4. Microscopic swimmers

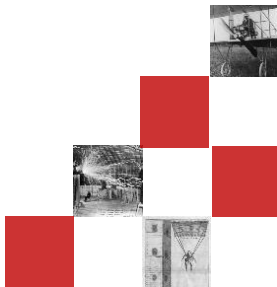
Team Croatia

Reporter: Mia Čmrlec

Problem statement

Investigate **experimentally and theoretically** the **locomotion** of bacterial or **eukaryotic cells** that use natural **flagella** to move in a liquid.

- theoretically: 3D simulation
- experimental: 4 temperatures



Euglena viridis

- microscopic organism
- the protista kingdom
- eukaryotic cell structure
- optimum temperature -> 25 ° C - 30 ° C

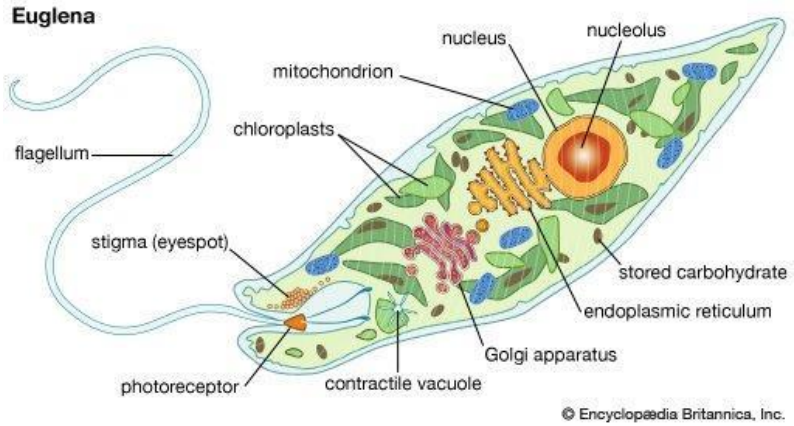


Figure 1. Euglena anatomy (Britannica, 2017)

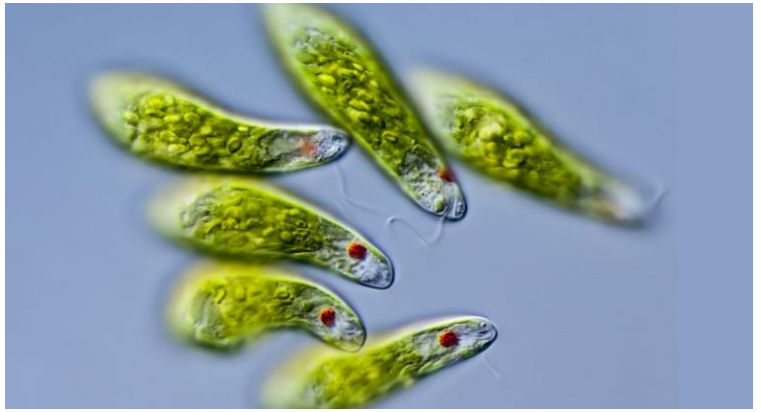


Figure 2. *Euglena viridis* under a light microscope (SPL, 2021)

Movement of euglena

Euglenoid movement:

