

SYSTEM AND DEVICE FOR SPAWNING AND AUTO-SEPARATION OF
EGGS AND LIVE-BIRTH AQUATIC ANIMALS

Cross-Reference to Related Application

- 5 [0001] This application claims the benefit of priority of Singapore Patent Application No. 10202101065U, filed 1 February 2021, the content of it being hereby incorporated by reference in its entirety for all purposes.

Technical Field

- 10 [0002] The present disclosure relates to an apparatus operable to concurrently spawn and have eggs and live-birth aquatic animals spontaneously removed from the apparatus. The present disclosure also relates to a system including such an apparatus.

Background

- 15 [0003] Existing farming techniques for breeding aquatic animals, such as fish, shellfish and crustaceans require significant number of manual interventions. For example, fish and shellfish farms established out in seas may render a condition favourable for their growth, but such farms tend to require farmers to tediously monitor the breeding process and growth, and then harvest the spawns manually at a suitable time. Such existing
20 farming techniques are time and labour consuming, and hence may not be able to keep up with the increasing demand for seafood, such as fish, shellfish and crustacean, due to a significant growing population. Various methods for improving production yield and collection efficiency from breeding aquatic animals, including the methods' economic viability, were then explored.

- 25 [0004] One example pertains to a breeding system. The system includes larvae collecting device connected to a cultivating pond for growing out a crustacean. The cultivating pond may have an overflow pipe that channels larvae into the collecting device.

- 30 [0005] In another example, there is reported a breeding method of cherax quadricarinatus, which involves controlling the water quality, selecting the parent shrimps, adjusting the illumination and the temperature and controlling the gonad development of the parent shrimps, the spawning time of the parent shrimp group, so

as to address the problem of uneven culturing specifications of seedlings in large-scale production.

[0006] In another reported aquaculture method for *Cherax quadricarinatus* and jewel fish in a hybrid manner. The method specifically includes (1) the *Cherax quadricarinatus* and the jewel fish aquacultured in a hybrid pond with adapted similar living conditions of the *Cherax quadricarinatus* and the jewel fish and different living water levels, so that the utilization rate of a pond is increased; (2) aquatic plants are planted at the bottom and water surface of the pond to provide inhabiting and living environments for the *Cherax quadricarinatus* and the jewel fish and the water quality was adjusted to increase the dissolved oxygen content in the pond; (3) a proper living environment is provided with the *Cherax quadricarinatus* and the jewel fish through respective stages of scientific management and aquaculture, so that the *Cherax quadricarinatus* and the jewel fish can grow rapidly, and higher-quality *Cherax quadricarinatus* and jewel fish can be obtained; therefore, the economic benefit of pond aquaculture may be enhanced.

[0007] In another culture hatching method to lower diseased infection rate, fertilized ova are cleaned and then are put into an *in vitro* hatching plate to perform artificial hatching. The *in vitro* hatching plate is provided with a front-arranged filter bucket matched with a water body, an ozone disinfection machine, a heating tube, an oxygen enriching machine and a separation net, the fertilized ova are put on the separation net, bubble stones are arranged at the bottom of the *in vitro* hatching plate to make a water flow so as to keep the fertilized ova slightly moving, the ozone disinfection machine controls regular disinfection in a time system mode, and the fertilized ova can be hatched into juvenile *cherax quadricarinatus* after about 40-50 days. From this, the infection rate of the fertilized ova can be reduced to be below 10%, the survival rate of hatching may be 90% or above, the survival rate of fertilized ovum hatching may be greatly improved, the young prawn yield may be effectively improved, and remarkable economic benefits may be produced.

[0008] Another method reports cultivating hybrid freshwater crayfish in rice and lotus field for improving cost. The method involves selecting rice and lotus field, sterilizing, applying basal fertilizer, transplanting rice or lotus, raising young crayfish, and use of filters to capture and avoid the crayfish from escaping.

[0009] Most of the reported developments tend to utilise changes in temperature to induce spawning by these aquatic animals.

[0010] The above methods reported do not adequately address the need for improved collection efficiency and yield of spawns (eggs), offspring, and/or live-birth aquatic animals.

[0011] There is thus a need for a device and/or system to address one or more of the limitations mentioned above. The device and/or system should provide at least a solution for concurrent spawning and auto-separation of eggs and live-birth aquatic animals, which include but are not limited to, fish, shellfish and crustaceans.

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Summary

[0012] In a first aspect, there is provided for an apparatus operable to concurrently spawn and have eggs and live-birth aquatic animals spontaneously removed from the apparatus, the apparatus includes:

a holding tank including one or more housing structures, wherein the one or more housing structures include a crevice configured to house aquatic animals for mating and/or spawning;

15 an outlet at bottom of the holding tank, wherein the outlet is configured with a porous mesh having an average pore size for eggs and live-birth aquatic animals to be removed from the holding tank;

an aeration element to channel air bubbles into the holding tank, wherein the aeration element is arranged circumferentially proximal to the porous mesh and away from the one or more housing structures; and

20 a collection tank in fluid communication with the holding tank for receiving the eggs and the live-birth aquatic animals.

