MOSQUITO REARING RACK

Technical Field

[0001] The present disclosure relates to a mosquito rearing rack.

Background

[0002] Only female mosquitoes require blood meals and bite animals. Stimuli that influence biting or blood feeding of female mosquitos include a combination of carbon dioxide, temperature, moisture, smell, colour and movement of the animals. Male mosquitoes do not bite animals, but feed on nectar of flowers or other suitable sugar source. Acquiring a blood meal as a source of protein is essential for egg production of a female mosquito, although male and female mosquitoes are both nectar feeders for their nutrition. In some species of mosquitos, female mosquitos feed on humans and are therefore vectors for a number of infectious diseases affecting millions of people every year. Past attempts are made to eradicate female mosquito population through genetic modification or using chemicals that harm the environment as well as human beings alike. Therefore, it is desirable to provide more effective and environmentally friendly means to reduce the mosquito population in order to prevent the infectious diseases.

[0003] Several approaches to reduce the mosquito population involve the rearing of mosquitoes and releasing sterile, infected or irradiated mosquitoes into the wild to control the mosquito population. The control mechanism is predominantly either in trying to suppress the mosquito population in the wild or replacing mosquito population with a variant that has a lower tendency to transmit certain diseases. The mosquitoes reared for either the suppression or replacement strategy, are well controlled in every step of their life-cycle. Mosquitoes thus have to be reared in the millions per week in large scale operations in order for these methods to work. The quantities to be released often at a scale that is larger than the target location’s wild mosquito population.

[0004] During the rearing process, the eggs are hatched and the larvae are reared in trays with a certain amount of water. The amount of water to larvae ratio for a given tray is generally kept well controlled. As the desire is to rear as many larvae as possible in a given space, the intent is to maximize the number of larvae in a tray. However, having too many larvae in a given tray results in competition among the larvae or insufficient nutrients provided to all larvae in the tray. This will result in inconsistent growth rates amongst the larvae in a single tray and also between different trays. Other factors affecting the growth rates of the larvae in a given

tray include the amount of food dispensed, the uniformity of the temperature distribution, amount of light exposure over the tray, amongst others. The depth of the water level for a given tray needed to rear larvae does not have to be deep, ranging between 1 cm to 10 cm. To be efficient in the space then, each tray should be as large as possible as long as other parameters like temperature uniformity can be maintained.

[0005] To maximize the total number of larvae that can be reared within a given area, it is desirable to stack as many trays as possible vertically in a mosquito rearing rack. This maximizes the quantity of mosquitoes that can be reared in a given volume of space. Once the eggs in a rack of trays are deemed to have matured sufficiently into pupae, they have to be collected for subsequent processing such as sorting. The pupae are collected by removing each tray from the rack and pouring out the water and pupae in a collection container. There may be other instances where it is desirable to remove the developing larvae from the trays temporarily and such larvae are similarly collected by removing each tray from the rack and pouring out the water and larvae in a collection container.

[0006] While it is desirable to maximize the size and number of trays in a mosquito requiring rack, having large trays stacked in a high rack poses challenges in collecting the pupae or larvae from the trays when needed. Firstly, having large trays means that each tray together with the water and pupae or larvae it contains will be heavy. The trays at the top of the rack will be especially difficult to harvest. Secondly, the total quantity of trays is going to be large. For example, if each tray can rear about 10,000 larvae therein, a facility rearing 5 million mosquitoes will need to maintain at least 500 trays. Collecting pupae or larvae from 500 trays in currently available mosquito rearing racks requires a significant number of personnel necessary in the facility, adding to the cost of production.

[0007] It is therefore desirable to provide a mosquito rearing rack that improves the process of collecting pupae and larvae therefrom while maximizing the size and number of trays in each rack to maximize the number of mosquitoes that can be reared in a given volume of space.