- movement by cytoplasmic contractions
- slow and limited movement

Flagellar movement

- the flagella creates two forces acting on the water that allow it to move

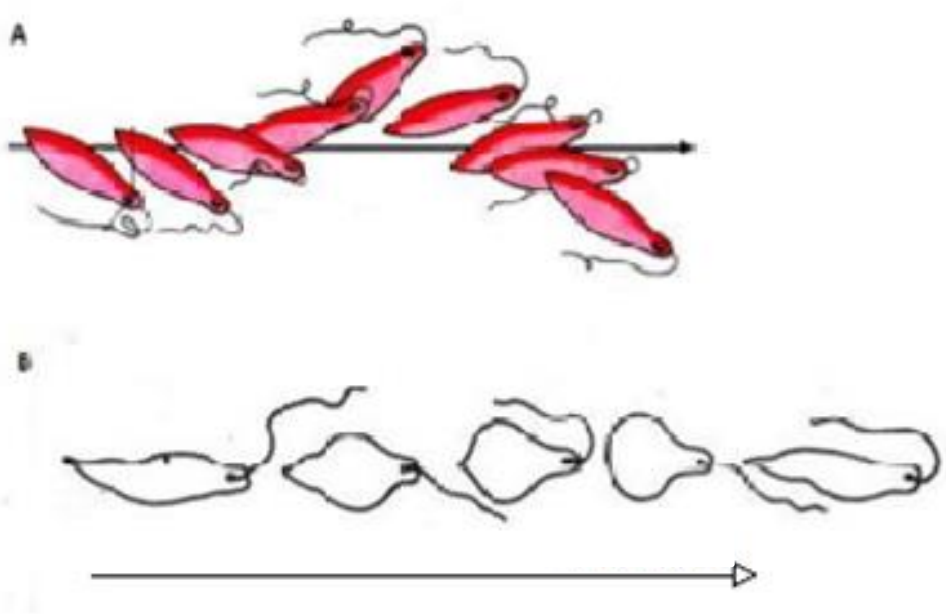
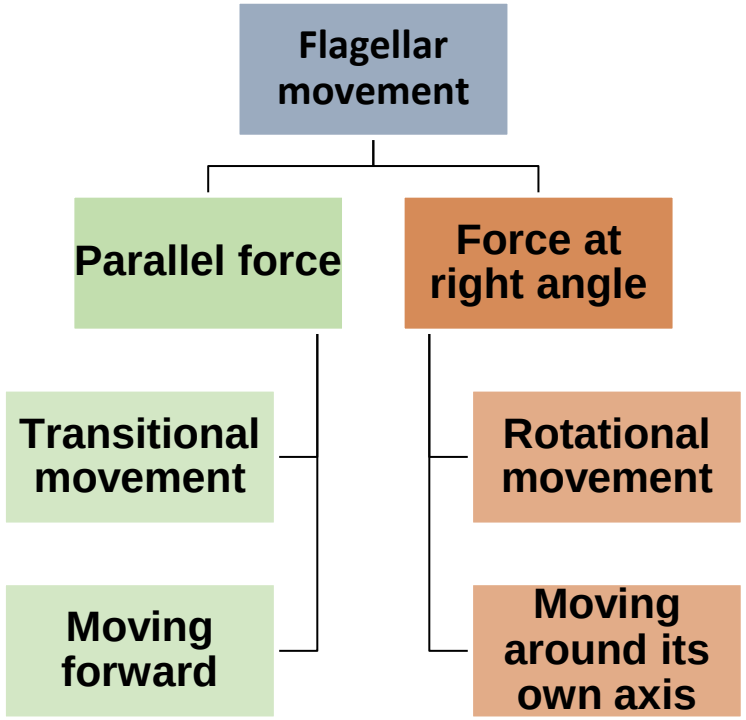
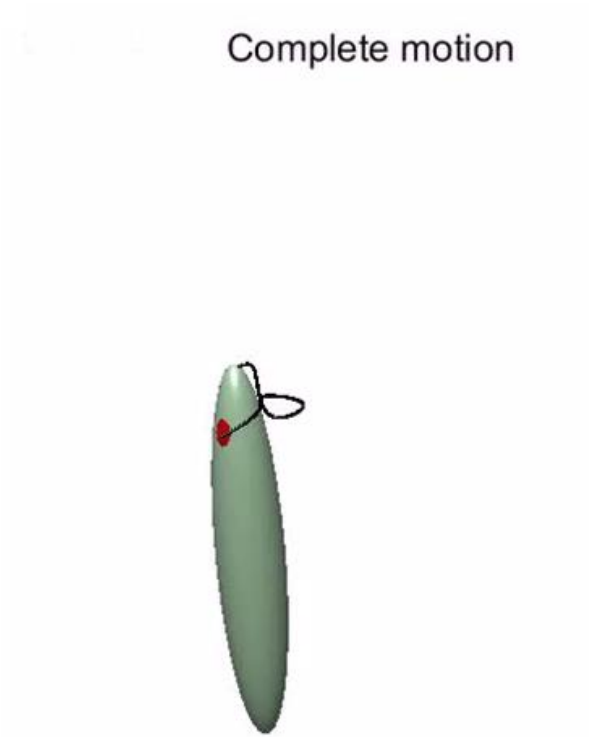


Figure 3. Movement in *Euglena viridis*: A) whipping; B) euglenoid movement (taken and adapted from Jain, 2013; Shah, 2013).