[0013] In another aspect, there is provided for a system that includes one or more apparatus described according to various embodiments of the first aspect.

Brief Description of the Drawings

25 [0014] The drawings are not necessarily to scale, emphasis instead generally being placed upon illustrating the principles of the present disclosure. In the following

description, various embodiments of the present disclosure are described with reference to the following drawings, in which:

[0015] FIG. 1A shows a top down view of an apparatus according to various non-limiting embodiments disclosed herein. The dimensions of components in the apparatus (length, width, height, cross-sectional diameter, etc.) are indicated and are merely
5 examples and not to be construed as limiting. The dimensions may be scaled up or down depending on the size of the device and system required. The dimensions are in inches except where indicated otherwise.

[0016] FIG. 1B shows a side cross-sectional view of an apparatus according to various
10 non-limiting embodiments disclosed herein.

[0017] FIG. 2 shows an isometric view of an apparatus according to various non-limiting embodiments disclosed herein.

[0018] FIG. 3 is another isometric view of the apparatus shown in FIG. 2, wherein FIG. 3 shows the components structurally configured in the apparatus according to various
15 non-limiting embodiments disclosed herein.

[0019] FIG. 4 shows a cross-sectional view of the apparatus according to various non-limiting embodiments disclosed herein. The dimensions of components in the apparatus (length, width, height, cross-sectional diameter, etc.) are indicated and are merely
20 examples and not to be construed as limiting. The dimensions may be scaled up or down depending on the size of the device and system required. The dimensions are in inches except where indicated otherwise.

[0020] FIG. 5 shows a mesh net, and an aero tube supported on a stainless steel (abbreviated as S. Steel in FIG. 5), according to various non-limiting embodiments disclosed herein.

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Detailed Description

[0021] The following detailed description refers to the accompanying drawings that show, by way of illustration, specific details and embodiments in which the present disclosure may be practiced.

30 [0022] Features that are described in the context of an embodiment may correspondingly be applicable to the same or similar features in the other embodiments. Features that are described in the context of an embodiment may correspondingly be

applicable to the other embodiments, even if not explicitly described in these other embodiments. Furthermore, additions and/or combinations and/or alternatives as described for a feature in the context of an embodiment may correspondingly be applicable to the same or similar feature in the other embodiments.

5 [0023] The present disclosure relates to an apparatus advantageously operable to concurrently spawn (to produce) and separate eggs and live-birth aquatic animals. The term “live-birth aquatic animals” may include fries, offspring and spawns of aquatic animals. The present disclosure also relates to a system that includes the apparatus. In the present disclosure, the term “apparatus” and “device” may be interchangeably used.

10 Aquatic animals herein include crayfish (which is also termed as “crawfish”) and are not limited to fish, shellfish and crustaceans. The aquatic animals may be freshwater aquatic animals, e.g. freshwater crayfish.

[0024] Advantageously, in the present apparatus and system, separation of the eggs and live-birth aquatic animals (including fries) is spontaneous and/or automatic. In other

15 words, the separation can take place without artificial intervention, i.e. having a user to manually select the eggs and live-birth aquatic animals for removal. Hence, the apparatus may be described herein as being operable for “auto-separation” of the eggs and live-birth aquatic animals.

[0025] Details of various embodiments of the present apparatus and system, and advantages associated with the various embodiments are described below and

20 illustrated with reference to, as non-limiting examples, the drawings. For brevity and clarity, certain components, such as pumps, valves, metering and/or measurement devices (e.g. flow rate meter), may not be illustrated in the drawings. Also, a skilled person can understand where and/or how to include such components in the present

25 apparatus, when and/or where their need arises.

[0026] In the present disclosure, there is provided an apparatus operable to concurrently spawn (to produce) and have eggs and live-birth aquatic animals spontaneously removed from the apparatus. The apparatus may include a holding tank. The holding tank may include one or more housing structures. The one or more housing structures

30 may include a crevice configured to house aquatic animals for mating and/or spawning. The “crevice” refers to a compartment in the housing structure having an opening for the eggs and live-birth aquatic animals to be drawn therefrom. The eggs and live-birth

