How to observe *Bacillaria* motility during a total solar eclipse

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Abstract

In order to prove that the stacked configuration of *Bacillaria* colonies in the dark is their natural behavior, we propose an outdoor test utilizing total solar eclipses.

Introduction

It has recently been proven that birds stop chirping during a total solar eclipse (Corless, 2025). This raises the important questions: do birds have intrinsic diurnal cycles, or not, or might they reflect the length of the day when they first evolved? We'll leave these deep birding questions to those who ponder why roosters wake them up.

What has this got to do with diatoms? We used to presume that the motility of colonial *Bacillaria* was diurnal. At night it closes down to the "stack of bricks" configuration. Margaret Kapinga proved this hypothesis incorrect (Kapinga, 1989). She found that on lights off they went into the stacked configuration, and apparently "yawning" (sequential movement of individual cells from the ends of each colony) they opened into their colony oscillations whenever the lights came back on. Her thesis contradicts the frequent observation that diatoms are diurnal (Jaubert et al., 2022). How such a fundamental fact about diatoms could prove to be misinformation propagated in diatom textbooks is concerning.

But is *Bacillaria* sleep a natural phenomenon? Surely it requires rigorous testing during a total solar eclipse, indoor lighting which follows *Homo sapiens* diurnal patterns being obviously inadequate. As the authors don't expect to live long enough to catch such in their vicinities, we wish to propose a method for future generations who would rather watch diatoms than an eclipse itself. This requires deep devotion as a professional or amateur diatomist. Why they sleep at all requires psychoanalysis of *Bacillaria* (Alicea et al., 2023) or diatomists.

Methods

The study should be carried out on dense cultures of *Bacillaria paxillifer* (*Bacillaria paradoxa*). It is essential that these are not kept under artificial light, as is usually the case, but are exposed to daylight so that they can adapt to the day and night cycle. To avoid direct exposure to sunlight,

a north-facing window in the northern hemisphere is well suited for cultivation (the Equator should be avoided, as it creates indecision). Tiptoeing (as *Bacillaria* may be sensitive to vibrations, even music: what they might prefer also needs study) without casting a shadow insertion to the window sill should be from outdoors. It is recommended that they are collected in clear containers placed on a rooftop carrier and transferred to Petri dishes as soon as possible so that no disruptive sampling is required prior to observation, unless one is graced by a home *Bacillaria* pond. The authors recommend the use of a nutrient solution according to Walne (Walne, 1970). Compared to Guillard's nutrient solution, it is easier to cultivate *Bacillaria* from samples and experience has shown that the growth rate of the cultures is higher, showing that *Bacillaria* have already made their choice. Isolation of an initial clonal colony outdoors with an inverted microscope and growing into a dense culture must be done in advance. But our experience is that presently eclipses (if not clouds) are predictable in advance with high probability, so this should not be a problem, nor endanger the seer diatomist with beheading, as in days of old.

The culture can be placed on the stage of an inverted microscope hours before the total solar eclipse. The experiment should be done outdoors from the window. The cover of the Petri dish must be removed so that the entire spectral range in which the sun shines can be effective, and noise (e.g. singing birds) and air flow can also influence the sample. The spectral transmission of the Petri dish cover could be known in advance, as that of an alternative, such as a water impermeable low density polyethylene (Figure 1), which might transmit the solar spectrum better. However, the evaporation during the eclipse should be minimal, especially as the ambient temperature (which should be continuously recorded) is not too high, and may transiently fall. Drying out should be avoided. If you are observing at sea, the entire apparatus has to be suspended on a gimbal. A heated stage is recommended at low temperatures. In the event of rain, you can stop the experiment. If the *Bacillaria* are from a brackish source, salt concentration should be kept constant. Fortunately, salt does not tend to evaporate at ambient temperatures.