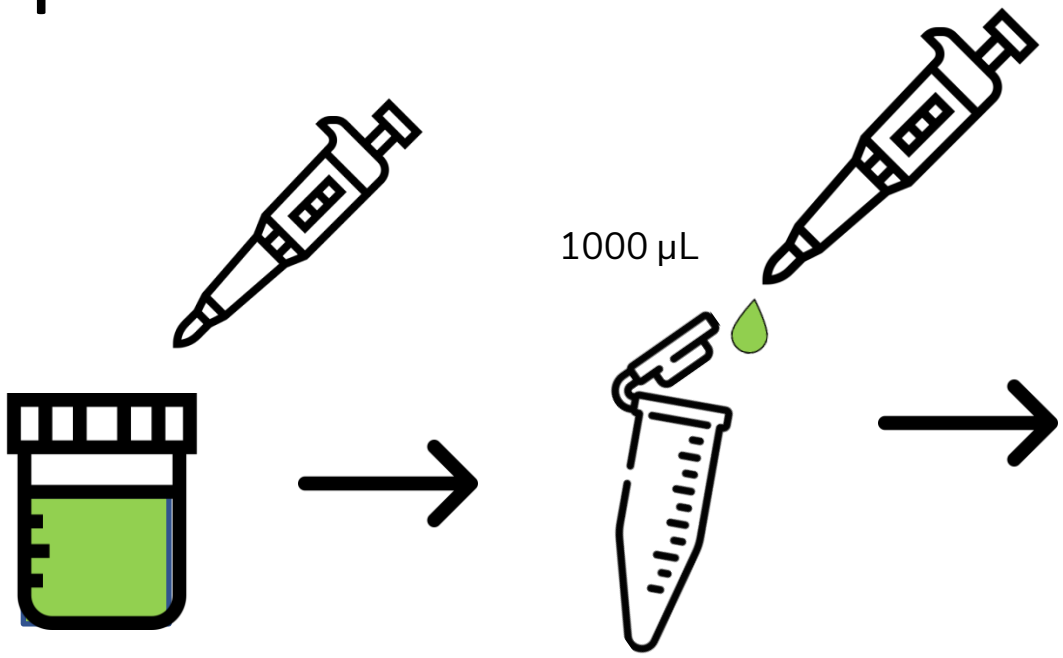
Theoretical movement of euglena





Video 1. 3D model of euglena motion according to Rossi et al. (2017)

Incubation of samples



Preparation of microscopy slides

- two drops of 20 µL
- magnification 400 ×
- recorded using a camera under a microscope

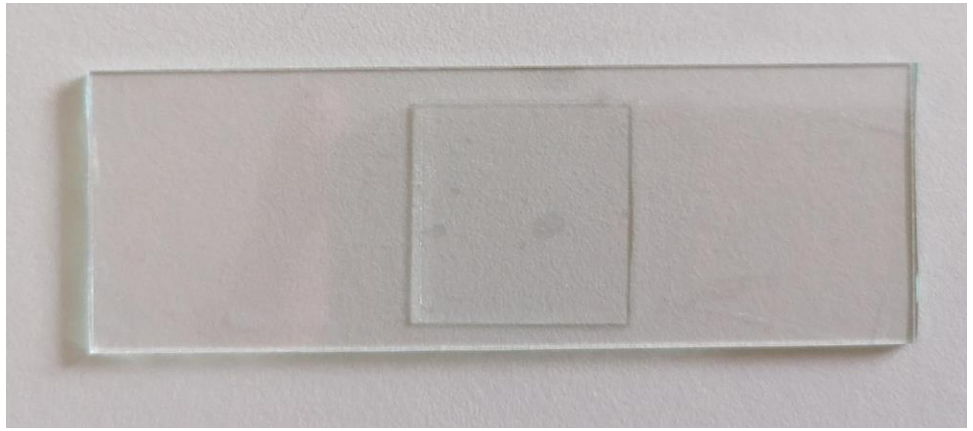


Figure 5. Preparation of one test group (photo: Čmrlec)

Figure 6. Microscope (XSZ-0900) used for microscopy of the preparation (photo: Čmrlec)

Video 2. Microscopic image used to analyze the movement of one sample

Data analysis

Adobe Photoshop

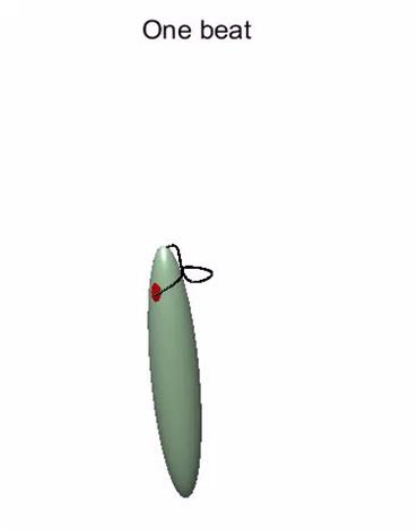
- video -> separate frames
- in each sample -> five euglenas -> movement constant in 25 frames