aquatic animals are drawn from the crevice by a fluid motion generated from gravitational flow and a vortex motion of fluid generated from an aeration element in the holding tank. The vortex motion is where a fluid revolves around a point (e.g. cross-sectional center of holding tank from a top down view) such that the eggs and live-birth aquatic animals can be horizontally drawn out of the crevice. The apparatus may include an outlet at bottom of the holding tank. The outlet may be configured with a porous mesh. The porous mesh may have an average pore size for eggs and live-birth aquatic animals to be removed from the holding tank through the outlet. The apparatus may include an aeration element to channel air bubbles into the holding tank. The aeration element may be arranged circumferentially proximal to the porous mesh and away from the one or more housing structures. The apparatus may include a collection tank in fluid communication with the holding tank for receiving the eggs and the live-birth aquatic animals. The term "fluid communication" means that a fluid can be channeled directly or indirectly from one component of the apparatus or system to another component of the apparatus or system. For example, in instances where the holding tank and the collection tank are in direct fluid communication, fluid from the holding tank can be delivered into the collection tank without any pipes. For instance, the holding tank may be placed on top and in connection with the collection tank such that a fluid flows from the holding tank directly into the collection tank. In instances where the holding tank and the collection tank are in indirect fluid communication, pipes and/or pumps may be present to deliver fluid from the holding tank to the collection tank. The fluid may include the eggs and live-birth aquatic animals.

[0027] For better understanding of a non-limiting example of the present apparatus, its various non-limiting embodiments, and its components, the various figures may be referred to, particularly FIG. 1B.

[0028] FIG. 1B depicts the present apparatus 100. The apparatus 100 may include a holding tank 102. The holding tank 102 may be cylindrical or rectangular in configuration. Other suitable shapes of the holding tank 102 may be configured. The holding tank may be supported by one or more stands or legs 110s. The holding tank 102 may include one or more housing structures 104. In various non-limiting embodiments, the one or more housing structures 104 may be arranged circumferentially in the holding tank. Said differently, the one or more housing

structures 104 may be arranged proximal to the walls of the holding tank 102. As can be seen in FIG. 1B, the one or more housing structures 104 are arranged close to the wall of the holding tank 102 and away from the center of the holding tank 102. For clarity, the crevices in the housing structures are not shown in detail. The crevices may be tubular, cuboidal, or any shape suitable for housing aquatic animals for mating and/or spawning. A tubular configuration of the crevice may have a circular or rectangular cross-section. In certain non-limiting embodiments, the crevice may have at least one opening facing away from the wall of the holding tank 102. In certain non-limiting embodiments, the crevice may have two openings, wherein one opening faces away from the wall of the holding tank 102 and the other opening faces the wall of the holding tank 102. Such opening are configured to have the eggs and live-birth aquatic animals drawn out (whether by gravitational flow or vortex motion of fluid in the holding tank 102) from the crevice, and hence from the housing structure 104. At the bottom of the holding tank 102, there is an outlet connected to drainage pipe 112. Fluid may exit the holding tank 102 through this outlet into the drainage pipe 112. At the outlet, there is a porous mesh 106. The porous mesh 106 may have an average pore size that allows eggs and live-birth aquatic animals to pass through, but not the aquatic animals that produce the eggs and live-births. Proximal to the porous mesh 106 is an aeration element 108. In FIG. 1B, the aeration element 108 is supported on a frame or stand, such that the aeration element 108 is elevated above the porous mesh 106. Eggs and live-births are drawn through the porous mesh 106 aided by the aeration element 108 and by gravitational flow of fluid (e.g. water) into the drainage pipe 112. Advantageously, due to the aeration element 108 and gravitational flow of fluid in the holding tank 102, the use of a pump to deliver and separate out the eggs and live-births from the holding tank 102 can be circumvented. The eggs and live-births can be spontaneously (i.e. automatically) delivered into a collection tank 114 through the drainage pipe 112. The eggs and live-births may be collected in a collection tray 116. The collection tray 116 may be floating on a fluid surface 118. One or more filters 120 may be arranged in the collection tank to remove any detritus. Water may be recycled back into the holding tank 102 via pump 122 and pipe 124. Having described the present apparatus in detail using FIG. 1B as a non-limiting example, further details of the present apparatus and system are described below.

[0029] In various non-limiting embodiments, the one or more housing structures may be arranged circumferentially in the holding tank.

[0030] In various non-limiting embodiments, the one or more housing structures may be arranged above the aeration element.

5 [0031] In various non-limiting embodiments, each of the one or more housing structures may include an assembly of crevices. Each of the crevice may have at least one opening for the eggs and live-birth aquatic animals to be drawn out therefrom. In certain non-limiting embodiments, the crevice may have at least one opening facing away from the wall of the holding tank. In certain non-limiting embodiments, the
10 crevice may have two openings (e.g. see FIG. 3), wherein one opening faces away from the wall of the holding tank and the other opening faces the wall of the holding tank. Such opening are configured to have the eggs and live-birth aquatic animals drawn out (whether by gravitational flow or vortex motion of fluid in the holding tank) from the crevice, and hence from the housing structure.

15 [0032] In various non-limiting embodiments, the porous mesh may have an average pore size of 0.1 cm to 5 cm, 0.5 cm to 5 cm, 1 cm to 5 cm, 2 cm to 5 cm, 3 cm to 5 cm, 4 cm to 5 cm, etc. In various non-limiting embodiments, the porous mesh may have an average pore size of, for example, 2 cm.

