A PORTABLE WATER SAMPLING DEVICE

Technical Field

[0001] The present disclosure generally relates to the automated collection and storage device for the microbial component of a water sample. More particularly, it relates to a device configured for collecting, storing, and analysing a water sample for further water quality monitoring and metagenomic and eDNA analysis.

Background

[0002] The following discussion of the background to the invention is intended to facilitate an understanding of the present invention. However, it should be appreciated that the discussion is not an acknowledgment or admission that any of the material referred to was published, known or part of the common general knowledge in any jurisdiction as at the priority date of the application.

[0003] Understanding the microbiome component of water along with potential plastic pollutants is key to preserving the health of the drinking water supply and the ecosystem as a whole. Present methods of collecting water samples data on the environment is done manually, requiring substantial manpower, and results in considerable variability from sample to sample. The collection of microplastics and nanoplastics from the water is presently done by nets.

[0004] The present invention attempts to overcome at least in part some of the aforementioned disadvantages and to provide a device for as described herein.

Summary of the Invention

[0005] According to various embodiments, there is provided a sampling device. The sampling device comprises a housing, a protective lid adapted for covering the housing, a container within the housing, the container having a first outlet, a second outlet and a third outlet. The sampling device further includes a primary pump operatively connected to a main tubing and operable to extract a liquid sample from a sampling source, and to discharge the collected liquid sample into the container from an end of the main tubing operatively connected to the first outlet, a secondary pump located within the housing, the secondary pump operatively connected to the second outlet via a secondary tubing and configured for drawing the collected liquid sample though a filtration cartridge removably attached to an end of the secondary tubing for filtering concentrate biomass from the collected liquid sample; and a discharge tubing operatively connected to the third outlet, and operable to discharge excess liquid sample from the container.

[0006] In some embodiments, the main tubing includes a pump controller operable to vary the flow rate and volume of the liquid sample extracted from the sampling source.

[0007] In some embodiments, the primary pump is a variable speed pump.

[0008] In some embodiments, the primary pump is a diaphragm pump.

[0009] In some embodiments, the secondary pump is a peristaltic pump.

[0010] In some embodiments, the primary pump is located at an opposed end of the main tubing distal from the housing.

[0011] The sampling device according to claim 1, wherein the primary pump is located outside the housing.

[0012] In some embodiments, the main tubing includes discrete indicators configured for positioning the main tubing at a desired depth below the surface of the sampling source.

[0013] In some embodiments, the discrete indicators include markings setting out the length of the main tubing at regular intervals.

[0014] In some embodiments, the sampling device further includes a power source in electrical communication with the primary pump and the secondary pump.

[0015] In some embodiments, the power source includes a primary battery and a secondary power source operatively connected to the primary battery.

[0016] In some embodiments, the secondary power source is a rechargeable battery.

[0017] In some embodiments, the secondary power source includes one or more solar panels attached to the exterior of the protective lid.

[0018] In some embodiments, the housing includes an aperture for allowing the passage of the discharge water from the third outlet to the exterior of the housing.

[0019] In some embodiments, the aperture and the discharge tubing forms a water-tight seal for preventing the flow of water into the interior of the housing.

[0020] In some embodiments, the sampling device further includes a spin down filter positioned along the main tubing between the primary pump and the container for filtering larger microplastic pieces from the liquid sample.

Brief Description of the Drawings

[0021] In the drawings, like reference characters generally refer to the same parts throughout the different views. The drawings are not necessarily to scale, emphasis instead generally being placed upon illustrating the principles of the invention. The dimensions of the various features or elements may be arbitrarily expanded or reduced for clarity. In the following description, various embodiments of the invention are described with reference to the following drawings, in which:

[0022] **Figure 1** illustrates a sampling device in accordance with embodiments of the present invention.

Detailed Description

[0023] The following detailed description refers to the accompanying drawings that show, by way of illustration, specific details and embodiments in which the invention

may be utilized. These embodiments are described in sufficient detail to enable those skilled in the art to practice the invention. Other embodiments may be utilized and structural, and logical changes may be made without departing from the scope of the invention. The various embodiments are not necessarily mutually exclusive, as some embodiments can be combined with one or more other embodiments to form new embodiments.

[0024] In order that the invention may be readily understood and put into practical effect, particular embodiments will now be described by way of examples and not limitations, and with reference to the figures. It will be understood that any property described herein for a specific product may also hold for any product described herein. It will be understood that any property described herein for a specific method may also hold for any method described herein. Furthermore, it will be understood that for any device or article or method described herein, not necessarily all the components or steps described must be enclosed in the product or device or method, but only some (but not all) components or steps may be enclosed.

