A time-saving sampling and extraction technique for arboreal arthropods

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A sampling method and a light and heat extraction technique for arboreal arthropods are presented. In the field arthropods dislodged from trees by jarring or beating are caught on a tarpaulin designed with a view to quick and reliable sampling of plant material and animals shaken down. Field sampling is quick, so during one day a large number of samples can be collected. Handling of samples is minimized. Application of an extraction technique means that tedious and selective collecting of individual canopy arthropods in the field is avoided and even microarthropods are recorded. Seemingly, the efficiency of the technique is high. The method is suitable for sampling of arthropods from canopies of small trees or from stems and low canopies of tall trees.

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Introduction

Many arboreal arthropods are dislodged from trees and shrubs by jarring and beating. This is a well-known collecting method, the arthropods being caught on a beating tray, a tarpaulin, or funnelled directly into a container (cf. Steiner 1962, Funke 1971, Harris et al. 1972, Nielsen 1975). On a tarpaulin very small arthropods, for instance collemboles, psocids, and thrips are easily overlooked. Further, some arthropods sham death, resembling budscales, bits of branches, etc. The presence of large quantities of plant material hampers the sampling of arthropods; this is especially true in spring and autumn, when jarring of trees may initiate a heavy fall of budscales and leaves, respectively. Finally, very mobile arthropods, e. g. spiders frequently escape from the tarpaulin. The efficiency of tree-beating methods can be improved by sweeping all animals and plant parts together, then extracting the fauna by combining the properties of a Berlese-Tullgren funnel and a photoeclector (cf. Funke 1971).

Preliminary studies on the arthropod fauna of oak (*Quercus robur* L.) stems and low canopy indicated that the free-living fauna was dominated by small arthropods, for instance psocids, thrips, collemboles, and small spiders, and several very mobile and strongly phototactic animals were present. Consequently, a sampling technique especially suitable for small arthropods was needed; further, the escape of very active species should be prevented. This required a tarpaulin designed with a view to quick and reliable sampling of plant material and animals shaken into it and made heavy demands on the extraction method applied; for instance arboreal arthropods generally have to be extracted from very large samples of plant material, especially leaves. This paper describes a sampling and extraction technique; its efficiency is discussed and possible applications within the field of arboreal entomology are suggested.

Methods

1. Design of field equipment

A tarpaulin (400 × 400 cm) was made from oilcloth, cut from the edge to the centre (Figs. 1–2). The hole in the centre of the tarpaulin was surrounded by a cut, stand-up collar (height 75 cm) made from oil-cloth and canvas (Fig. 2). The two sides of the tarpaulin were hemmed so that they could accommodate two aluminium tubes, which supported the tarpaulin. To the sides of the tarpaulin two lengths of oilcloth

Fig. 1. The tarpaulin ready for sampling in an oak stand; winter aspect (N. Skyberg phot.).

(width 130 cm) could be affixed by strong press buttons.

The tarpaulin was placed around a tree stem, the slit in the tarpaulin and the collar was closed using strong press buttons, and the collar was closed tightly around the trunk using an adjustable clamp (Fig. 2), fitting stems ≦ 35 cm in diameter. The tarpaulin was hung up on six aluminium poles (length 250 cm) attached to couplings (Fig. 1). The pointed poles were thrust into the forest floor, and the tarpaulin was arranged so that the cross-section was U-shaped (Figs. 1–2), longitudinally with a slope away from the slit in the oilcloth. Irrespective of the topography of the field site, the suspension of the tarpaulin was easily adjusted.

2. Sampling procedure

In the actual investigation twigs and branches of the lower 250 cm of oak stems were hit sharply ten times using long sticks. In some cases all twigs were cut and the stems were carefully swept. The sampling was done in dry, calm weather. By means of soft brushes plant material and animals were swept together and funnelled directly into extraction containers. Larger plant parts were cut into sections. Due to the smooth surface of the oilcloth and the inclination of the tarpaulin, the sweeping was easily carried out and the escape of mobile, non-flying species prevented. The time needed for the initial mounting of the tarpaulin was about 15 minutes and for the sampling (one sampling unit) about 5 minutes. The tarpaulin and the longitudinal aluminium tubes were easily removed as one entity; for the re-erection of the equipment only about 5 minutes were needed.