Summary

[0008] According to a first aspect, there is provided a mosquito rearing rack comprising: a plurality of trays, each tray configured to contain therein a volume of water and at least one of: a number of mosquito eggs, a number of mosquito larvae and a number of mosquito pupae; a frame provided to support the plurality of trays such that the trays are provided one on top of another and a space is provided above each tray; a collection container provided below the plurality of trays; a board provided at a distance from the plurality of trays and configured to

receive thereon the contents of each tray and to channel the contents of each tray into the collection container; a support structure on which the frame, the board and the collection container are mounted, and a tilting mechanism provided to simultaneously tilt every tray such that the contents of every tray simultaneously flows onto the board and into the collection container when the tilting mechanism is activated.

[0009] The frame may be pivotable about a horizontal axis relative to the support structure and the tilting mechanism may pivote the frame supporting the plurality of trays about the horizontal axis when tilting every tray.

[0010] The horizontal axis may be located near or at a centre of gravity of the frame supporting the plurality of trays.

[0011] Alternatively, the horizontal axis may be located at a bottom portion of the brim of the frame and a bottom portion of the brim of the frame pivotably engages the support structure about the horizontal axis.

[0012] The board may be attached to the frame and may rotate together with the frame supporting the plurality of trays.

[0013] Each tray may be pivotable about a distinct horizontal axis relative to the frame and the tilting mechanism may pivot every tray about its distinct horizontal axis when tilting every tray.

[0014] The distinct horizontal axis for each tray may be located at a first portion of the brim of each tray and a second portion of the brim of each tray opposite the first portion of the brim may be moved downwards when the tilting mechanism is activated.

[0015] Alternatively, the distinct horizontal axis for each tray may be located at a second portion of the brim of each tray and a first portion of the brim of each tray opposite the first portion of the brim may be moved upwards when the tilting mechanism is activated.

[0016] The distinct horizontal axis for each tray may be located near or at a centre of each tray

[0017] The tilting mechanism may be configured to allow simultaneously tilting of every tray to be performed manually.

[0018] The tilting mechanism may be motorised to automatically and simultaneously tilt every tray when activated.

[0019] Activation of the tilting mechanism may be configured to be performed by a human user.

[0020] Activation of the tilting mechanism may be programmed to be performed at at least one predetermined time.

[0021] The at least one predetermined time may comprise preset intervals of time.

[0022] The mosquito rearing rack may further comprise a releasable locking mechanism provided to prevent activation of the tilting mechanism.

[0023] The mosquito rearing rack may further comprise at least one light source provided to aid larva growth.

[0024] The at least one light source is provided on the support structure opposite the board to stimulate larva movement towards the board.

Brief Description of the Drawings

[0025] In order that the invention may be fully understood and readily put into practical effect there shall now be described by way of non-limitative example only exemplary embodiments of the present invention, the description being with reference to the accompanying illustrative drawings.

FIG. l is a schematic illustration of a first exemplary embodiment of a mosquito rearing rack.

FIG. 2 is a schematic illustration of a second exemplary embodiment of a mosquito rearing rack.

FIG. 3 is a schematic illustration of a third exemplary embodiment of a mosquito rearing rack.

FIG. 4 is a schematic illustration of a fourth exemplary embodiment of a mosquito rearing rack.

FIG. 5 is a schematic illustration of a fifth exemplary embodiment of a mosquito rearing rack.

FIG. 6 is a schematic illustration of a first exemplary embodiment of a lighting arrangement for a mosquito rearing rack.

FIG. 7 is a schematic illustration of a second exemplary embodiment of a lighting arrangement for a mosquito rearing rack.

FIG. 8 is a schematic illustration of a third exemplary embodiment of a lighting arrangement for a mosquito rearing rack.

FIG. 9 is a schematic illustration of a fourth exemplary embodiment of a lighting arrangement for a mosquito rearing rack.

Detailed Description

[0026] Exemplary embodiments of a mosquito rearing rack 10 will be described with reference to FIGS. 1 to 9 in which the same reference numerals are used across the figures to refer to the same or similar parts.

