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USE OF THE "CDC BACKPACK ASPIRATOR" FOR SURVEILLANCE OF *AEDES AEGYPTI* IN SAN JUAN, PUERTO RICO

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ABSTRACT. We constructed a battery-powered backpack aspirator to collect adult *Aedes aegypti* mosquitoes. This simple, easily constructed aspirator facilitates the indoor collection of this important vector species. The collections made with the aspirator provide useful information about the biology and behavior of *Ae. aegypti* that can be used in education and vector control programs and in the evaluation of ultra-low volume insecticide spray programs directed against this species. The cost for construction is *ca.* $150.

Aedes aegypti (Linn.), the principal vector of dengue and dengue hemorrhagic fever (DHF), is not readily collected in large numbers in traps used to collect other mosquito species (Chan 1985). Human landing-biting collections have been used to detect the presence of *Ae. aegypti* and measure adult density, but this method has certain inherent limitations. First, it is difficult to standardize results between field collectors, locations, and the time of day that collections were made. Second, it is time consuming and generally results in a low yield for the effort made (Giglioli 1979); in general, it is often an expensive use of scarce human resources. Finally, it yields only female mosquitoes, specifically those that are host-seeking, and during periods of dengue virus transmission, landing-biting collections unnecessarily place the field worker at risk for infection.

Meyer et al. (1983) described the "AFS sweeper," which was designed to collect mosquitoes that were resting on outdoor vegetation (e.g., *Culex tarsalis* Coq., *Cx. quinquefasciatus* Say, and *Culiseta inornata* Williston). Briefly, the aspirator consisted of a mechanical blower and rechargeable battery mounted on a backpack frame, controlled by an on–off switch attached to the frame. A handheld polyvinylchloride (PVC) collecting tube with a mesh-covered collecting carton was attached to the blower.

Following the basic design of the "AFS sweeper," we constructed the "CDC backpack aspirator" for use in field studies of adult *Ae. aegypti*. A complete list of the components used for constructing the backpack aspirator is presented in Appendix 1; Appendix 2 includes step-by-step instructions for constructing the aspirator. Figures 1 and 2 present various views of the aspirator and show the location of its major components. The backpack aspirator with battery weighs about 11 kg.

To construct the "CDC backpack aspirator," we made 7 specific changes to the basic "AFS sweeper." We 1) eliminated the shelf where the two 6-V gel batteries were positioned; 2) attached a ⅜-in.-thick piece of plywood (with a 2 × 2-in. hole for blower exhaust) on the base of the backpack frame; 3) placed the blower to the right rear of the collector and eliminated the lateral extension tube connected to the flexible hose; 4) placed the net-covered collecting carton on the end of the collecting tube, rather than at "midstream"; 5) rotated the blower 90° to the rear so that the exhaust air was vented downward rather than toward the rear of the collector; 6) replaced the two 6-V gel batteries with a single, rechargeable 12-V motorcycle battery; and 7) installed a wire mesh battery compartment, covered with duct tape, for the battery and the wires leading to the blower and the control switch, which we attached to the right vertical support of the frame.

We found that the lead acid batteries were much easier to procure and had a longer life in the field than the gel cells if the aspirator is switched off when it is not in use (2.5:0.75 h). We evaluated other, less expensive blowers but found that they rapidly discharged the battery. In addition, they created too much suction and injured or killed mosquitoes that had been collected.

We selected the Las Virtudes sector (*urbanizacion*) of urban San Juan, Puerto Rico, in which to evaluate the aspirator because it had high densities of *Ae. aegypti*, based on data from previous ovitrap collections (CDC, unpublished data). The area consisted of 200 houses that had been constructed of concrete blocks in the early 1950s. Originally, all had the same basic, single-story floor plan and contained about 63 m^2 of floor space. The windows and exterior doors were unscreened, primarily because of the residents' desire to have air circulating that was unimpeded by screen material.

