An Inexpensive Macroinvertebrate Bioassay Table For Use in Continuous-Flow Toxicity Tests

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Interest in continuous-flow toxicity testing and bioassays with aquatic macroinvertebrates has increased in recent years. The use of macrobenthos in this type of investigation requires a relatively small holding vessel to facilitate observations of the organisms during treatment. Several devices have been described for macroinvertebrate bioassays, but have been developed for specific insects (FREMLING 1970), or are extremely costly (NEBEKER and LEMKE 1968). ARTHUR (1969) successfully used 4-gallon all glass aquaria fitted with stand pipes and bottles resulting in water volumes of about 12.5 l, however, when a large number of tests is required the cost of aquaria is substantial.

In the present work, a bioassay apparatus was designed to meet the following criteria: 1) accommodate a large number of tests; 2) be generally acceptable to a wide range of macroinvertebrate organisms; 3) require a minimum of space; 4) be relatively inexpensive. A controlled temperature bioassay table using one-gallon glass jugs as test chambers was developed. The apparatus was designed for use with three proportional diluters (MOUNT and BRUNGS 1967).

METHODS AND MATERIALS

A table was constructed from marine plywood and 4" x 4" stock. Walls were built onto the table top to form a water bath which was waterproofed with epoxy-enamel paint.

Eighteen test chambers (Fig. 1) were assembled. Each vessel was constructed by removing the bottom of the jugs with a bottle and jug cutter. Adjustable stand pipes were fashioned by placing glass tubing through a rubber stopper, which was inserted into the neck of the jug. A cylinder constructed from fiberglass screening was placed over the stand pipe to prevent escape of organisms. Each chamber was seated, neck down, into holes drilled into the table top, and sealed with clear silicone sealer. Effluent water from the chambers was discarded by leading rubber tubing

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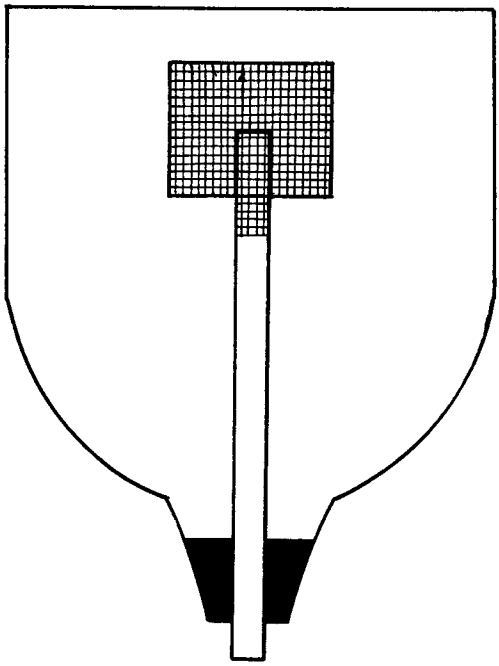

Figure 1. Test chamber constructed from one-gallon jug, glass tubing, rubber stopper, and fiberglass screen.

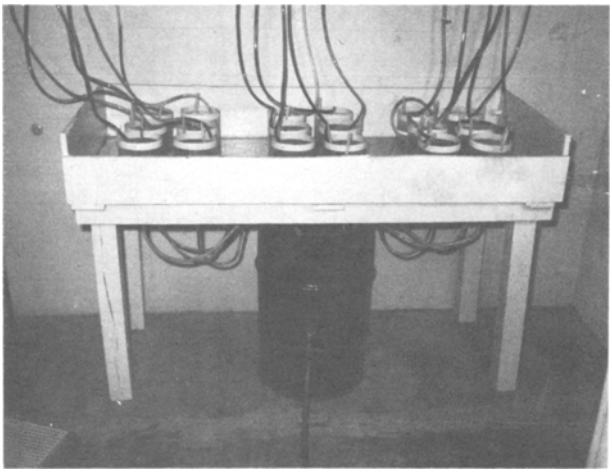

Figure 2. Macroinvertebrate continuous-flow bioassay table.

from the stand pipes to a 30-gallon drum under the table. A faucet and hose attached to the drum emptied effluent to a floor drain. The system is illustrated in Fig. 2.