[0033] In various non-limiting embodiments, the porous mesh may be arranged to
20 cover the outlet. For example, the porous mesh may be arranged over the outlet.

[0034] In various non-limiting embodiments, the aeration element may be arranged to have the air bubbles (i) directed upward away from the porous mesh and (ii) revolve in a circular motion in the holding tank. The upward circular motion of the air bubbles in the holding tank away from the porous mesh and outlet creates a vortex motion of the
25 fluid (e.g. water) in the holding tank. The fluid's vortex motion propels or draws the eggs and live-births downward to the porous mesh from the crevices of the housing structure. The fluid's vortex motion may include propelling or drawing the eggs and live-births horizontally out from the crevice. Further, gravitational forces in the fluid also aid in directing the eggs and live-births toward the porous mesh and outlet.
30 Advantageously, use of a pump for drawing the eggs and live-births out of the holding tank is circumvented. In other words, the eggs and live-births can be auto-separated

from the adult aquatic animals in the holding tank. Also, without the use of a pump, the quality and yield of the eggs and live-births are not compromised.

[0035] In various non-limiting embodiments, the aeration element may be arranged peripherally around the porous mesh. That is to say, the aeration element may be arranged near or at the edge of the porous mesh to surround the porous mesh.

[0036] In various non-limiting embodiments, the aeration element may include one or more aeration tubes, each of the one or more aeration tubes may include at least one hole arranged to channel air bubbles into the holding tank to generate the motion of fluids mentioned above.

[0037] In various non-limiting embodiments, the aeration element may be arranged on a support and proximal to the porous mesh. In various non-limiting embodiments, the support may be a ceramic, plastic, stainless steel stand or a ceramic, plastic, stainless steel frame. In certain non-limiting embodiments, the aeration element may be arranged in the same plane (e.g. at same height) as the porous mesh.

[0038] In various non-limiting embodiments, the outlet may be in fluid communication with a drainage pipe to channel the eggs and the live-birth aquatic animals to the collection tank.

[0039] In various non-limiting embodiments, the collection tank may include a collection tray to sieve out the eggs and the live-birth aquatic animals. The collection tray may be anchored and floatable. The collection tray may be horizontally movable while floating on a fluid surface in the collection tank. The collection tray may be anchored and yet horizontally movable while floating on a fluid surface in the collection tank.

[0040] In various non-limiting embodiments, the collection tank may include one or more filter beds for removing detritus. The one or more filter beds may be arranged vertically (i) in the middle or proximal to the middle of the collection tank and (ii) extends across the collection tank to capture any detritus. The one or more filter beds may be arranged in series as shown in the various figures, e.g. FIG. 1B.

[0041] In various non-limiting embodiments, the collection tank may include a pump to recycle water into the holding tank.

[0042] The present disclosure also provides for a system that includes one or more the apparatus as described above. Embodiments and advantages described for the present

apparatus of the first aspect can be analogously valid for the present system herein, and vice versa. As the various embodiments and advantages have already been described above and examples demonstrated herein, they shall not be iterated for brevity.

[0043] The word “substantially” does not exclude “completely” e.g. a composition
5 which is “substantially free” from Y may be completely free from Y. Where necessary, the word “substantially” may be omitted from the definition of the present disclosure.

[0044] In the context of various embodiments, the articles “a”, “an” and “the” as used with regard to a feature or element include a reference to one or more of the features or elements.

10 [0045] In the context of various embodiments, the term “about” or “approximately” as applied to a numeric value encompasses the exact value and a reasonable variance. The variance may be $\pm 1\%$, $\pm 5\%$, $\pm 10\%$, $\pm 20\%$, etc.

[0046] As used herein, the term “and/or” includes any and all combinations of one or more of the associated listed items.

15 [0047] Unless specified otherwise, the terms "comprising" and "comprise", and grammatical variants thereof, are intended to represent "open" or "inclusive" language such that they include recited elements but also permit inclusion of additional, unrecited elements.

20

Examples

[0048] The present disclosure relates to a field of aquaculture. The present disclosure relates to an apparatus operable for spawning and auto-separation of eggs and live-birth aquatic animals, which include but are not limited to, fish, shellfish and crustaceans (e.g. freshwater crayfish, which is also termed as “crawfish”). The present disclosure
25 also relates to a system including one or more of such devices (i.e. apparatus) operable for spawning and auto-separation of eggs and live-birth aquatic animals. The present apparatus, which is operable for mating, spawning, and the auto-separation and collection of eggs and live-birth aquatic animals (e.g. fish, shellfish and crustaceans), when two or more of the present apparatus are to be used, may be connected in series.
30 The system may include a plurality of the apparatus (e.g. least 2 units of the apparatus) connected in series.

[0049] The present apparatus, and system, are described in further details, by way of non-limiting examples, as set forth below.

[0050] Example 1: Non-Limiting Example of the Present Apparatus

[0051] The apparatus of the present disclosure includes at least the following.