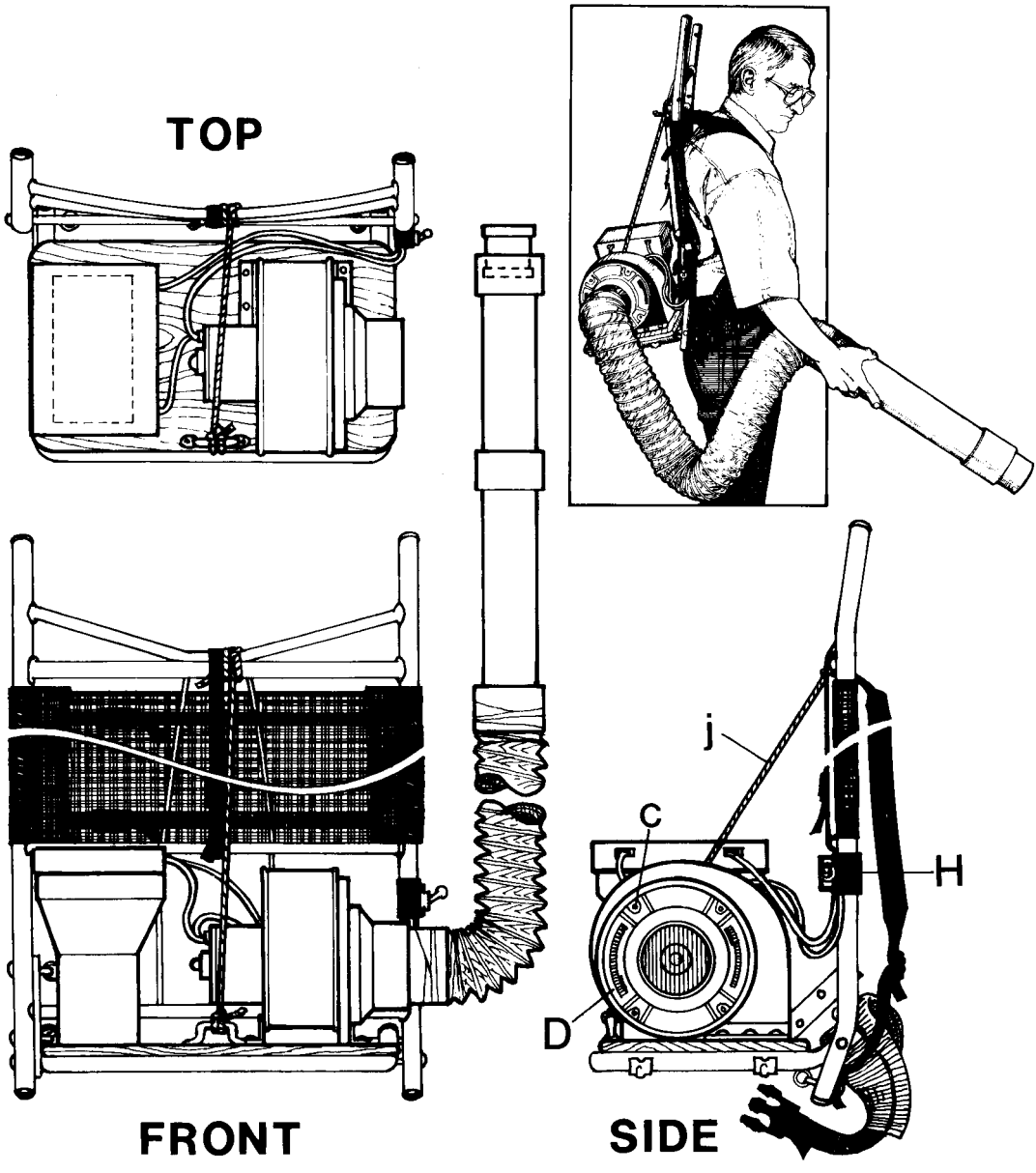

Fig. 1. Three views of the "CDC backpack aspirator" showing the various components. Refer to Appendix 1 for a complete list of components and Appendix 2 for step-by-step assembly instructions.

