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A Modified Shannon Trap for Use in Forensic Entomology

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Abstract

The objective of this study was to determine the efficacy of a modified Shannon trap to capture adult insects that are involved in cadaveric decomposition processes. The Shannon trap proposed here is composed of a thin fabric tent with a top formed by a transparent bottle containing a compartment filled with alcohol gel on which the captured insects are affixed. The trap was effective both for weather resistance and the quantity, quality and diversity of insects caught.

Keywords

Forensic Science, Flight Interception Trap, Diptera, Cadaveric Decomposition

1. Introduction

Forensic entomology is characterized by the use of insects, mites and other arthropods in legal procedures. Entomologic information allows the *post morten* interval (PMI) estimates to be obtained with reasonable accuracy, even after months of death. The study of cadaveric succession includes corpse necrophagous fauna analysis, which is based on the levels of decomposition. The fauna may vary because each period offers ideal conditions for the development of certain species. The development of the eggs and larvae is extremely predictable, and detailed observations of the biological stages of several insect species as well as their succession in the decaying corpse may reveal important information regarding the place and time of death [1].

Several traps can be used in forensic entomology to analyze the cadaveric entomofauna and to determine the relationship of the entomological succession with the phases of decomposition [2]-[5]. These traps are primarily

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characterized by the assembly of a rectangular iron framework that is usually clothed laterally by organza with an opening at the bottom to enable insects to enter the trap. Insect collection is generally performed manually using an entomological net wrapped over the top of the trap. However, some experiments do not use traps, and the insects are collected at the cadaver using insect hand nets [6]-[10]. For both methods, the researcher can collect the insects under the organza in addition to collecting the flying adults at the carcass. This practice may be harmful to the researcher, because these insects are known to be pathogen vectors [11] [12].

A similar trap was described by Shannon (1939) [13], and it was used primarily for the capture of day-flying sylvan mosquitoes and insects attracted by any type of bait. This trap consists of a rectangular compartment that is covered by muslin and four sides composed of mosquito netting. The trap is approximately 65 cm above ground with a large space below for the insects. The mosquitoes are caught with a suction tube inserted into a small opening in the side of the trap.

These traps remain assembled for undetermined lengths of time, thus allowing the collection of insects to visit the cadaver (or bait) throughout the day. However, without a bottle collector, the number of captured insects is low because many insects eventually die and fall to the ground and the nocturnal insects are not captured. In many experiments, oil is used as a fixative substance, which may alter the colors and structures of the insects that are prepared for identification.

In this study, we describe and test a modified Shannon trap for forensic entomology experiments. This trap has the following improvements: 1) collects the visiting insects during the entire decomposition process without prejudice based on the quantity and quality of the collected specimens, 2) prevents direct contact with the collected insects and 3) optimizes the time because of easy implantation that enables collection within a short period.

2. Materials and Methods

Trap Description

The trap proposed in this study consists of a voile textile tent fastened to the nozzle of a flask and fixed to the ground by four stakes, forming a pyramid with sides 10 to 30 cm from the ground to enable insect entry. The flask is fastened to two fixed points by its upper part, and there is an opening in the middle to which a collecting vial containing 70% gel alcohol is tied. Therefore, the collection is performed externally to the trap, and the insects are found adhered to the alcohol. The instructions for assembly are shown in **Figure 1**.

The trap was tested in experiments conducted in two distinct regions in Brazil between January and August, during the summer and winter seasons, respectively. The experiments were performed in the cities of São Paulo (at the campus of the Faculty of Medicine at the University of São Paulo, location 23˚33'S and 46˚40'W) and Peruíbe (in the EEJI—Estação Ecológica Juréia-Itatins, location 24˚22'S and 47˚01'W).

Four experiments were conducted, two during each season. The duration of each experiment was standardized to 20 days despite the variations in the decomposition periods of the carcasses at the two locations.

