Low-cost wind tunnel for micro-arthropods

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Introduction

A wind tunnel is a tool often used in chemical ecology experiments with flying insects [1–3]. The construction of such tunnel, however, does not allow a close-up observation of tiny species like *Trichogramma* spp. and other minute parasitic wasps or mites. The latter do not have wings but many are known to exhibit dispersal posture and actively take-off in the presence of wind [4].

Although there are small-scale wind tunnels used for testing aerodynamics of three dimensional models or for calibration of anemometer probes commercially available (Figure 1), they have the following disadvantages:

1. They are very expensive.
2. Their measuring chambers are usually not suitable for microscope.

Figure 1: A small, benchtop wind tunnel, with visible working section (www.armfield.co.uk).

Objectives

The aim of our work was to design and construct a simple and low-cost wind tunnel which would allow to study the response of micro-arthropods to various conditions like wind speed, temperature, humidity or presence of volatiles.

Materials and Methods

The wind tunnel is 110 centimeters long and was made of 28 glass plates glued into seven compartments with inner dimensions 6x6 centimeters (Figure 2). Compartments are fixed together using sticky tapes and placed on an aluminum support. This allows to take the tunnel apart when necessary (e.g. for cleaning and adding diffusers).

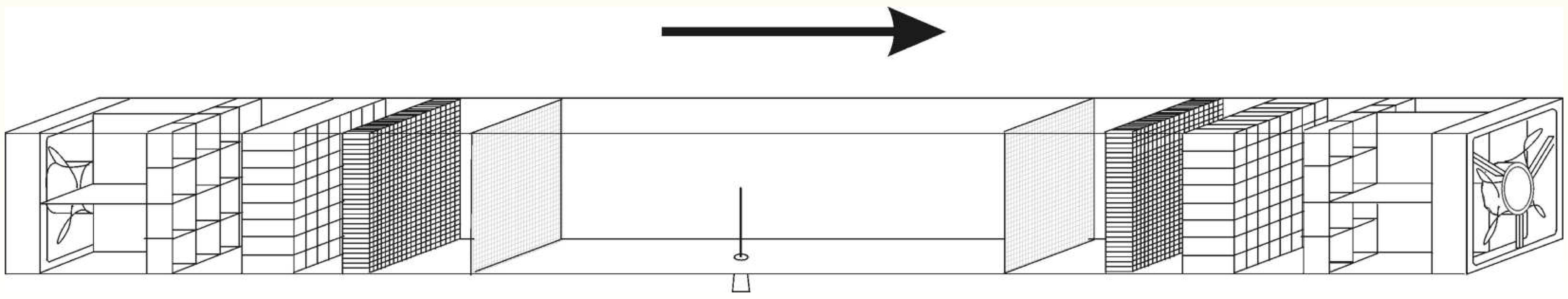

Figure 2: Schema of the wind tunnel. The middle compartment is 40 centimeters long and is used as an observational chamber. For this purpose it has a hole drilled in the middle of bottom plate where object is inserted on a thin glass rod while it can be observed using a dissection microscope placed above the chamber. Arrow indicates the direction of air flow.

Two 6x6 centimeters 12V electric fans fixed at inlet and outlet compartments provide source of wind. They are connected to AC/DC variable voltage transformer. The wind speed can thus be adjusted by changing voltage on the transformer. Several diffusers (Figure 3) were tested to minimize wind turbulence inside the observation chamber. Turbulence was measured by a precise TESTO hot-ball anemometer and visualized by smoke.

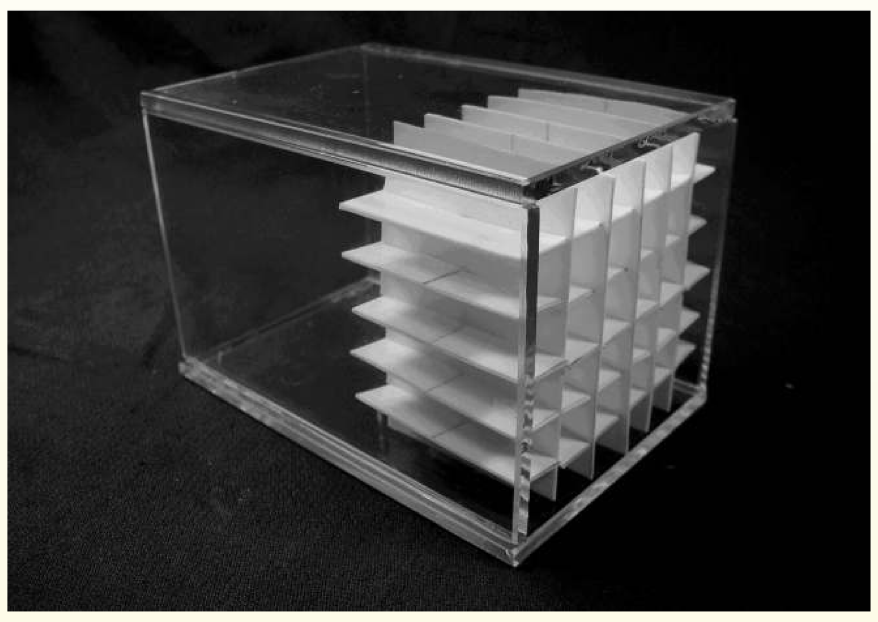

Figure 3: Detail of a medium size diffuser used to eliminate turbulences in the tunnel.

The tunnel was used to study the effect of wind speed on dispersal behavior of *A. carvi* (Figure 4). Mites used in the experiments were collected from umbel galls sampled in caraway fields.