Indoor collections of *Ae. aegypti* were made by a 2-person team. One person operated the backpack aspirator while the second person assisted by providing light with a flashlight and using an insect net to collect mosquitoes that had escaped aspiration or were disturbed by the aspirator operator or air exhausted by the blower. At the conclusion of the collection, the net was everted, and mosquitoes were aspirated from it into the collection carton. Cartons were then appropriately labelled and stored in a field storage chest containing chemical coolants (cold packs).

Collections were made in all rooms and hallways of the house. Every bedroom had a closet, and each closet was carefully examined for mosquitoes resting on the hanging clothing. These mosquitoes were aspirated first to minimize the number of mosquitoes flying in the room. Once this area had been disturbed, all clothing was shaken and moved to expose any uncollected

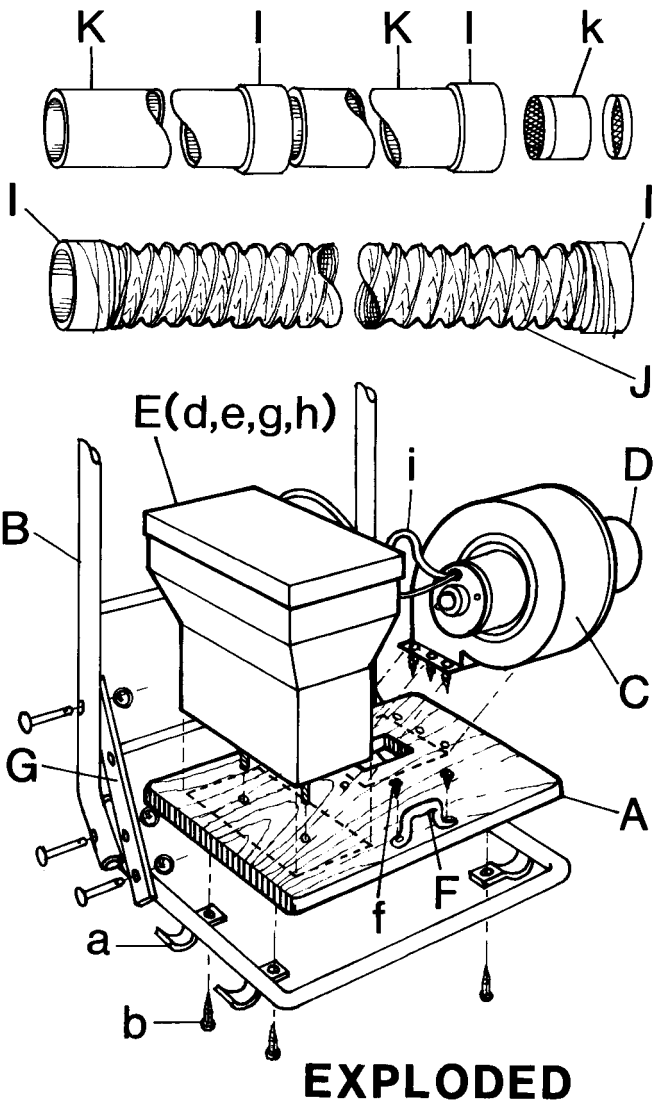

Fig. 2. Exploded view of the "CDC backpack aspirator."

mosquitoes. In other rooms of the house, mosquitoes were collected from under furniture and tables, around lamps or other articles on tables, and from furniture and near pictures.

Throughout these collections, an effort was made to collect all mosquitoes present in the house. Although the collection period had no defined time limit, we spent an average of 0.5 h per house. Collecting was begun at approximately 0900 h and terminated by 1330 h. This period was selected to accommodate daily activities of the residents and to avoid an overlap with the late afternoon peak of oviposition activity (Chadee and Corbet 1987; P. Reiter, personal communication). At the conclusion of each collection period, all spiders that had been collected with the mosquitoes were removed. Once all collections for the day had been completed, samples were returned to the laboratory for examination.

