# Automatic detection of soil microarthropods

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## INTRODUCTION

Soil mesofauna plays a vital role in regulating nutrient cycling and decomposition. This group is represented in the soil in high number and diversity. Our knowledge about their ecological features and their activity, which can affect the soil processes, is still limited. There is an increasing need to monitor their activity and population density. However, it is a time-consuming and financially demanding process.

Estimating relative abundances of arthropod populations can be enhanced by using sensors, which can detect individuals in the field. The use of cameras supported by artificial intelligence (AI) could be a solution. AI-based image analysis techniques have already been used for target species detection in pest management.

Fig. 1: Prototyped probes produced in 2020.

We prototyped probes for the detection and taxonomic classification of surface-living microarthropods (Fig. 1.). By using a deep-learning algorithm the probe is capable of continuous, online, in-situ measurements in the field when sunk into the ground. However, the sensor part of the probe can be installed under Berlese Funnels (Fig.2). Therefore it can also be used for soil-living microarthropods. The sensor provides taxon-abundance data in time series.

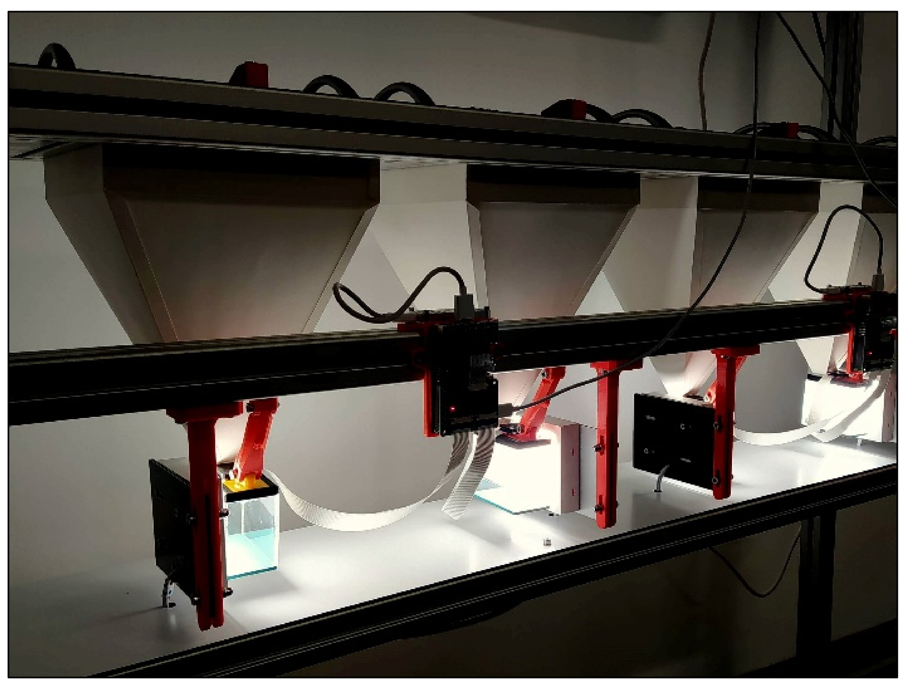

Fig. 2: Berlese Funnel equipped with sensor

## MATERIALS AND METHODS

The detection occurs when a microarthropod falls into the trap and then arrives at the photo plate. Here the device takes photos and AI software analyses it immediately. Based on the learning database developed by our team, the software can conduct taxon-level, real-time identification. Upon completion of detection, the microarthropods are automatically blown down into a sample container (Fig. 3).