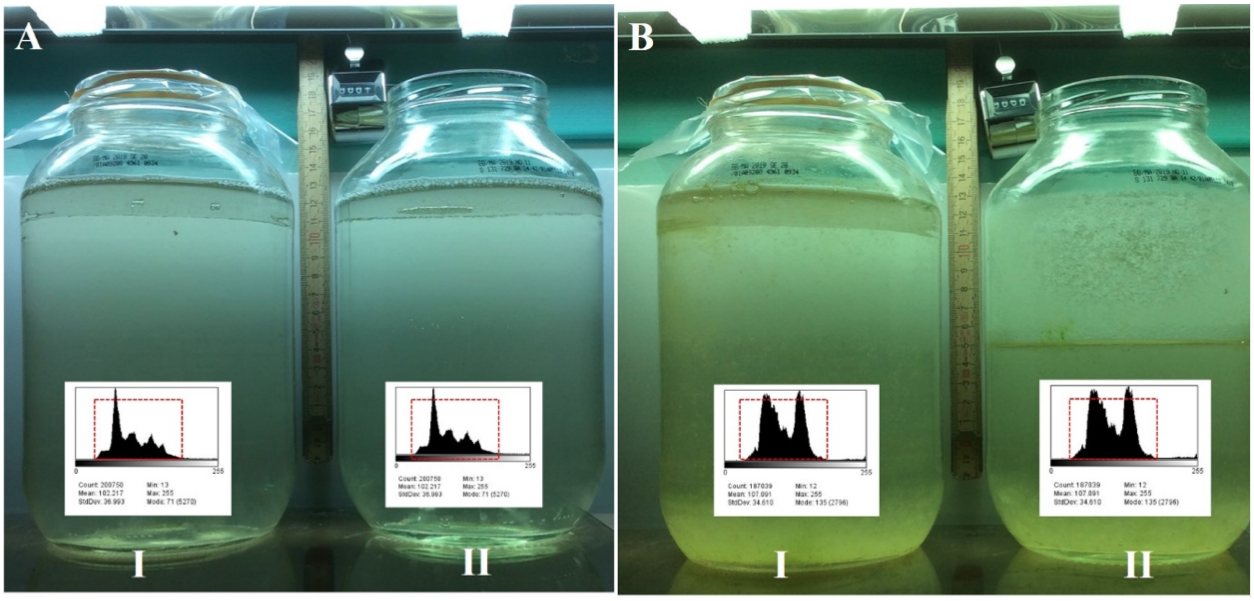

Figure 1. After 50 days (third right) no water has evaporated from a jar of pond water covered with low density polypropylene, but gas exchange allows growth of algae. Spectral transmission of the LDPL was not determined. Spectra of algae kindly determined by Vandana Vinayak. From (Khan et al., 2022) Supplement.

Observation should be made with a low magnification objective (approximately 2x to 5x) so that a large number of *Bacillaria* colonies are recorded simultaneously. This allows a statistical statement to be made about the proportion of colonies that respond to the eclipse. As an illustration, Figure 2 shows a phase contrast image of such a culture as is typically found in the dark.