In the laboratory, each carton was placed in a −70°C freezer to kill the mosquitoes quickly before they were transferred to a plastic Petri dish for examination under a 10× dissecting microscope. Mosquitoes were identified to species, and males and females were separated and counted.

On 8 occasions, after the routine house collection had been completed, cartons with mosquitoes were placed in the field refrigerator, and

Table 1. *Aedes aegypti* females collected in 2 consecutive indoor collections, San Juan, Puerto Rico.

House	Date	No. in 1st collect.	No. in 2nd collect.	% efficiency
Alegria 750	Feb. 12	21	6	78
	Feb. 26	30	6	83
Dignidad 736	Feb. 19	14	1	93
Dignidad 740	Feb. 12	31	2	94
	Feb. 26	37	3	93
Felicidad 746	Feb. 12	8	1	89
	Feb. 19	14	2	88
	Feb. 26	21	2	91

a second collection was made to assess the efficiency of the method. In this evaluation, the initial aspirator operator and assistant switched roles before the 2nd collection was made to thoroughly resurvey for remaining mosquitoes. They also alternated as the initial aspirator operator. This period began within 10 min of the conclusion of the 1st collection period. Efficiency during this evaluation varied from 78 to 94% (Table 1). The house with the 2 lowest values was clearly the most unkempt of the 4 houses surveyed. When clothing and other household articles are strewn about the house, it is more difficult to collect all mosquitoes from the house efficiently.

The use of this aspirator is restricted to areas where electricity is available to recharge the batteries. This collection procedure allows public health personnel to obtain mosquitoes from indoor sites quickly and efficiently. These mosquitoes then can be analyzed and provide valuable information on vector presence and density, the impact of attempted adult control measures, vector–host density, preferred mosquito resting sites, presence of mosquito-borne viruses, vector–host preference, frequency of vector–host contact, and other aspects of mosquito biology and behavior.

We have used this procedure successfully in a series of weekly and daily collections to study the indoor resting behavior of *Ae. aegypti* (CDC, unpublished data), and the aspirator was used as an integral part of 2 international, multiagency evaluations of ULV insecticide applications against *Ae. aegypti* (P. Reiter, personal communication). The parts for this aspirator, including battery, cost *ca.* $150. With all parts at hand, it can be assembled in about 3 h and several have been constructed for vector control/research programs in the Americas.

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APPENDIX 2.

Steps for constructing the backpack aspirator.

1. On the plywood panel (A), 3 in. from the short axis and ¾ in. from the long axis, cut out a 2 × 2-in. hole.
2. Detach the base portion of the frame from the backpack frame (B).
3. Attach the plywood panel to the base of the frame from the underside with four ½-in. metal clamps (a), using 4 metal screws (1½ × ⅛ in.) (b). The holes should be drilled with a ⅛-in. drill bit. The screws should be secured with washer and nut.

Appendix 1. Parts list and source of backpack aspirator components. Components not mentioned in footnotes can be obtained at most local hardware, plumbing supply, and auto supply stores.

Component[1]	Description	Quantity
	motorcycle battery (12N12A-4A 12-V)	1
A	⅜-in. plywood (8 × 13 in.)	1
B[2]	L-shaped backpack frame (*ca.* 14 × 31 × 10 in.)	1

Appendix 1. Continued.