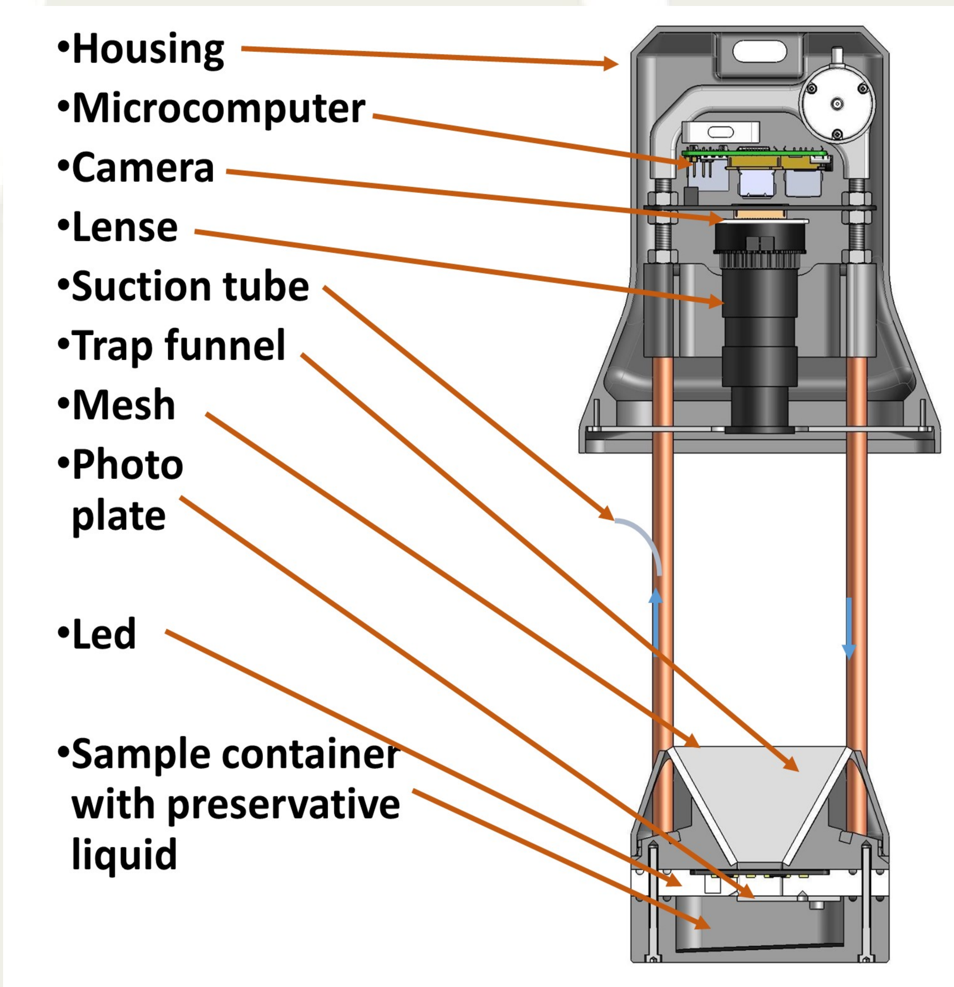


Fig.3: Cross sectional view of Edaphocam – model 2020

We built a learning database of the image analysis software for collembolan species cultured in our laboratory using 3784 photos taken by the sensor itself. We labelled the photos according to species. The convolutional neuronal network model for the computer vision was built on the TensorFlow platform.

The efficiency of the detection was tested for three Collembola species. 50-50 individuals from each species were dropped into the probe, and the detection efficiency was calculated by comparing the number of specimens dropped to the number of accurate detections (Fig. 4).

## MAIN RESULTS

The accuracy of species-level identification ranged from 86% to 100% (Table 1). The error may be due to incorrect species identification and lack of detection. This can be improved by increasing the number of photos of the species in the learning database. The database can also be extended with new species, depending on the experiment.

Table 1: The efficiency of the detection at three Collembola species.

| | correct detection | false detection | no detection | detection efficiency |
|---|---|---|---|---|
| *Heteromurus nitidus* | 50 | 0 | 0 | 100% |
| *Coecobrya magyari* | 43 | 7 | 0 | 86% |
| *Folsomia candida* | 49 | 0 | 1 | 98% |

With further improvements, the tool may be suitable for estimating the amount of microarthropod biomass and the automatic testing of sublethal effects. The blow-off pump provides an automatic collection of biological materials for further analysis.

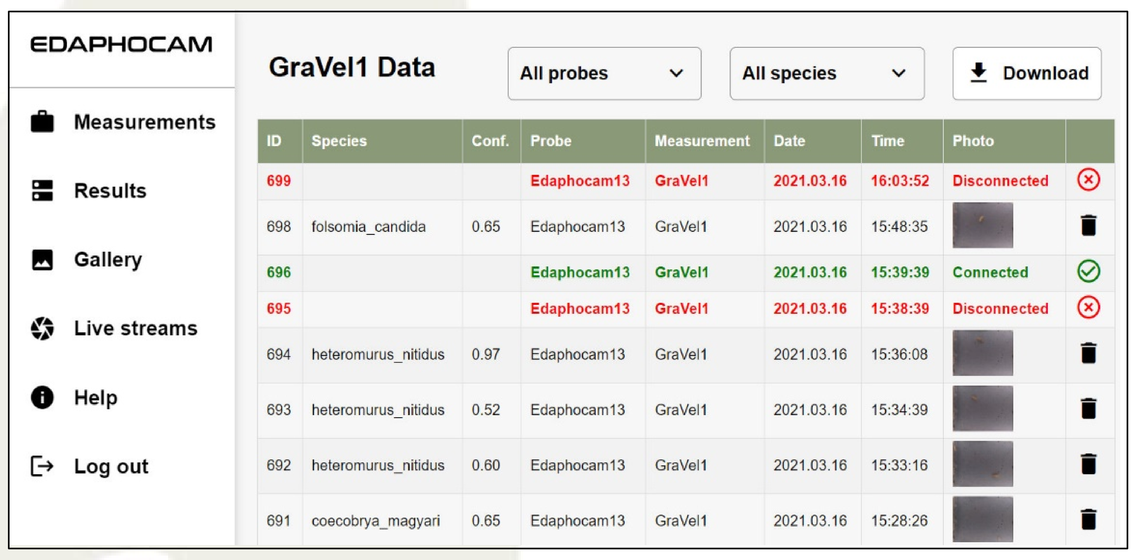



Fig. 4: During real-time measurements, data are automatically transmitted to the server. That way, the end-user receives quantitative data about microarthropods from the field daily or even immediately.

After uploading the learning database with the main microarthropod's taxa, the ZooLog sensor system can be used for local or even national monitoring and drawing predictions of specific microarthropod species' abundance and diversity. Taxon-specific detection is the key to improvement and image analysis seems to be a promising method for this.