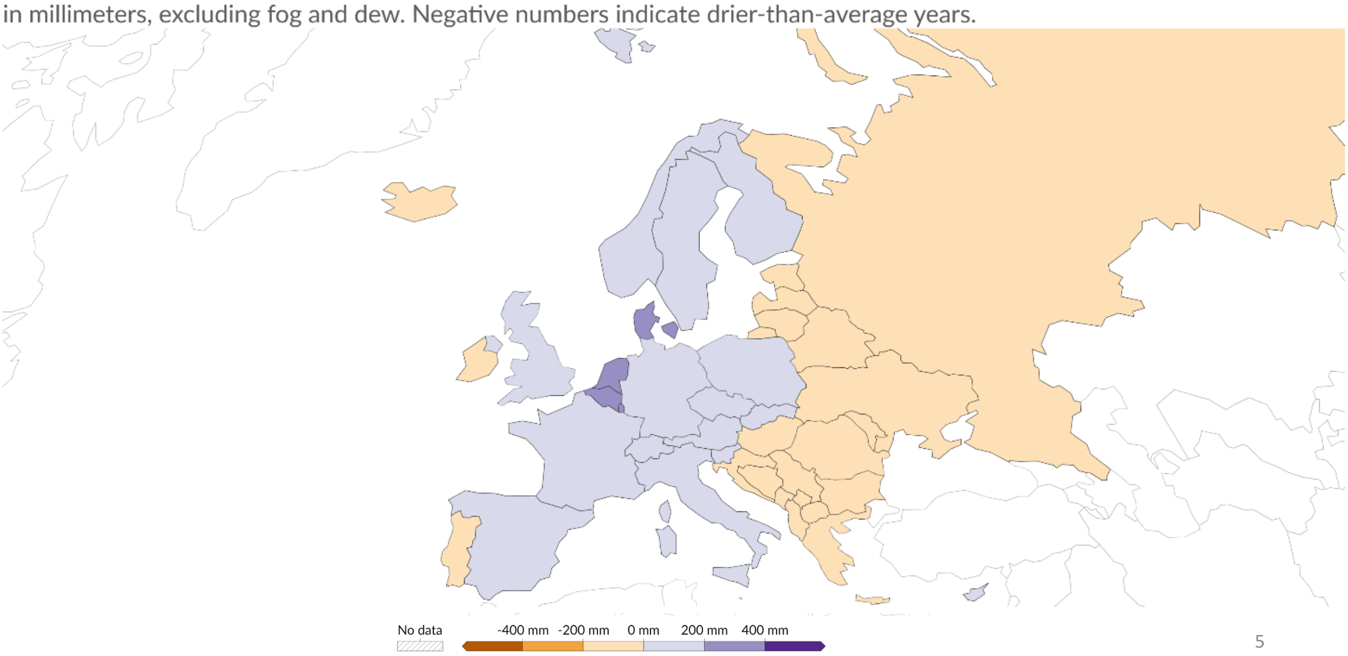
https://ourworldindata.org/grapher/temperature-anomaly

Climate change – precipitation

Precipitation anomaly, 2024

Our World in Data

The difference in a specific year's total precipitation — rain and snow — from the 1991–2020 average, measured in millimeters, excluding fog and dew. Negative numbers indicate drier-than-average years.



