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A CONVENIENT MOSQUITO MEMBRANE FEEDING SYSTEM

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ABSTRACT. A convenient, electronically controlled, *in situ,* membrane feeding system is described. Evaluation of the system for feeding single pair-mated *Aedes aegypti* with defibrinated, refrigerated pig blood indicated no significant difference from mouse-fed controls in rate of egg maturation, fecundity, or pupal yield. The feeding system is also suitable for use with substitute protein meals.

Several artificial feeding systems (Rutledge et al. 1964, Bailey et al. 1978, Wirtz and Rutledge 1980, Benzon and Apperson 1987, Hagen and Grunewald 1990) have been developed. These have differed with respect to the composition of the meal, the nature of the membrane, and the method of temperature regulation. Where large numbers of cages are kept, of different sizes, and where single pair matings are made, no artificial feeding system currently used is sufficiently versatile. Membrane-fed mosquitoes can show a lower degree of fecundity and fertility than those fed on live animals (Bunner et al. 1989). For genetic experiments with mosquitoes it is par-

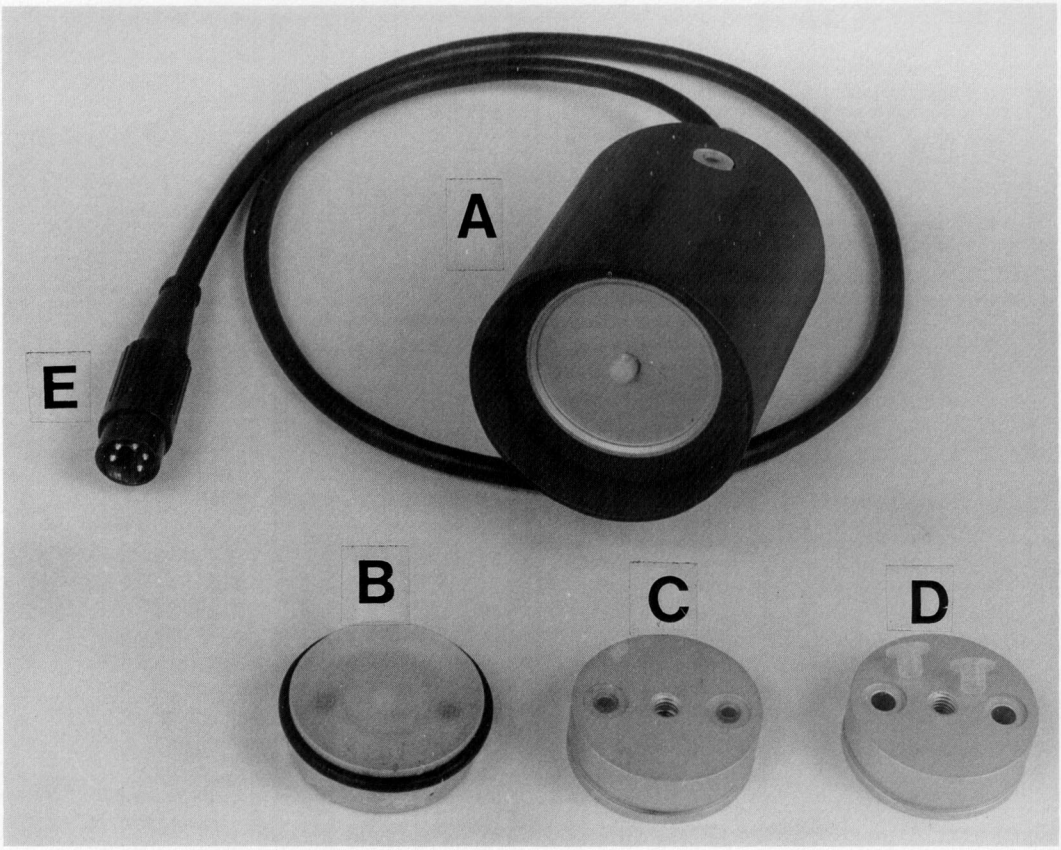

Fig. 1. Feeding unit with reservoir detached. A. Access to temperature control is provided near the base of the PVC casing that encloses heater, temperature control, and insulation; a screw is located on the middle of the heating block to receive the reservoir. B. Detached reservoir with collagen membrane secured by O-ring. C. Reservoir reversed to show 2 apertures for filling and threaded aperture for attachment to heating block screw. D. As C but with plastic plugs to close filling apertures. E. 6-V connector for heater and temperature control.

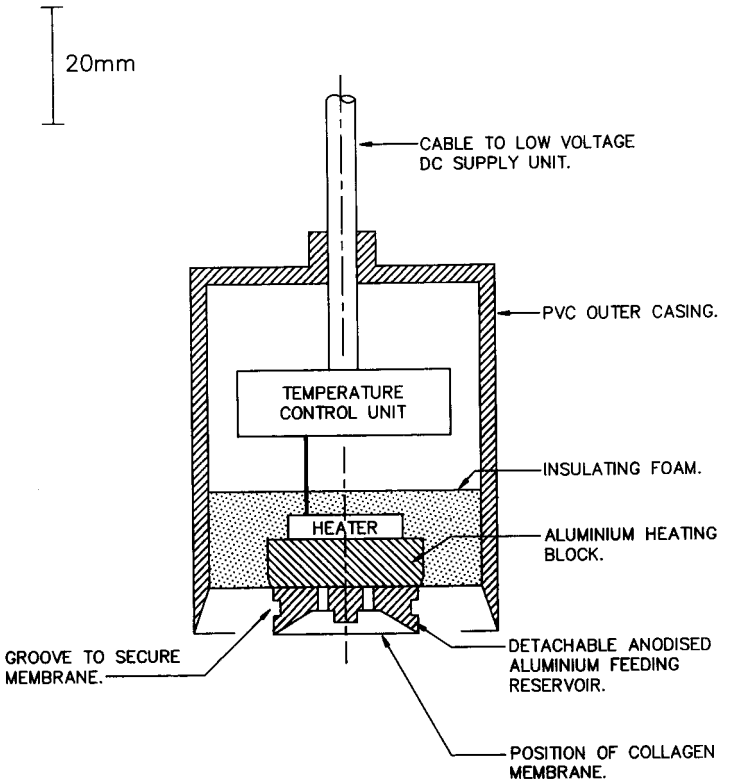

Fig. 2. Schematic diagram of individual mosquito feeding unit.

