The BenthoTorch – Quick and easy phytobenthos measurement.

A. Dahlhaus[1], H. Dahlhaus[1], J. Hoffmüller[1], C. J. Carpentier[2] , C. Moldaenke[1]
[1]bbe Moldaenke, Germany, bbe@bbe-moldaenke.de;
[2] Environmental Institute, the Netherlands, carpentier@eurei.com

Abstract

This summer, a small study on micro-phytobenthos was performed in Lake Westensee to test our new BenthoTorch under real-life conditions. Algae were measured on artificial and natural substrates. The results for the chlorophyll-a content achieved with the BenthoTorch were compared to the classical method: scratching the exposed surfaces regularly and performing chlorophyll extraction to determine the total chlorophyll-a content. The results were evaluated in order to compare the BenthoTorch results with the classical method and show the development of the three algae classes – green algae, blue-green algae and diatoms – over time.

The bbe BenthoTorch:

In many rivers, lakes and dams, benthic algae provide an enormous contribution to the ecology, oxygen production and taste and odour problems. Therefore, their presence in water bodies is sufficient reason to measure their effects.

The bbe BenthoTorch is designed to measure the concentration of chlorophyll-a of benthic algae and discriminate diatoms, green algae and cyanobacteria simultaneously.

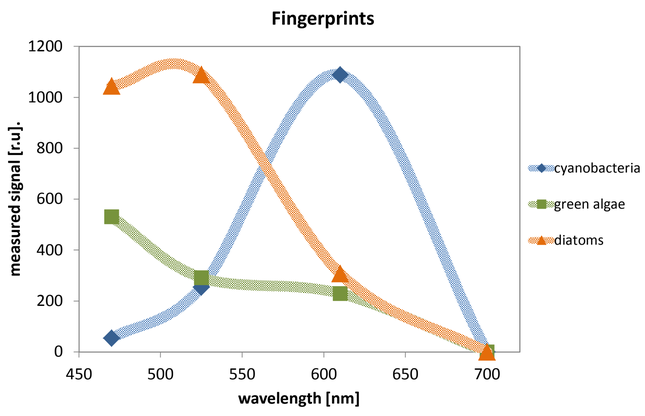
Data are displayed immediately after measurement on the built-in LCD screen. This method simplifies traditional methods tremendously, even making them obsolete.

Principles:

The bbe BenthoTorch is based on the same principals as the bbe FluoroProbe and the bbe AlgaeTorch. All three instruments use an excitation spectrum and detect chlorophyll-a fluorescence at about 700nm.

From the discrimination of the signals coming from the 470nm, 525nm and 610nm LEDs, the BenthoTorch calculates the chlorophyll-a content belonging to the algae classes diatoms, green algae and cyanobacteria.

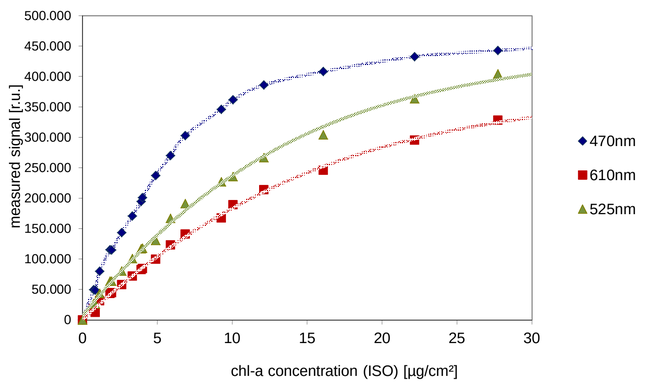
The fingerprints - normalised spectra on 1µg/cm² chlorophyll-a - are shown in the graph on the right.

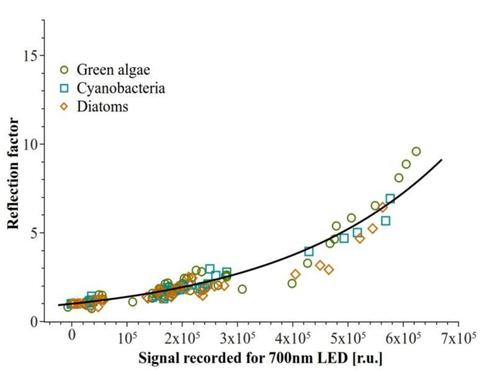


Saturation:

Fluorometric measurements struggle with the thickness of the layers. The figure on the right displays the dependency of each excitation wavelength on the chlorophyll content of a layer.

It can be seen that concentrations up to 20µg/cm² can be resolved and mathematically corrected.





Background reflection:

The fluorescence response from a sample also depends on the properties of the substrate. To obtain a measure of these properties, an additional 700nm scattering measurement is implemented.

The graph on the right gives an idea of how chlorophyll measurements have to be corrected depending on the varying substrates. The data show the responses from samples with the same algae concentrations, the x-axes reflect the scattering, the y-axes the factor with which the concentration seems to be multiplied.

Capabilities:

The bbe BenthoTorch is an instrument which enables a quick screening of the benthos in rivers, lakes and dams. The instrument is light-weight, measurements can be carried out in seconds, results are shown instantly on the internal LCD display and, together with the GPS location co-ordinates, can now be exported to Google Maps (example map for the bbe AlgaeTorch).

Sample Site

The sample site was chosen in Lake Westensee due to the lack of a suitable and safe place in a small river. After the Weichsel-Ice Age, the Westensee remained as a glacial lake surrounded by terminal moraines. A spot was chosen in the lake close to a small footbridge on private property to avoid vandalism and to gain easy access. The location is near the small town of Felde at the Resenis, a small peninsula in the lake. Here, the depth of the water reaches eighty centimetres. The bottom of the lake is sandy. The spot was chosen where the vegetation was not too dense to avoid shadowing of the samples and mechanical destruction of the biofilm. The poles for mounting the substrates were placed on the water side of the reed belt of the lake.