Component[1]	Description	Quantity
C[3]	12-V (DC) Dayton model 2C646 blower (176 cfm)	1
D	3-in. PVC closet ring	1
E	metal cloth (½ × 1 in. mesh), 3 ft. wide	1.5 ft.
F	3-in. door handle	1
G	5-in. metal bar	1
H	switch, canopy push button	1
I	3-in. PVC coupling rings	4
J	4-in. dryer hose	5 ft.
K	3-in. white PVC pipes (14 in.)	2
Miscellaneous materials		
a	½-in. metal clamps	4
b	1½ × ⅛-in. machine screws, with nuts and washers	12
c	1-in. metal screws	4
d	small metal rings	20
e	duct tape	1 roll
f	½-in. wood screws	4
g	no. 45 alligator clips	2
h	no. 10-14 power clip (push-on type, quick disconnect)	2 males, 2 females
i	no. 12 heavy duty insulated wire	1 ft.
j	cord or Velcro® strap	3 ft.
k[4]	collection carton: 1 pint paper, with 26-mesh nylon screening on top and bottom	1

[1] Refers to Appendix 2 and Figs. 1 and 2.
[2] Cabela's, Inc., 812 13th Avenue, Sidney, NE 69160.
[3] W. W. Grainger, Inc., 5959 W. Howard Street, Chicago, IL 60648 (catalog no. 50272-000).
[4] Kuhn Paper Co., 9001 Hampton Overlook, Capital Heights, MD 20743 (item no. 020410).

4. Place the blower exhaust (C) over the hole (cut in step 1) and mark the holes for the screws; drill with the ⅛-in. drill bit; place the blower in the opening; attach it with 4 screws (1½ × ⅛ in.) (b); and secure with washer and nut.
5. Attach the PVC closet ring (D) to the blower intake with 4 metal screws (1 in.) (c). The closet ring should be centered on the intake opening to ensure maximum suction by the blower.
6. Measure the battery that will be used. Form a frame for the storage box with the metal cloth (E), which will be held together with small metal rings (d). Cover the exterior of the frame with duct tape (e). Mount the storage box to the left side of the blower and attach it (from the inside) to the plywood base with 4 screws (1½ × ⅛ in.) (b), which should be secured on the underside by washer and nut. Cover the interior of the box with duct tape to minimize possible leakage of battery acid. Form a cover for the box with the metal cloth, cover it with duct tape, and attach it to the box with small metal rings (d).
7. At the extreme rear of the plywood base, attach the door handle (F) with 4 wood screws (½ in.) (f).
8. Reattach the base of the backpack frame with the utility pins that came with the backpack frame.
9. To provide additional support for the base, attach the 5-in. metal bar (G) at about a 30° angle from the left side of the base to the vertical frame support. Holes should be marked and drilled with a ⅛-in. drill bit. The bar can be attached with the utility pins, provided with the backpack frame. To reduce the pressure of the weight on the frame, pass the string or Velcro strap (j) through the door handle and the top middle section of the frame, adjust and tie securely.
10. On the right vertical support, about 4 in.

above the base, attach the control switch (H) with duct tape.

11. With a razor blade or knife, cut 2 small perforations on the side (adjacent to the blower) of the battery storage box (E). Insert the electrical wires that will be connected to the battery. Cut off the electrical attachment terminals of the blower, attach an alligator clip (g) to the negative (black) wire from the blower and insert it into the storage box. This wire will be attached to the negative battery terminal.
12. Attach one side of the quick disconnect power clip (h) to the red wire from the blower and the other side to one of the black wires from the switch.
13. Attach one side of the quick disconnect clip (h) to the 2nd switch wire and the other to the no. 12 heavy duty wire (i). Attach an alligator clip to the other end of the heavy duty wire and insert through the hole in the storage box. This clip will be attached to the positive terminal of the battery.
14. Attach 2 3-in. PVC coupling rings (I) to the ends of the flexible 4-in. dryer hose (J) with duct tape.
15. Connect the two 14-in. sections of PVC pipe (K) with a 3-in. PVC coupling ring (I). Attach the remaining 3-in. PVC coupling ring (I) to one end of a 14-in. section. Connect the 3-in. PVC coupling ring attached to the flexible dryer hose to the free end of the other 14-in. PVC pipe. Finally, attach the 3-in. PVC coupling ring on the flexible section to the closet ring (D) previously attached to the blower. Use a 1-pint cardboard carton (k), in which the top and bottom have been replaced with 26-mesh netting, for collecting mosquitoes.