Claims

1. A floatable closed containment aquaculture production apparatus comprising:

a hull having a bottom portion, opposed outer side portions extended therefrom, and a centre portion arranged between the outer side portions and extending from the bottom portion to increase strength of the hull and define at least one recess between the centre portion and the outer side portions, wherein at least the bottom portion ~~and the outer side portions include~~includes at least one ballast water space therein;

at least one closed containment aquaculture cultivation tank arranged in the at least one recess,

wherein the centre portion and/or the outer side portions are provided with void spaces configured to allow the hull, together with the at least one cultivation tank, remain semi-submerged in water when the hull is arranged in a body of water.

2. The apparatus of claim 1, wherein at least one of the at least one cultivation tank is abuttedly arranged between the centre portion and at least one of the outer side portions to provide at least one transverse bulkhead to the hull.

3. The apparatus of any one of claims 1 to 2, wherein the centre portion is arranged generally at the centre of the hull and includes a lengthwise dimension which substantially extends along a length or diameter of the hull.

4. The apparatus of any one of claims 1 to 3, wherein the centre portion is provided with a through passage.

5. The apparatus of any one of claims 1 to 3, wherein the centre portion is provided with a dry caisson.

6. The apparatus of ~~any one of claims~~claim 4 ~~to 5~~, wherein the through passage ~~or the dry caisson~~ is arranged between opposed inner side portions wherein at least one of the opposed inner side portions, at least one of the outer side portions and at least a part of the bottom portion form a cross-sectional profile having two U-shapes, or two W-shapes, or two V-shapes.

7. The apparatus of ~~any one of claims 1 to 6~~claim 4, wherein ~~a depth of~~ the ~~hull, which is defined by the outer side portions and the bottom~~centre portion~~, is at least 90 percent~~

~~submerged in~~ includes waste transfer pipes and/or water ~~when the hull is~~supply pipes which are arranged in ~~a body of water.~~ the through passage.

8. The apparatus of any one of claims 1 to 7, wherein the hull includes a top plan profile selected from the group consisting of a circle, a square, a rectangle, a hexagon, an octagon, and a hexadecagon.

~~9. The apparatus of any one of claims 1 to 8, wherein the hull includes a top plan profile and a bottom plan profile, wherein the top plan profile is larger than the bottom plan profile.~~

9. The apparatus of any one of claims 1 to 8, wherein the at least one ballast water space is arranged into a plurality of compartments, wherein at least one of the compartments is configured to be ballasted in response to a discharge of aquatic animals and water from one of the at least one cultivation tank to allow the hull maintain equilibrium in the body of water.

10. The apparatus of any one of claims 1 to 8, wherein the at least one cultivation tank includes a plurality of cultivation tanks, and wherein at least some of the at least one ballast water space is arranged as a plurality of compartments which are respectively arranged adjacent to the cultivation tanks.

11. The apparatus of any one of claims 1 to 10, wherein a cross-sectional profile of the hull in operative position includes a tilted down E-shape.

12. The apparatus of any one of claims 1 to 11, further comprising:

an inlet channel fluidly coupled to a water source, which includes the at least one ballast water space, to receive water therefrom and at least one water supply pipe fluidly coupled between the inlet channel and the at least one cultivation tank; and

at least one tank discharge pipe fluidly coupled to the at least one cultivation tank and a discharge channel fluidly coupled between the tank discharge pipe and a discharge destination, which includes a waste water storage tank; and

a water treatment system configured to treat waste water of the waste water storage tank,

wherein the at least one ballast water space is configured to receive the treated water.

13. The apparatus of claim 12, wherein the at least one tank discharge pipe is fluidly coupled to a bottom section of the at least one cultivation tank and configured to discharge water from the at least one cultivation tank to the discharge channel by gravity siphonic drainage.

14. The apparatus of claim 13, wherein the bottom section is tapered and includes a reverse conical portion.

15. The apparatus of any one of claims 12 to 14, wherein each water supply pipe includes spaced openings configured to discharge water into the at least one cultivation tank to produce a circular water current therein.