https://ourworldindata.org/grapher/global-precipitation-anomaly

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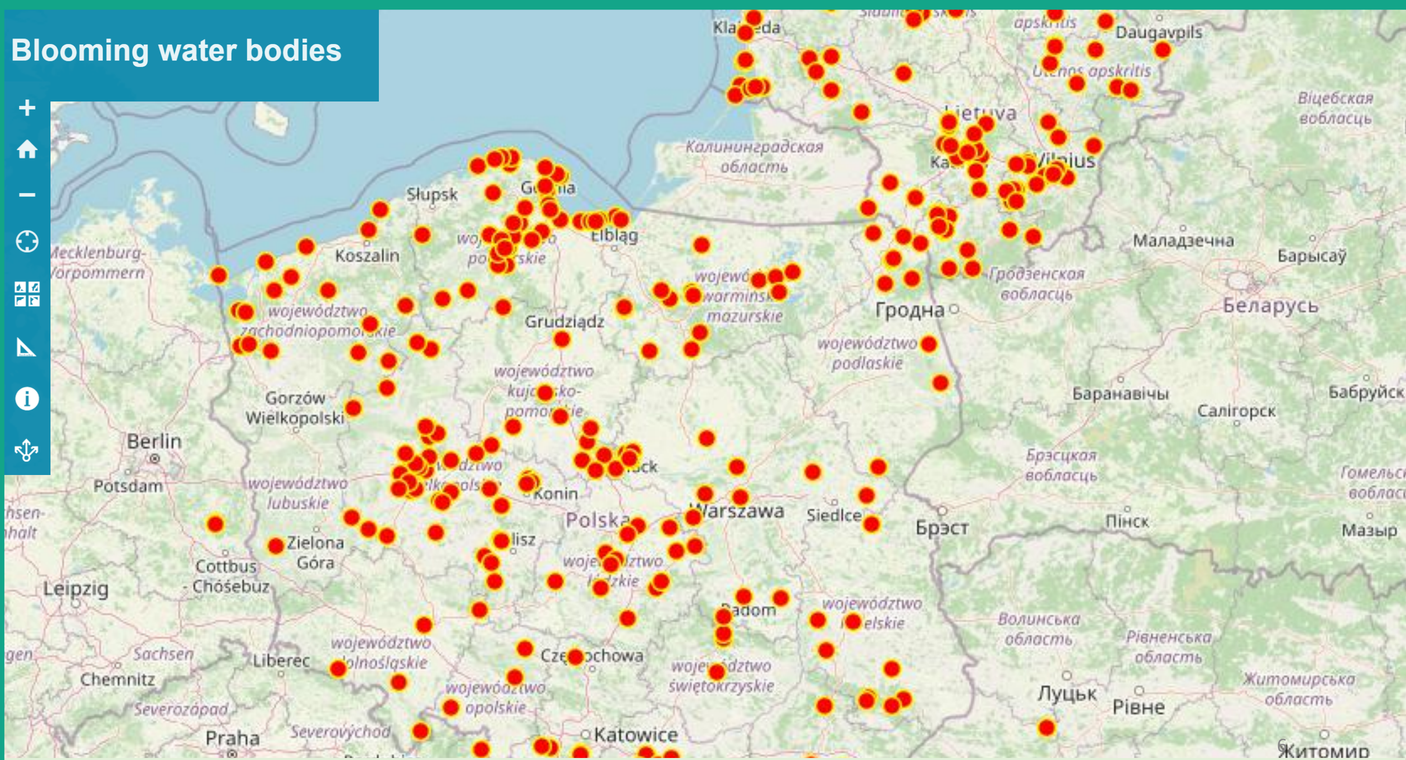
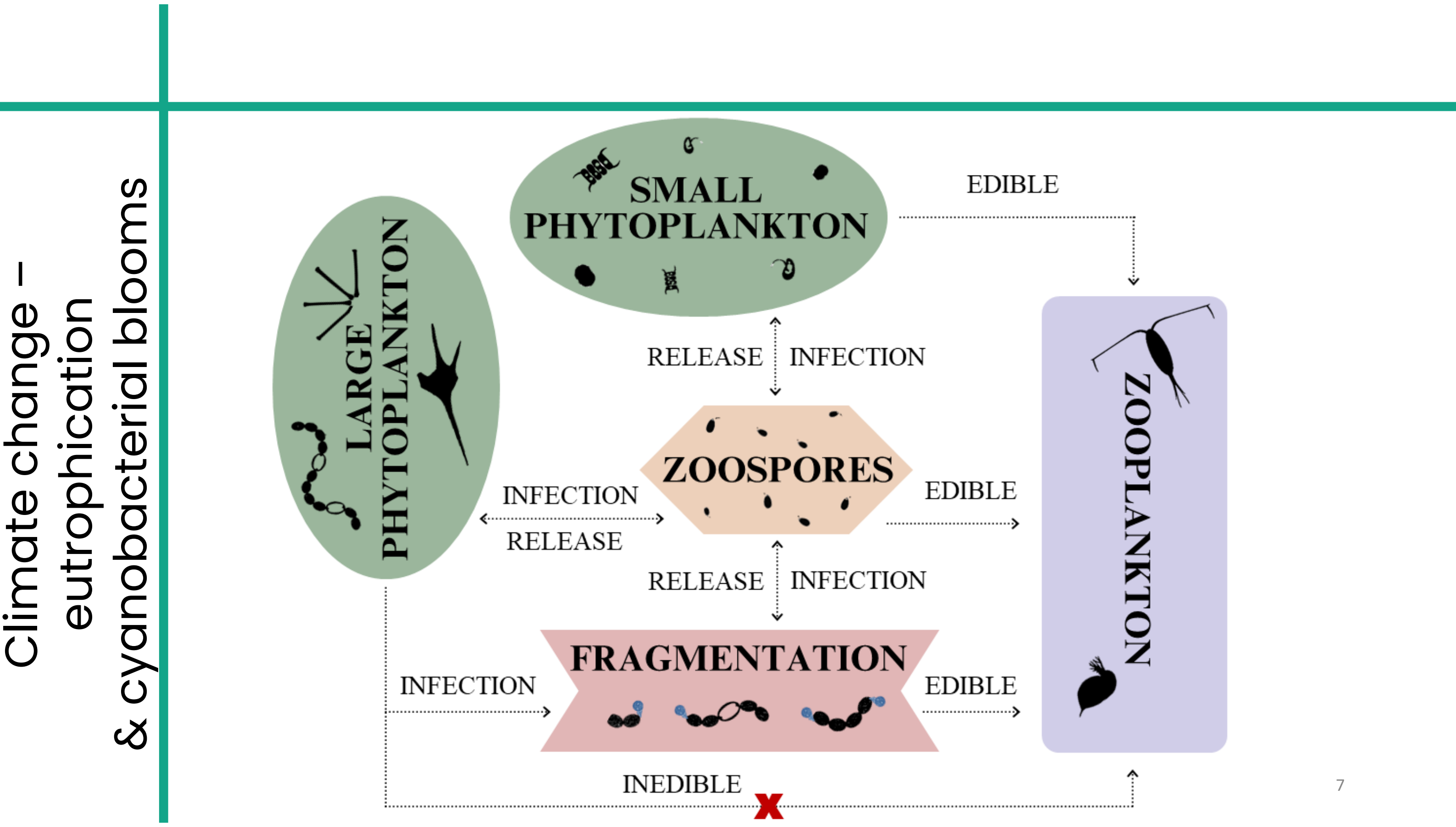
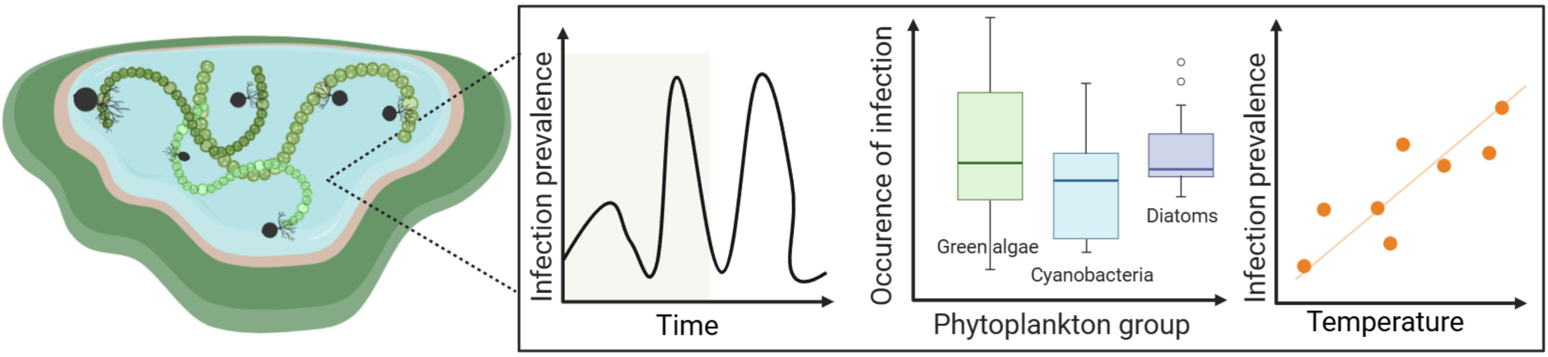
Climate change – eutrophication & cyanobacterial blooms



(life17 env/lt/000407) https://gpf.maps.arcgis.com/apps/View/index.html?appid=297d0c6b02b14719868e9d6d6b885327


Climate change – eutrophication & cyanobacterial blooms
SMALL PHYTOPLANKTON
EDIBLE
LARGE PHYTOPLANKTON
RELEASE
INFECTION
ZOOPLANKTON
ZOOSPORES
INFECTION
RELEASE
EDIBLE
RELEASE
INFECTION
FRAGMENTATION
INFECTION
EDIBLE
INEDIBLE
7