[0025] In the specification the term "comprising" shall be understood to have a broad meaning similar to the term "including" and will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps. This definition also applies to variations on the term "comprising" such as "comprise" and "comprises".

[0026] To achieve the stated features, advantages and objects, the present invention is directed to a portable sampling device for collecting all biomass from water samples on-site. Particularly, the present invention comprises a single portable or a detachable portable device that is designed to function under outdoor conditions with a reservoir that allows the operator to measure the level of trace chemicals or components and other pollutants in water and various other parameters including but not limited to: temperature, salinity and PH value for in a given water sample as well as dissolved oxygen, ammonia,

hydrogen sulfides, nitrates, as well as or including but not limited to biological samples such as fluoresce Dissolved Organic Material (FDOM) / Chromophoric Dissolved Organic Material (CDOM).

[0027] The sampling device is configured to collect and store microbiological, viral, and nutrient information in any given water sample. The collection of biological data for metagenomic analysis sets this device apart from any other commercially available device. The collection and storage of marine microbial communities on filter cartridges allow for a full and detailed analysis of genetic, biogeochemical, and microbiome community dynamics in any body of water in response to environmental parameters.

[0028] The sampling device combines different components relevant for such environmental studies into a single integrated sampling device with various configurations and functions, which can be operated and used by a minimum number of persons in a more time and cost efficient way.

[0029] In some embodiments, the sampling device has the capacity to take microbiological, viral, and nutrient information. The collection of biological data for metagenomics analysis sets this device aside from other devices available commercially. The collection and storage of marine microbial communities on varies types and sizes of filters allows for a full characterization of the genetic and biogeochemical potential of water provinces in response to environmental parameters (such as increased temperature, pH, or salinity, and the presence or absense of pathogens).

[0030] In some embodiments, the sampling device provides a one-stop portable and easy to use solution for the purposes of measuring trace chemicals, plastic components or other pollutants in bodies of water.

[0031] In some embodiments, the sampling device can be attached to a seagoing vessel or other such craft in order to be used to detect pollutants and filter biological material in bodies of water.

[0032] The present invention improves on the present devices and methods of collection of raw data on the environment especially in bodies of water which is labor intensive requiring unduly substantial manpower as well as the combined effort of such persons or resources working together over a long period of time outdoors. This is especially so when measuring pollution in bodies of water.

[0033] Figure 1 depicts an example embodiment of a portable sampling device 100 according to one embodiment of the invention. The sampling device 100 comprises a water-proof housing 110 adapted to receive a protective lid 120, a container 8 for receiving a water sample from a water system, a primary pump 11 in communication with a pump controller 3, a secondary pump 7, and a power source located in a box within the housing. The container has a first outlet which is in fluid communication with the primary pump via a main tubing 13, and a second outlet in fluid communication with the secondary pump via a secondary tubing 9 to perform various functions, details which will be explained hereinafter. In some embodiments, more than one secondary pump is utilized to obtain liquid samples simultaneously. The housing 110 and the protective lid 120 forms a water-tight seal when the protective lid 120 is closed over the housing 110, and they protect the contents therein: the power source, the container and the secondary pump and a storage compartment within the housing 110 from water, shock and other environmental conditions that can impact the operation of the sampling device 100. The storage compartment 130 provides storage space for storage of the primary pump 11, the main tubing 13, the secondary tubing, the pump controller, filtration cartridges containing liquid samples, and other storage media and paraphernalia associated with the collection, storage and analysis of the liquid samples.

[0034] In some embodiments, at one end of the main tubing 13, the main tubing 13 is operatively connected to the first outlet of the container 8, and at the opposite end of the main tubing 13, the main tubing 13 is operatively connected to the primary pump 11. In some embodiments, the main tubing 13 is configured to be removably detachable from the container 8 when not in use and stored in the storage compartment 130. The main tubing 13 directs the flow of liquid from the sampling source or water system to the container 8. In some embodiments, the primary pump 11 is a variable speed pump used to generate a desirable level of vacuum within the main tubing 13 that enables the collection of the liquid sample and its movement through the sampling device 100. In other embodiments, the primary pump 11 can be a mechanical or diaphram pump or such other pumps with mechanical means. In some embodiments, the primary pump 11 is positioned outside or within the housing. The primary pump 11 is configured to continously pump liquids from the sampling source, for example, a water system or body, through the main tubing 13 and into the container 8. In some embodiments, a pump controller is located along the main tubing proximate to the housing and is controllable by a user to vary the flow rate and volume of the liquid sample through the main tubing. In some embodiments, the pump controller is a speed modulator. The primary pump 11 is used for pumping a desired amount of liquids, for example, a water sample, from the sampling source at a suitable flow rate to faciliate the collection of a sufficient desired quantity for collection, storage and analysis. In principle, the primary pump 11 may pump virtually any selected volume of fluid from the sampling source.