Figure 4: Scanning electron micrograph of *Aceria carvi* female. Photo by F. Reindl.

Adult mite was placed into the tunnel and its behavior was recorded for 300 seconds by means of The Observer.

Results

No turbulence in the observational chamber was measured when three plastic honeycomb-like diffusers and one metal mesh were inserted on both sides of the tunnel (Figure 5). Under this setup the wind speed could be precisely adjusted within a range between 0 and 3 m/s.

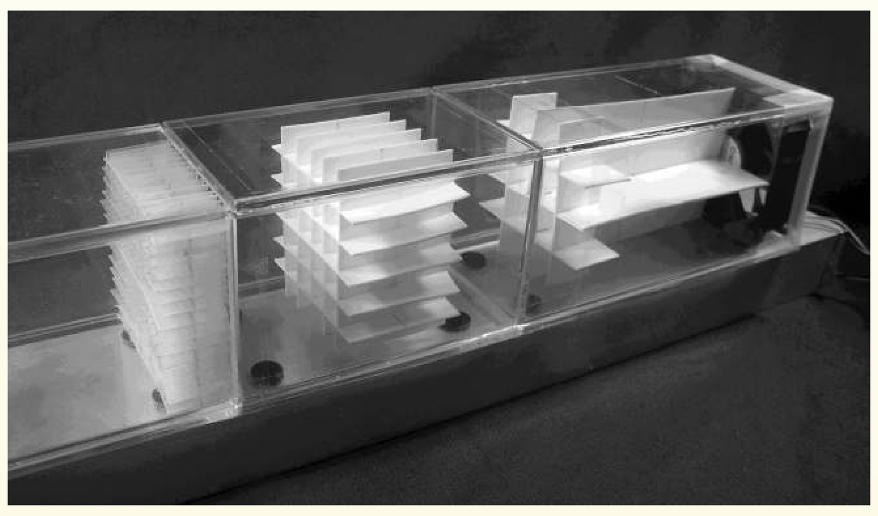

Figure 5: Set of three plastic diffusers on one side of the tunnel.

Wind-tunnel experiments with *A. carvi* showed that a dispersal posture occurred at all used wind speeds but no mites took off at speed of 0.5 m/s. Speed of 1 m/s was high enough to enable aerial dispersal in some mites (Figure 6). Time to mite dispersal behavior and take-off decreased as wind speed increased.

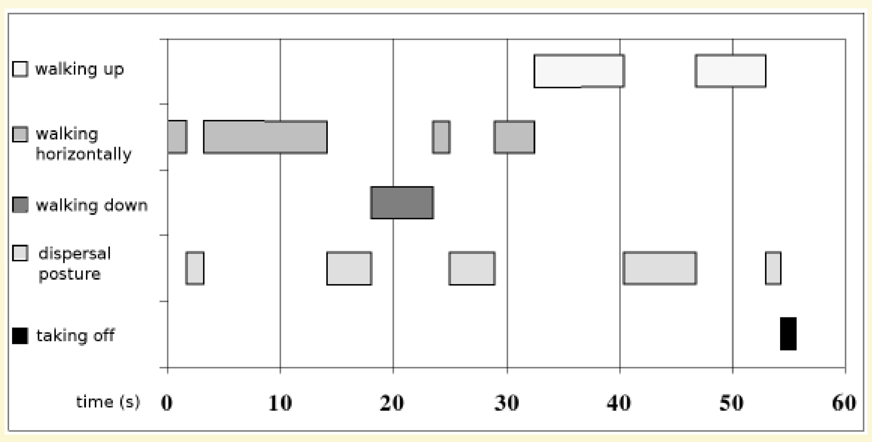

Figure 6: Time-event plot of *Aceria carvi* behavior. The first three tracks at top indicate time when mite walked up, horizontally or down the glass rod, respectively. Dispersal posture is defined as state when mite stands up on its caudal suckers while moving its legs rapidly. The last track indicates time when mite was dislodged from the glass rod.

Conclusions

- **The wind tunnel described above can be build easily and with small costs while its parameters are good enough for precise control of wind speed.**
- **The tunnel is suitable for various experiments with small arthropods which need to be observed using microscope.**
- **Digital high-speed video camera mounted on the microscope will further enhance it with the possibility to capture and analyze fast movement behavior.**

Acknowledgements

This work was supported by the Ministry of Education, Youth and Sports (grant No. 2B06005 - "New alternative approaches in pest control of the horse-chestnut leaf miner *Cameraria ohridella* supporting biodiversity of its natural enemies"). The authors thank Mrs. J. Jabůrková for her technical assistance.

References

[1] Barata E.N., Arajo J. 2001. Olfactory orientation responses of the eucalyptus woodborer, Phoracantha semipunctata, to host plant in a wind tunnel. *Physiol. Entomol.* 26: 26.

[2] Bhasin A., Mordue A.J., Mordue W. 2000. Responses of the biting midge *Culicoides impunctatus* to acetone, CO2 and 1-octen-3-ol in a wind tunnel. *Med. Vet. Entomol.* 14: 300.

[3] McIntyre N.E., Vaughn T.T. 1997. Effects of food deprivation and olfactory and visual cues on movement patterns of two *Eleodes* species (Coleoptera: Tenebrionidae) in a wind tunnel. *Ann. Entomol. Soc. Amer.* 90: 260–265.

[4] Smitley D.R., Kennedy G.G. 1985. Photo-oriented aerial-dispersal behavior of *Tetranychus urticae* (Acari: Tetranychidae) enhances escape from the leaf surface. *Ann. Entomol. Soc. Amer.* 78: 609–614.