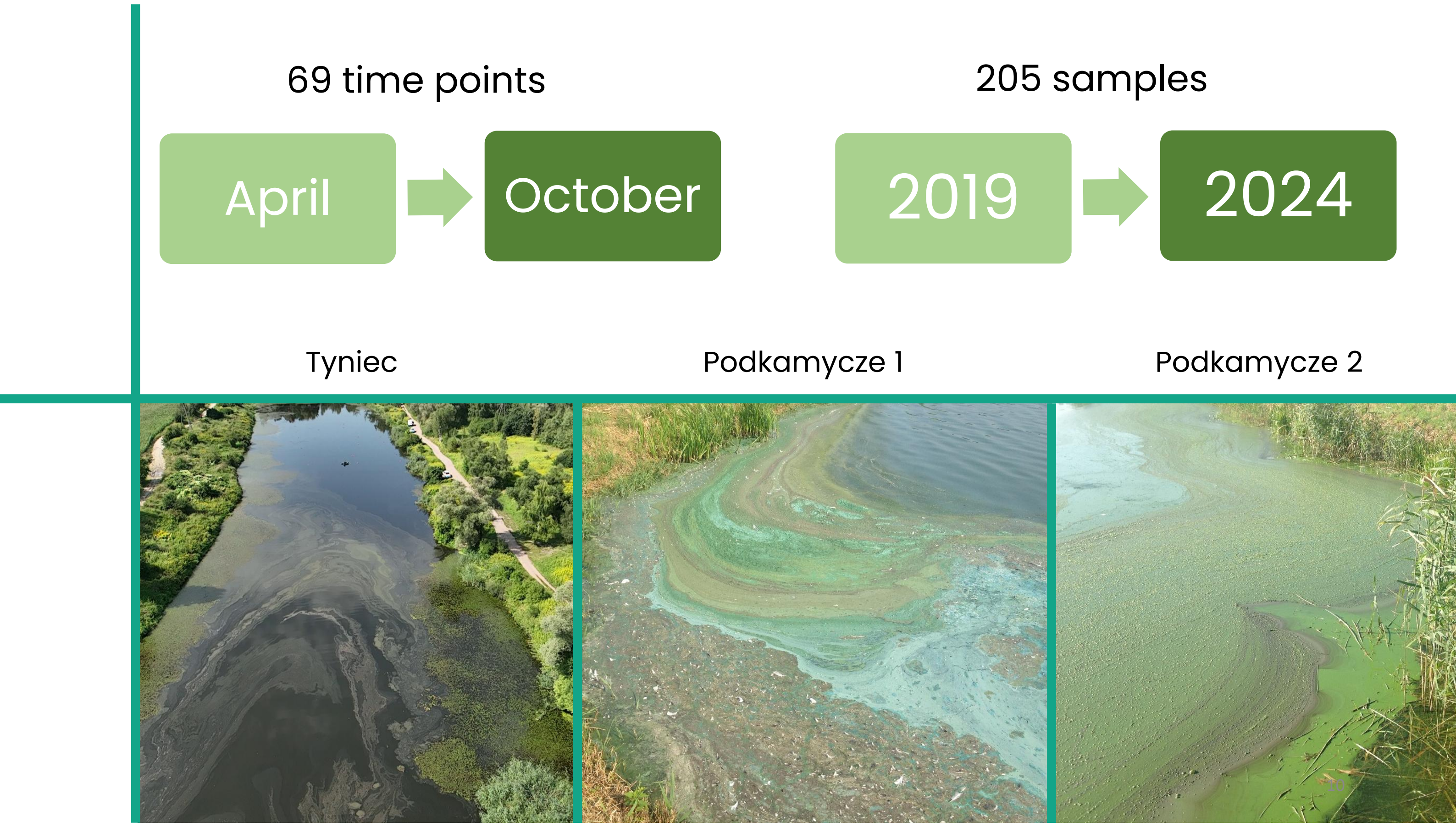
The aim of the study was to **infer occurrence, prevalence and dynamics of parasitic infections on phytoplankton under natural conditions**



We hypothesised that:

(i) the occurrence of chytrid infections and high infection prevalence would correspond to high phytoplankton biomass, particularly during cyanobacterial blooms,

(ii) infection prevalence would increase with increasing temperature and nutrient concentrations.


69 time points
April
October
205 samples
2019
2024
Tyniec
Podkamycze 1
Podkamycze 2

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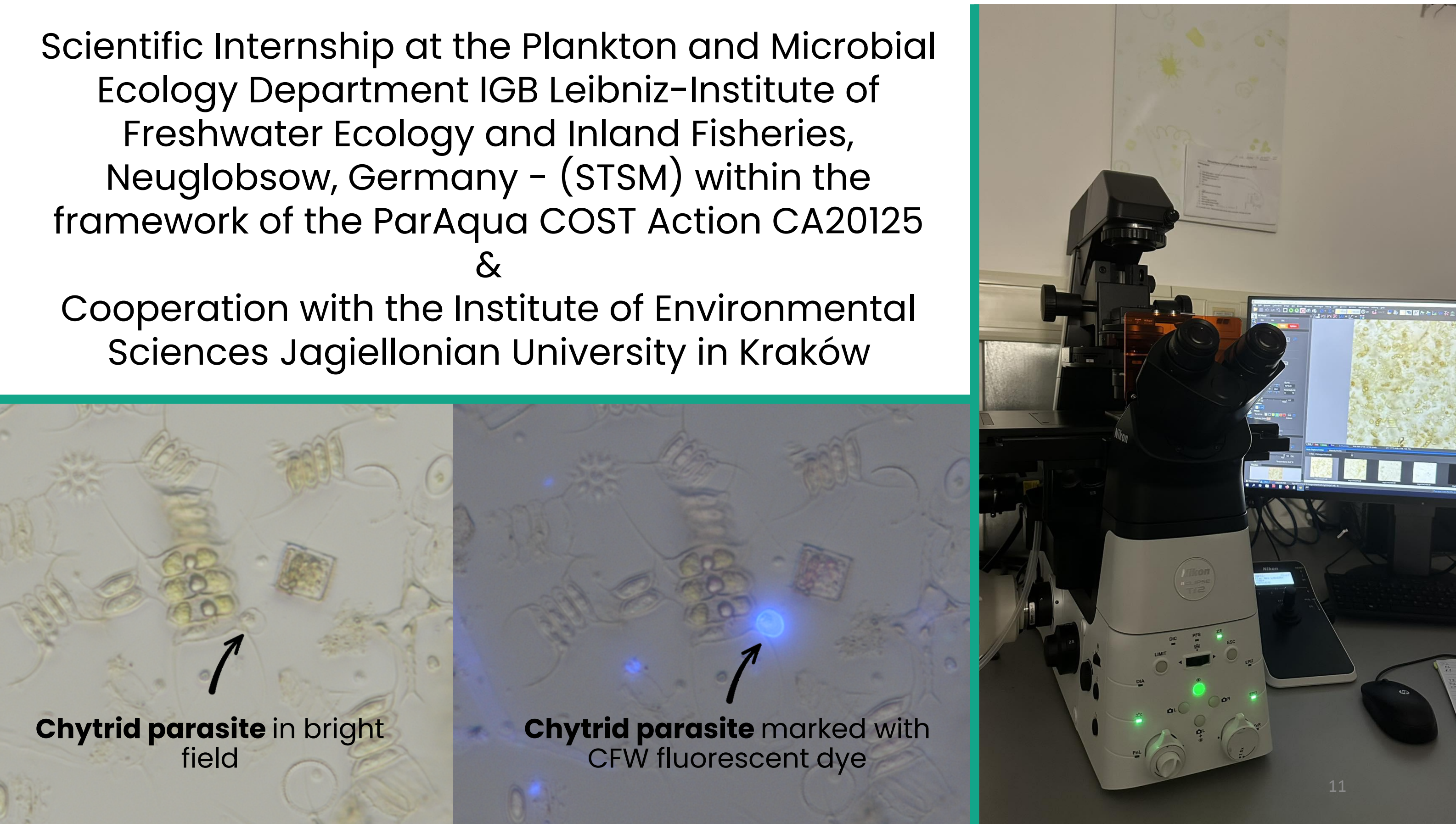