[0027] In general, as can be seen in FIGS. 1 to 5, the mosquito rearing rack 10 comprises a plurality of trays 20. Each tray 20 is provided for rearing larvae and pupae from mosquito eggs and/or mosquito larvae, and is therefore configured to contain therein a volume of water and a number of mosquito eggs, a number of mosquito larvae and/or a number of mosquito pupae. The typical volume of water that each tray 20 needs to carry is between 1 litre to 20 litres depending on the scale of the project. To save space, water in each tray 20 is typically filled close to a brim of the tray 20. Each tray 20 is typically rectangular in shape with each side ranging from 30 cm to 130 cm long, although trays of other shapes and sizes may be provided.

[0028] The rack 10 further comprises a frame 30 provided to support the plurality of trays 20. The trays 20 are supported by the frame 30 in such a way that the trays 20 are provided one above another and a space 40 is provided above each tray 20. The trays 20 are thus vertically stacked up and spaced apart 40 in the rack 10. Having trays 20 too close together limits the amount of air ventilation afforded to larvae reared in the trays. With each tray 20 containing typically 10,000 to 50,000 larvae, insufficient air flow or increased temperature will adversely affect their consistent growth. Too small a space 40 will also impose limitations to the feeding and water replenishment to the trays 20. Naturally, having larger spaces 40 between trays 20 improves aeration but this reduces the number of trays 20 that can be supported in a frame 30 of the same size and accordingly reduces the total number of larvae that can be reared. A typical space 40 between adjacent trays 20 may range between 1cm to 10 cm high, allowing for aeration as well as dispensing of feed to each tray 20.

[0029] The rack 10 includes a collection container (not shown) provided below the plurality of trays 20. A board 60 is provided to receive thereon the contents of each tray 20 and to channel

the contents of each tray 20 into the collection container. The rack 10 also includes a support structure 70 on which the frame 30, the board 60 and the collection container are mounted.

[0030] A tilting mechanism is provided to simultaneously tilt every tray 20 such that the contents of every tray 20 simultaneously flows onto the board 60 and into the collection container when the tilting mechanism is activated. When the trays 20 are simultaneously tilted, a first portion of the brim 21 of each tray 20 is positioned higher than a second portion of the brim 22 of each tray 20, the second portion of the brim 22 being opposite the first portion of the brim 21. The board 60 is provided near the second portion of the brim 22 of each tray 20.

[0031] In some embodiments, the tilting mechanism may be configured to allow all the trays 20 to be simultaneously tilted manually. In other embodiments, the tilting mechanism may be motorised to automatically and simultaneously tilt every tray 20 when activated. Activation of the motorised tilting mechanism may be performed by a human user either by physical operation or remote activation, or may be programmed to be automatically performed at at least one predetermined time. For example, the at least one predetermined time may be a certain time when it is determined that the pupae are sufficiently mature for collection, or the at least one predetermined time may comprise preset intervals of time where it is desired to collect the growing larvae.

[0032] Various embodiments of the tilting mechanism may be provided to simultaneously tilt every tray 20 and will be described in greater detail below.

[0033] In a first group of embodiments of the tilting mechanism as shown in FIGS. 1 and 2, the frame 30 is pivotable about a horizontal axis P relative to the support structure 70, as indicated by the black double-ended arrows. The tilting mechanism pivots the entire frame 30 supporting the plurality of trays 20 about the horizontal axis P when the tilting mechanism is activated, thereby simultaneously tilting every tray 20 such that the contents of every tray 20 flow out onto the board 60. In the first group of embodiments, the board 60 may remain stationary when the tilting mechanism is activated, or the board 60 may alternatively be attached to the frame 30 (not shown) and rotate together with the frame 30 when the tilting mechanism is activated. A locking mechanism (not shown) may be provided to immobilise the frame 30 relative to the support structure 70 during normal rearing to prevent any accidental movement of the frame 30 which may undesirably tilt the trays 20 from the horizontal rearing position. For example, the locking mechanism may comprise a releasable latch that immovably secures the frame 30 to the support structure 70 during normal rearing to keep the trays 20

horizontal. To tilt the trays 20, the latch is released to allow the frame 30 to be rotated relative to the support structure 70.

