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NOTES

An inexpensive and lightweight sampler for the rapid collection of aquatic macrophytes[1]

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INTRODUCTION

The quantitative sampling of aquatic macrophytes demands that all plants be sampled along a series of line transects, or within a large number of randomly-chosen quadrats (Gertz 1984, Nichols 1984). SCUBA divers are frequently employed for this purpose, and offer the advantage of precise removal (by hand) of all plants within a sampling frame, regardless of substrate type and water depth (Wetzel 1964, Westlake 1969). Their effectiveness is reduced in turbid waters, though, and even under optimal conditions this is an exceedingly time-consuming process.

As an alternative to divers, remote sampling devices, such as corers, scoops, and dredges, can be employed from small boats to speed the collection process. Problems have been documented with these samplers, however, including small sample areas, the wrongful inclusion and exclusion of plants at the edges, and their inability to operate satisfactorily on hard lake bottoms (Westlake 1969, Raschke and Rusanowski 1984). Several customized macrophyte samplers have been developed to overcome these problems (Forsberg 1959, Brown 1984, Osborne 1984, Sabol 1984, Sliger et al. 1990), but these are generally massive and complicated devices which require permanent platforms with booms, winches, or pumps.

None of these methods or devices were suitable for a survey of aquatic plants in northwestern Ontario, due to the number of lakes involved and the fact that many are without road access. This prompted the development of a new sampling device, designed to meet the following criteria: 1) allow the retrieval of rooted macrophytes from a known area of substrate without the need of a diver's assistance; 2) be rapidly deployed by a single operator; 3) be lightweight and easily transported from site to site; 4) be inexpensive to manufacture; and 5) function at both shallow and deep water sites, in clear or turbid water. This paper describes the design and operation of this sampler, and includes some observations on its use in these lakes.

METHODS

Construction

The sampler has no moving parts; its primary components are a cutting blade fixed to the base of a vertical shaft to shear off plant stems at the substrate surface, and a collection rake to allow retrieval of the freed vegetation. It is manufactured entirely of aluminum, with the exception of its steel cutting blade and collection rake, and weighs only 2.1 kg.

The shaft consists of a hollow tube 2.8 cm in diameter and 135 cm in length, within which slides a second solid shaft 2.5 cm in diameter and 125 cm in length (Figure 1(A)). The inner shaft is drilled with a series of holes at 10 cm intervals. A quick-release pin near the top of the outer tube can be removed to allow the inner shaft to be adjusted up or down to suit the sampling depth. The pin is then re-fitted through the appropriate hole to securely fix the shaft. If the maximum sampling depth (2.6 m) is deemed insufficient, a third telescoping shaft could be added with a slight engineering modification.

A horizontal rod 1.6 cm in diameter and 50 cm in length is attached to the top of the inner shaft and functions as the handle, allowing the device to be rotated. A cutting blade is fitted horizontally to the bottom of the outer shaft. A 10 cm length of 0.8 cm diameter round rod, sharpened to a spear point, is threaded into the centre of the shaft below the cutting blade to anchor the sampler and minimize lateral movement during rotation. A longer anchor peg (e.g. 25 cm) may be beneficial if loose sediments are commonly encountered.

The cutting blade consists of a bar of hardened steel 0.4 cm in thickness and 2.5 cm in width, bevelled, and sharpened to a knife edge (Figure 1(C)). The length of the blade can vary; on the prototype it was 45.7 cm, which equates to a circular quadrat of 0.164 m^2. To ensure that plant stems do not slip off the edge of the blade uncut, retaining bars of dimensions 0.4 cm by 1.0 cm by 10 cm are welded to the outer ends of the blade. As the device is rotated, these retaining bars determine whether plants along the outer edge will be positioned against the blade or excluded, and thus define the true outer margin of the sampling radius. The ends of these bars are bent inward slightly, to ensure that the distance between their opposing tips at either end of the blade