$$\text{IPC} = \frac{Ni}{Nt} \text{ x } 100\%$$

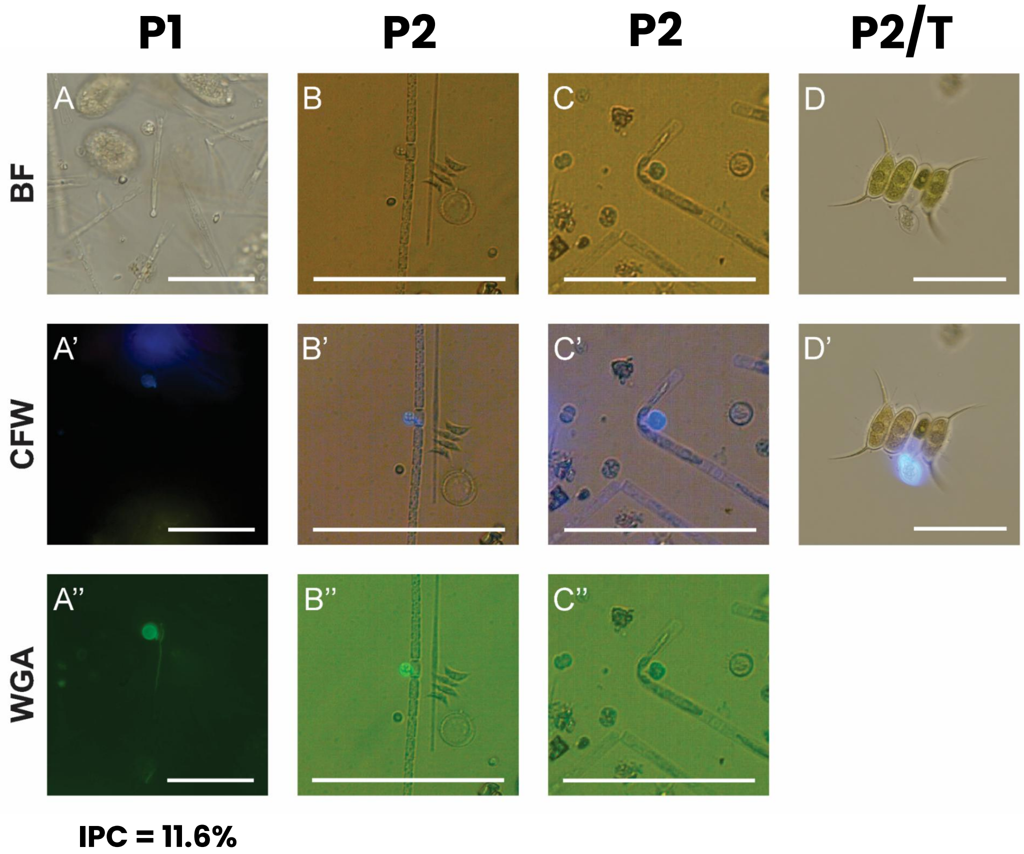
Where:
Ni is the number of cells infected by chytrids
Nt is the total number of cells

INFECTION PREVALENCE

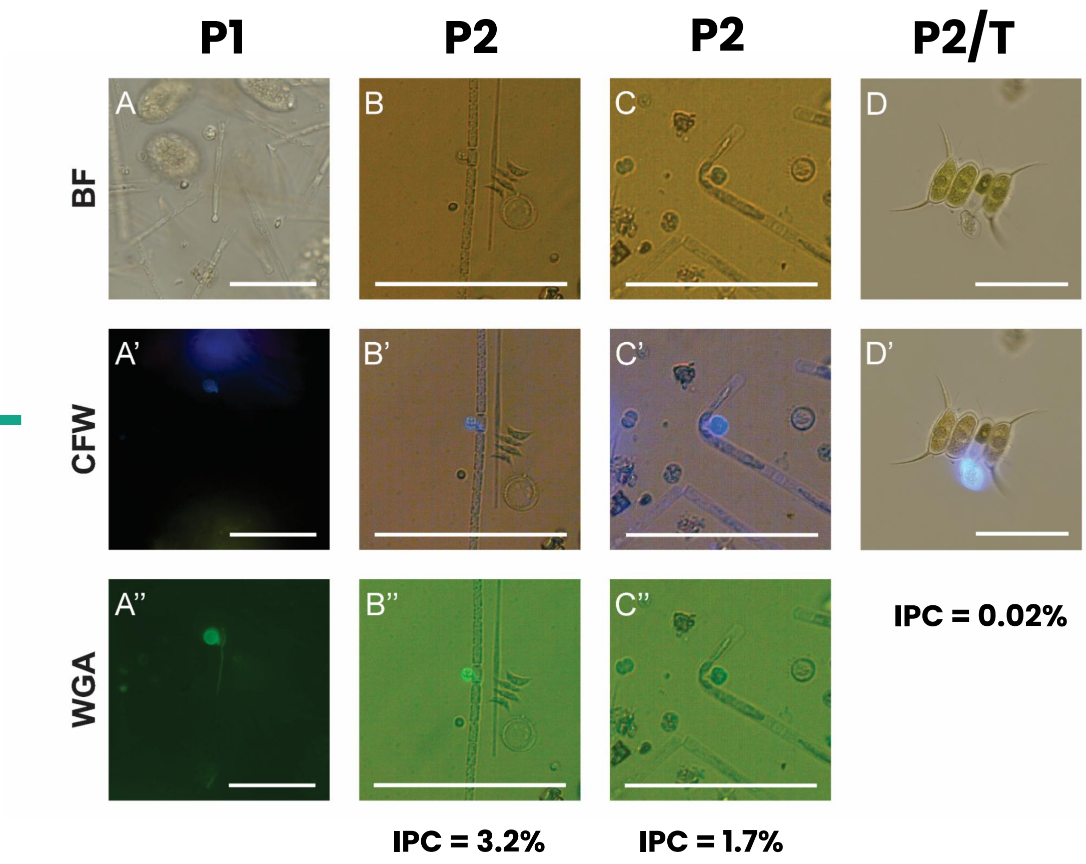
$$\text{IS} = \frac{Nps}{Ni}$$

Where:
Nps is the number of attached sporangia
Nt is the number of cells infected by chytrids

MEAN INFECTION SEVERITY



Examples of microscopic micrographs of phytoplankton hosts with attached chytrid parasites obtained during seasonal surveys in (A) Podkamycze 1 – *Asterionella formosa*, (B) Podkamycze 2 – *Aphanizomenon gracile*, (C) Podkamycze 2 – *Mougeotia* sp. and (D) Tyniec – *Desmodesmus* sp. The scale bar represents 50 µm. BF = bright field, CFW = Calcofluor White, WGA = Wheat Germ Agglutinin