[0034] In a first configuration in the first group of tilting mechanism embodiments, as can be seen in FIG. 1, the horizontal axis P may be located near or at a centre of gravity of the frame 30 supporting the plurality of trays 20. Locating the horizontal axis P at or close to the centre of gravity of the frame 30 reduces the force required to rotate the frame 30 supporting the plurality of trays 20, making it easier for the motor (in the case of a motorised tilting mechanism) or a person (in the case of a manual tilting mechanism) to perform the task. In this embodiment, the tilting mechanism may comprise a motor 90 mounted to the support structure 70 to rotate the frame 30 relative to the support structure 70.

[0035] Alternatively, in a second configuration in the first group of tilting mechanism embodiments as shown in FIG. 2, the horizontal axis P may be located at a bottom edge of the frame 30. In this embodiment, the tilting mechanism may comprise a bottom edge of the frame 30 pivotably engaging the support structure 70 about the horizontal axis P. Where the tilting mechanism is motorised in this configuration, a motorised actuator (not shown) may be provided to rotate the frame 30 about the horizontal axis P. For example, the motorised actuator may comprise a hydraulic arm where a first end of the arm is attached to the support structure 70 while a second end of the motorized actuator is attached to the frame 30 so that extension of the hydraulic arm rotates the frame 30 about the horizontal axis P.

[0036] In a second group of embodiments of the tilting mechanism as shown in FIGS. 3 to 5, each tray 20 is pivotable about its own horizontal axis (P_1 to P_n for n number of trays 20), as indicated by the black double-ended arrows. The tilting mechanism pivots every tray 20 about its own horizontal axis P_n when the tilting mechanism is activated, thereby simultaneously tilting every tray 20.

[0037] In a first configuration of the second group of tilting mechanism embodiments, as can be seen in FIG. 3, its own horizontal axis P_n for each tray 20 may be located at the first portion of the brim 21 of each tray 20 where the first portion of the brim 21 of each tray 20 is pivotably attached to a fixed part of the frame 30. In this configuration, the second portion of the brim 22 of each tray 20 is attached to a movable part 31 of the frame 30 and moves in a vertical direction as indicated by the white arrows in FIG. 3 when the movable part 31 is moved vertically, while the first portion of the brim 21 of each tray 20 remains stationary in the vertical direction. During normal rearing, the movable part 31 is at a first position that keeps the plurality of trays 20 in a horizontal rearing position. A locking mechanism (not shown) may be provided

to prevent accidental movement of the movable part 31 during normal rearing. When it is desired to collect the contents of the trays 20, the movable part 31 is moved downwards, lowering the second portion of the brim 22 below the first portion of the brim 21. This positions the first portion of the brim 21 of each tray 20 higher than the second portion of the brim 22 of each tray 20 such that all the trays 20 are simultaneously tilted and their contents flow out onto the board 60. To return the trays 20 to the horizontal rearing position, the movable part 31 is moved upwards.

[0038] Alternatively, in a second first configuration of the second group of tilting mechanism embodiments, as can be seen in FIG. 4, its own horizontal axis P_n for each tray 20 may be located at the second portion of the brim 22 of each tray 20 where the second portion of the brim 22 of each tray is pivotably attached to a fixed part of the frame 30. In this configuration, the first portion of the brim 21 of each tray 20 is attached to a movable part 31 of the frame 30 and moves in a vertical direction as indicated by the black arrow in FIG. 4 when the movable part 31 is moved vertically, while the second portion of the brim 22 of each tray 20 remains stationary in the vertical direction. During normal rearing, the movable part 31 is at a first position that keeps the plurality of trays 20 in a horizontal rearing position. A locking mechanism (not shown) may be provided to prevent accidental movement of the movable part 31 during normal rearing. When it is desired to collect the contents of the trays 20, the moveable part 31 is moved upwards, raising the first portion of the brim 21 above the second portion of the brim 22. This positions the first portion of the brim 21 of each tray 20 higher than the second portion of the brim 22 of each tray 20 such that all the trays 20 are simultaneously tilted and their contents flow out onto the board 60. A motor 80 positioned on the support structure 70 may be provided to rotate a mechanism 82 that moves the movable part 31 upwards to tilt the trays 20, allowing the contents in the trays 20 to flow out when the rays 20 are tilted. Alternatively, the part 31 may be manually raised by a user to simultaneously tilt all the trays 20. To return the trays 20 to the horizontal rearing position, the movable part 31 is moved downwards.

