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Water quality — Sampling in deep waters for macro-invertebrates — Guidance on the use of colonization, qualitative and quantitative samplers

Qualité de l'eau — Échantillonnage de macro-invertébrés en eaux profondes — Guide d'utilisation des échantillonneurs de colonisation, qualitatifs et quantitatifs

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 9391 was prepared by Technical Committee ISO/TC 147, *Water quality*, Sub-Committee SC 5, *Biological methods*.

Annexes A and B form an integral part of this International Standard.

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Introduction

A major problem when using benthic macro-invertebrate communities as indicators of water quality in rivers is the inherent natural differences in community structure caused by factors other than water quality, for example current velocity and the nature of the substratum. In upland rivers, riffles provide suitable comparable sampling sites where differences in water quality can be detected biologically. In lowland rivers, suitably located riffles may not be available, and in larger deeper rivers riffles may be totally absent. In addition, methods suitable in shallow waters are not practicable for deeper, waters where alternative methods have to be used. Therefore, although desirable for purposes of comparison, it is not possible to adopt a standard method of sampling for the benthos of all rivers.

In lowland rivers, riffles are not always available for sampling and therefore a corresponding standard benthic biotope for comparison using water quality is not always available. Although the smaller, slow-flowing lowland rivers with a depositing substratum and rooted plants support a characteristic rich macro-invertebrate fauna, such biotopes are not always available in the lower stretches of larger rivers. In such rivers, the benthic macro-invertebrate fauna may be severely restricted by adverse physical conditions such as a strong current flowing over a substratum of bed-rock, or an unstable substratum of deposited silt which is subject to frequent scouring by high river currents. It is therefore necessary to use an alternative biotope for the assessment of the biological quality of lowland rivers, which is independent of the natural substratum. This need is fulfilled by the colonization sampler, which provides an artificial substratum, although it is accepted that this may be more selective of the flora and fauna present in the habitat.

If the location is suitable for actual sampling, the choice of the type of sampler to be used is largely dictated by one of the following three broad objectives.

a) List of taxa, for example families, with no measure of relative or absolute abundance. (The minimum requirement is a sampler that adequately collects material from all types of micro-habitat on the river bottom. A dredge would suffice.)

b) The relative abundance of species. For this purpose, the sampler has to be operated in a standard manner for all the types of substrata that are to be investigated. Although a qualitative sampler, for example a dredge, is adequate, quantitative samplers are preferable because their performance is less affected by the operator.

c) The number or biomass of invertebrates per unit area. Only quantitative samplers, for example grabs, corers, air-lift samplers, can be used for this purpose and many replicate sampling units need to be taken for each type of habitat.

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Water quality — Sampling in deep waters for macro-invertebrates — Guidance on the use of colonization, qualitative and quantitative samplers

WARNING — SAFETY PRECAUTIONS

Working alone is not recommended, particularly with high current velocities, deep waters, unstable beds and with boats. Boats should be equipped to meet at least the minimum national safety requirements. Users of compressed air should ensure that appropriate pressure regulators, piping and hoses are installed.

1 Scope

This International Standard provides guidance on the use of colonization samplers and the sampling of macro-invertebrates using qualitative and quantitative samplers for deep rivers.

Colonization samplers allow water quality to be assessed by providing a collection of macro-invertebrates indicative of the water quality at the sites of concern. They do not sample the natural invertebrate fauna, which may be restricted by physical conditions unrelated to water quality. They are to be used when studying lowland river waters of depth over 1 m. They are not recommended when they could be subjected to debris accumulation, floods, exposure above the water level, vandalism or anchorage problems.

The deep water samplers are for use in rivers deeper than 1 m and on substrata ranging from mud to stones. They are unsuitable when sampling over macrophytes or stones of sizes greater than about 15 cm, or in very fast flowing water.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 9391. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 9391 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 5667-3:1985, *Water quality — Sampling — Part 3: Guidance on the preservation and handling of samples.*

ISO 7828:1985, *Water quality — Methods of biological sampling — Guidance on handnet sampling of aquatic benthic macro-invertebrates.*

3 Definitions

For the purposes of this International Standard, the definitions given in ISO 7828 and the following definition apply.

3.1 deep water: Water from 1 m below the water surface to the limiting depth for efficient sampling.