Swine carcasses weighing approximately 12 kg were placed directly on the ground inside 70 × 50 × 50 cm cages in shallow pits approximately 10 cm deep. This procedure was performed to protect the carcasses from vertebrate predators and to allow for adequate colonization. The cages were closed and strung in the surrounding vegetation to avoid predation as previously discussed. The trap was assembled above the cage to verify its efficacy and applicability for both experimental and forensics use. The collections were performed on alternating days at both locations.

After collection, the samples were transported to the laboratory and later grouped according to the decomposition phase. With the objective of evaluating the practical applicability of the trap in routine forensics, two collections with a one-hour interval were performed (the first collection at noon and the second collection at 1 p.m.). After this procedure, the collection vial was repositioned in the trap for additional collections.

3. Results and Discussion

A total of 10,833 arthropods that belonged to 53 families of insects were collected. The majority of the insects were from the order Diptera (96.9%), but specimens from the orders Coleoptera (2.12%), Hymenoptera (0.71%), Lepidoptera (0.14%), Hemiptera (0.10%) and Orthoptera (0.03%) were also observed. **Table 1** shows the number of insects collected at each decomposition stage, and a quantitative analysis of the collected insects accord-

ing to their taxonomic level of family is presented in **Table 2**.

The modified trap (**Figure 2**) retained the insects, and it was resistant to inclement weather. All of the collections were successful.