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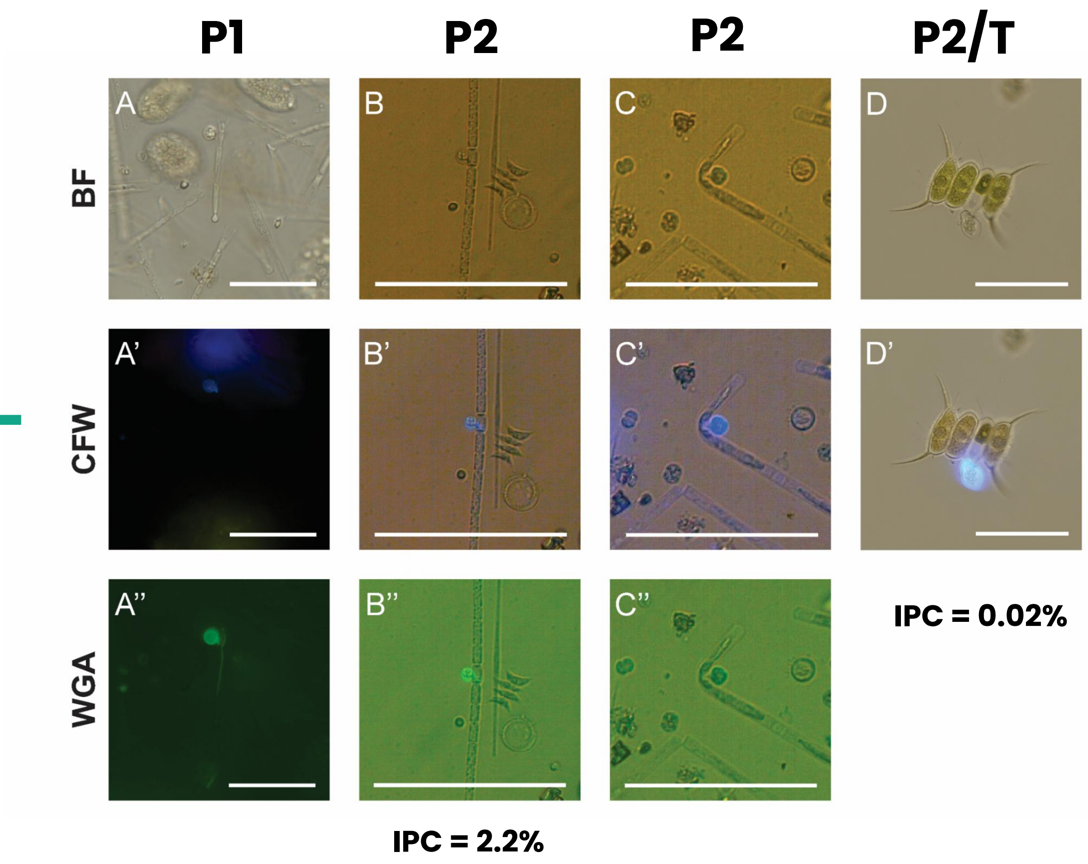

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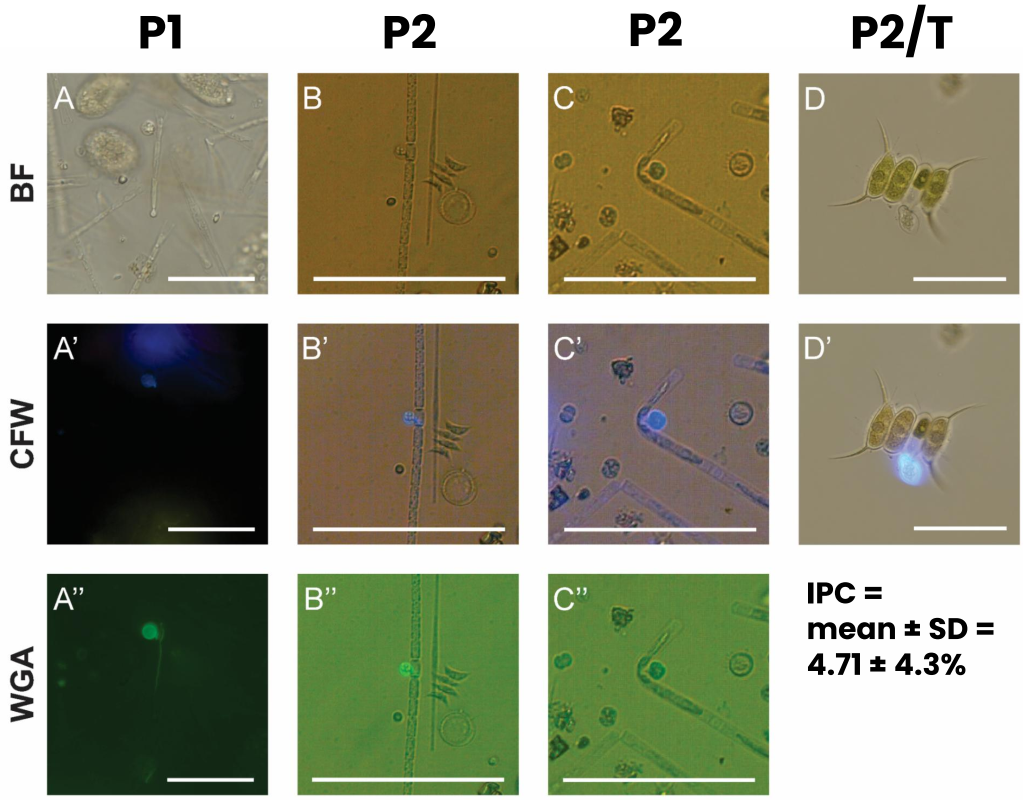