3. Design of extraction equipment

Theoretically, any extractor combining the properties of a Berlese-Tullgren funnel and a photoeclector is applicable for the extraction of arthropods from plant material. However, since large amounts of plant material, especially leaves, are generally dislodged by beating, the

extraction equipment was designed to very large sample units. The containers used in the present study were made from PVC-tubes; design and dimensions are presented in Fig. 3. The upper end of the collar B is closed by a closely fitting, transparent PVC-lid (A), the lower end of the tube C, which contains the sample, by a piece of nylon gauze (mesh 5 × 5 mm); when detritus swept from the stems was dealt with, a piece of fine meshed gauze (mesh 2 × 2 mm) covering the central part of the coarse nylon gauze, was inserted. The collar (B) and the lower, detachable cup (D) were filled with a saturated solution of benzoic acid with a few drops of detergent added. The samples were transferred to the containers through a funnel, the tube and point of which were cut of; in this way contamination of the collar (B) with detrital material was prevented. In order to increase the extraction efficiency large amounts of plant material was distributed on several loosely packed containers. When the sample was transferred to the container, the latter was placed in a wooden rack. Immediately, mobile, strongly phototactic species walked towards the transparent lid, and sooner or later the struggling arthropods were caught in the benzoic acid in the collar. Thus the light extraction of animals actually started in the field.

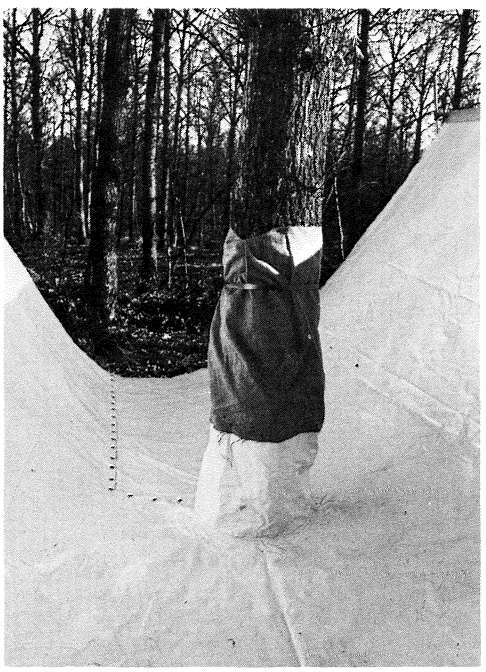

Fig. 2. The collar closed around tree trunk (N. Skyberg phot.).

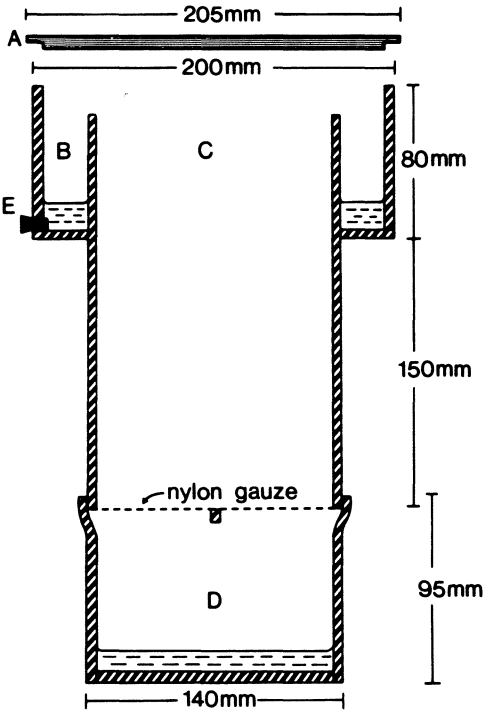

Fig. 3. Longitudinal section of the container used for light and heat extraction. A. Transparent lid; B. Collar; C. Container; D. Detachable cup; E. Outlet closed by means of rubber stopper.

In the laboratory ten containers were placed in each of four extractors available (Fig. 4); thus samples deriving from about a day's field work could be extracted simultaneously. The lower, detachable cups (Fig. 3) were kept cool in a water bath.