[0035] In some embodiments, as the collected liquid sample is passed through the main tubing, a spin down filter 10 positioned along the main tubing between the primary pump and the container filters relatively larger microplastic pieces for collection. The collected liquid sample is then directed to the container 8 to form a reservoir. The container includes an opening at its top end which allows for the introduction of probes with sensors through the opening of the container that can detect and measure certain parameters of the collected liquid sample. For example, the plurality of sensors on the

probe will measure various parameters including but not limited to temperature, salinity and pH where water sample measurements include, but are not limited to, chemical properties, dissolved oxygen, ammonia, hydrogen sulfide and nitrate therein and also fluoresce such as Fluoresce Dissolved Organic Material (FDOM) / Chromophoric Dissolved Organic Material (CDOM) and suspended chlorophyll.

[0036] The material of the main tubing, secondary tubing and other tubing used in the present invention is preferably constructed from inert, non-leaching materials (for example, Teflon-lined or equivalent). Generally, the tubing should be flexible, structurally capable, and manufacturer-approved to withstand forces imposed on the tubing.

[0037] The container 8 has a second outlet adapted to receive one end of the secondary tubing from which the liquid sample from the reservoir is subequently directed to a secondary pump 7 that draws the collected liquid sample through the secondary tubing. In some embodiments, the secondary pump is a peristaltic pump. In some embodiments, the peristaltic pump includes at least two rollers in a circular casing, and the secondary tubing is fitted within the circular casing and the liquid sample is pushed through the secondary tubing when the two rollers in contact with the secondary tubing are rotating. The liquid sample is pushed through the secondary tubing to a filtration cartridge removably attached to an end of the secondary tubing. The secondary tubing at the distal end from the container 9 is adapted to receive a filtration cartridges of any size (not shown) or a nano-pore filter configured to filter the collected liquid sample and trap biological material, including viruses, and nanoplastic particles larger than a predetermined size. In some embodiments, the secondary pump is operatively connected to another secondary pump in series via a tubing for simultaneous collection of more liquid samples. In this case, a separate tubing from an outlet of the secondary pump allows the liquid sample to flow through the separate tubing from the secondary tubing. The separate tubing is adapted to receive a filtration cartridge for filtering the collected liquid sample. The filtration cartridge is designed to trap particles larger than a certain

size in a solution designed for long-term storage and preservation of biological materials for future analysis. In some embodiments, the filtration cartridge is attached to the end of the secondary tubing 9 via a luer lock. The purpose of the filtration cartridge is to filter all of the biological material found in the liquid sample and store it on the surface of a filter within the filtration cartridge. Once the filtration cartridge has served its purpose, a person disconnects the filter cartridge from the luer lock, adds a fixant to preserve the DNA material, seals both ends of the cartridge and stores it for future analysis in a lab setting. In some embodiments, the secondary tubing 9 is configured to allow various types of filtration cartridges to be attached.

[0038] A skilled person would understand that filtration cartridges are known in the art, and that filter cartridges are available in a wide variety of sizes, materials and a user would select a filtration cartridge that is suitable and acceptable for use for the sampling source and the desired size of genetic material intended for collection. Filtration cartridges are disposable and interchangeable and are usually in a transparent canister for the smaller sizes, and can be easily unscrewed to get access to the cartridge. Since the filtration cartridges are interchangeable, this provides considerable operational flexibility to meet changing requirements.

[0039] In some embodiments, the container includes a third outlet adapted for receiving a discharge tubing for discharging excess filtered liquid from the liquid sample outside of the housing. The housing includes an aperture for allowing the passage of the discharge tubing from the container located within the housing to the outside of the housing to allow the excess filtered liquid to discharge outside the housing. The aperture on the housing and the discharge tubing forms a water-tight seal in order to prevent water from flowing inside the housing.