Mount and Brung's proportional diluters were used to deliver toxicants to the test chambers. The diluters were calibrated to deliver a nominal dilution factor of 0.5 with each descending concentration. In order to check the reliability of the system, NaCl was used to provide a source of measurable ions. The salt concentrations were monitored by measuring conductivity twice daily with a YSI Model 33 Salinity-Conductivity-Temperature meter. NaCl concentration were monitored for 4 days, the standard time interval for an acute bioassay.

RESULTS AND DISCUSSION

Fig. 3 shows the mean conductivity values, and 95% confidence limits, for the five dilution factors of each diluter. The dilution factors were calculated by subtracting the ambient conductivity of the dilution water from the conductivity of each test chamber. The graphs for each diluter are quite similar, differing only in the position of the slope, which was due to the variation in NaCl concentration of the diluters. These data show the apparatus to be reliable over the test period.

The cycling of the diluters must function perfectly to ensure the concentrations of the test chambers do not vary. In this system, the volume of each chamber is 2.5 l. If there is a malfunction of the dipping bird, drastic alterations in concentrations will occur. This problem was overcome by checking the flow rates and timing of each diluter twice daily.

The advantage of the system lies primarily in its versatility and low cost. The adjustable stand pipe allows water volumes in each vessel to be varied from 1 to 3 l. The water bath can be used to control temperature in the vessels by placing portable heating or cooling units in the bath. The apparatus is capable of accommodating fifteen concentrations of a single toxicant; five concentrations of three toxicants; or three replicates of five concentrations of one toxicant. If only one diluter was available, a splitter tank could be used to supply all eighteen vessels. The maximum cost for the system is about $50. This price was computed using one-gallon jugs, marine plywood, epoxy enamel, and 4" x 4" stock as the basic materials. When compared to the cost of a comparable system utilizing aquaria, there is a minimum saving

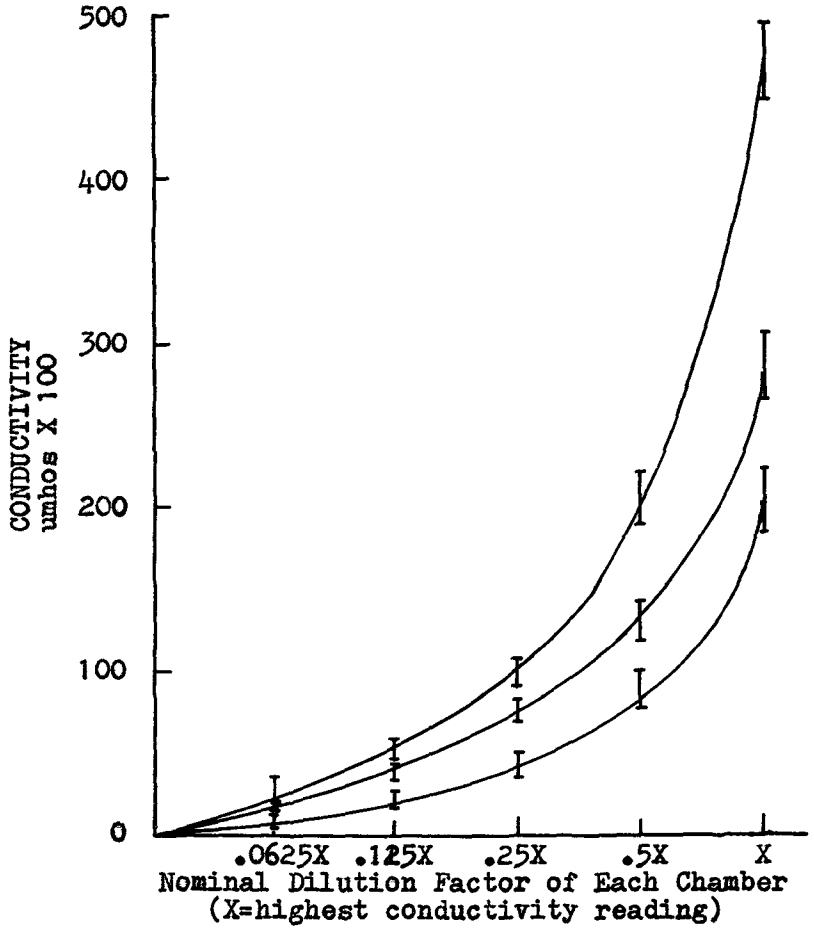

Figure 3. Mean conductivity of each chamber for the three diluters.

of 50%. The apparatus is particularly useful for nonpredaceous macroinvertebrate groups.

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