4. Extraction

In the extractors the containers were illuminated from above by means of bulbs (25 Watt) acting as photoeclectors. After approximately 24 hours the activity of phototactic species ceased, so light extraction stopped, and the animals caught in the benzoic acid in the collar (Fig. 3) were removed. The extraction was continued under three infra-red lamps (250 Watt) without the transparent lid (Fig. 3). Equable heating of the containers was ensured by means of three heat distribution screens and a fan

(Fig. 4). By inserting a variable resistor (0–220 V), the heating was gradually increased, reducing the risk of heat death among slow-moving invertebrates. Gradually, animals avoiding warmth and dryness were extracted from the plant material and accumulated in the lower cup (Fig. 3). In the upper layers of the samples the temperature soon rose to >40°C, at the bottom it was cooler and more moist. Gradually, the emigration of arthropods from the samples ceased and after 12 days' extraction a PVC-ring was inserted under the rim of the lower cup (Fig. 4), so the lower layer of the sample was elevated to the bottom level of the extractor, the temperature at the bottom of the sample rising to >60°C. After further 2 days, even plant material resting directly upon the nylon gauze was completely dry, surviving arthropods, if any, left at the bottom of the sample were expelled, and the extraction was stopped. For an efficient extraction a total of about 15 days was needed.

Discussion

1. Comparison of sampling methods

In the initial phase the fauna of oak low canopy was dislodged by jarring and larger arthropods observed on the tarpaulin were caught using a modified vacuum cleaner; about 3 hours of field work were spent per tree. The considerable amount of plant material dislodged was swept together, stored in plastic bags, and carried to the laboratory, where fauna extraction in Tullgren funnels was started immediately. Due to the size of the sample units collected a large number of Tullgren funnels was required. When the improved sampling technique was introduced, two persons only needed 20–30 minutes per tree (3 successive samples); consequently, the number of trees considered in the sampling programme could be increased considerably. Further, by the latter method animals and plant material collected were directly transferred to containers utilized in the extraction process, thus repeated handling and temporary storing of samples in plastic bags were avoided. The densities of arthropods recorded by the original and the improved sampling techniques were compared; when the latter technique was applied, the density of arthropods per oak stem unit approximately doubled and up to 800–1000 arthropods (including mites and collemboles) per meter of oak stem were recorded.

2. Field sampling

The efficiency of the field sampling technique depends strongly on the strength put into the

Fig. 4. Extractor including cooling unit (water bath and tubes). Front of extractor removed; eight containers immersed into the water bath, to the left container elevated by means of PVC-ring (N. Skyberg phot.).

beating, the structure of the host tree, the composition of the fauna actually present, etc. Preferably the efficiency of the field sampling technique should be evaluated by means of a number of successive samples from the same oak tree followed by the removal of all branches and leaves. In the initial phase this destructive method was only employed once; after three successive samples (1016 arthropods recorded), 55 additional free-living arthropods (mainly collemboles) were extracted from the plant material removed from the tree; thus about 95 % of the total arthropod fauna actually present were recorded by beating. When the three successive catches from the oak tree mentioned above were plotted against the cumulative sums of animals caught (cf. Nielsen 1975) the points lay close to a straight line and the regression method resulted in a population density and an efficiency estimate extremely close to those observed above. Consequently, the efficiency of the sampling method was further evaluated by means of the regression method; 4 trees were treated and in all cases the regressions suggested a very high efficiency; for instance, after three successive samples 98–99 % of the collemboles seemed to be recorded (slope of regression lines – 0,79 to –0.84). For spiders and beetles a comparable high efficiency was estimated.

The relation between the amount of plant material treated and the number of arthropods per sample was analysed; the number of arthropods per sample was not proportional to the amount of plant material dislodged, thus the number of arthropods recorded was primarily an effect of the beating per se.

3. Extraction

In the oak fauna recorded by light extraction Araneae, Coleoptera, and Hymenoptera made up about 80 %; in the fauna extracted by heat Acarina and Collembola contributed > 90 %. Since more than 95 % of Araneae and about 90 % of Hymenoptera were extracted by light and > 95 % of Collembola and > 80 % of Acarina by heat, light as well as heat extraction must be applied; for instance, when the latter treatment is omitted the number of microarthropods is seriously underestimated and only about 30 % of the invertebrate fauna actually present is recorded.