4 Colonization samplers

4.1 Principle

Standard artificial substrata are positioned in deep rivers and left for a period of several weeks. The artificial substrata are colonized by macro-invertebrates during this period. The artificial substrata are then removed from the river to allow qualitative or quantitative assessment of the colonization.

4.2 Sampling equipment

4.2.1 Standard colonization bag

Each bag consists of approximately 40 pieces of a biological filter medium as used in sewage treatment, such as slag, placed inside a coarse mesh polyamide bag. Although the size and type of slag will vary on a regional basis, including the surface area to volume ratio, it is recommended that slag of a nominal size of 40 mm ± 5 mm be used, to reduce the overall mass of the sampler and prevent complete submersion and fouling in a mud substratum.

4.2.2 Standard colonization unit

Each unit consists of about 14 pieces of a plastics biological filter medium assembled into a cylindrical shape (see figure 1), wherein two layers each of a single central piece surrounded by six peripheral ones are joined together, for example by using polyamide string or straps. To minimize the loss of animals whilst retrieving the sampler, the lower quarter, including the base, is covered with a polyamide gauze of ten meshes per centimetre.

4.3 Procedure

4.3.1 Location

It should be ensured that the colonization sampler (4.2.1 or 4.2.2) is placed in the main flow of the river and not in any backwater or static area, unless the quality of these locations is specifically required. The sampler should be sufficiently covered by water and remote from the bank to minimize any likelihood of vandalism, becoming exposed during drought, or the river level dropping thus causing fouling with extraneous matter.

4.3.1.1 Shallow waters

When sampling in relatively shallow waters, namely about 1 m deep, a standard colonization unit (4.2.2) should be pinned onto the bed of the river using a steel rod, with a rubber bung fixed on the rod above the sampler to prevent any upward movement.

4.3.1.2 Deep waters

In deep waters, namely greater than 1 m deep, where it is impossible to peg a standard colonization unit to the river bed, it is essential that the sampler be held against the bed of the river. This is easily achieved by using a weight, such as house bricks which are tied to the sampler via a synthetic-fibre cord that is passed vertically through the centre of the sampler. If a synthetic-fibre cord is used, it should be attached securely to the bank, preferably in a concealed position above the high-water mark.

In depositing zones, the weight at the base of the sampler should penetrate into the surface mud until the colonization sampler rests on the surface substratum. If the penetration of the sampler is too much, a board of marine ply, for example, should be fixed to the base of the sampler before immersion.

4.3.2 Period of submersion

To give a good assessment of the water quality, it is recommended that colonization samplers are left in place in the river being sampled for a period of four weeks. If such a period of immersion is impracticable, a feasibility study is recommended to determine the optimum colonization time at different sites.

4.3.3 Replication

As there is usually only a limited amount of time available for routine surveillance work, it is recommended that a minimum of three replicates should be taken at each sampling site, with the number of taxa combined in the data analysis and interpretation.

4.3.4 Retrieval

After the period of immersion, the samplers should be removed from the river, care being taken to prevent any loss of organisms. This is facilitated by using a handnet and placing it immediately downstream of the sampler, and by moving the net under the sampler as the sampler is lifted from the bed of the river. In deeper waters, the mesh base of the standard colonization unit prevents any initial loss of organisms when lifting the sampler from the river bed. In practice, it has been found useful to use the net to assist in lifting the sampler from the river. The complete sampler (excluding any weight), together with any animals in the handnet, should be placed in a strong plastics container in a small quantity of water and sealed for transport to the laboratory.

If, for any reason, there is a delay in returning to the laboratory, preservation of the sampler and its contents should be carried out (see ISO 5667-3).

4.3.5 Laboratory sorting

The contents of the sampler and the container should be placed in a sieve of aperture size 4 mm and washed through into a fine retaining sieve of aperture size 250 µm to ensure that all animals dislodged from the sampler are trapped (see annex B). This can be best achieved by placing the colonization unit upside down on the sieve and washing out the contents of the unit with water.