5 [0052] A large holding tank with pipe drainage at the bottom centre or proximal to the cross-sectional centre (from a top down view) of the holding tanks' bottom (e.g. see FIG. 2 and 3). The holding tank may have a circular cross-section (from a top down view). The holding tank may be cylindrical or may have a rectangular cross-section (from a top down view).

10 [0053] The bottom of the holding tank can be flat and/or can be in any shape that channels the eggs, spawns and live-births downward or toward a desired direction. Such shape may include conical, frusto-conical, or having one or more planes designed with an angle that channels the eggs, spawns and live-births downward or in a desired direction. In other words, the holding tank may have one or more vertical surfaces,
15 wherein the vertical surfaces are adjoined to one or more surfaces proximal to the outlet at the bottom of the holding tank and the one or more surfaces are structurally angled to channel the eggs, spawns and live-births out from the holding tank.

[0054] The apparatus may include at least one housing structure having multi-layered rectangular crevices which can be elevated from or arranged away from the bottom of
20 the holding tank, wherein the crevices may be configured for aquatic animals to mate and for spawning thereof. These crevices, or sets of crevices (e.g. see FIG. 3 and 4), may resemble, for example, compartments assembled in the form of x by y per side in a holding tank, wherein x and y each represents a whole number integer. For example, there may be 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 or more of the housing structure, and in each
25 housing structure, there may be 1 to 1000 crevices/compartments (or more, depending on size of holding tank). Said differently, as non-limiting examples, x may range from 1 to 1000 and y may independently range from 1 to 1000. For instance, housing structures of 5 x 2 (crevices) per side can be assembled (or more depending on size of tank).

30 [0055] The apparatus may be operably configured with temperature control, IOT system, water chemistry monitoring system. The abbreviation "IOT" denotes internet of things. Non-limiting examples of IOT operable with the present apparatus and

present system may include: automated water monitoring system, wherein results can be loaded onto the cloud for remote monitoring, any artificial intelligence (AI) for operating the apparatus, remotely controlling changes to water parameters, etc. Such IOT elements may be used to operate and/or control the air flow rate into the aeration element and hence the rate at which bubbles are generated.

[0056] The apparatus may have the porous mesh. The term “porous mesh” is interchangeably herein referred to as a “mesh net” and simply a “mesh”. The porous mesh may have an average pore size or spacing in the range of 0.1 cm to 5 cm, 0.5 cm to 5 cm, 1 cm to 5 cm, 2 cm to 5 cm, 3 cm to 5 cm, 4 cm to 5 cm, etc. For example, the average pore size or spacing of the mesh may be 2 cm. The mesh may be arranged at the bottom of the holding tank, which covers or surrounds the outlet to the holding tank bottom drainage pipe (e.g. see FIG. 3). The mesh net is configured to allow only the eggs, fries, effluent water and live-birth aquatic animals to pass through to a collection tank via gravitational suction and forces generated by air bubbles from the aeration element. The aeration elements can be in the form of one or more tubes. For example, surrounding the mesh there can be one or more *in situ* tubes (e.g. see FIG. 5) that provide nano-bubbles, micro bubbles and/or fine bubbles. The one or more *in situ* tubes may be referred to as an “aero tube”. The one or more *in situ* tubes, which can provide various types of bubbles, may be supported on or by a frame (or stand) as shown below. The frame (or stand) can be formed from various type of materials, including metals such as stainless steel, ceramics, high density polyethylene (HDPE), or any plastic. The frame or stand supports the aero tube above the mesh and/or tank drainage pipe. The tank drainage pipe may be connected to or at the outlet located at bottom of tank. The mesh may be positioned over or on the outlet at bottom of holding tank. In certain non-limiting examples, the aeration element can be in the same plane as the porous mesh (arranged at the same height), i.e. without being supported on a frame or stand.

[0057] As mentioned above, the aeration element may be used to channel air bubbles into the holding tank. The aeration element may be configured to an air generation device that provides the air bubbles to be channeled through the aeration element. The air bubbles may be nano-bubbles having an average size ranging from 50 nm to 500 nm, micro-bubbles with an average size may range from 1 μ m to 5 μ m, and/or fine bubbles with an average size that may range from 0.9 mm to 2 mm. The generation of