16. The apparatus of any one of claims 1 to 11, further comprising:

an inlet pump fluidly coupled to the at least one ballast water space and configured to draw water of the at least one ballast water space for entry into the at least one cultivation tank; and

a filtration system configured to filter the water drawn from the at least one ballast water space prior to entry of the filtered water into the at least one cultivation tank.

17. The apparatus of claim 16, further comprising:

a waste water storage tank configured to receive the discharged water of the at least one cultivation tank; and

a water treatment system configured to treat water of the waste water storage tank, prior to entry of the treated water into the at least one ballast water space for subsequent circulation of the treated water to the at least one cultivation tank.

18. The apparatus of any one of claims 16 to 17, further comprising:

at least one sensor configured to detect an adverse condition in the body of water in which the hull is arranged,

wherein the inlet pump is alternatively fluidly coupled to the at least one ballast water space and the body of water and configured to switch water intake therebetween, wherein the inlet pump is configured to draw the water, which is for entry into the at least one cultivation tank, exclusively from the at least one ballast water space when the adverse condition is detected.

19. The apparatus of any one of claims 1 to 18, further comprising:

a plurality of solar panels arranged over the at least one cultivation tank.

20. The apparatus of any one of claims 1 to 19, wherein the apparatus is movable by towing or self-propulsion.

21. An aquaculture production method, the method comprising:

cultivating aquaculture in at least one floatable aquaculture production apparatus of any of claims 1 to 20 which is arranged in the body of water;

ballasting at least partially the at least one ballast water space to maintain hull equilibrium in the body of water.

22. An aquaculture production method, the method comprising:

cultivating aquaculture in at least one floatable aquaculture production apparatus of any of claims 1 to 20 which is arranged in the body of water;

filtering water of the at least one ballast water space;

transferring the filtered water into the at least one cultivation tank;

discharging water of the at least one cultivation tank;

treating the discharged water; and

transferring the treated water into the at least one ballast water space,

wherein filtering the water of the at least one ballast water space includes filtering the treated water of the at least one ballast water space.

23. The aquaculture production method of claim 22, further comprising:

detecting an adverse condition in the body of water,

wherein transferring the treated water into the at least one ballast water space includes transferring the treated water into the at least one ballast water space when the adverse condition is detected.

~~10. The apparatus of any one of claims 1 to 9, wherein the ballast water space is arranged into a plurality of compartments along a length or circumference of the hull, wherein each compartment is configured to be ballasted in response to a discharge of aquatic animals and~~

water from one of the at least one cultivation tank being adjacent to each compartment to allow the hull maintain equilibrium in the body of water.

11. The apparatus of any one of claims 1 to 10, further comprising:

an inlet channel fluidly coupled to a water source and at least one water supply pipe fluidly coupled between the inlet channel and the at least one cultivation tank; and

a plurality of tank discharge pipes fluidly coupled to the at least one cultivation tank and a discharge channel fluidly coupled between the tank discharge pipes and a discharge destination,

wherein the inlet channel is arranged over the discharge channel which is arranged over the centre portion of the hull.

12. The apparatus of claim 11, wherein the tank discharge pipes are fluidly coupled to a bottom section of the at least one cultivation tank and configured to discharge water from the tank to the discharge channel by gravity siphonic drainage, and wherein discharge channel is arranged proximate to a top section of the at least one cultivation tank to receive an overflow from therefrom.

13. The apparatus of claim 12, wherein the bottom section is tapered.

14. The apparatus of any one of claims 11 to 13, wherein the tank discharge pipes and the water supply pipe are respectively configured to discharge water from the cultivation tanks and supply water to the cultivation tanks at a similar flow rate.

15. The apparatus of any one of claims 11 to 14, wherein each water supply pipe includes spaced openings configured to discharge water into the at least one cultivation tank to produce a circular water current therein.

