The BG-Counter: A smart Internet of Things (IoT) device for monitoring mosquito trap counts in the field while drinking coffee at your desk.

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Features of the BG-Counter

The BG-Counter is an innovative and autonomous mosquito trap station that differentiates mosquitoes from other insects, counts them, and wirelessly transmits the results to a cloud server. Via the web application you can manage and control the trap station from your desk.

This will provide new insights into daily activity patterns, adult density indices, population dynamics and effectiveness of your mosquito control activities.

Vector control professionals can now establish surveillance programs with unprecedented data density and accuracy, overcoming labor constraints associated with manual inspection. Also, the effectiveness of control measures can be validated immediately.

The BG-Counter

- **reports mosquito counts remotely** from everywhere in the world to an internet web page
- **samples local environmental data** such as temperature, relative humidity, and optional wind speed, rainfall, or water levels in potential breeding sites
- **lets you manage the trap** and the application of attractants remotely
- **reduces costs** associated with manually checking mosquito traps

Data are transferred to a web page that can be accessed via PC, smartphone or tablet.

BG-Counter station with BG-Sentinel 2 trap, CO_2 source, battery and rain shield. The station runs on solar power (the solar panel is not displayed here).

Technical Details

The heart of the BG-Counter is a highly integrated printed circuit board which incorporates:

- an infrared sensor
- environmental sensors for temperature, relative humidity and ambient light
- a cellular module for communication with the web server
- an SD card for onboard data storage, fan and CO_2 valve control
- connections for optional peripheral devices such as attracting lights, rain sensors, wind sensors and standing water sensors
- an optional network module to allow traps to wirelessly connect with remote devices and each other
- two powerful microprocessors for control and communication

Detection of mosquitoes

The patented insect sensor consists of arrays of infrared LEDs and light detectors that provide reliable and sensitive detection and differentiation of moquitoes from other objects entering the trap, see figure 1 and 2. This technology was developed by onVector Technology in collaboration with Biogents.

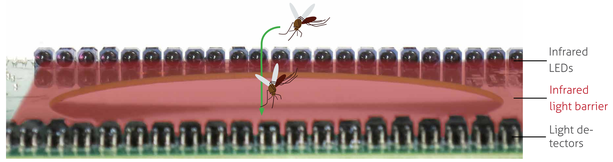

Figure 1: An insect is sucked through the BG-Counter and disrupts the infrared ray. This is detected by the light detectors.

The signal from the light detectors depend on the size, shape, and wingbeat frequency of the insect.

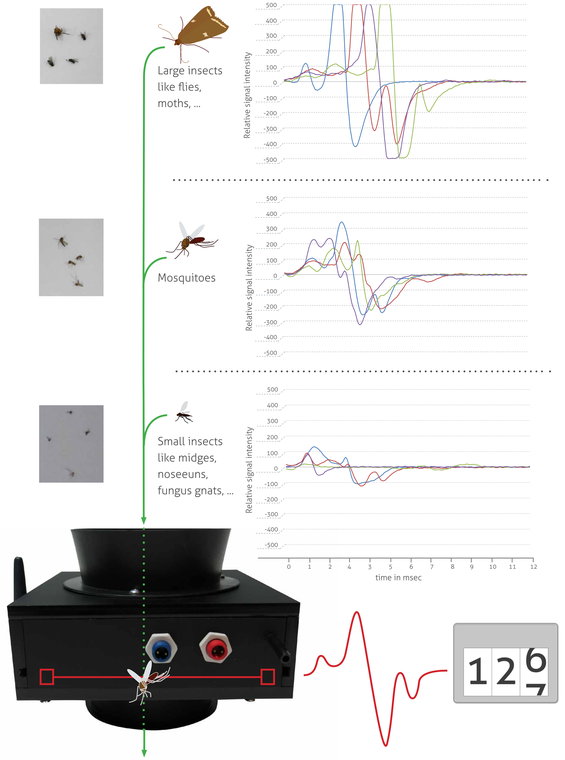

Figure 2: A mosquito that is sucked through the BG-Counter is detected by light detectors and generates a typical signal that can be differentiated from the signals generated by larger or smaller insects.

Accuracy of correct mosquito counts under field conditions

To maximize the accuracy of the system the trap has to be rather selective for a broad range of mosquito species. This is accomplished by the use of CO_2 as an attractant and by the particular trap design. Mosquito counts with an accuracy of 90% have been established in field tests when working with CO_2 as an attractant, see table 1 and 2. The maximum counting frequency is about 5 mosquitoes per second. This means that up to 18,000 mosquitoes can be counted per hour.

