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AN INEXPENSIVE, PORTABLE TULLGREN EXTRACTOR SUITABLE FOR THE TROPICS

In conjunction with a study of seasonal changes in abundance and diversity of litter arthropods in montane New Guinea (Allison, in prep.), I encountered serious difficulties using standard Tullgren extractors such as those described in T.R. Southwood (1978, *Ecological methods with particular reference to the study of insect populations,* 2nd. Ed., Chapman & Hall, London, 524 p.) and other manuals on collection techniques. High environmental humidity, particularly at night, led to problems with condensation. Also, ants, despite elaborate precautions, destroyed a number of samples, and minute flying insects attracted to lights at night often managed to get inside the extractors even though the laboratory windows were screened.

To overcome these problems, I constructed a hanging device that is generally similar to other Tullgren extractors: a small amount of leaf litter or soil is placed in a wire mesh basket and heat from an incandescent lamp is used to drive the litter inhabitants (mostly arthropods) through the mesh into funnels leading to a collection vial containing preservative (Fig. 1, 2). The significant modification involves exclusion of extraneous arthropods through a "closed" system that also allows enough ventilation to prevent condensation. The apparatus has the additional advantages of being inexpensive and portable and the components are readily available from hardware stores.

Construction of the extractor is simple, taking about an hour. The upper unit, an inverted plastic bucket housing an incandescent lamp, is attached by wire clips to the lower unit, an identical bucket with plastic funnel and collection vial attached through the bottom. The lower unit is covered with fine mesh cloth netting at the top and houses a wire sample basket and acetate funnel.

The dimensions of the various components depend on the sizes of the buckets. The buckets that I use hold ca. 9 liters, have slightly tapering sides, and are 25 cm diam. at the top and 25 cm deep.

The heat for extraction is provided by an incandescent bulb hanging inside the upper unit in which 8 equally spaced 2×2 cm holes are cut around the top. A 25 watt bulb is suitable for most work. I have occasionally used bulbs of higher wattages when extracting samples in cool montane areas.

The apparatus is suspended by the electrical cord to the incandescent lamp. A round sheet metal plate or jar lid placed between the lamp and the top of the inverted bucket prevents the bucket from melting and splitting from the heat of the bulb. The light bulb should be 2–3 cm above the lower unit. This can be adjusted by tying a knot in the electrical cord as shown in Fig. 2.

The lower unit is made by cutting a hole in the bottom of the bucket just slightly smaller than the outside diameter of the funnel top and inserting the funnel into the hole. The funnel has a lip around the top and this together with a carefully cut hole provides for a snug fit.

The collection vial, a 25 cm^3 plastic snap-cap vial, is attached by perforating the cap to accommodate the end of the funnel stem. The cap is held in place with tape, allowing the collection vial to be easily placed on and removed. I use 70% ethanol with a few drops of glycerin to collect and preserve samples.

The wire basket is nestled inside the top of the bucket. It should be ca. 12 cm deep and