16. The apparatus of any one of claims 11 to 15, wherein the water source includes the at least one ballast water space and water from the body of water external of the hull,

wherein the apparatus further comprises:

at least one sensor configured to detect an adverse condition in the body of water external of the hull; and

an inlet pump configured to draw water exclusively from the at least one ballast water space when the adverse condition is detected.

17. The apparatus of claim 16, wherein the discharge destination includes at least one waste water storage tank arranged at the hull and configured to receive water from the discharge channel at least for waste treatment when the adverse condition is detected.

18. The apparatus of claim 17, further comprising:

a water treatment system configured to treat water in the waste water storage tank, wherein the waste water storage tank is fluidly coupled to the ballast water spaces to allow water treated by the water treatment system enter the ballast water spaces.

19. The apparatus of any one of claims 11 to 18, wherein the inlet channel and the discharge channel are arranged at an incline between an assigned forward section or bow of the hull and an assigned rear section or stern of the hull.

20. The apparatus of any one of claims 1 to 19, further comprising:

a tank support structure arranged against the centre portion and one of the outer side portions; and

an additional cultivation tank arranged on the tank support structure and over the at least one cultivation tank.

21. The apparatus of any one of claims 1 to 20, further comprising:

at least one alternative renewable energy source being a hydrogen converter;

a plurality of solar panels arranged over the at least one cultivation tank and coupled to the hydrogen converter, wherein the solar panels are configured to supply electrical energy, which is converted from solar energy, to the hydrogen converter to convert sea water into a hydrogen fuel and an oxygen gas which is to be circulated to the at least one cultivation tank.

22. The apparatus of any one of claims 1 to 21, further comprising:

a watertight roof configured to provide a watertight connection with the hull to allow partial submersibility of the apparatus underwater in adverse weather to maintain stability of the hull.

~~23~~24. An aquaculture production and transfer system comprising:

at least one floatable aquaculture production apparatus of any one of claims 1 to ~~22~~20 arranged in the body of water;

a station keeping apparatus coupled to the at least one floatable aquaculture production apparatus;

a custodian transfer apparatus having a custodian chamber, a chute having an inlet fluidly coupled to the custodian chamber and an outlet, and at least one pump arranged at the chute, wherein the custodian chamber is configured to be fluidly coupled to ~~at least one of the tank discharge pipes~~the at least one cultivation tank to receive aquatic animals therefrom, wherein the pump is configured to draw a flow of water through the chute such that the aquatic animals are transported towards the outlet of the chute by the flow of water.

~~24~~25. The system of claim ~~23~~24, wherein at least a portion of the chute is floating on the body of water.

~~25~~26. The system of any one of claims ~~23 to 24~~24 to 25, wherein at least a portion of the chute is submerged.

~~26~~27. The system of any of claims ~~23 to 24~~24 to 25, wherein the custodian transfer apparatus comprises a sorting apparatus configured to detect sizes of the aquatic animals which are of a predetermined size and allow entry thereof into the chute.

~~27~~28. The system of any one of claims ~~23 to 26~~24 to 27, wherein the custodian transfer apparatus comprises a first counter apparatus configured to count a number of the aquatic animals entering the chute.

~~28~~29. The system of any one of claims ~~23 to 27~~24 to 28, wherein the custodian transfer apparatus includes a fish lift arranged at the outlet of the chute and configured to vertically lift the aquatic animals leaving the chute.

~~29~~30. The system of any one of claims ~~23 to 28~~24 to 29, wherein the custodian transfer apparatus includes a second counter apparatus arranged at the outlet of the chute and configured to count a number of the aquatic animals leaving the chute.

~~30~~31. The system of any one of claims ~~23 to 29~~24 to 30, wherein the at least one floatable aquaculture production apparatus includes a plurality of floatable aquaculture production apparatuses, the system further comprising:

a waste collector pipe fluidly coupled to the discharge channel of the at least one floatable aquaculture production apparatus and traversing the lengths and/or breams of at least some of the floatable aquaculture production apparatuses, wherein the waste collector pipe includes a first end portion and a second end portion which are configured to alternatively elevate relative to each other to discharge waste therefrom by gravity.