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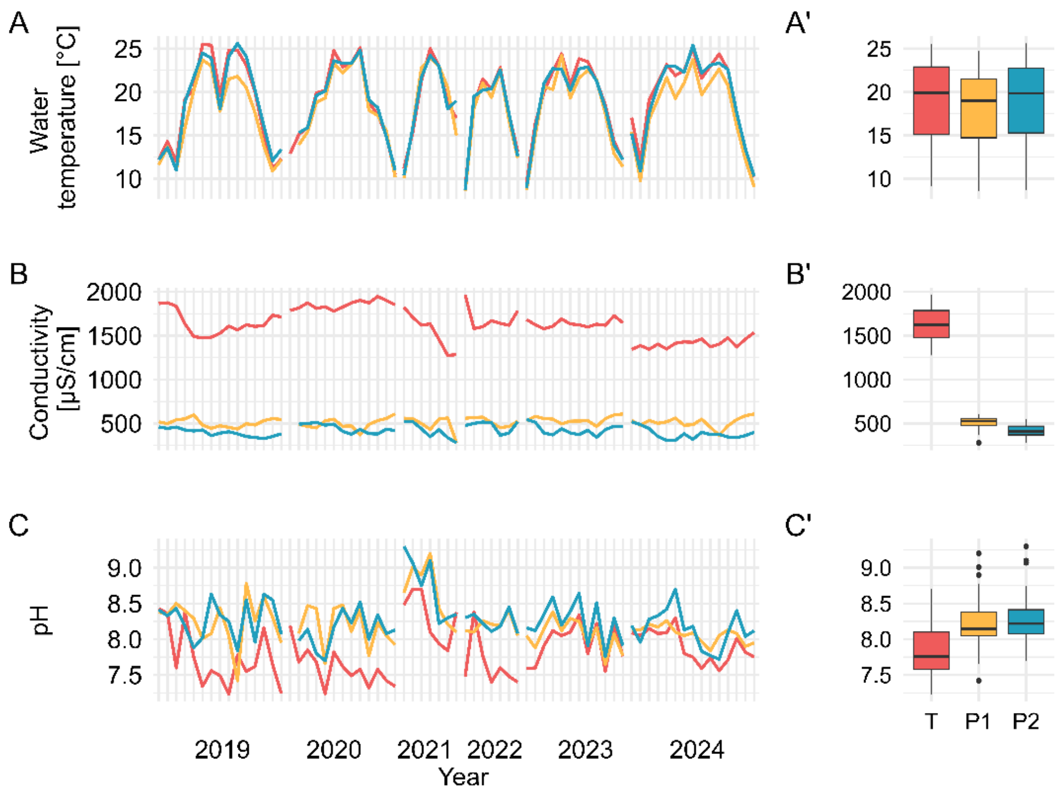
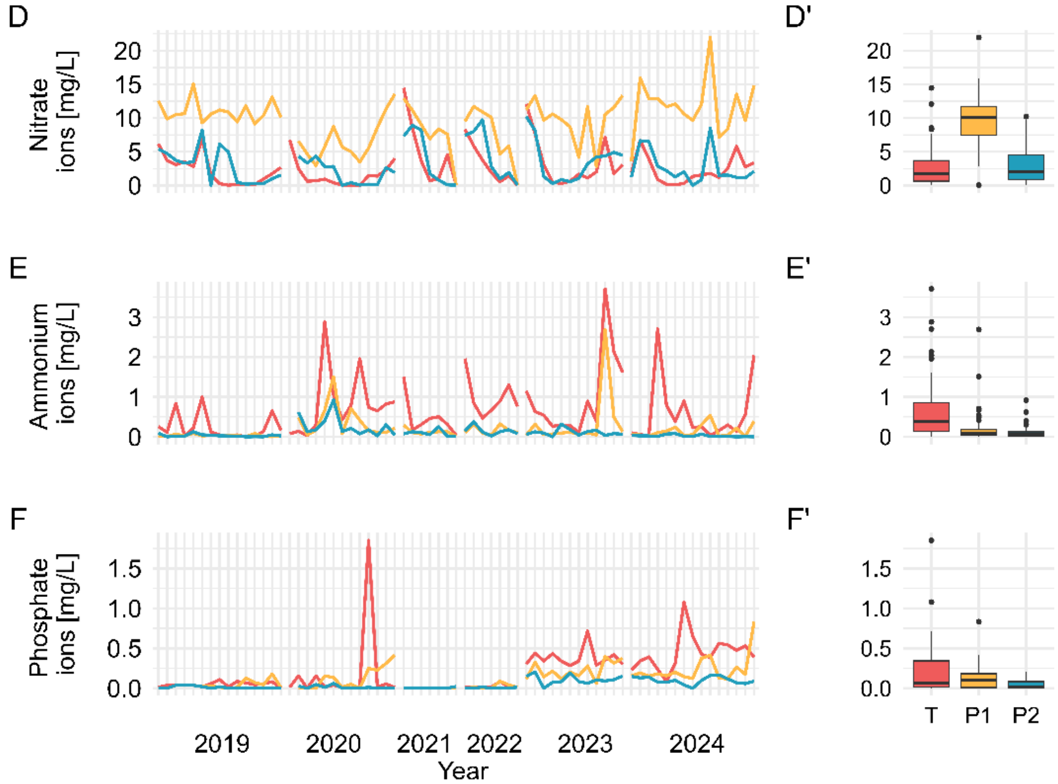
Model results of the generalized linear model analysis of infection occurrence as dependent variable with pH, water temperature [°C], phosphates [mg/L] and nitrates [mg/L] as explanatory variables on observation data in studied reservoirs.

Occurrence of infection	**Estimate**	**SE**	**z-value**	**Pr(>|z|)**
Intercept***	21.2815	6.3970	3.327	< 0.001
pH***	-3.4676	0.8395	-4.131	< 0.001
Phosphates***	7.6459	2.0093	3.805	< 0.001
Nitrates***	-0.4625	0.1200	-3.855	< 0.001
Water temperature***	0.2675	0.0772	3.465	< 0.001



Seasonal trends in (A) water temperature, (B) conductivity, (C) pH, (D) nitrate, (E) ammonium, (F) phosphate across the three waterbodies (T, P1, P2) over the study period (2019-2024). Total values of explanatory variables for selected water bodies.