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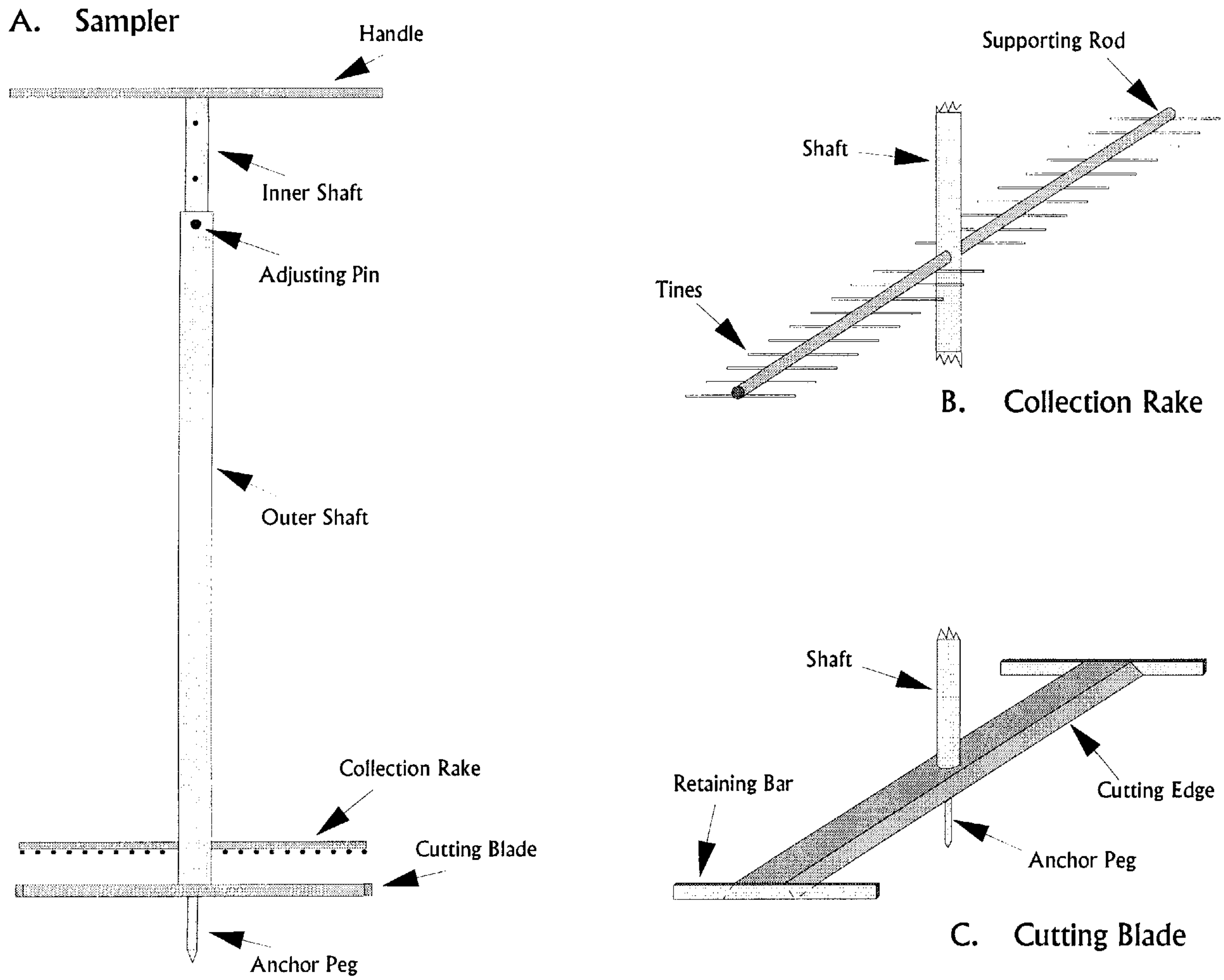

Figure 1. Schematic diagrams of (A) the entire sampler, in lateral view; (B) the collection rake, in oblique view; and (C) the cutting blade, in oblique view. The drawings are not to scale; see text for measurements of the individual components.

is identical to that of the blade's length, and the desired quadrat diameter is maintained.