Manual Tracking Plugin

- eye spot monitoring
- flagellar movement

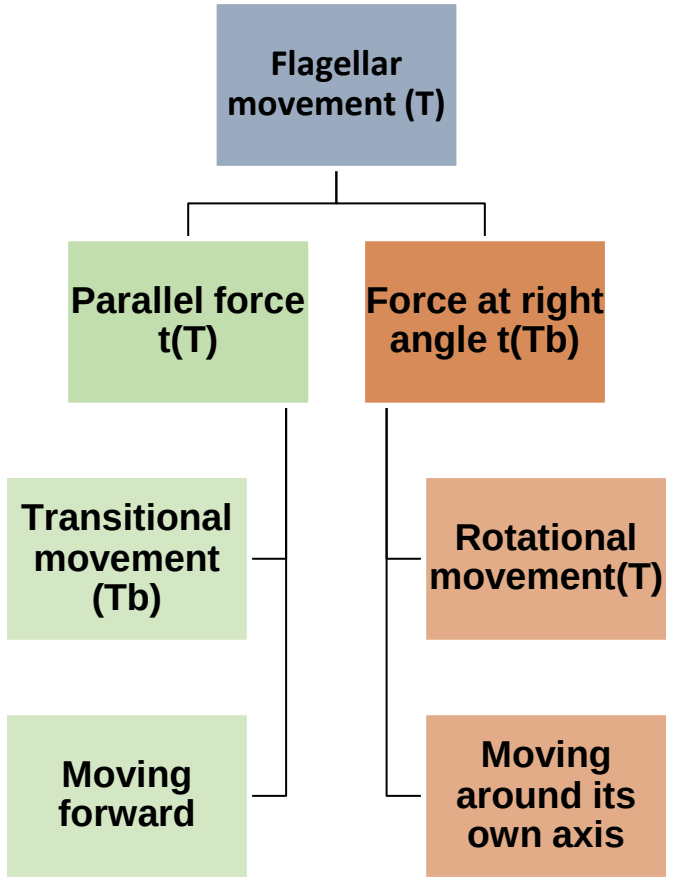
Figure 7. Video analysis of a single sample in Adobe Photoshop

The formula for calculating the motion of euglena



Video 3. 3D model of euglena motion according to Rossi et al. (2017)

