A MODIFIED FLOW TANK DESIGN THAT FACILITATES CHOICES OF CURRENT VELOCITY (RIFFLE VERSUS POOL)

MICHELE F. SECREST AND MICHAEL R. WILLIG

Ecology Program, Department of Biological Sciences and The Museum, Texas Tech University, Lubbock, Texas 79409-3131

ABSTRACT.—Artificial streams are an effective means of studying the behavior of aquatic insects because the simulated environment can be controlled and manipulated easily. The described modifications to the design of Herrmann et al. (1992) present several advantages over previous designs. The modified flow tank allows for choice of current velocity as well as substrate, and provides a larger area for study. The design is inexpensive ($650.00, 1993), easy to construct, and provides homogeneous currents throughout riffle or pool areas.

Field experiments involving aquatic taxa have been conducted directly in streams to maintain the environmental conditions required for the survival of the organisms. In general, organisms were placed in screen cages which were partially or completely submerged. Unfortunately, problems such as flooding or human intervention contributed to the loss of organisms or experimental replicates (Sudia, 1951). Additional problems with the screen cages included the inability to control abiotic factors such as temperature, pH, and oxygen content. Finally, current velocity surrounding screen cages was inconsistent due to resistance of the screen decreasing water velocity (Sudia, 1951). Laboratory flow tanks were developed to eliminate such complications. Artificial streams provide a practical means of controlling many abiotic factors while varying factors of interest.

Artificial streams provide an opportunity to study lotic organisms in a controlled environment where all but characteristics of interest are held constant (Lauff and Cummins, 1964). In general, flow tanks are ideal for behavioral studies evaluating intra- and interspecific interactions such as competition and predation (Feltmate, 1987; Williams, 1987; Fuller and Rand, 1990). More specifically, studies of habitat selection with flow tanks (Herrmann, 1992; Herrmann et al., 1993) have proven effective because abiotic factors and substrate are easily modified to correspond to particular experimental designs.

Early flow tanks were large, complex, expensive to build, and difficult to manipulate (Sudia, 1951). Subsequent designs were specific for experiments evaluating the behavior of particular species (Bainbridge and Brown, 1958; Vogel and Feder, 1966; Svoboda, 1970), and often were too specialized for general ecological studies. Flow tanks were designed later that were less complex, economical, and easy to construct (Vogel and LaBarbera, 1978; Mackay, 1981; Lamberti and Steinman, 1993). Recently, Herrmann et al. (1992) designed a flow tank with notable advantages over previous designs. Their flow tank