different bubble sizes advantageously provides for direct oxygenation and also a disinfection effect on the water. The different bubble sizes may be generated and/or controlled based on, for example, the size of holes which air exits from the aeration element, flow rate of air through the holes of the aeration element, the device that provides the air into the aeration element, by using a flow control or flow rate meter (a valve, venturi), etc. The types of bubbles to be used may consider the incoming raw water conditions, breeding density and feed density. The bubbles, and hence the one or more tubes, are configured/designed to provide an upward circular vortex motion of air nano bubbles. This renders the air bubbles to flow in a circular vortex motion that propels or pushes the eggs and babies into the mesh. This is a design that is safe for (i.e. neither damage nor harm) spawns, e.g. eggs, fries, offspring, and live-birth aquatic animals. Said differently, the one or more *in situ* tubes are purposefully arranged to render the eggs, live birth aquatic animal, detritus, feed and uneaten food to pass through (via a vortex motion) the mesh located at the bottom of the device. Any suitable porous medium that fulfils this requirement may be used as the mesh. More specifically, the one or more tubes (i.e. aero tubes) may be tubular, arranged proximal and in a circular arrangement surrounding the mesh. As the one or more tubes are arranged surrounding the mesh that may be centred at the bottom of the holding tank, it follows that the aeration element (e.g. one or more tubes) may also be centred with respect to the bottom of the tank. The one or more tubes are arranged away from the crevices (and housing structure) so as to prevent the crevices from hindering formation of the vortex wave motion. The aeration element (e.g. one or more tubes) may be arranged in about the same plane as the mesh. The aeration element (e.g. one or more tubes) are so arranged in a manner such that when bubbles are generated/provided therefrom, a vortex wave motion around and/or from the mesh may be rendered to have the eggs, live birth aquatic animals, detritus, feed and uneaten feed to be sucked into the mesh, with assistance of or via gravitational flow. The vortex wave motion minimizes uplifting or swirling the eggs around in the holding tank. The vortex wave motion may draw fluid through the mesh more effectively, thereby increasing efficiency in collection of spawns, eggs, live birth aquatic animals etc. At the same time, the vortex wave motion and gravitational flow direct fluid and matters (e.g. not only the eggs and live birth aquatic animals, but also detritus, feed and uneaten feed) through the mesh,

thereby providing an automatic/spontaneous way of purification/filtration to the holding tank simultaneously.

[0058] The drainage pipe of the holding, which may be extended from the bottom up, may allow the eggs, fries, effluent water and live-birth aquatic animal to flow into another tank (collection tank) which may be located on a lower gradient than the holding tank (e.g. see FIG. 4). The drainage pipe connected to the outlet of the holding tank may be flushed with the bottom wall of the tank. The drainage pipe may also extend from bottom into the holding tank. The drainage pipe may extend from bottom and into the holding tank but remains at a height below the crevices (and housing structure).

[0059] The tank drainage pipe may be in fluid communication with one or more pumps operable to deliver fluid and matters from the holding tank into a collection tank. At the end or near the end of drainage pipe may include an arc designed with a flow control gauge for controlling the flow of water, eggs, fries and live-birth aquatic animal into the collection tank (e.g. see FIG. 2 to 4).

[0060] At the collection tank, all the incoming water, eggs, fries and live-birth aquatic animals may pass through a collection tray to sieve out the eggs, fries and live-birth aquatic animals.

[0061] The collection tray may include a mesh size 20 at its bottom. Other suitable mesh size for the collection tray may be used. This tray may be an anchored floatation device (e.g. not movable and floating on water surface) or it can also be semi-permanently anchored in the collection tank. The term “semi-permanently anchored” means that the tray is attached or anchored to the collection tank but remains entirely movable (e.g. due to fluid motion in the tank) and may be floating on the water surface.

[0062] At the middle of or proximal to middle (in terms of height) of the collection tank, there may include one or more filter beds for filtering out detritus, feed, etc. The filter beds may be connected in series or any suitable arrangement for this purpose. There may 1, 2, 3, 4 or more filter beds.

[0063] Located at the bottom of the collection tank may be one or more submersible pumps that delivers the water to at least one of 2 directions, i.e. to a water treatment system such as a Recirculating Aquaculture system (RAS) and/or back to the holding tank. The submersible pump may be operable to pump the water to (i) either a

Recirculating Aquaculture system via a return pipe or (ii) back to the holding tank directly and/or through a return pipe having an outlet located above the holding tank.

[0064] At the end of this return pipe may be a water treatment system or a series of water treatment system. The water treatment system may include a disinfection system
5 (e.g. a chamber operable for ozone treatment, ultraviolet (UV) treatment, hydrocavitation), an oxygenation system, and/or a water structuring system.

[0065] The return pipe may render a circular flow of water in the holding tank by having the outlet of the return pipe positioned to have water exiting the return pipe enter the surface of water in the holding tank at an angle that renders the circular flow of water
10 therein. The outlet of the return pipe may be positioned at a 45-degree angle, or approximately a 45-degree, or any angle that renders the circular flow of water in the holding tank (e.g. see FIG. 4).

[0066] The present apparatus may be operable on or operable with a circulation water system.

15 [0067] The present apparatus can be used for floating cage farms, outdoor pond with a flow through system, a semi-flow through system, or a RAS system, and/or an indoor farm that is using a flow-through, a semi-flow through or a RAS system.

[0068] The surfaces of the holding tank and/or collection tank may be painted in a dark colour, e.g. dark green or black. In the holding tank, there can be one or more feeding
20 pipes, e.g. either 2, 3 or 4 feeding pipes, to provide food to the aquatic animals.