ticularly important that progeny sizes are as large as possible. The portable multiunit system described in this paper has temperature under fine control, which helps to enhance fecundity and fertility.

A light-weight (223-g, including 1-m cable), electronically controlled, thermally insulated feeding unit, 70 × 59 mm diam, has been developed (Figs. 1 and 2). The aluminium reservoir has a 5-ml capacity. Defibrinated blood or an artificial protein meal is introduced into the reservoir through one of 2 ducts, which are then sealed with plastic plugs. Fifty mosquitoes can feed at the same time through a collagen membrane secured by a rubber O-ring seated in a groove. The heater and temperature control have been designed and made for this sole purpose, from standard electronic components. Both heater and control are powered along the same cable by a stabilized low-voltage DC power supply, for safety. The units are plugged into a bus circuit within the insectary room, fed from an adjustable voltage power supply outside the room. The temperature of each unit can be maintained to within ±0.1°C of the set temperature, which can be varied from 1 to 20°C above ambient room temperature.

The collagen membrane was supplied by Devro, the same source used by Wirtz and Rutledge (1980). Devro collagen casing proved to be the most suitable out of a number of protein, plastic, and wax membranes tested, being acceptable to mosquitoes and easy to handle. The casings can be stored at room temperature. A piece of membrane, 60 mm in diameter, is slightly moistened with tap water before being secured to the feeding unit.

A preliminary evaluation was made of pig blood for feeding *Aedes aegypti* (Linn.). The blood was passed through several layers of cotton gauze to defibrinate it, and then refrigerated at 5°C. Blood up to 5 days old was presented to 10 single pair-mated females through a collagen membrane at 35°C. Ten other females were allowed to feed on mice as controls. The mice were narcotized by intraperitoneal injection with sodium pentobarbitone (Sagatal, May and Baker Ltd.). Eggs were collected and counted from both treatments and hatched, and subsequently pupal counts were made. The experiment was repeated

4 times. No significant difference could be found between membrane-fed mosquitoes and mouse-fed controls in the rate of feeding: 27 out of 40 fed on membrane, 33 out of 40 on mice (chi square = 2.4, $P > 0.05$). Other comparisons made and tested for significance using Student's t-test were: day of oviposition post blood meal, membrane 3.0 ± 0.2 days, mouse 3.3 ± 0.3 days; eggs per ovipositing female, membrane 72.0 ± 6.3, mouse 79.6 ± 7.4; pupae per ovipositing female, membrane 52.4 ± 5.4, mouse 62.9 ± 6.6. None of the differences were significant.

The results show that our feeding unit is a viable alternative to animal host feeding. *Aedes aegypti* and *Anopheles stephensi* Liston have been maintained routinely on defibrinated pig blood. *Anopheles gambiae* Giles, *Anopheles arabiensis* Patton, and *Culex quinquefasciatus* Say have been kept continuously this way for 3 or 4 generations. *Aedes aegypti* and *An. stephensi* are now being maintained on a specially formulated protein meal, based on that of Kogan (1990), details of which will be published later. Although fecundity is not quite as high as with pig blood or a live mouse, it is being improved on the basis of experience.

The feeding units will be available for purchase in the near future. Fan-cooled control units to produce a stabilized DC power supply sufficient for up to 20 feeding units, and low voltage bus circuit modules, can also be supplied, according to demand.

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REFERENCES CITED

Bailey, D. L., D. A. Dame, W. L. Munroe and J. A. Thomas. 1978. Colony maintenance of *Anopheles albimanus* Wiedemann by feeding preserved blood through a natural membrane. Mosq. News 38:403–408.

Benzon, G. L. and C. S. Apperson. 1978. An electrically heated membrane blood feeding device for mosquito colony maintenance. J. Am. Mosq. Control Assoc. 3:322–324.

Bunner, B. L., R. L. Scott, S. E. Dobson, L. M. Anderson and L. R. Boobar. 1989. Comparison of artificial membrane with live host bloodfeeding of *Aedes aegypti* (L.) (Diptera: Culicidae). J. Entomol. Sci. 24:198–203.

Hagen, H. E. and J. Grunewald. 1990. Routine blood feeding of *Aedes aegypti* via a new membrane. J. Am. Mosq. Control Assoc. 6:535–536.

Kogan, P. H. 1990. Substitute blood meal for investigating and maintaining *Aedes aegypti* (Diptera: Culicidae). J. Med. Entomol. 27:709–712.

Rutledge, L. C., R. A. Ward and D. J. Gould. 1964. Studies on the feeding response of mosquitoes to nutritive solutions in a new membrane feeder. Mosq. News 24:407–419.

Wirtz, R. A. and L. C. Rutledge. 1980. Reconstituted collagen sausage casings for the blood feeding of mosquitoes. Mosq. News 40:287–288.