Macro-invertebrates which spin nets or threads (*Hydropsyche* ssp., *Simulium ssp.*) or build mucilaginous tubes (*Corophium curvispinum*, *Chironomidae*) are best removed by spraying the unit with a jet of water. The substrate should be inspected

and attached invertebrates which were not removed by spraying should be picked off with forceps. Cased caddis (particularly *Limnephilidae, Phyganeidae* and *Leptoceridae*), molluscs (particularly *Lynmaeidae, Physidae, Viviparidae, Hydrobiidae* and *Ancylidae*) and *Odonata*, which often become trapped within the unit, are usually removed by mechanical shaking or trapping. Attached leeches are the most difficult to remove, but placing the unit in a dilute solution of formalin [about 0,4 % (*V/V*) formaldehyde] or warm water quickly dislodges the animals without damaging them. Flatworms, which are easily damaged by heel-kick sampling (see ISO 7828), are normally found on colonization samplers and they should be removed first in the sorting process.

Dimensions in centimetres

Figure 1 — Standard colonization unit

5 Other deep water samplers

5.1 Principle

Qualitative or quantitative sampling of benthic macro-invertebrates in deep rivers, usually from a boat.

5.2 Sampling equipment

5.2.1 Type of sampler

The following samplers are recommended: naturalist's dredge (medium or large size), pole-operated Birge-Ekman grab, weighted Ponar grab and the FBA air-lift sampler. The limitations of each sampler are given in annex A. These samplers are described as follows:

a) The naturalist's dredge (see figure 2) has a sturdy rectangular frame (small version typically 46 cm × 19 cm of mass about 9 kg; large version typically 61 cm × 20 cm of mass about 15 kg) supporting a collecting net of about 35 cm in length. The mesh size of the net may be altered to suit the purpose of the study (see annex B).

b) The pole-operated Birge-Ekman grab (see figure 3) is an open-ended box (typically 15 cm × 15 cm × 15 cm, giving a sampling area of 225 cm^2) two spring-loaded jaws that are activated by a manually-operated release mechanism. Two hinged plates at the top of the box reduce the shock wave as the sampler approaches the bed of the river, by allowing a free flow of water through the box and also by reducing the loss of material as the sampler is raised. The pole-operated version allows greater control and penetration than one suspended from a rope, but it can only by used in water of depth less than 3 m. The shape of the sample taken is approximately cubic from mud and approximately hemicylindrical from gravel, and therefore the sampler is particularly suitable for collecting surface-dwelling organisms in gravel [see also c): Ponar grab].

c) The weighted Ponar grab (typically of sampling area 560 cm^2 and mass about 23 kg) has two large jaws that are closed via a scissor action with a series of lever arms (see figure 4). A cross-bar holds the arms and jaws apart and is automatically released when the grab settles on the bed of the river. As the grab is raised, the jaws close. The shape of the sample taken is hemicylindrical from mud and saucer-shaped from gravel; the sampler is therefore suitable for collecting surface-dwelling organisms in gravel.

d) The FBA air-lift sampler (typically of sampling area 415 cm^2 and mass about 14 kg) has a sampling pipe or riser of typically 10 cm diameter whose length can be altered by inserting lengths op pipe (see figure 5). Air from compressed air bottles is fed through hosing to the base of the riser. An inclined pipe at the top of the riser directs the water and sample into a net whilst air is vented at its other end. The sampling area is enclosed by an open-ended stainless steel cylinder which allows continuous replacement of water during pumping. The sampling cylinder and riser can be raised above the base of the outer cylinder in which they are supported, where they can be held by catches that are released by a handle near the top of the sampler. An air-driven vibrator is attached to the cylinder and air is supplied through pressure hosing. The passage of this air through the cylinder helps to dislodge material within the cylinder, increases the uptake of material for a given air flow and can also increase the penetration of the cylinder into the substratum. Exhaust air from the vibrator is returned to the surface to supplement the supply to the riser. An air-flow gauge is usually inserted in the final section of air-line to the riser so that it measures the total flow to the riser. The gauge is essential for making efficient use of air and of differing conditions of water-depth and type of substratum. (See 5.3.4.)