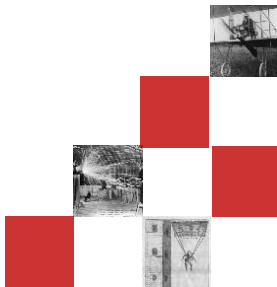
$$\mathbf{T = t(T) \div t(Tb)}$$



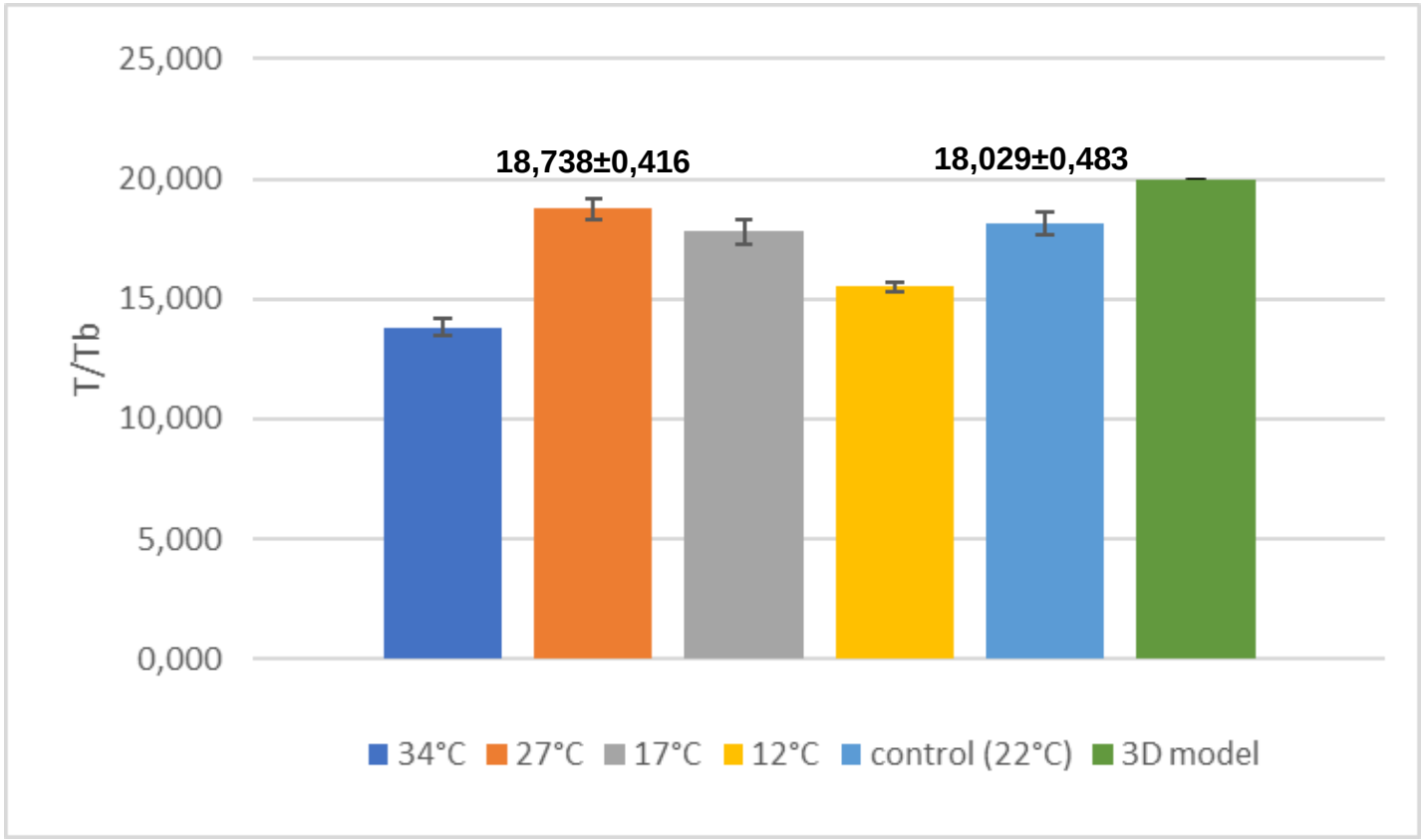
HYPOTHESES

H1: **Theoretical data** on the movement of euglena according to the **3D model** will best correlate with the **experimental data** on the movement at **27 ° C**