~~31~~32. The system of any one of claims ~~23 to 30~~24 to 31, further comprising:

an amalgamated facility comprising at least one facility selected from the group consisting a research and development (R&D) facility, a hatchery facility, at least two berthing spaces, an import facility configured to receive the aquatic animals from the chute, a sorting facility configured to sort the aquatic animals by weight, size and/or specie, an aquaculture processing facility configured to process the aquatic animals into aquaculture products and/or by-products, an import facility configured to receive aquatic animals from other than the aquaculture production apparatus, and an export facility configured to allow loading of the aquaculture products and/or by-products onto transport vehicles, a farming facility, and an accommodation facility.

~~32~~33. The system of any of claims ~~23 to 31~~24 to 32, wherein the station keeping apparatus comprises a plurality of legs and a gravity-based foundation which is attached to the legs and secured to the bottom of the body of water, wherein the offshore aquaculture production apparatus is mechanically coupled to the legs.

~~33~~34. The system of any one of claims ~~23 to 31~~24 to 32, wherein the station keeping apparatus comprises a plurality of mooring lines for coupling the hull to a plurality of gravity-based foundations and configured to restrict movement of the at least one floatable aquaculture production apparatus within an area defined by the mooring lines; and

wherein the at least one floatable aquaculture production apparatus comprises at least one anchor leg configured to be secured to the bottom of the body of water external of the hull and further configured to allow weather vaning of the at least one floatable aquaculture production apparatus about the at least one anchor leg.

~~34~~35. An aquaculture production and transfer method, the method comprising:

cultivating aquaculture in at least one floatable aquaculture production apparatus of any of claims 1 to ~~22~~20 which is arranged in the body of water;

transferring aquatic animals from the floatable aquaculture production apparatus ~~through one of the tank discharge pipes~~ to a custodian transfer chamber; and

transporting the aquatic animals through an inlet and an outlet of the chute by drawing a flow of water through the chute, wherein the inlet of the chute is fluidly coupled to the custodian transfer chamber.

~~35~~36. The method of claim ~~34~~35, further comprising:

vertically lifting the aquatic animals from the outlet of the chute onto an amalgamated facility.

~~36~~37. The method of any one of claims ~~34 to 35~~35 to 36, further comprising:

processing the aquatic animals into aquaculture products at the amalgamated facility and exporting the aquaculture products from the amalgamated facility.

~~37~~38. The method of any one of claims ~~34 to 36~~35 to 37, further comprising:

discharging aquatic animals and water from one of the at least one cultivation tank and, in response thereto, ballasting a compartment which is adjacent to the one of the at least one cultivation tank, wherein the compartment includes one of the ballast spaces, to maintain equilibrium of the hull.

~~38~~39. The method of any one of claims ~~34 to 37~~35 to 38, further comprising:

discharging water from the at least one cultivation tank to a discharge channel, by siphonic drainage~~, through the plurality of tank discharge pipes which are fluidly coupled between the at least one cultivation tank and the discharge channel~~; and

discharging water from the at least one cultivation tank to the discharge channel by an overflow from the at least one cultivation tank.

~~39~~40. The method of any one of claims ~~34 to 38~~35 to 39, further comprising:

supplying the at least one cultivation tank with water at a flow rate similar to discharging the at least one cultivation tank of water.

~~40~~41. The method of any one of claims ~~34 to 39~~35 to 40, wherein supplying the at least one cultivation tank with water includes alternatively receiving, at the at least one cultivation tank, water from the body of water or water stored in the ballast water space.

~~41~~42. The method of claim ~~40~~41, further comprising:

in response to receiving, at the at least one cultivation tanks, water stored in the ballast water space, transferring water discharged from the at least one cultivation tanks to a waste water storage tank arranged at the hull;

treating water in the waste water storage tank to produce treated water; and

transferring the treated water to the ballast water space.