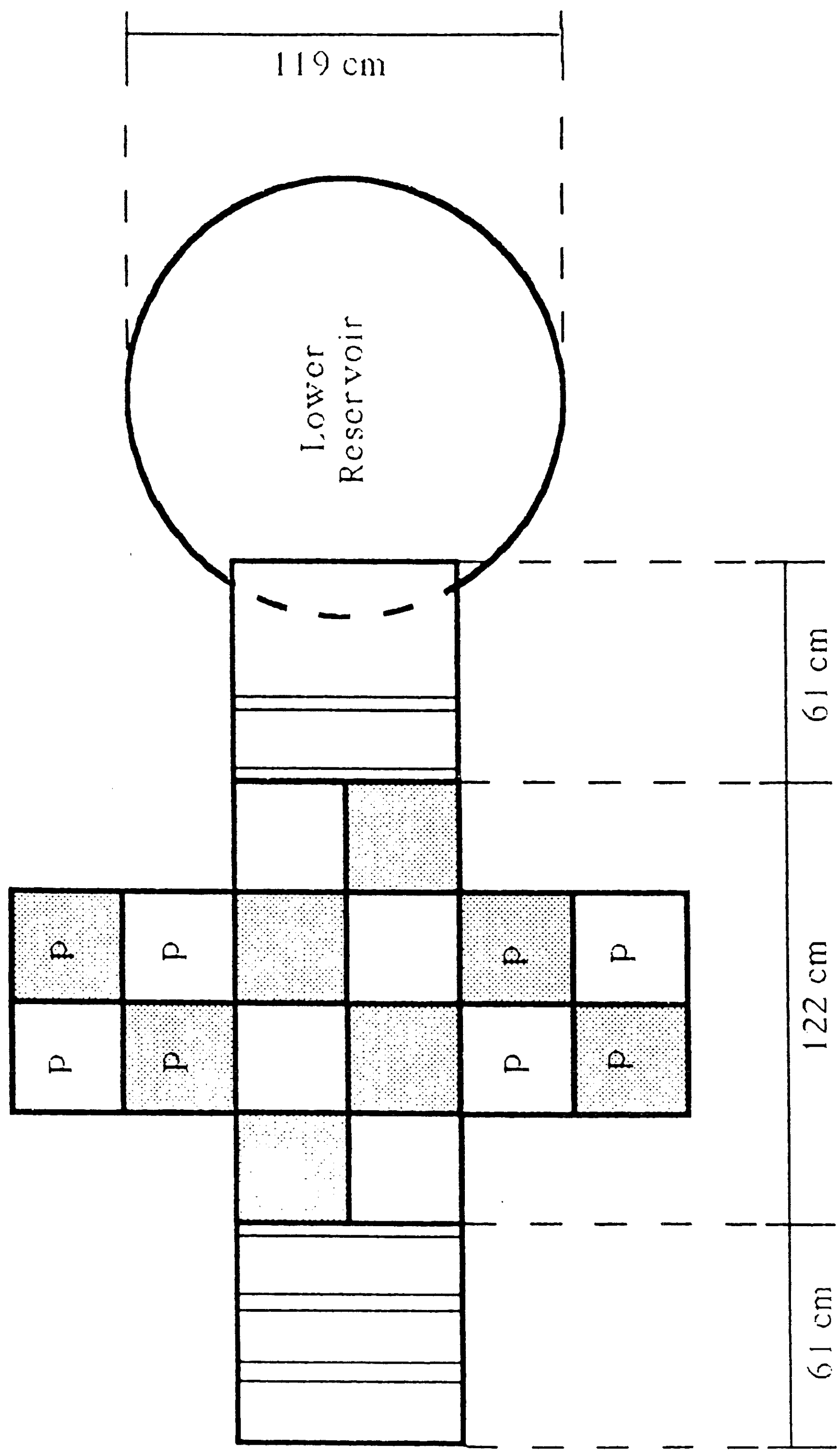

FIGURE 1. Diagrammatic representation of the artificial stream. Quadrats in pool area are represented by a "P" whereas riffle areas are unmarked. Alternating configuration of substrate is indicated by shaded vs. non-shaded areas.

required little floor space, produced accurate current velocities, simulated a riffle environment, and produced currents which were consistent spatially and temporally throughout the tank (Herrmann et al., 1992). Their design was inexpensive and easy to build; one person could construct a tank in two days. Although this design facilitates substrate choice, it does not permit a choice of current velocites (e.g., riffle vs. pool).

Modifications of the flow tank design to allow a choice of velocity are presented hereafter. In particular, modifications allow organisms to choose between a riffle and pool habitat, with substrate contrasts offered in each habitat (fig. 1).

Materials and Methods

In general, the flow tank design was modified from that of Herrmann et al. (1992). The flow tank comprises four main sections: riffle area, pool area, water supply, and water pump. The riffle area is a long rectangular trough supported by four posts, whereas the pool area is divided into two square troughs each supported by three posts. The riffle and pool areas together form the upper reservoir. A cylindrical tin tank contains the water supply and submersible pump (lower reservoir) which circulates the water throughout the entire flow tank. Water is lifted through the plumbing to the emptying chamber in the upper reservoir where it flows via gravitation toward the lower reservoir, falls into the tin tank, and is recycled.

Upper reservoir.—The riffle area of the upper reservoir was constructed according to Herrmann et al. (1992). Pool areas were constructed from 1.9 cm (three-fourths in) plywood. Galvanized nails and silicone were used to secure the walls to each base plate. Each pool section measured 61 cm by 61 cm (2 Ft by 2 Ft), so that the total pool area was 244 cm by 61 cm (8 Ft by 2 Ft, fig. 1). The entire upper reservoir was then covered with a single sheet of 6 mm plastic, to prevent water leakage. Total riffle area was equal to the total pool area available for experimentation. Each pool section was divided into four qudrats using 2.5 cm (1 in) corner molding as partitions. The riffle area was bounded by an upper and a lower mesh screen to keep organisms within the study area. A single weir was used in the upper reservoir to control water turbulence within the emptying chamber. Water levels were controlled by the lower mesh screen and lower weir, whereas water velocity was controlled by the pump and gate valve. The lower weir can be removed to achieve maximum current velocity in the riffle area. Water depth (with the lower weir in place) remains constant at approximately 20.3 cm; however, water depth can be changed by adjusting current velocity (via the gate valve) and weir placement.

Lower reservoir.—The lower reservoir comprises a cylindrical galvanized tin tank, a submersible 0.5 Hp sewage pump (Goulds model 3887, Seneca Falls, New York), and PVC plumbing for transport of water to the upper reservoir. The diameter of the tin tank is 119 cm, with a volumetric capacity of 2.73 m^3. Water temperature may increase initially due to electrical resistance within the pump; however, maximum temperatures measured were 29°C (Herrmann et al., 1992). A gate valve was fitted between PVC piping to control current velocities. No directional flow of water was detected in pool areas. The gate valve can be manipulated to produce a variety of current velocities in the riffle area between 0 and 45.45 cm/second.

Discussion

The modified flow tank presented herein not only contains all the advantages of the previous design (Herrmann et al., 1992), but offers a larger study area and permits selection of current velocities. Modifications to the flow tank were inexpensive (approximately $150.00); total cost of a modified flow tank equals $650.00. Construction of a modified flow tank by a single individual can be accomplished in three days.

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