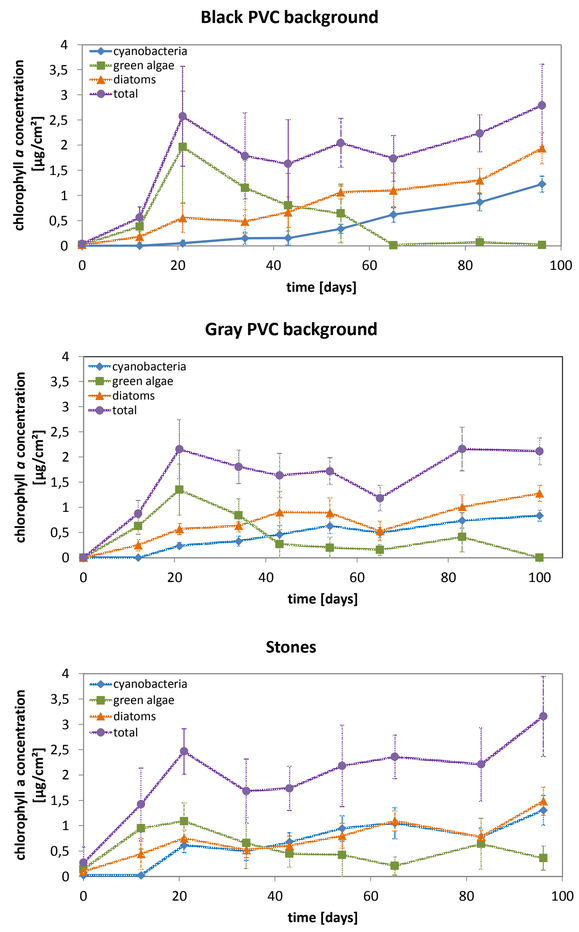
Material and Methods:

Different materials were used as substrates for the micro-phytobenthos. Black and grey PVC cut into tiles (4x8 cm) were used as substrates. A mounting system for object slides was constructed in order to use glass as a substrate as well. To compare these three artificial substrates, pebble stones with flat surfaces were exposed as a natural substrate. A set of twelve black and ten grey tiles were used. For the object slides, two mounting systems with twelve slides each were used. Moreover, to test the influence of the substrate on the algal class composition a set of ten stones was exposed in the lake.

The PVC tiles were mounted together with the frames for the object slides on a wire on four poles to form a one meter square at a depth of 25cm below the water surface. The stones were placed in directly on the lake bottom.

Two samples of each substrate were taken and the substrates were replaced immediately after sampling every ten days between April and August. Each tile was measured in five places with the BenthoTorch before taking them to the laboratory. The remaining substrates were measured in two places and left at the sample site. Each field day one stone was brought to the laboratory together with the substrate samples.

In the laboratory, the samples were scratched and the biofilm was suspended in water quantitatively. The suspension was filtrated onto GF/F glass fibre filters (Whatman) and extracted in cold ethanol over night for chlorophyll-a determination (DIN 16L).



Development over time:

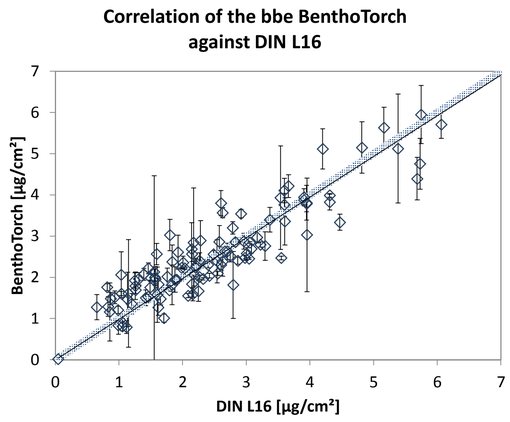
Over the period from the 27.04.2011 to 01.08.2011 different materials were exposed as substrates for the micro-phytobenthos. The three graphs to the left present results collected every 10 days over the whole period of time with the bbe BenthoTorch. The average changes of the chlorophyll-a content over time on the black PVC, gray PVC and a set of stones are shown.

In all three cases, the same tendency was registered. The maximum of green algae chlorophyll-a repeatedly appears in the middle of May (Day 22 of measurement). Over the 100 days of measurement the diatoms and cyanobacteria content rises constantly.

Reference measurements:

The correlation to wet chemical methods is very linear across a wide range of applications. The graph on the left shows the analysis of different substrates. Out of 117 measurements, only 6 were excluded from analysis. The parameters of a fitted curve are given in the table bellow.

	R^2	slope
BT vs. DIN L16	0,7911	0,9876
BT vs. HELCOM	0,8283	0,9278



Discussion:

The direct comparison between the extraction method and the total chlorophyll-a content measured by the BenthoTorch shows good correlation. Thus, considering that the measurements were taken on very different surfaces with different characteristics - beginning with a highly reflective surface, i.e. glass, via a patchy surface, i.e. stones to black PVC - it could be concluded that the automatic background correction of the BenthoTorch improved the results considerably.
It has been shown that the development of algal biomass in biofilms irrelevant of the substrate used could be quantified reliably. As expected, the instrument was able to detect the succession of the algal classes throughout the experimental period. Furthermore, it is possible to use different materials such as PVC or stones as substrates for fouling experiments. Thus, it can be concluded that the bbe BenthoTorch's non-invasive method is capable of estimating the chlorophyll-a content effectively on all of the surfaces used.