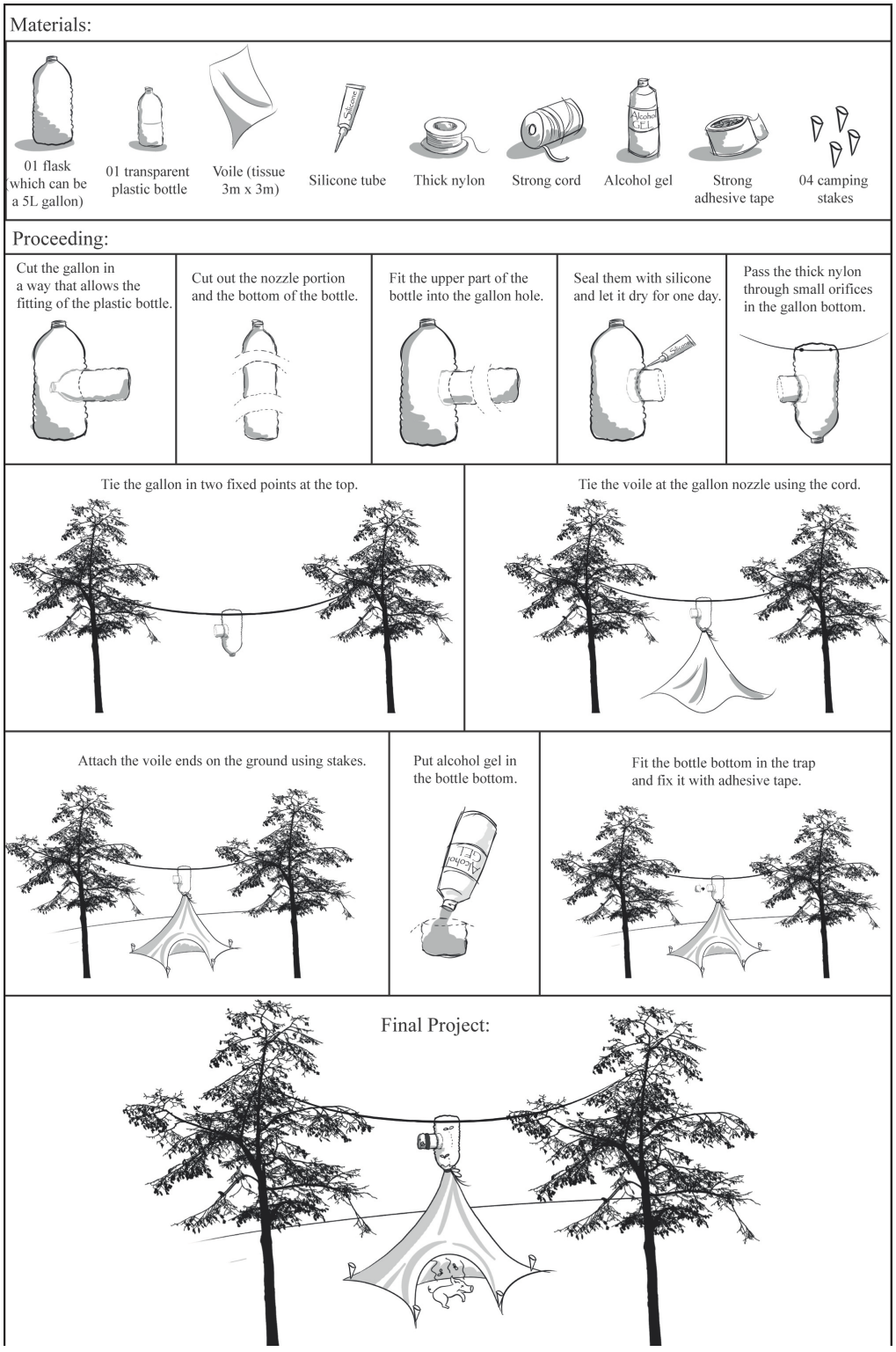

Figure 1. Step-by-step: assembly instructions trap.

To test the functionality of the trap for experimental studies, the trap was maintained above the carcass during all phases of cadaveric decomposition. The collected insects were directly related to the phase during which they were found, thereby allowing analysis of the pattern of entomological succession. In addition, quantification of the collected insects made it possible to identify the abundance of the orders and families.

An evaluation of the efficacy of the number of specimens captured was performed by comparison with results from other studies that used similar traps or insect hand nets as shown in **Table 3** [2]-[10]. Based on this analysis, our trap was more efficacious because of the increased number of insects captured during the process of decomposition and the variety of species captured.

To test the applicability of this trap for use in forensics, the quickness of assembly and the potential to collect insects in a short period were assessed. The results of both evaluations were positive because the implantation of the trap was simple and an estimated 30 to 80 insects were collected per hour.

Table 1. Number of insects collected by decomposition stage.

Stage of decomposition	Number of specimens collected			
	EEJI-S*	SP-S*	EEJI-W*	SP-W*
Fresh	327	38	282	173
Bloat	746	273	480	97
Marbling		378	1295	427
Active decay	1589	701	1428	558
Skeletonization	691	323	654	373
Total	3353	1713	4139	1628

*EEJI-S—Peruíbe experiment during the summer. SP-S—São Paulo experiment during the summer. EEJI-W—Peruíbe experiment during the winter. SP-W—São Paulo experiment during the winter.

Table 2. Total insects collected.

Order/Family		Abundance			
		EEJI-S*	SP-S*	EEJI-W*	SP-W*
Coleoptera	Cleridae	-	-	-	16
	Coccinellidae	-	-	1	2
	Lathridiidae	1	-	-	-
	Leiodidae	2	-	-	-
	Staphylinidae	192	-	15	1
Diptera	Anisopodidae	-	-	1	-
	Anthomyiidae	1	-	-	6
	Apioceridae	-	-	1	-
	Calliphoridae	286	93	757	806
	Ceratopogonidae	-	-	1	-
	Chloropidae	-	-	71	17
	Chyromyidae	-	-	1	-
	Clusiide	-	-	1	-
	Conopidae	-	-	1	-
	Culicidae	-	-	1	-
	Dolichopodidae	14	-	29	-
	Drosophilidae	13	-	91	79
	Empididae	-	-	5	-
	Fannidae	1401	348	1007	196
	Heleomyzidae	-	-	-	1
	Lauxaniidae	-	-	6	-
	Lonchaeidae	1	-	28	-

