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Standard Practice for Collecting Benthic Macroinvertebrates with Multiple-Plate Samplers[1]

This standard is issued under the fixed designation E 1469; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the procedures for obtaining qualitative and quantitative samples of macroinvertebrates on an artificial substrate sampler in rivers, streams, lakes, and reservoirs. The device can be used in areas where no other method is feasible.

1.2 Multiple-plate samplers are usually colonized by a wide variety of macroinvertebrates that actively and passively enter the current or the water column.

1.3 This practice facilitates standardization of collection procedures at sampling sites and is excellent for water quality purposes. Standardized sampling is especially desirable when the results from different investigators and from different environments are to be compared.

1.4 Multiple-plate samplers are devices of standard composition and configuration placed in the water for a predetermined exposure period and depth for colonization by macroinvertebrates.

1.5 The multiple-plate sampler can be used either alone or can effectively augment bottom substrate sampling because many of the physical variables encountered in bottom sampling are minimized (for example, variable depth and light penetration, temperature differences, and substrate types).

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautions, see Section 7.

2. Referenced Documents

2.1 *ASTM Standards:*

D 1129 Terminology Relating to Water[2]

E 1468 Practice for Collecting Benthic Macroinvertebrates with the Basket Sampler[3]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this practice, see Terminology D 1129.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *benthos*—the community of organisms living in or on the bottom of other substrate in an aquatic environment.

3.2.2 *habitat*—the place where an organism lives, for example, mud, rocks, shoreline, twigs, riffle, pool, and so forth.

3.2.3 *macroinvertebrates*—benthic or substrate dwelling organisms visible to the unaided eye and retained on a U.S. Standard No. 30 (0.595-mm mesh openings) sieve. The standard sieve opening for marine benthic fauna is also 0.595 mm (U.S. Standard No. 30 sieve). To accommodate some historical data bases, a 1.0 mm, U.S. Standard No. 18 sieve may be used. Examples of macroinvertebrates are aquatic insects, macrocrustaceans, mollusks, annelids, nematodes, and echinoderms.

3.2.4 *microhabitat*—a smaller and more restricted habitat, for example, certain positions on a rock, certain particle size sediment, and so forth.

3.2.5 *multiple-plate sampler*—constructed of 8 or more tempered hardboard or ceramic material cut in 76 mm (3 in.) square or circular plates and separated by a specific arrangement of spacers. The plates and spacers are placed on a ¼ inch eyebolt.

3.2.6 *substrate sampler*—any collecting device that is made of natural or artificial substrate materials for the colonization of macroinvertebrates.

4. Summary of Practice

4.1 Multiple-plate samplers consist of standardized, reproducible artificial substrate surfaces (tempered hardboard or ceramic plates) for colonization by indigenous aquatic organisms. Their uniform shape and texture compared to natural substrates greatly simplifies the problem of sampling. The sampler can be purchased or constructed from readily available materials.

4.2 Total surface area of the 8 plate sampler is approximately 939 cm^2 (0.09 m^2), and the 14 plate sampler is 1160 cm^2 (0.116 m^2). The 14 plate, tempered hardboard, multiple-plate sampler weighs about 1 lb (0.45 kg).

4.3 The recommended exposure period for multiple-plate sampler is six weeks, and the time of exposure may be critical to development of a relatively abundant and diverse community of organisms. Three replicate samples at each station are an absolute minimum. Collecting five replicate samples at each station will increase statistical precision and accuracy.

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[1] This practice is under the jurisdiction of ASTM Committee E-47 on Biological Effects and Environmental Fateand is the direct responsibility of Subcommittee E47.08on Biological Field Testing.

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[2] *Annual Book of ASTM Standards*, Vol 11.01.

[3] *Annual Book of ASTM Standards*, Vol 11.05.

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5. Significance and Use

5.1 The multiple-plate sampler is a highly effective device for evaluating the biological integrity of surface waters and for studying macroinvertebrate communities **(Refs 1-21)**.[4] Multiple-plate samplers are used to collect qualitative and quantitative samples from lentic and lotic waters containing benthic macroinvertebrates living on various types of substrates.

5.2 The organisms in the sampler are used to define macroinvertebrate community characteristics in water quality studies and ecological assessments.

5.3 Physical factors such as stream velocity and depth may variably affect degree of colonization. The sampling method is selective for drifting organisms (biased for insects) and for those which preferentially attach to or live on hard surfaces.

5.4 Multiple-plate samplers are excellent for water quality monitoring, contain uniform substrate type at each station for better comparison, give quantitatively comparable data, contain negligible amounts of debris permitting quick laboratory processing, but may require additional weight for stability.

5.5 Multiple-plate samplers sample a known area at a known depth for a known exposure period. Multiple-plate samples provide no measure of the biota and condition of the natural substrate at a station. They record only biota accumulated during exposure period.