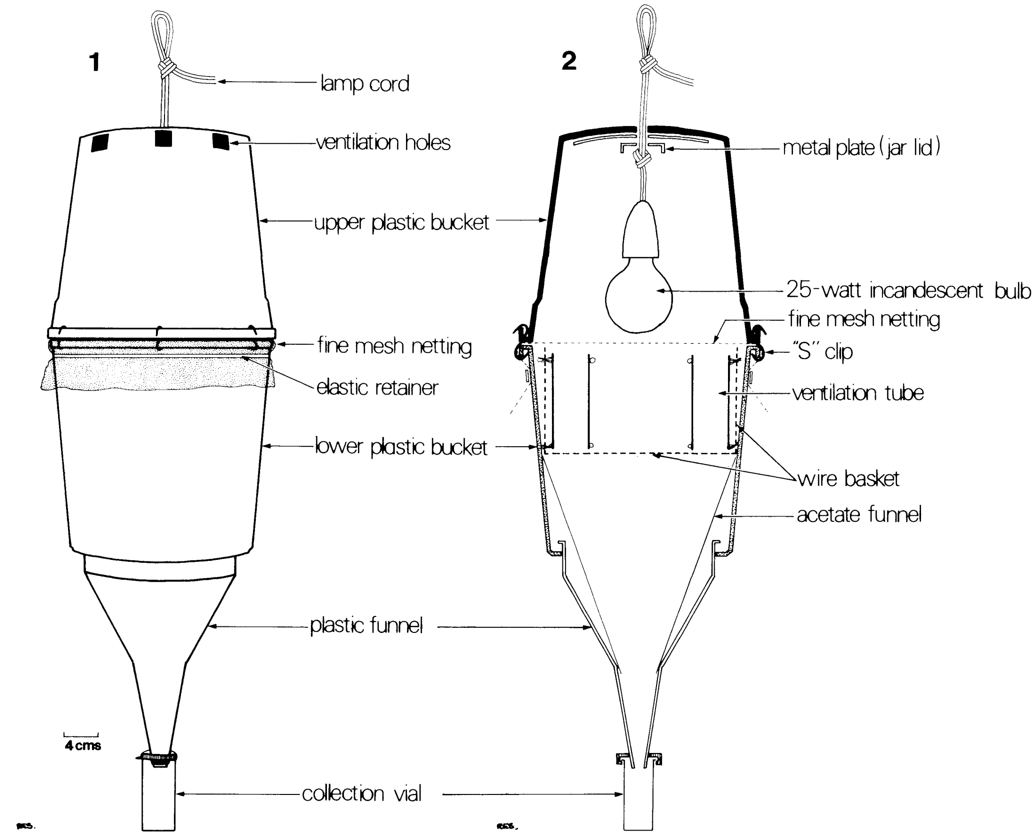

FIG. 1–2. Modified Tullgren extractor. **1,** exterior. **2,** interior.

have an outside diameter equal to the inside of the bucket ca. 10 cm from the top. The basket is held in place by the tapering sides of the bucket; the top of the basket should be flush with the top of the bucket. I use baskets that are 21 cm diam. constructed from 5 mm galvanized wire mesh. Other mesh sizes can be substituted, depending on the type of material being extracted. The easiest way to construct the basket is to roll a 12 cm wide piece of wire mesh into a cylinder to form sides and to attach a precut circle of mesh to one end of this to form the bottom.

Two 10 cm lengths of 5 cm diam. PVC pipe fastened upright to opposite sides inside the wire basket (Fig. 2) provide adequate ventilation under most conditions and keep humidity low enough to prevent condensation inside the extraction chamber. This is necessary to restrict fungal growth in the litter sample and on the bottom of the wire basket and to prevent small arthropods from becoming trapped by water droplets on the sides of the funnels. Condensation can still be a problem with very wet litter or at high elevations under cool conditions, and extra pieces of pipe may be needed to provide additional ventilation. However, too much ventilation will make the extraction incomplete, since it allows the bottom of the litter sample to dry out, forcing many of the inhabitants into the center where they remain and die.

The acetate funnel, which prevents arthropods from becoming trapped by the lip of the plastic funnel, is made by cutting a piece of paper into a circle with a radius 3 cm larger than the distance between the bottom of the wire basket and the neck of the plastic funnel (35 cm for my buckets). This paper circle is cut along radii into equal thirds (120° angle), and one of the resulting pie-shaped pieces is used as a template to cut an identical piece from a sheet of acetate (thickness 1.0 mm). The acetate is formed into a cone by joining the edges together with electrical insulating tape. The apex of the cone is cut off to produce an opening 2–3 cm diam. and is installed as shown in Fig. 2. Additional cutting may be necessary to produce a snug fit.

The fine mesh cloth netting is held in place with elastic. It prevents extraneous insects from getting into the extraction chamber or collection vial and ensures that none of the litter inhabitants escape from the extractor. The 2 units are held together with S-shaped clips of wire inserted through the lip of the upper bucket in such a way that they can be twisted around to hold the lip of the lower bucket.

Heat from the light bulb makes the top of the device too hot for ants to cross, preventing their access. In addition, although I did not find this necessary, one could coat part of the electrical cord with Tanglefoot™ or some similar sticky substance to keep ants away.

This device extracted all arthropods from small (30–40 g dry mass) samples of leaf litter within a few days (determined by carefully examining the extracted litter) and thus compares favorably with more sophisticated, less portable, and generally more expensive extractors. The apparatus is lightweight. The buckets and funnels can be stacked together and the acetate folded to reduce volume for shipping. Flying insects cannot get into the collection vials and the apparatus is ant-proof. The extractor can therefore be used in the field wherever power is available. This makes it particularly attractive for the tropics, where facilities are often rustic and ants are abundant, serious pests, even inside buildings.

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