Table 1: Field testing of the BG-Counter in the Florida Keys
The trap was programmed to release CO_2 in half hour intervals.

Date Set	Date collected	Counted By	Total Mosquitoes	% Accuracy
14/10/2015	15/10/2015	Human	120	**100.00%**
		BG-Counter	120	
21/10/2015	22/10/2015	Human	139	**99.29%**
		BG-Counter	140	
23/10/2015	24/10/2015	Human	171	**98.84%**
		BG-Counter	173	
27/10/2015	28/10/2015	Human	169	**95.27%**
		BG-Counter	161	
14/12/2015	15/12/2015	Human	183	**77.22%**
		BG-Counter	237	
15/12/2015	16/12/2015	Human	164	**79.23%**
		BG-Counter	207	
05/01/2016	06/01/2016	Human	5	**35.71%***
		BG-Counter	14	
09/01/2016	10/01/2016	Human	38	**82.61%**
		BG-Counter	46	
13/01/2016	14/01/2016	Human	11	**100,00%**
		BG-Counter	11	

* = heavy rain during sampling

Table 2: Field testing of the BG-Counter in Suffolk VA
The trap was programmed to release CO_2 continuously.

Date Set	Date Collected	Counted By	Mosquitoes	% Accuracy
15/10/2015	16/10/2015	Human	136	**95.59%**
		BG-Counter	130	
20/10/2015	21/10/2015	Human	67	**83.75%**
		BG-Counter	80	
21/10/2015	22/10/2015	Human	197	**94.42%**
		BG-Counter	186	
22/10/2015	23/10/2015	Human	259	**85.71%**
		BG-Counter	222	
26/10/2015	27/10/2015	Human	55	**83.64%**
		BG-Counter	46	
27/10/2015	28/10/2015	Human	450	**90.00%**
		BG-Counter	405	
28/10/2015	29/10/2015	Human	404	**94.80%**
		BG-Counter	383	
29/10/2015	30/10/2015	Human	695	**90.36%**
		BG-Counter	628	
03/11/2015	04/11/2015	Human	238	**86.97%**
		BG-Counter	207	
04/11/2015	05/11/2015	Human	206	**87.86%**
		BG-Counter	181	
05/11/2015	06/11/2015	Human	199	**90.95%**
		BG-Counter	181	
09/11/2015	10/11/2015	Human	92	**97.83%**
		BG-Counter	90	

Web Service

The system is supported by a web-service including data communication and cloud storage of mosquito counts, geospatial and environmental data.

The data can be accessed, displayed, analyzed, and downloaded as Excel files at the push of a button. The intuitive graphical user interface can be accessed from PCs as well as smartphones and tablets.

The web application allows you to remotely switch the traps on and off in the field. It also allows you to set up varying time schedules to run the traps and set up application times of CO_2.

The BG-Counter samples local environmental data such as temperature, humidity, and light. Other optional sensor modules in the trap station's periphery supply additional data: for example sensors for precipitation and wind, or wireless standing water sensors provide „wet" or „dry" status of nearby larval sites. As a result, both presence of adult mosquitoes and the formation of breeding sites can be detected earlier and with greater precision, enabling faster and more targeted responses.

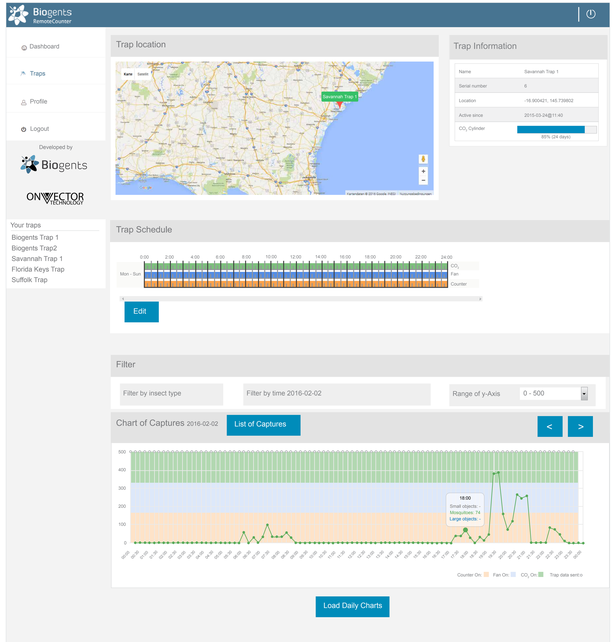

Figure 3: Example display of the user interface.

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