5.6 The distinct advantages of the multiple-plate sampler are its small size and light weight. It is the most adaptable of the recommended benthic invertebrate artificial substrate devices.

6. Description of the Modified Hester-Dendy Multiple-Plate Sampler

6.1 The modified multiple-plate (Fig. 1) is constructed of 0.25 in. (0.3 cm) tempered hardboard or ceramic material with 3 in. (7.6 cm) round or square plates and 1 in. (2.5 cm) round spacers that have ⅝ in holes drilled in the center **(6)** and **(13)**. The plates are separated by spacers on a 0.25 in. (0.63 cm) diameter eyebolt, held in place by a nut at the top and bottom. A total of 14 large plates and 24 spacers are used in each sampler. The top nine plates are each separated by a single spacer, plates 9 and 10 are separated by two spacers, plates 11 and 12 are separated by three spacers, and plates 13 and 14 are separated by four spacers. The hardboard sampler is about 5.5 in. (14 cm) long, 3 in. (7.6 cm) diameter, exposes approximately 1160 cm^2 (0.116 m^2) of surface area for the attachment of organisms, and weighs about 1 lb (0.45 kg). The ceramic sampler is 6.5 in. long and weighs 2.2 lbs (1 kg). The ceramic plates can be chemically cleaned, oven dried and reused indefinitely as they are stable and unaffected by long-term immersion in water. The sampler will not warp with time; therefore, the spacings between plates do not change, assuring replicate and efficient sampling. Each sampler is supplied with a 20 ft (6 m) long nylon suspension rope. The total weight is 2.2 lbs (1 kg). Sturdy wire stakes for holding the sampler above the riverbed are recommended accessories.

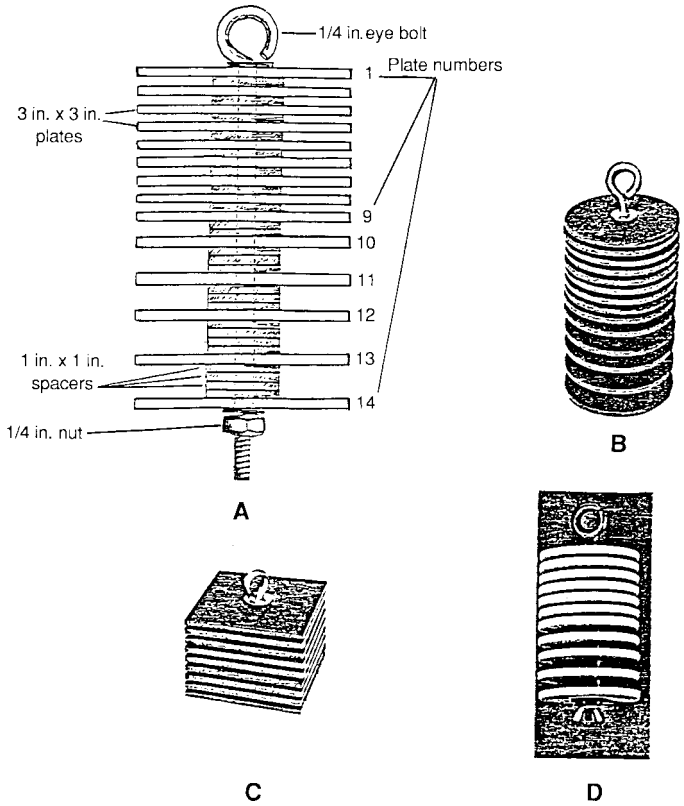

FIG. 1 Artificial multiple-plate samplers: (*a*) schematic drawing of multiple-plate sampler; (*b*) modified round; (*c*) original square, tempered hardboard, Hester-Dendy samplers; and (*d*) round ceramic multiple-plate macroinvertebrate sampler

6.2 Another type of modified Hester-Dendy multiple-plate artificial substrate sampler (Ohio EPA **(17)**) is constructed of ⅛ in. tempered hardboard cut into 3 in. (7.6 cm) square plates and 1 in. (2.5 cm) square spacers. A total of eight plates and twelve spacers are used for each sampler. The plates and spacers are placed on a ¼ in. eyebolt so that there are three single spaces, three double spaces, and one triple space between the plates. The total surface area of the sampler, excluding the eyebolt, is 145.6 $in.^2$ (939 cm^2) (0.09 m^2). Five samplers are placed in streams tied to a concrete construction block which anchors them in place and prevents the multiple-plates from coming into contact with the natural substrates.

7. Precautions

7.1 Samplers and floats may be difficult to anchor; they may be a navigation hazard.

7.2 Samplers are susceptible to vandalism and often lost.

7.3 Recovery techniques are critical for ensuring the collection of all organisms retrieved in the sampler.

7.4 Caution should be exercised in the reuse of samplers that may be subjected to contamination by toxicants, oils, and so forth.