Continued

	Micropezidae	12	2	114	-
	Milichiidae	90	-	81	6
	Muscidae	268	91	445	203
	Mycetophilidae	-	-	7	1
	Neriidae	-	-	2	1
	Otitidae	355	5	128	23
	Phoridae	221	23	653	83
	Piophilidae	28	16	49	15
	Pompilidae	-	-	1	-
	Pteromalidae	-	-	2	-
	Psillidae	-	-	-	6
	Richardiidae	-	-	2	-
	Ropalomeridae	-	-	2	-
	Sarcophagidae	118	92	165	94
	Sciaridae	-	-	8	1
	Sepsidae	270	1031	364	29
	Sphaeroceridae	-	-	14	4
	Stratiomyidae	37	-	3	-
	Strongylophtalmyiidae	-	-	1	-
	Syrphidae	8	3	20	1
	Tephritidae	-	1	-	-
	Tethinidae	-	-	26	-
	Tipulidae	-	-	9	-
Hemiptera	Psyllidae	-	-	-	11

*EEJI-S—Peruíbe experiment during the summer. SP-S—São Paulo experiment during the summer. EEJI-W—Peruíbe experiment during the winter. SP-W—São Paulo experiment during the winter.

Figure 2. Demonstrative image trap.

Table 3. Comparision with results from other studies.

Reference	Local	Type of collection	Time/number of experiments	Number of collected specimens	Number of identified families
Ref [2]	Mountainous Area	Trap with squid bait	- 90 consecutive days - 9 traps - 54 collections	Total: 19,676 Calliphoridae samples, averaging 364 copies per bait	11 species of Calliphoridae
Ref [3]	Forest Area (650 m altitude)	Trap with a 5.5 × 7 cm container for bait	- 12 months - 12 experiments	Total: 25,995 dipteran, averaging 2166 samples per experiment	13 families of Diptera
	Forest Area (1120 m altitude)	Trap with a 5.5 × 7 cm container for bait	- 12 months - 12 experiments	Total: 14,185 dipteran, averaging 1182 samples per experiment	
	Forest Area (1550 m altitude)	Trap with a 5.5 × 7 cm container for bait	- 6 months - 6 experiments	Total: 2475 dipteran, averaging 412 specimens per experiment	
Ref [4]	Cerrado Area	Air pet bottle trap with ground beef bait	- 60 days - 3 traps (simultaneously)	Total: 5976 dipteran, averaging 1992 samples per experiment (each 60 days)	4 families of Diptera
Ref [5]	Urban Area	Tissue trap and collection with insect net	- 1 year - 12 experiments (approx. 26 days each)	Total: 258 Calliphoridae specimens, averaging 64 per experiment	4 species of Calliphoridae
Ref [6]	Semi-Rural Area	Insect net over bait (pig carcass)	- 97 days - about 40 collections	Total: 3382 insects (Diptera and Coleoptera)	10 families of Diptera
Ref [7]	Forest Area	Insect net over bait (pig carcass)	- 1 year - 12 experiments (trials 3× daily)	The number of specimens is not available	4 species of Calliphoridae
Ref [8]	Urban Area	Insect net over bait (pig carcass)	- 42 days	The number of specimens is not available	2 families of Diptera
Ref [9]	Forest Area	Insect net over bait (rodent carcass)	- 1 year - 32 experiments (daily collections)	Total: 820 samples (4 orders), average of 25 per carcass	13 families of Diptera
Ref [10]	Forest Area	Insect net over bait (pig carcass)	- 1 year - 4 experiments (40 days; daily collections)	Total: 11,996 Diptera' samples, averaging 2999 per experiment	24 families of Diptera
Present experiment	Forest Area	Present trap, with pig carcasses as bait	- 2 experiments - 30 days each	Total: 7942 insects samples (5 orders), averaging 3746 per experiment	39 families of Diptera
	Urban Area	Present trap, with pig carcasses as bait	- 2 experiments - 30 days each	Total: 3341 insects samples (4 orders), averaging 1670 per experiment	21 families of Diptera

4. Conclusion

We conclude that the trap showed favorable results. Its low cost, ease of manufacturing and efficient collection and preservation of the specimens captured facilitates further identification and characterization of necrophagous fauna. Furthermore, this study demonstrated that the trap met the expectations of feasibility related to the duration of the experiments, the number and quality of the specimens captured and the richness of the species collected. Therefore, this trap can serve as a complementary resource for forensics practice and experimentation.

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