[0069] Example 2: Non-Limiting Example of the Present System

[0070] The system of the present disclosure includes the apparatus of the present disclosure.

[0071] The system of the present disclosure can include several (e.g. 2, 3, 4, 5 or more)
25 holding tanks in fluid communication (i.e. any arrangement that renders the fluid communication possible) or connected in series (e.g. fluid flow path is not split into two), be it vertically, horizontally or diagonally. The holding tanks can be arranged according to any suitable layout. In certain non-limiting embodiments, the holding tanks may be arranged into a single horizontal row. In order to minimize space occupied
30 by the holding tanks, the apparatus may be arranged in a vertically stacked formation, such as vertically stack rows of holding tanks in a file formation, wherein each vertical

stack may have 2, 3 or 4 of the apparatus or more arranged to be stacked on top of each other.

[0072] The present apparatus is operable under any suitable operating conditions, such as elevated temperature and elevated pressure. Auxiliary heating, cooling or pressure devices may thus be provided to help achieve the desired operating and/or water treatment conditions. There may be no restriction to the operating conditions arising from the present apparatus and system, and it is entirely possible to carry out the collections of eggs, fries or live-birth aquatic animals under any combination of temperature to obtain a desired spawning outcome.

[0073] The present apparatus and system can be used alone or in combination with any known or commercially available water treatment devices such as RAS system, disinfection system, oxygenation system, KDF-55 filters, granular activated carbon filters, ozonators, reverse osmosis devices, water softeners, etc.

[0074] Example 3: Summary of the Present Apparatus (i.e. Present Device)

[0075] The present disclosure includes a device for mating of aquatic animals which include, for example, fish, shellfish and/or crustaceans. The device may be operable for spawning of aquatic animals which include, for example fish, shellfish and/or crustaceans (e.g. freshwater crayfish). The device may be operable for auto-separation of eggs, fries and live-birth aquatic animals which include, for example, fish, shellfish and/or crustaceans. The device may be operable for auto-collection of eggs, fries and live-birth aquatic animals which include, for example, fish, shellfish and/or crustaceans. The device has been described hereinabove and hereinbelow by way of non-limiting examples.

[0076] The device may have the following capabilities: auto-feeding, auto-treatment of water via connection to a Recirculation Aquaculture System, and/or an auto-online water chemistry analysis via IOT, 2G, 3G, 4G, Cloud, Wi-Fi connectivity. 2G, 3G, 4G denote for the different generations of cellular networks.

[0077] The device can include or can be operable with one or more of the following features. A large circular holding tank with pipe drainage at the bottom centre. Multi-layered rectangular crevices (that resembles housing structures) which is elevated from the bottom of the holding tank for aquatic animals to mate and for spawning. The present device may involve temperature control, IOT system, water chemistry

monitoring system, etc. A mesh net of 2 cm spacing may be located at the bottom of the holding tank. An *in situ* nano bubble tube that surrounds the mesh net may be included. A tank drainage pipe may be included. One end of the drainage pipe may have an arc design and fitted with a flow rate control gauge. A collection tank having a collection tray with a mesh size 20 may be included at its bottom and located within the collection tank. The collection tray may be an anchored floatation tray or be semi-permanently anchored in the collection tank. A series of 1, 2, 3, 4, or more filter beds may be fitted in the middle of the collection tank. A submersible pump may be located at the bottom of the collection tank. Water treatment systems (such as RAS system) may be connected to the submersible pump. A return pipe for delivering the water from collection tank back to the holding tank may be connected to a water treatment system. A water treatment system or a series of water treatment system may be connected at the end of this return pipe. Disinfection system such as, without being limited to, ozone, UV, hydrocavitation, oxygenation system, and a water structuring system, may be included.

[0078] The device may be operable for inducing or facilitating natural or induced mating of fish, shellfish and crustaceans. The device may include a region for spawning of eggs and/or live-births of aquatic animals in a natural or induced state which include fish, shellfish and crustaceans. The device may have an auto-separation region for auto-separation of eggs, fries and live-birth aquatic animals which include fish, shellfish and crustaceans. The device may have an auto-collection region for auto-collection of eggs, fries and live-birth aquatic animals which include fish, shellfish and crustaceans. The device may include a region having the following one or more of the capabilities, e.g. auto-feeding, auto-treatment of water via connection to a Recirculation Aquaculture System, auto-online water chemistry analysis operated via IOT, 2G, 3G, 4G, Cloud, Wi-Fi connectivity.

[0079] One or more of the devices may be connected in series, in a horizontal sequence or vertical sequence, and in any numbers. The device may further include coupling and/or piping elements for conveying aqueous liquid, eggs, live birth aquatic animals from one part of the device to another, wherein the coupling and/or piping means may be or may include u-bend connectors, 2-way dividers, elbow stem adapter, equal elbow

connector, equal straight connector, female adaptors, male adaptors, reducing elbows, tees, and threaded stem adaptors.