8. Procedures

8.1 In deep water three multiple-plate samplers are suspended from floats, cement structures, or rods driven into the stream-bed or lake-bed and positioned well up in the euphotic zone of good light penetration (1 to 3 ft, or 0.3 to 0.9 m) for

[4] The boldface numbers in parentheses refer to the list of references at the end of this practice.

maximum abundance and diversity of macroinvertebrates. A4-ft (1.2 m) depth is acceptable unless the water is exceptionally turbid.

8.2 The optimum period for substrate colonization is six weeks for most types of water. Three replicate samples at each station are an absolute minimum.

8.3 For uniformity of depth, suspend the multiple-plate samplers from floats on ⅛-in. (3.2 mm) steel cable. If vandalism is a problem, use subsurface floats or put the sampler on supports placed on the bottom. Regardless of the installation technique, use uniform procedures (for example, the same depth and exposure period, sunlight, current velocity, and habitat type).

8.4 At shallow water stations (less than 4-ft (1.2 m) deep), install samplers so that the exposure occurs midway in the water column at low flow. The samplers may be installed in pools or runs suspended below the water surface. The collections should be as representative of the reach as possible by ensuring that the samplers are not close to the bank.

8.5 In streams up to a few metres in width, install the device at approximately midstream. In larger streams, install the device at approximately one-quarter of the total width from the nearest bank. Multiple-plate samplers may require additional weight for stability.

8.6 If the samplers are installed in July when the water depth is approximately 4 ft (1.2 m), and the August average low flow is 2 ft (0.6 m), the correct installation depth in July is 1 ft (0.3 m) above the bottom. The sampler will receive sunlight at optimum depth 1 ft (0.3 m) and will not be exposed to air anytime during the sampling period. Care should be exercised not to allow the sampler to touch bottom which may permit siltation, thereby increasing the sampling error.

8.7 In shallow streams with sheet rock bottoms, multiple-plate samplers can be secured to ⅜-in. (0.95 cm) steel rods that are driven into the substrate or secured to rods that are mounted on low, flat, rectangular blocks half-way between the water surface and the stream bed. However, these must be anchored securely to the rock bottom to avoid loss during floods.

8.8 Factors such as the time of year and the body of water sampled should be considered in the determination of exposure time. The exposure time should be consistent among sites during the study. If study time limitation reduce this period, the data must be evaluated with caution, and in no case should data be compared from samplers exposed for different time periods.

8.9 Samplers must be protected from loss of invertebrates during retrieval. Most insects rapidly leave the sampler when disturbed; thus a retrieval method to prevent their escape must be used.

8.10 In shallow water, approach the multiple-plate samplers from downstream, lift the sampler quickly, and place the entire sampler in a polyethylene bag or jug containing 10 % formalin or 80 % ethanol. The fixative, formalin, should be used only if the specimens collected require special processing for identification. Once the sampler is touched, it must be removed from the water immediately or many of the animals will leave the sampler. If the sampler must be disturbed during the recovery process so that it cannot be lifted straight up out of the water, a net should be used to enclose the sampler before it is disturbed.

8.11 To accomplish this, the multiple-plate sampler should be enclosed either in a sieving bucket with U.S. Standard No. 30 sieve screen or by a dip net constructed of U.S. Standard No. 30 sieve or finer grit bolting cloth that can be pulled around the sampling device before retrieval. Also, samplers exposed in deep water may be enclosed in a retrieval net and brought to the surface by divers. If the sampler can be pulled quickly from the water without undue disturbance, as described in 8.10, it may not be necessary to enclose it.

8.12 The organisms can be removed in the field by disassembling the sampler in a tub or bucket partially filled with water and scrubbing the plates with a soft-bristle brush to remove clinging organisms. The contents of the bucket are then poured through a No. 30 or 70 sieve and washed into a jar and preserved with 10 % formalin or 80 % ethanol. If the organisms are not removed in the field, the multiple-plate samplers can be taken to the laboratory and disassembled if placed in a water-tight container or sturdy plastic bag containing a fixative or preservative. Also, due to its cylindrical configuration, the round multiple-plate sampler fits various wide mouth containers with tight lids for shipping and storage purposes. The samples must be labelled with the location, habitat, date, and time of collection.

8.13 Cleaned multiple-plates can be reused to assemble multiple-plate samplers. Do not reuse the multiple-plates if there is reason to believe that they were exposed to contamination by toxicants (for example, chemicals or oils). These substances may be toxic to the macroinvertebrates or may inhibit colonization. Do not reuse the multiple-plates that have been exposed to fixatives or preservatives.

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