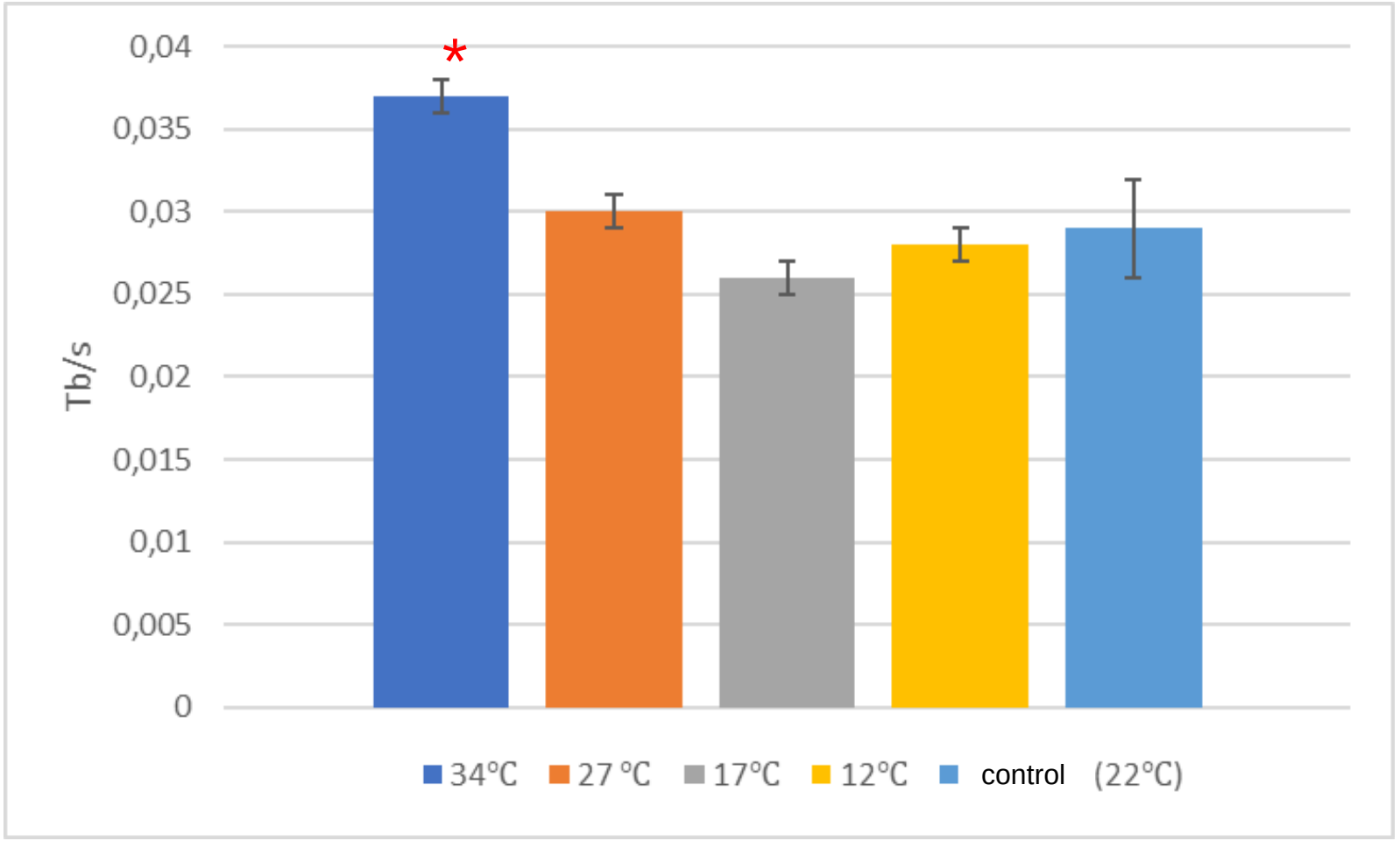
H2: The **activity** of the **euglena flagella** will **increase** to a temperature of **27 ° C**, while at a temperature of **34 ° C** there will be a **decrease in the activity** of the flagella



H1: Theoretical data on the movement of euglena according to the 3D model will best correlate with the experimental data on the movement at 27 ° C