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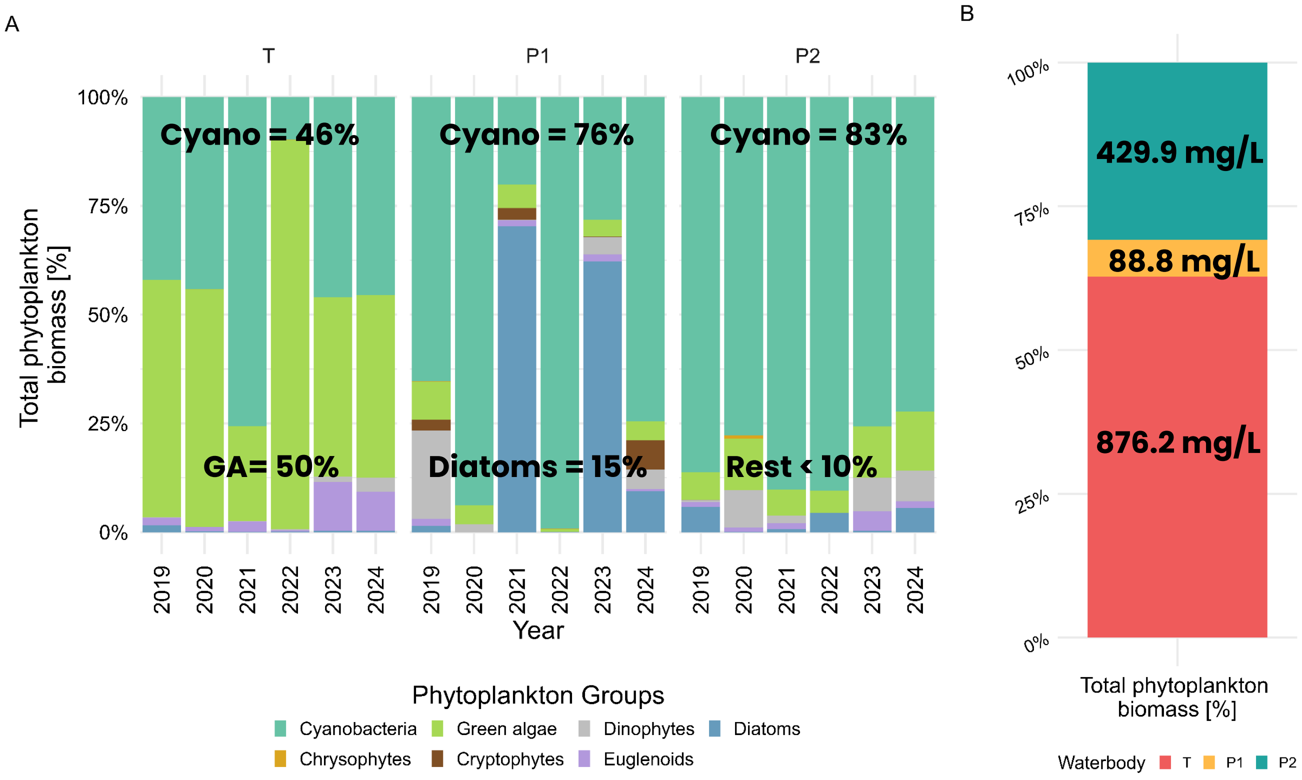
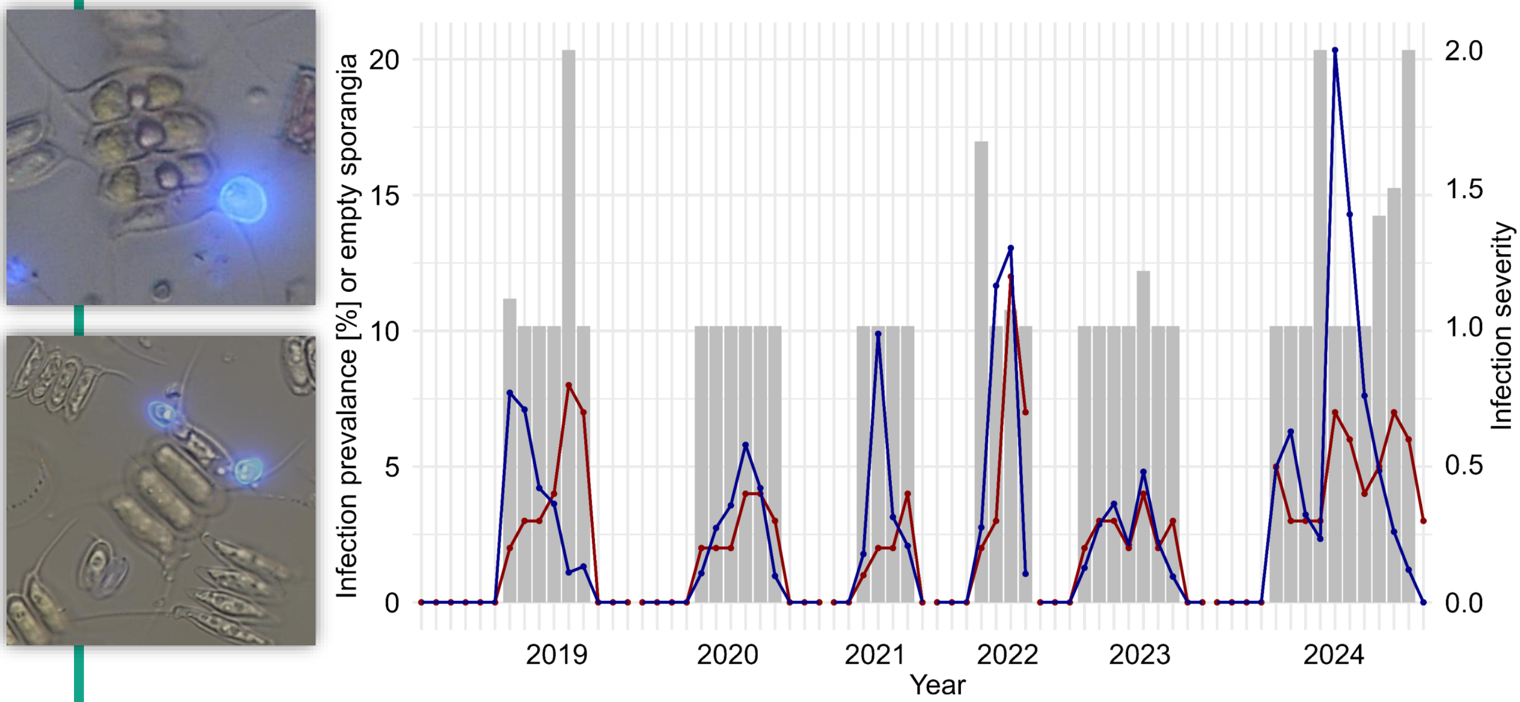
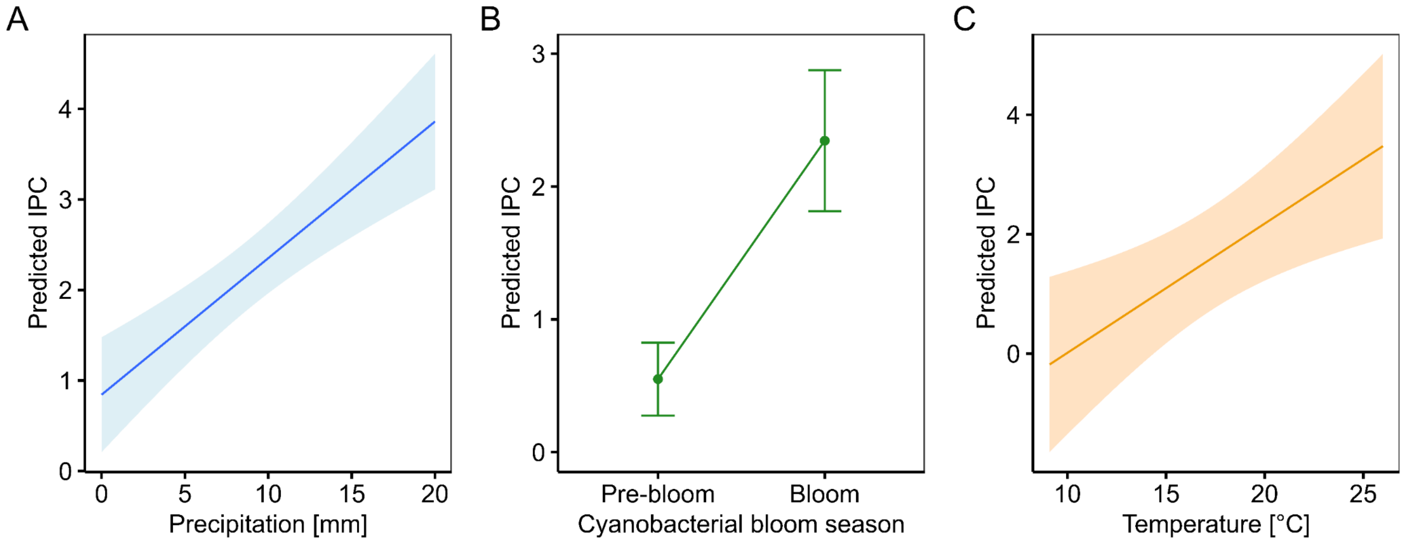