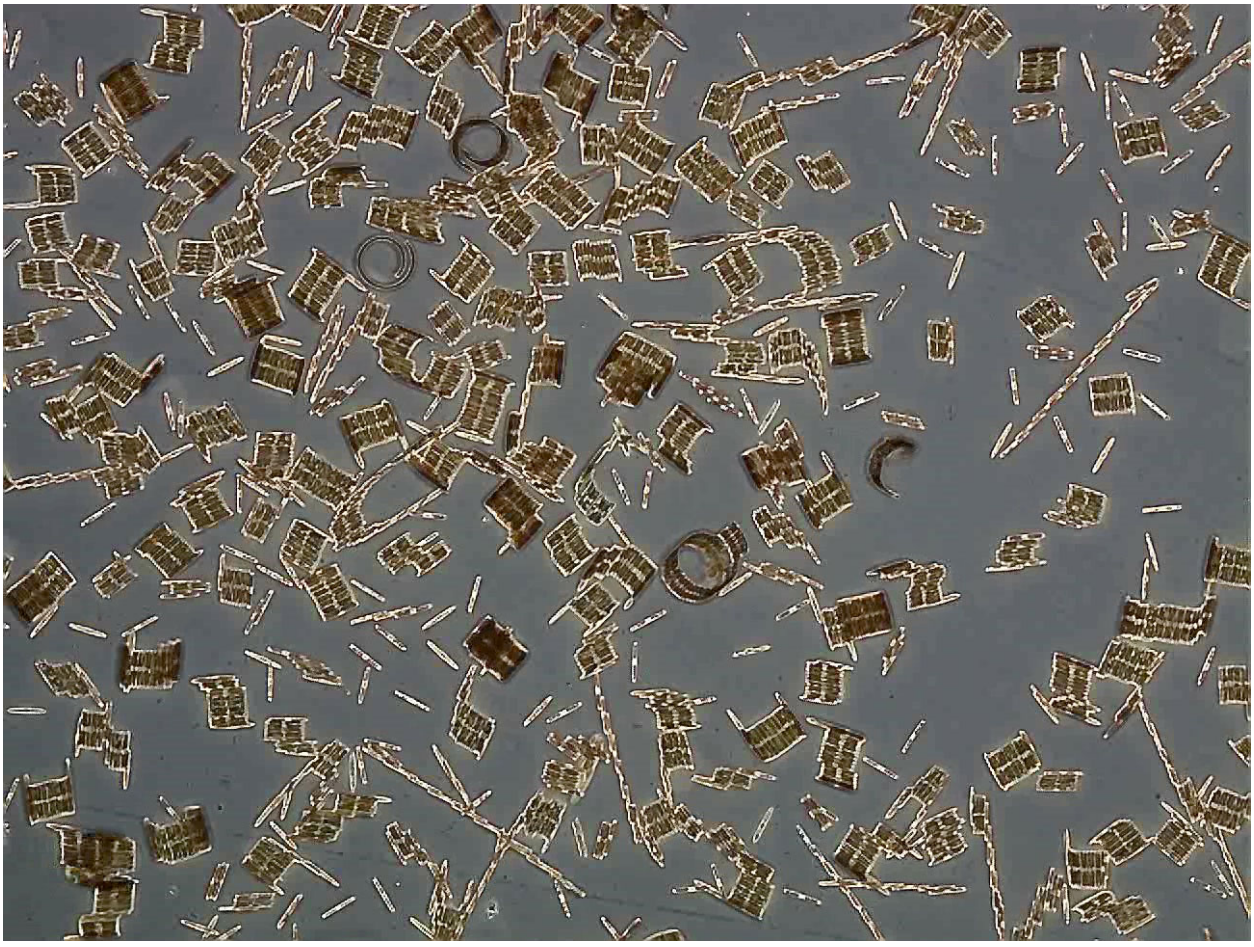

Figure 2. *Bacillaria paxillifer* from fresh water (Neckar River, Germany). The culture was about three weeks old at the time of photography. The pictures were taken several hours after the artificial lighting was switched off.

The colonies are almost at rest, in a stacked configuration (apex next to apex) and often laterally rolled up. A few colonies show the typical active locomotion, moving back and forth between the stretched positions. Error: Reference source not found shows the culture in the same observation field after 10 minutes under moderate microscope illumination.

