The Autonomous Epiphyte Lysimeter

A custom-built, ultra-low-power field instrument for resolving fog, rain, and evapotranspiration fluxes of canopy epiphytes — developed in-house for the GArua research unit (subproject C3).

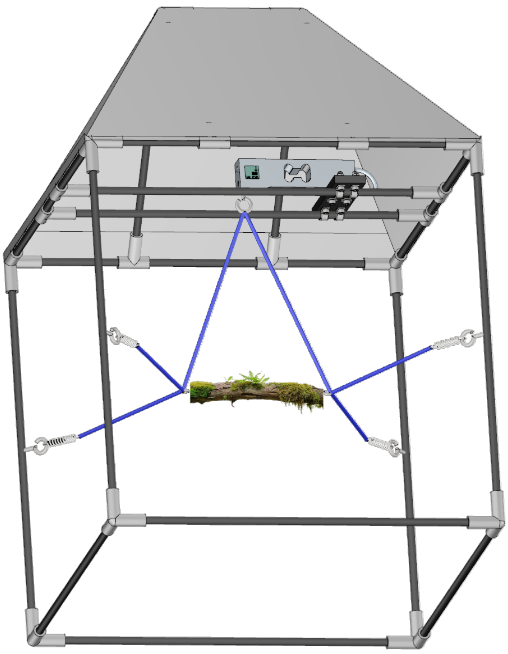

Fig. 2 | Galápagos canopy epiphytes — the functional interface between fog, rain and the soil water balance.

Designed for the Galápagos highlands:
battery-powered, weather-sealed, fully autonomous over weeks, and tailored to the sub-gram water-flux signatures that current interception models cannot resolve.

Fig. 1 | Aluminium-frame field rig: an epiphyte sample is suspended via four tension springs from a high-precision load cell; a piezoelectric plate underneath records throughfall droplet-by-droplet. An optional rain shelter can be deployed to further study the impact of fog vs. rain interception.

Why we built it

Cloud-water interception (CWI) and the water held by epiphytic mats are central — yet poorly quantified — components of the Galápagos highland water cycle. Conventional rain gauges and tipping buckets cannot resolve the sub-gram, sub-minute fluxes by which fog wets, saturates, drips from, and re-evaporates off an epiphyte cushion. GArua subproject C3 requires direct, mechanistic observations of these processes to parameterize an epiphyte-informed interception module and to test how invasive vegetation and shifting garúa regimes propagate through the fog–canopy–soil system.

The autonomous Epiphyte Lysimeter closes this measurement gap. It continuously weighs a representative epiphyte sample with milligram resolution, while a co-located piezoelectric disdrometer records the throughfall droplet spectrum.

What the lysimeter sees

- **Fog and cloud-water uptake.** Weight gain when the canopy slowly soaks up moisture from drifting cloud — the hard-to-measure flux that drives the garúa season water balance.
- **Rain interception and storage.** How much rainfall is intercepted by the epiphyte cushion before it ever reaches the ground.
- **Evapotranspiration losses.** Weight loss between events, showing how quickly intercepted water is given back to the atmosphere.
- **Drip-off and throughfall.** Each individual drop that falls through is detected, so we can tell a brief shower from steady drip and distinguish small from large droplets.

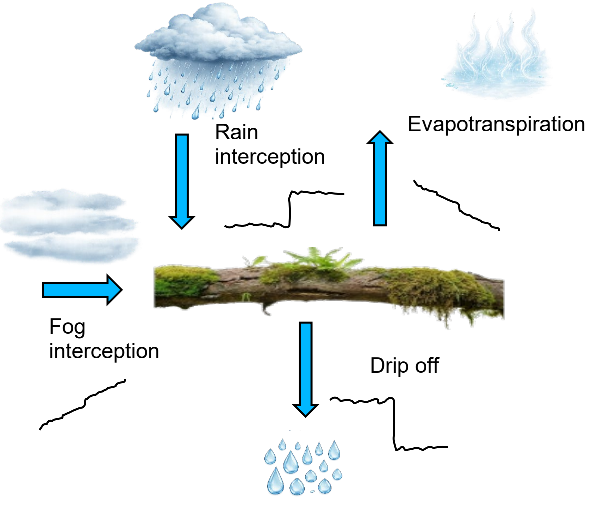

Fig. 3 | The figure shows the relevant in- and outputs from the epiphyte lysimeter. Black lines indicate the expected weight change.

Why it matters for GArua

The Epiphyte Lysimeter is conceived as the **hydrological hub of GArua's experimental work**. It sits at the meeting point of three coordinated field experiments — the fog-exclusion plots of A1, the epiphyte-removal trial of B3, and the community survey of B4 — and turns them into a single, mechanistic data set on how Galápagos canopies move water from cloud to soil.

Subproject C3 uses these data to answer questions the consortium has put at the centre of the research programme: how much extra water do epiphytes deliver to the soil? How does that depend on the kind and density of the epiphyte community? And what happens to dry-season groundwater recharge if invasive species or a shorter garúa season change the canopy?

But the value of the lysimeter reaches well beyond C3. Across GArua, **six partner subprojects depend on the data it generates**:

- **A1 — climate & remote sensing.** Uses the field-measured fog inputs to validate satellite-based, archipelago-wide estimates of cloud-water interception.
- **B2 — plant ecophysiology.** Combines the lysimeter-paired soil-moisture data with its measurements of water use in native and invasive tree species.
- **B3 — vegetation experiments.** Links the response of its epiphyte-removal plots to a quantified change in the canopy water balance.
- **B4 — epiphyte communities.** Interprets species-level differences in fog uptake and desiccation using the lysimeter's high-frequency records.
- **C1 — litter & decomposition and C2 — soil nutrients.** Use the same canopy-throughfall data to trace how interception controls the timing of nutrient and carbon turnover in the soil.

By deploying **twenty-eight units in parallel** across two seasons — under fog-exclusion and rain-exclusion treatments, in native and invasive plots, and at four epiphyte density levels along the Santa Cruz fog gradient — the lysimeter will, for the first time, provide a direct, experiment-grade data set linking canopy biology to the island water cycle. These data feed straight into the epiphyte-informed interception model developed in C3 and, in the second project phase, into GArua's archipelago-wide assessment of how Galápagos ecosystems — and the freshwater resources they sustain — will respond to climate change and biological invasion.

> **For the prospective PhD candidate:** *you will work at the interface of tropical ecohydrology, sensor engineering and process-based modelling — operating a one-of-a-kind instrument in one of the world's most iconic island ecosystems, and generating data that directly addresses a long-standing gap in cloud-forest hydrology.*