[0040] The sampling device allows for control in the water column, allowing the operator to sample on the very surface, and then on to multiple depths past the mixed zone up to 65 meters. In some embodiments, the main tubing 13 is several meters long

and is connected to the first outlet of the container at one end and includes the primary pump 11 at the opposed end. In some embodiments, the main tubing includes markings or indicators configured to allow the operator to position the main tubing 13 at a desired sample depth below the surface of the water body. In some embodiments, the indicators can be markings or indentations on the main tubing 13 setting out the length at regular intervals. For example, the main tubing 13 can having discrete indicators at every meter. In use, the operator simply lowers the primary pump 11 and main tubing 13 below the surface of the water to the desired indicator that corresponds to the depth below the surface of the water for conducting sampling. This also sets this device apart from anything else on the market.

[0041] The sampling device has a power source in a box located inside the housing 110 that includes at least one primary power source and at least one alternative power source. The power source is operably connected to one or more components of the sampling device, for example, the primary pump and the secondary pump for operational functioning of the sampling device via wiring. In some embodiments, the primary power source is a conventional battery, for example, a rechargeable battery or a lithium-ion battery. In some embodiments, the alternative power source can be a rechargeable battery operably connected to the conventional battery. In other embodiments, the alternative power source can be derived from alternative energy sources such as solar. The alternative power source will generate its power from the environment when the portable sampling device is in operation. The alternative power source may include a solar panel or other means of alternative energy such as wind energy. With the use of a primary power source and an alternative power source, energy from the alternative power source can be fed back into the primary power source. In some embodiments, solar panels may be placed on top of the waterproof protective lid. In some embodiments, a generator may be attached on the exterior of the housing to provide alternative sources of power in the event the primary power source is defective. In ideal conditions, the portable sampling device is self-sustaining for long periods of time on its own power.

[0042] The device allows genetic data to be collected from the environment on its own without constant supervision and intervention of human operators. This allows the portable sampling device to be installed and left to operate on its own at a desired location whether on a seagoing vessel or at a fixed point such as a meteorological station for days.

[0043] While the invention has been particularly shown and described with reference to specific embodiments, it should be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention as defined by the appended claims. The scope of the invention is thus indicated by the appended claims and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced.

What is claimed is:

1. A sampling device comprising:

a housing;

a protective lid adapted for covering the housing;

a container within the housing, the container having a first outlet, a second outlet and a third outlet;

a primary pump operatively connected to a main tubing and operable to extract a liquid sample from a sampling source, and to discharge the collected liquid sample into the container from an end of the main tubing operatively connected to the first outlet;

a secondary pump located within the housing, the secondary pump operatively connected to the second outlet via a secondary tubing and configured for drawing the collected liquid sample through a filtration cartridge removably attached to an end of the secondary tubing for filtering concentrate biomass from the collected liquid sample;

a discharge tubing operatively connected to the third outlet, and operable to discharge excess liquid sample from the container.

2. The sampling device according to claim 1, wherein the main tubing includes a pump controller operable to vary the flow rate and volume of the liquid sample extracted from the sampling source.

3. The sampling device according to claim 1, wherein the primary pump is a variable speed pump.

4. The sampling device according to claim 1, wherein the primary pump is a diaphragm pump.

5. The sampling device according to claim 1, wherein the secondary pump is a peristaltic pump.

6. The sampling device according to claim 1, wherein the primary pump is located at an opposed end of the main tubing distal from the housing.

7. The sampling device according to claim 1, wherein the primary pump is located outside the housing.

8. The sampling device according to claim 1, wherein the main tubing includes discrete indicators configured for positioning the main tubing at a desired depth below the surface of the sampling source.

9. The sampling device according to claim 7, wherein the discrete indicators include markings setting out the length of the main tubing at regular intervals.

10. The sampling device according to claim 1, further including a power source in electrical communication with the primary pump and the secondary pump.

11. The sampling device according to claim 8, wherein the power source includes a primary battery and a secondary power source operatively connected to the primary battery.

12. The sampling device according to claim 11, wherein the secondary power source is a rechargeable battery.

13. The sampling device according to claim 11, wherein the secondary power source includes one or more solar panels attached to the exterior of the protective lid.

14. The sampling device according to claim 1, wherein the housing includes an aperture

for allowing the passage of the discharge water from the third outlet to the exterior of the housing.

15. The sampling device according to claim 14, wherein the aperture and the discharge tubing forms a water-tight seal for preventing the flow of water into the interior of the housing.

16. The sampling device according to claim 1, further including a spin down filter positioned along the main tubing between the primary pump and the container for filtering larger microplastic pieces from the liquid sample.

17. The sampling device according to claim 1, further including a second secondary pump in fluid communication with the secondary pump via the secondary tubing, wherein the second secondary pump has an outlet, and a separate tubing is connected to the outlet for drawing the collected liquid sample to a second filtration cartridge removably detachable from the separate tubing.