Inevitably, simultaneous heat extraction of several taxa of canopy arthropods means that a compromise must be accepted. For instance an efficient extraction of slow-mowing arthropods requires gently heating for several days, however, by this procedure eggs, for instance of thrips, present on the vegetation may hatch (cf. Lewis 1973), the composition of the fauna changing during extraction.

After extraction the plant material was carefully examined under a microscope; no surviving and only a very few dead arthropods were observed, thus properly applied the method appeared to be highly efficient for the extraction of free-living arthropods from large samples of leaves and twigs.

Conclusion

Sampling methods previously used may have severely underestimated the density of small arthropods in the foliage of trees. The method described here is especially adequate for the sampling and extraction of small, free-living arboreal arthropods; even microarthropods present in plant material dislodged are recorded. Very large samples of leaves, twigs, etc. can be treated in the extractors. Tedious and selective collecting of individual canopy arthropods is avoided, and since the sampling is unbiased, the actual size class distribution of the canopy fauna is reflected in the material recorded. In the present study the efficiency and reliability of the method was high. However, since the efficiency of the sampling technique depends on several factors, the actual efficiency should be evaluated in every single case. The field sampling is quick, thus during one day a large number of samples can be collected. Handling of samples is minimized and escape of mobile arthropods, e. g. spiders, is prevented. However, the escape of flying insects readily taking off is expected, especially in hot weather; on warm, sunny days the white tarpaulin may attract some flying insects, for instance the settling of cynipids and the chrysomelid *Lema melanopa* L. was observed.

The method presented is suitable for the sampling of arthropods from the canopies of small trees, for instance in hedges, orchards, young growths, and in the understory of forest stands, as well as from stems and low canopies of tall trees.

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References

Funke, W. 1971. Food and energy turnover of leaf-eating insects and their influence on primary production. In: H. Ellenberg (ed.): Integrated Experimental Ecology, Ecol. Stud. 2, pp. 81–93. Springer, Berlin.

Harris, J. W. E., Collis, D. G. and Magar, K. M. 1972. Evaluation of the tree-beating method for sampling defoliating forest insects. – Can. Ent. 104: 723–729.

Lewis, T. 1973. Thrips, their biology, ecology and economic importance. Academic Press, London and New York.

Nielsen, B. Overgaard 1975. Nedbankning med køller anvendt som indsamlingsmetode på bøg. – Ent. Meddr, 43: 37–61.

Steiner, H. 1962. Methoden zur Untersuchungen der Populationsdynamik in Obstanlagen. – Entomophaga 7: 207–214.

Sammendrag:

En tidsbesparende metode til kvantitativ indsamling af arthropoder fra træer.

Til registrering af den fritlevende arthropod-fauna på vanris og stammer af egetræer er udviklet en indsamlings- og uddrivningsteknik, der nærmere beskrives. I et bankelagen bestående af en voksdugspresenning ophængt på aluminiumsstænger og lukket tæt omkring en træstamme, blev nedbankede plantedele og dyr opsamlet, fejet sammen og direkte overført til særlige beholdere; disse anbragtes i et uddrivningsapparat, hvor uddrivning af faunaen skete ved hjælp af lys og varme. Arthropoder, der blev tiltrukket af lys, og former, der skyede varme/udtørring, opsamledes under uddrivningsprocessen i forskellige afsnit af prøvebeholderne. Indsamling af prøver i felten var særdeles hurtig, således at et meget stort antal prøver kunne indsamles per dag. Håndtering af prøverne var minimal, selektiv indsamling af arthropoder efter nedbankning i felten blev ganske undgået, og selv mikroarthropoder kunne registreres uden øget tidsforbrug. I den foreliggende undersøgelse, hvor arthropoder blev uddrevet fra meget store prøver af egeblade og -kviste, var metodens effektivitet høj; effektiviteten må dog afprøves i hvert enkelt tilfælde. Metoden kan anvendes til indsamling af arthropoder fra kronen på små træer eller fra træstammer, vanris eller lavthængende grene på højere træer.