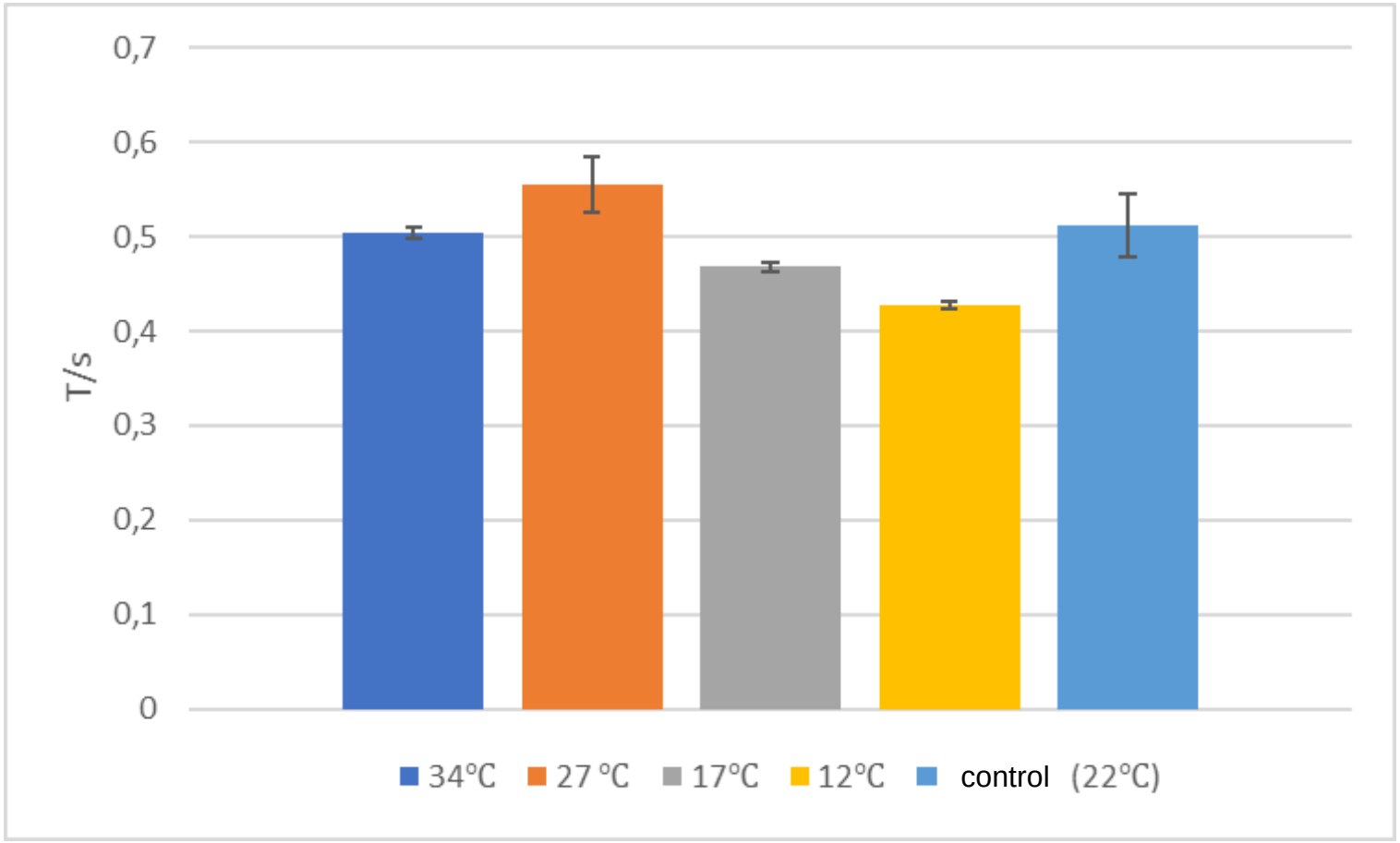


Graph 1. Change in the number of rotational movements using the flagella of the 3D model and at different temperatures (12 ° C, 17 ° C, 27 ° C, 34 ° C) of experimental and control groups expresed as T / Tb.



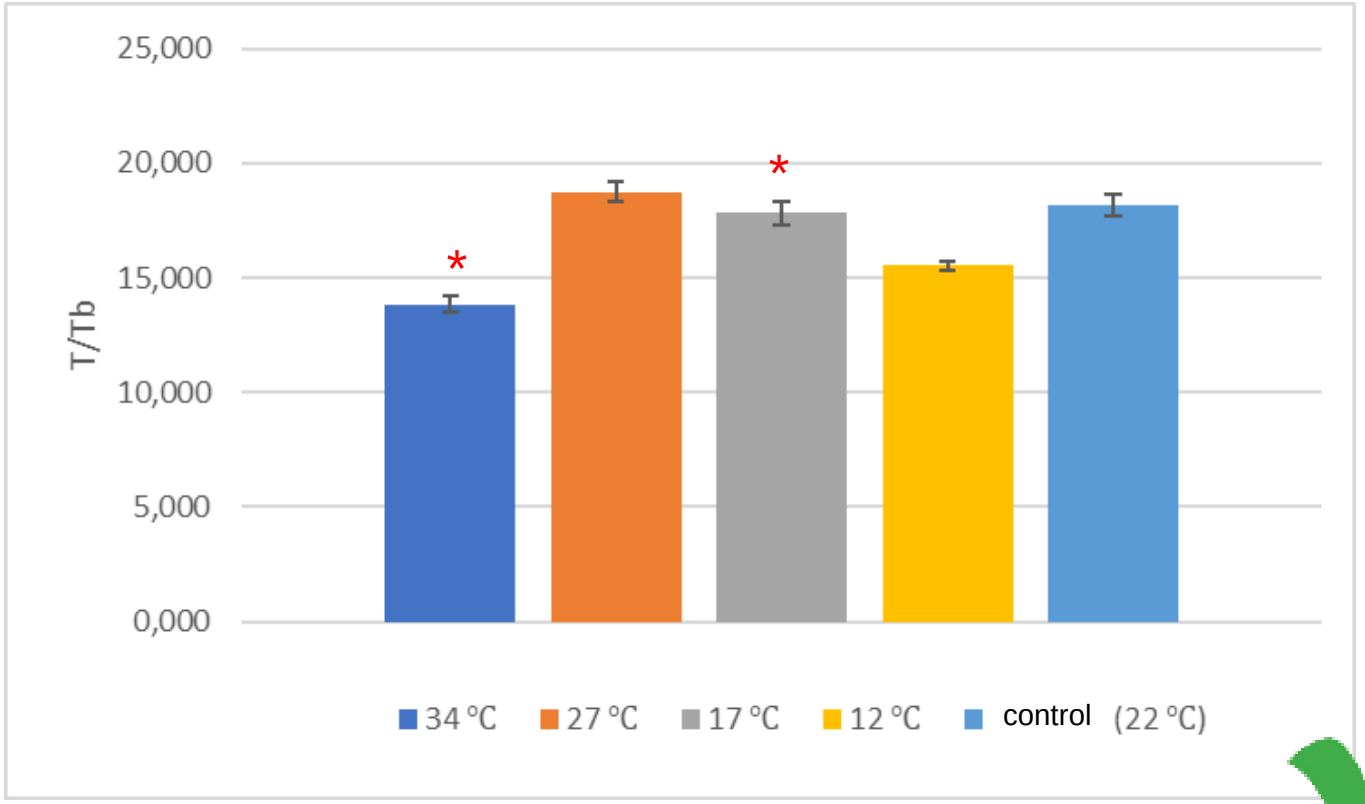
Graph 2. Time required for transitional flagella movements at different temperatures (12 ° C, 17 ° C, 27 ° C, 34 ° C) of experimental and control groups expressed in seconds.