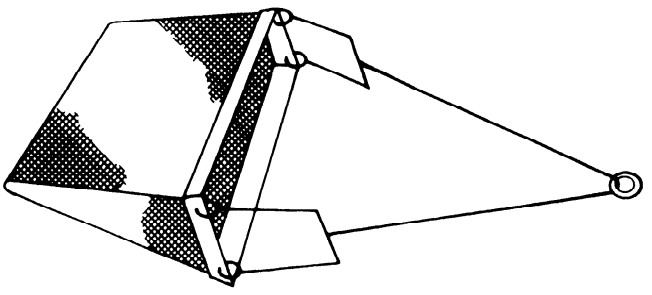

Figure 2 — Naturalist's dredge

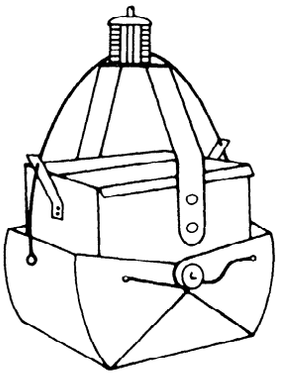

Figure 3 — Birge — Ekman grab

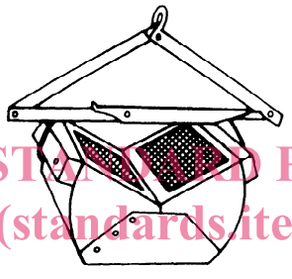

Figure 4 — Ponar grab

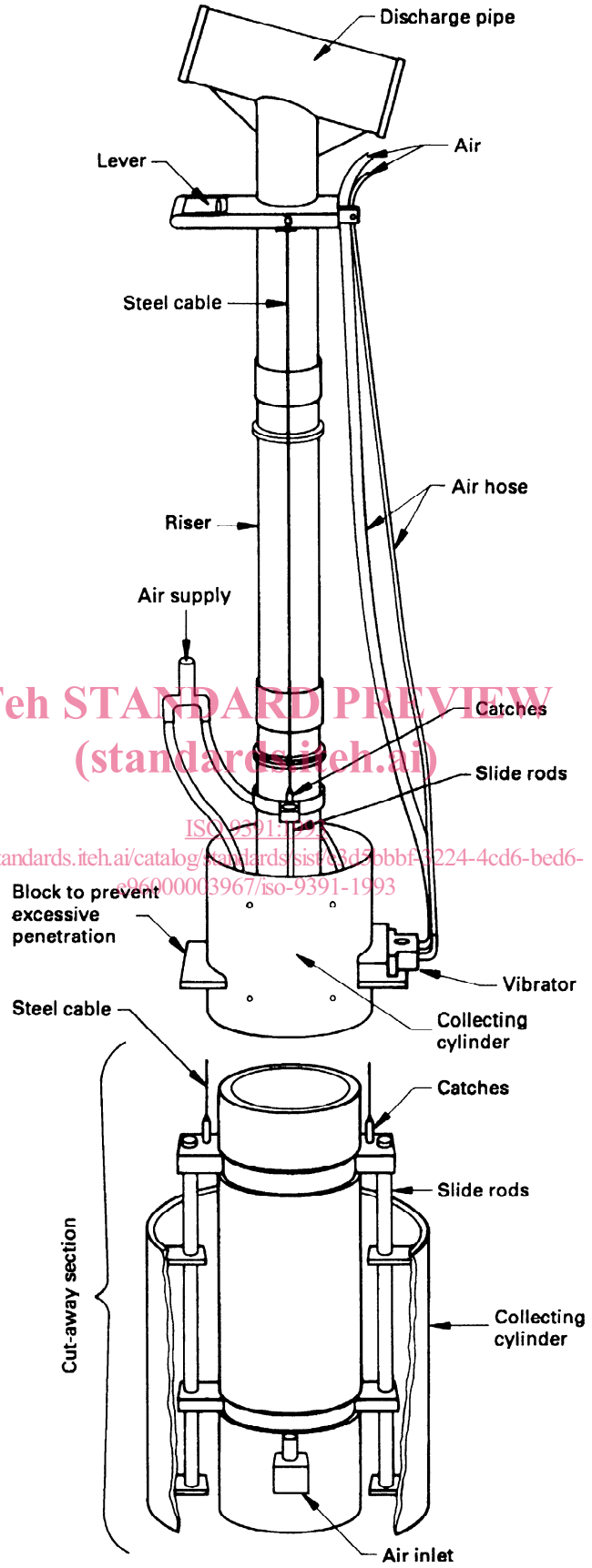

Figure 5 — FBA air-lift sampler