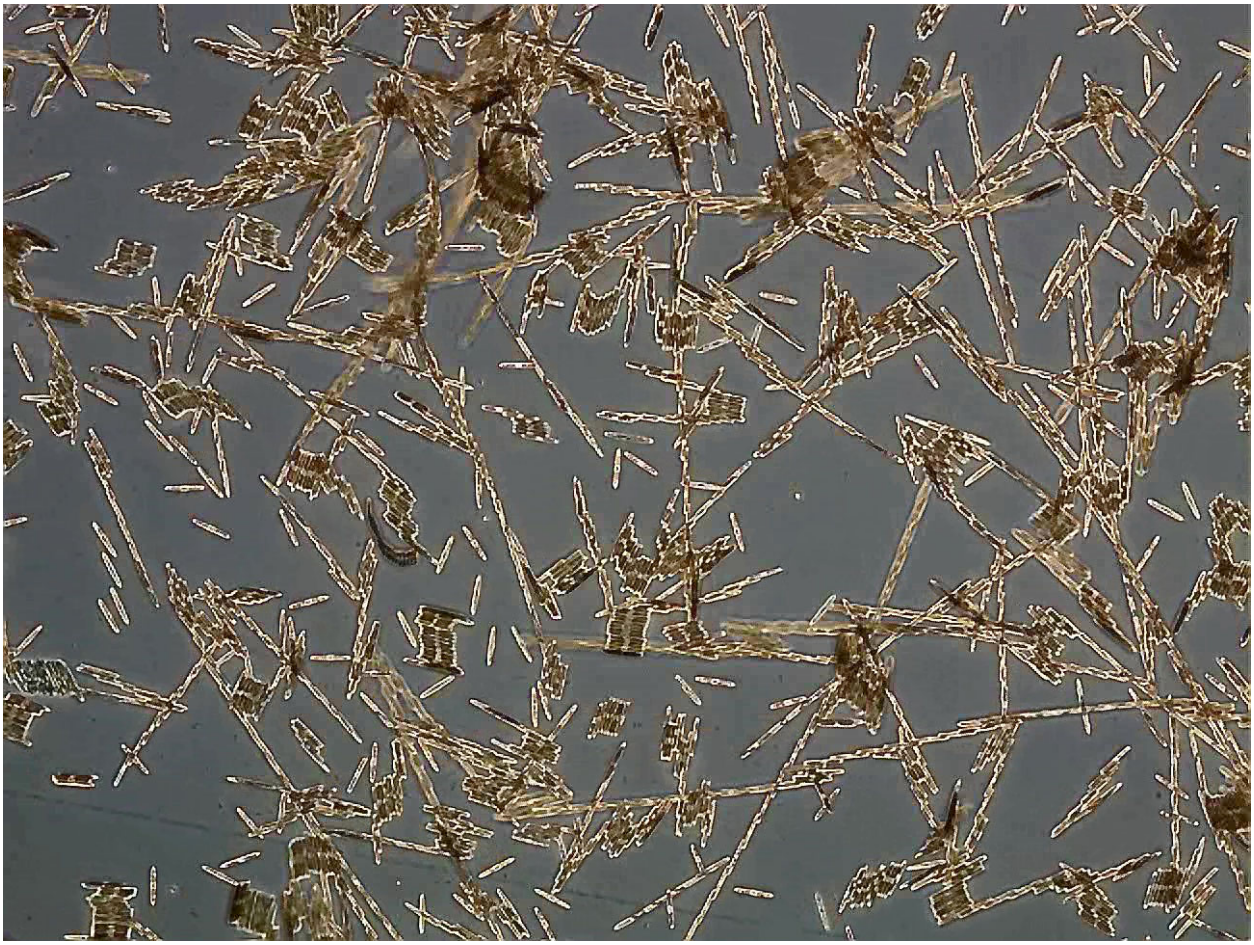

Figure 3. *Bacillaria paxillifer* colonies are predominantly in motion and collide frequently. Movement is therefore not limited to the focal plane.

The majority of the colonies are in the typical movement phase. However, some of the colonies have not moved or have only moved at their ends. In view of the short duration of the total solar eclipse, it is therefore not possible to do without a statistical time-series analysis.

Since the effect of the solar eclipse on the behavior is to be investigated, the influence of the observation apparatus must be as small as possible. As the light from the corona during the total eclipse is not sufficient for imaging, artificial microscope illumination has to be used. The following recommendations are given to minimize its disturbing influence:

- Use of a high-sensitivity camera. This requires a low spatial resolution. However, the resolution should still be high enough to identify diatoms.
- Recording a sequence of images instead of continuous video recording. A complete movement cycle of a colony takes about 1 minute. It is therefore sufficient to take pictures at intervals of a few seconds to study their behavior. The lighting is only switched on for the minimum shutter time required.
- The spectrum of the light source is placed outside the spectral range relevant for the diatoms. To minimize the possible influence of illumination, simultaneous observation

with several microscopes in the infrared and ultraviolet range can be used (see (Jaubert et al., 2022).

Discussion

The next total solar eclipse in Germany is expected on September 3, 2081, which allows for careful preparation of the observations and application for funding. In Alaska, a similar event will take place on March 30, 2033, albeit at temperatures that could be well below the freezing point of beer (Reigrut et al., 2021). Otherwise, in the USA, you will have to wait until the total solar eclipse on August 23, 2044. Eclipse trajectories and timings are available (Espenak, 2025). England, that harbinger in diatom studies and wry humor, is stuck with essential confirmatory research (Sept. 23rd 2090).

As transporting a culture any distance is difficult while retaining natural lighting, it is clear that one must wait for the next local total solar eclipse.

An alternative to waiting for a solar eclipse might be to construct a starshade (Bertrand et al., 2024), but scattered atmospheric light discounts this method on Earth. Putting *Bacillaria* in space, while allowing starshade use at any time, raises the problem that we are totally lacking in successful studies of diatoms under microgravity, despite many proposals (Gordon et al., 2007; Nienow, 2020; Rai et al., 2025; Rai et al., 2022).

Conclusion

The proposed experiment offers the chance to answer a question that every diatomist has already asked him/herself. Although the authors (already retired) are unlikely to be involved in the observations, they politely request notification and publication of the results that the scientific world is waiting for, by whatever communication medium works after the chosen eclipse.

Acknowledgement

We thank Mohamed Ghobara, an expert on diatom optics, for his critical comments.

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Published in the May 2025 issue of *Micscape* magazine.