# An artificial habitat to investigate *Boquila trifoliata* mimicry

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## Summary

*Boquila trifoliata,* a climber at home in the temperate rainforests of southern Chile, exhibits extraordinary leaf mimicry. It can adopt the leaf coloring, shape, and size of other plants in close proximity to it, seemingly without requiring physical contact (Fig. 1 and (Gianoli & Carrasco-Urra 2014)). This behavior is seen in no other plant. However, the underlying mechanism remains elusive. Additionally, this form of leaf mimicry has only been observed in the wild and it is unclear if *B. trifoliata* will maintain this behavior in a more controlled environment. We propose building a Biosensor that will monitor *B. trifoliata* growth under laboratory conditions to establish a mimicry model for biological experiments experiments. To this end we will design a chamber with precise humidity and temperature controls in which *B. trifoliata* can grow isolated or near other plants that are endemic to its natural habitat, for instance *Rhaphithamnus spinosus.* Our proposal is a first step in unravelling the mysterious mimicry mechanism that this brilliant shapeshifter utilizes to successfully phenocopy the diverse array of plants that grow around it. Our understanding of plant-plant communications will change dramatically if *B. trifoliata* can indeed sense and adapt to its environment without physical contact.

## Proposal

To reproduce *B. trifoliata* leaf mimicry in the laboratory, we propose building a humidity, temperature, and luminosity controlled habitat for growing *B. trifoliata* under precise and reproducible conditions. *B. trifoliata* is an evergreen that lives in temperate rainforests, i.e. extremely humid environments (bogs, rivers, lakes) with almost constant rainfall, which we need to simulate.

We intend to make use of several inexpensive “maker” style technologies. *B. trifoliata* and its endemic neighbors’ seeds are available on online marketplaces. The enclosure will be built from inexpensive aluminum construction rails, and custom laser cut acrylic. This will be facilitated by use of the Cambridge Makespace, where D. Jordan is a member and trained user of the laser cutters. Temperature control will be handled with a PID (proportional integral differential) controller and a set of Peltier effect thermoelectric coolers. A custom current amplifier circuit will be controlled by an Arduino on which the PID software will run. Illumination will be achieved using LEDs with BuckPuck current controllers and actual light output will be measured via a custom luminometer based on a phototransistor IC, with readouts taken by a Raspberry Pi. Humidity and soil moisture will be measured by Arduino sensors from Seed Studios. Humidity control will be done using inexpensive piezo electric “foggers” that utilize ultrasound to vaporize water at room temperature. If funding permits, we will incorporate oxygen moisture will be measured by Arduino sensors from Seed Studios. Humidity control will be done using inexpensive piezo electric "foggers" that utilize ultrasound to vaporize water at room temperature. If funding permits, we will incorporate oxygen and carbon dioxide sensors into the design, also controlled via the Raspberry Pi.

Our first goal will be the successful germination and growth of *B. trifoliata* in an artificial habitat. Once this is achieved we will compare plants that were grown in isolation with ones grown near other plants from the same region (e.g. *Rhaphithamnus spinosus*). Eventually we would like to investigate what happens when *B. trifoliata* grows close to plants that are not part of its natural habitat, for instance European vines.

The proposed project lies at the forefront of plant biology and, if successful, will contribute dramatically to our understanding of plant communication and mimicry.

All work will be equally shared between D. Jordan and M. Jakobs.

## Costs

Arduino Leonardo £20
Seed Humidity Sensor £5
Seed Moisture Sensor £5
Peltier Elements £50
Bipolar 5A power supply £200
Raspberry Pi £40
Acrylic sheet £50
Phototransitor £10
Ultrasonic Foggers £5
Aluminum Construction Rails £100
Electronic Components £100

Total ~£585

Gianoli, E. & Carrasco-Urra, F., 2014. Leaf Mimicry in a Climbing Plant Protects against Herbivory. *Current Biology*, 24(9), pp.984–987.