* -> statistical significance



Graph 3. Time required for rotational movements using flagella at different temperatures (12 ° C, 17 ° C, 27 ° C, 34 ° C) of experimental and control groups expressed in seconds.

H2: The activity of the euglenas flagella will increase to a temperature of 27 ° C, while at a temperature of 34 ° C there will be a decrease in the activity of the flagella



Graph 4. Change in the number of rotational movements using flagella at different temperatures (12 ° C, 17 ° C, 27 ° C, 34 ° C) of experimental and control groups expressed in Tb (transitional movement).

* -> statistical significance

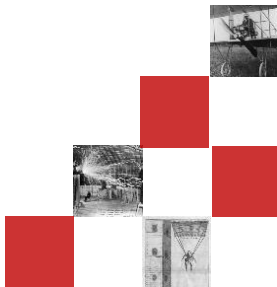
Conclusions

- the **first hypothesis** was **confirmed** -> **3D motion model** correlates with **experimental data** on motion at 27°C

-> correlation at room temperature (22 °C)

- the **second hypothesis** was **confirmed** -> the **activity of the flagella** at temperatures of **12 ° C, 17 ° C and 34 ° C** is **lower** compared to the **control**

- the **change in temperature** has a **significant effect** on the movement of ***Euglena viridis***



Literature

Rossi M., Cicconofri G., Beran A., Noselli G., DeSimone A. (2017.): Kinematics of flagellar swimming in Euglena gracilis: Helical trajectories and flagellar shapes. PNAS December 12, 2017 114 (50) 13085-13090

Habdija I. 1996. Jednostanične životinje, Praživotinje, U Lenčik S. (ur.), Raznolikost živog svijeta životinjski svijet – priručnik-udžbenik iz biologije za drugi razred gimnazije. Profil, Zagreb str. 6-14

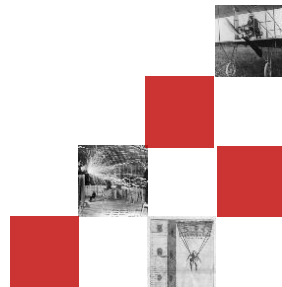
Habdija I., Primc-Habdija B., Radanović I., Špoljar M., Matoničkin Kepčija R., Vujčić Karlo S., Miliša M., Ostojić A., Sertić Perić M. 2011. Razred: Gastropoda (puževi), Novoselić D. (ur.), Protista – Protozoa – Metazoa – Invertebrata Strukture i funkcije. ALFA, Zagreb, str. 231-245.

SPL 2021. Images. © Science Photo Library Limited. https://www.sciencephoto.com/ (12. 12. 2021.)

VS 2018. Images. ©2018 Visuals Unlimited. https://visualsunlimited.photoshelter.com/ (12. 12. 2021.)

Shah R. 2013. Euglena Viridis: Habitat, Structure and Locomotion | Protozoa

http://www.biologydiscussion.com/invertebrate-zoology/protozoa/euglena-viridis-habitatstructure-and-locomotion protozoa/28141 (19. 11. 2021.)



Thank you!

Team Croatia

Reporter: Mia Čmrlec

IYNT TSKNETI 2022