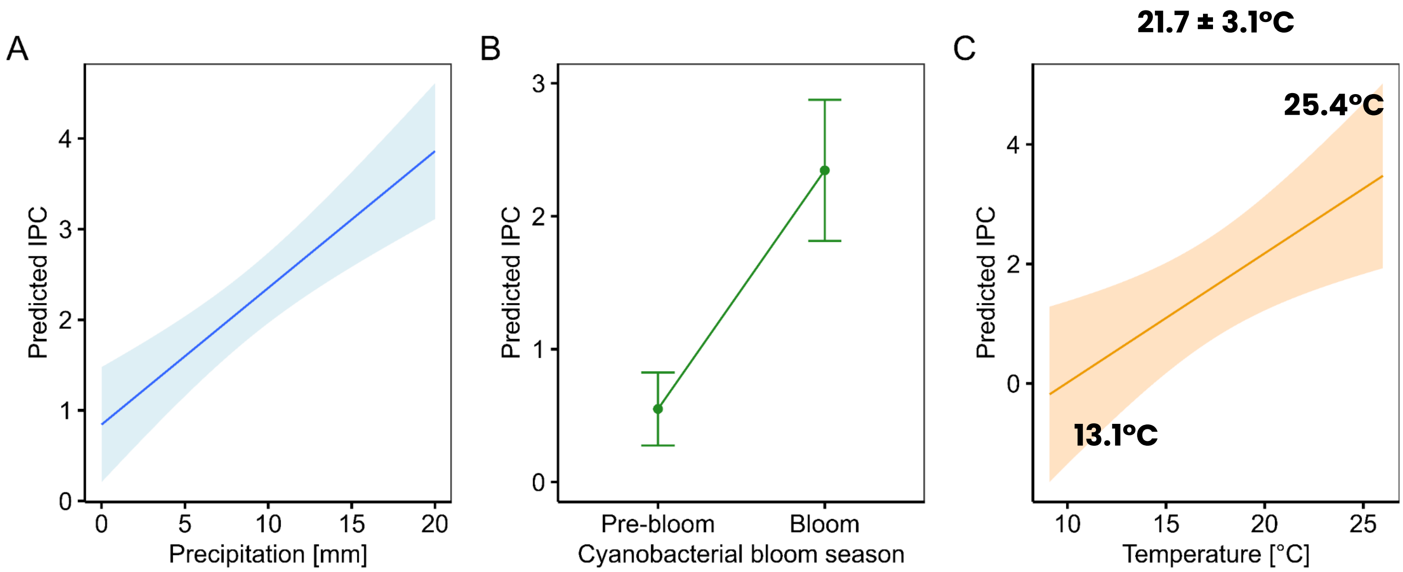
A) Distribution of phytoplankton groups biomass, across the three waterbodies (T, P1, P2) over the study period (2019-2024). B) Proportion of total biomass in each waterbody.



Time series of infection prevalence (%, blue, left), empty sporangia (red, left), and infection severity (grey, right).



Relationship of infection prevalence with (A) precipitation [mm], (B) cyanobacterial bloom season and (C) water temperature [°C] on observation data in Tyniec oxbow lake.



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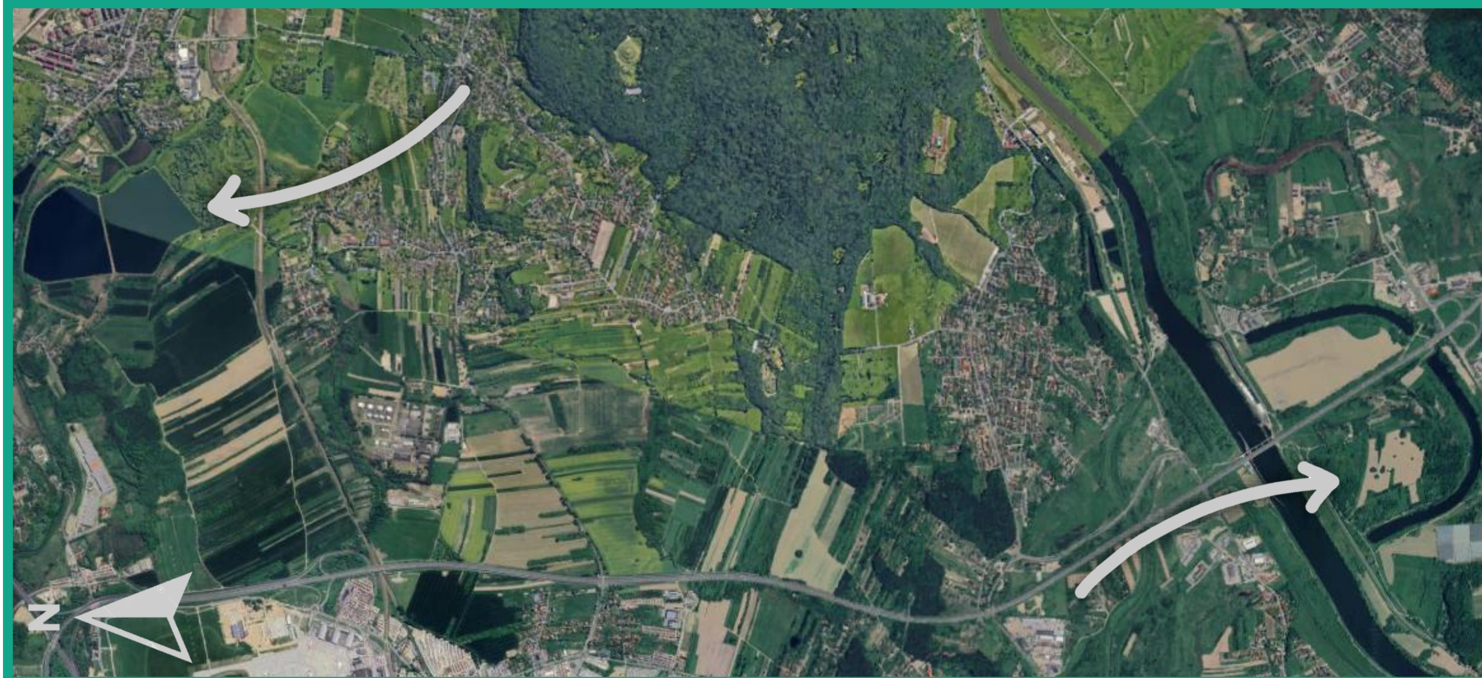
Valois & Poulin (2015) *Limnology and Oceanography*

Podkamycze 1 & Podkamycze 2



Tyniec oxbow lake

27

The findings suggest that **different factors determine occurrence** of parasitic infections in different water bodies compared to **different factors influencing** the extent of parasites **infection prevalence**

Acknowledgements

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If you have any questions, please don't… …hesitate to ask

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