A structure resembling a double-sided rake is positioned 4.5 cm above the cutting blade to entangle the severed vegetation (Figure 1(B)). It consists of a round supporting rod, 1.0 cm in diameter, and of similar length as the cutting blade. A series of 'tines', each 14.5 cm in length and 0.3 cm in diameter, are welded to the supporting rod at 2.0 cm spacings. The addition of a second collection rake (not shown) may be advantageous when encountering certain types of vegetation. It would be of similar construction to the first, but fitted with a sliding collar to allow it to be positioned at different heights and angles along the shaft, and may aid in collecting plants not readily entangled.

Operation

While grasping the handles in an upright position, the sampler is thrust to the lake bottom, and the anchor peg pressed firmly into the substrate until the cutting blade rests on the sediment surface. Taking care to maintain a strict vertical position, the sampler is then rotated in either a clockwise or counter-clockwise direction. A rotation of 180° will sever the stems of firmly attached plants from their root systems, or free the roots of those weakly attached from the sediments.

The rotation of the sampler should continue for at least one entire revolution which ensures that the severed plants become firmly entangled in the collection rake and along the shaft of the sampler. The device is then withdrawn and the plants removed. Care should be taken to lift the sampler vertically through the water column following the same path through which it was dropped, so the sample will represent a circular 'plug' of vegetation of known diameter.

The sampler can be utilized by a single operator wading in shallow waters, or working from a sampling platform (i.e. boat or canoe). If a platform is used, it must remain in a fairly stationary position throughout the sampling operation to minimize lateral movement which could alter the quadrat size and introduce sampling error.

The sampler is relatively maintenance-free. A simple rinse between samples removes any mud or plant remnants from the collection rake. The cutting blade should be honed occasionally to maintain a keen edge; no other upkeep is required.

RESULTS AND DISCUSSION

Through underwater observations, a qualitative assessment was made of the relative efficiency of the sampler's operation with different classes of aquatic plants and on different substrates. A number of submersed plants (e.g. *Potamogeton richardsonii*, *Myriophyllum heterophyllum*), floating-leaved varieties (e.g. *Nymphaea odorata*, *Potamogeton natans*), and emergent species (e.g. *Equisetum fluviatile*, *Eleocharis palustris*, *Sagittaria latifolia*, *Hypericum ellipticum*) appear to be sampled effectively. These plants all have slender stems that shear off cleanly above the roots, or else their roots pull free from the sediments as they become entangled in the collection rake.

Plants not effectively sampled include small submersed varieties which embrace the bottom (e.g. *Isoetes macrospora, Carex lasiocarpa*). These species have stems or leaves of insufficient length (less than 8 cm) to ensure entanglement in the collection rake. Difficulties were also encountered with large emergent forms with robust stems (e.g. *Typha latifolia, Scirpus acutus, Phragmites maximus*), which could not be readily severed with the sampler. In addition, the rigidity of their stems hampers their entanglement in the rake; in this case a second collection rake positioned further up the shaft may help reduce sample loss.

The sampler functions best on a clean, firm substrate, such as gravel, sand, or clay, or where silt or detritus are present in relatively thin layers only, allowing the anchor peg to penetrate into the more compact material below. On these surfaces, the sampler can be firmly placed and pivoted on its anchor peg with the absence of noticeable lateral drift. Plants growing on a hard substrate are usually firmly attached, and this facilitates a clean severing of the stems and their effective collection by the sampler.

A decline in the sampler's performance is noticeable where deep accumulations of muck, marl, silt, or detritus occur. Under these conditions, the anchor point is unstable and lateral movement can occur, altering the quadrat size. This problem may be alleviated somewhat by replacing the anchor peg with one of longer length. As with most other sampling devices, this sampler is also ineffective in areas where rubble and larger rock material predominate. It is often difficult to establish a firm anchor point, and the uneven surface may provide inadequate clearance for the blade to rotate.

Quantitative comparisons with other techniques are required to fully assess the utility of this device as a biomass sampler. These initial field observations, however, reveal that the sampler is effective for sampling a variety of macrophytes over a range of conditions, while possessing the design features of prime importance: lightweight, low cost, and easily used.

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