[0080] The device may have at least one chamber unit (i.e. crevice), each chamber unit further includes securing means for providing a secure attachment between each
5 chamber and the coupling means. The securing means may be selected from the group consisting of compression fittings, flanged fittings, bulkhead fittings, and flangeless fittings. The shape of the flow compartment (i.e. drainage pipe fitted to bottom of holding tank for channeling fluid into the collection tank) may be selected from the group consisting of cylindrical, cuboid, and dome shaped. The flow compartment is
10 annular shaped, said annular shape being the annular space defined between an inner cylindrical core and an outer cylindrical cover. The entire device may have all its materials, inner cylindrical core and/or outer cylindrical cover, comprise of a material selected from the group consisting of stainless steel, copper, aluminium, iron, nickel, chromium, molybdenum, manganese, silicon, carbon, PVC, fibreglass, plastic,
15 polymer, HDPE, and a mixture thereof.

[0081] Where there are more than one devices, the devices may be connected in series. There may be at least two water treatment units (including disinfection system such as, without being limited to, ozone, UV, hydrocavitation, oxygenation system, and a water structuring system) arranged and connected in a spiral, horizontal, or vertical formation.
20 In certain instances, there may be at least two devices arranged within a hermetically sealed housing. The device may contain or house a fluid, the fluid may be an aqueous liquid that includes water from natural precipitation, tap water, sea water, industrial water, ground water, and water-based liquid foods.

[0082] While the present disclosure has been particularly shown and described with
25 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 present disclosure as defined by the appended claims. The scope of the present disclosure is thus indicated by the appended claims and all changes which come within the meaning and range of equivalency of the claims are therefore
30 intended to be embraced.

CLAIMS

1. An apparatus operable to concurrently spawn and have eggs and live-birth aquatic animals spontaneously removed from the apparatus, the apparatus comprising:
 - a holding tank comprising one or more housing structures, wherein the one or more housing structures comprise a crevice configured to house aquatic animals for mating and/or spawning;
 - an outlet at bottom of the holding tank, wherein the outlet is configured with a porous mesh having an average pore size for eggs and live-birth aquatic animals to be removed from the holding tank;
 - an aeration element to channel air bubbles into the holding tank, wherein the aeration element is arranged circumferentially proximal to the porous mesh and away from the one or more housing structures; and
 - a collection tank in fluid communication with the holding tank for receiving the eggs and the live-birth aquatic animals.
2. The apparatus of claim 1, wherein the one or more housing structures are arranged circumferentially in the holding tank.
3. The apparatus of claim 1 or 2, wherein the one or more housing structures are arranged above the aeration element.
4. The apparatus of any one of claims 1 to 3, wherein each of the one or more housing structures comprise an assembly of crevices.
5. The apparatus of any one of claims 1 to 4, wherein the porous mesh has an average pore size of 0.1 cm to 5 cm.
6. The apparatus of any one of claims 1 to 5, wherein the porous mesh is arranged to cover the outlet.

7. The apparatus of any one of claims 1 to 6, wherein the aeration element is arranged to have the air bubbles (i) directed upward away from the porous mesh and (ii) revolve in a circular motion in the holding tank.
8. The apparatus of any one of claims 1 to 7, wherein the aeration element is arranged peripherally around the porous mesh.
9. The apparatus of any one of claims 1 to 8, wherein the aeration element comprises one or more aeration tubes, each of the one or more aeration tubes comprising at least one hole arranged to channel air bubbles into the holding tank.
10. The apparatus of any one of claims 1 to 9, wherein the aeration element is arranged on a support and proximal to the porous mesh.
11. The apparatus of claim 10, wherein the support is a ceramic, plastic, or stainless steel stand or frame.
12. The apparatus of any one of claims 1 to 9, wherein aeration element is arranged in the same plane as the porous mesh.
13. The apparatus of any one of claims 1 to 12, wherein the outlet is in fluid communication with a drainage pipe to channel the eggs and the live-birth aquatic animals to the collection tank.
14. The apparatus of any one of claims 1 to 12, wherein the collection tank comprises a collection tray to sieve out the eggs and the live-birth aquatic animals.
15. The apparatus of claim 14, wherein the collection tray is anchored and floatable.
16. The apparatus of claim 14, wherein the collection tray is horizontally movable while floating on a fluid surface in the collection tank.

17. The apparatus of any one of claims 1 to 16, wherein the collection tank comprises one or more filter beds for removing detritus.
18. The apparatus of claim 17, wherein the one or more filter beds are arranged vertically (i) in the middle or proximal to the middle of the collection tank and (ii) extends across the collection tank to capture any detritus.
19. The apparatus of any one of claims 1 to 18, wherein the collection tank comprises a pump to recycle water into the holding tank.
20. A system comprising one or more apparatus of any one claims 1 to 19.