[0039] A further configuration of the second group of tilting mechanism embodiments is shown in FIG. 5 which is largely similar to the configuration shown in FIG. 4. However, instead of providing a motor to rotate a mechanism that moves the movable part 31 upwards to tilt the trays 20, in the configuration of FIG. 5, an actuator 80 mounted on the support structure 70 may be provided to raise one side of a bottom part 32 of the frame 30 that is pivotable about a horizontal axis P_f located on the fixed part of the frame 30. The bottom part 32 is also rotatably attached to the movable part 31 so that raising one side of the bottom part 32 about the horizontal axis P_f moves the movable part 31 upwards to simultaneously tilt all the trays 20.

[0040] Embodiments of the mosquito rearing rack 10 may be further provide with one or more illumination sources 90 (as shown in FIGS. 6 to 9) that can provide both light and heat to the trays 20 on the rack 10 to aid larva growth or to stimulate larva movement to a desired location in a tray 20. The wavelengths emitted by the illumination sources can be fixed or variable to accommodate the different stages that the larvae or the operator requires. The illumination source 90 may comprise strips of light emitting diodes (LEDs), fluorescent tubes, light filaments or other light emitting devices located on one or more sides of the rack 10.

[0041] As shown in FIG. 6, the illumination source 90 may be provided on one side of the rack 10 opposite where the board 60 is provided, i.e., nearer the first edges 21 of the trays. Light emitted by the illumination source 90 can encourage larvae and pupae within the trays 20 to move away from the first edges 21 of the trays 20 towards the board 60, as indicated by the large black arrow. This allows easier feeding from the second edges 22 of the trays and easier collection of the contents of the trays 20 when the trays 20 are tilted such that the contents flow over the second edges of the trays 20 onto the board 60. The illumination source 90 may comprise strips of light emitting diodes (LEDs), fluorescent tubes, light filaments or other light emitting devices located on one or more sides of the rack.

[0042] In alternative embodiments as shown in FIGS. 7 and 8, the illumination source 90 may comprise vertical light sources 90 provided at the corners 71 of the support structure 70. Additional vertical light sources 90 may be provided at the sides 72 of the support structure 70 as shown in FIG. 8. The height of each vertical light source 90 can encompass a partial or full height of the rack 10. For example, the vertical light source 90 may extend from 10 cm the bottom of the rack to 180 cm from the bottom of the rack 10. The length of each vertical light source 90 can range from 30 cm to 200 cm.

[0043] In another embodiment as shown in FIG. 9, the illumination source 90 may comprise light panels provided on the supporting structure 70 that cover specific areas of the rack 10. For example, these light panels can be located at intervals along the sides of the rack 10.

[0044] Using the presently disclosed rack 10, all the trays 20 are simultaneously tilted with a single activation of the tilting mechanism to pour out their contents over the second portion of the brim 22 of every tray 20 onto the board 60 and into the collection container. The presently disclosed rack 10 thus greatly reduces the amount of time and effort required to collect the contents of all the trays 20 when compared to prior art racks where each tray must be individually removed from the frame in order to pour out its contents. The present rack 10 also allows much larger trays 20 to be provided in each rack 10 as the trays 20 do not have to be

removed from the frame 30 but remain supported by the frame 30 while the trays 20 are simultaneously tilted to pour out their contents

[0045] While there has been described in the foregoing description exemplary embodiments of the present invention, it will be understood by those skilled in the technology concerned that many variations in details of design, construction and/or operation may be made without departing from the present invention. It will be appreciated that many further alterations, modifications and permutations of various aspects of the described embodiments are possible that fall within the spirit and scope of the appended claims.

Claims

1. A mosquito rearing rack comprising:
   a plurality of trays, each tray configured to contain therein a volume of water and at least one of: a number of mosquito eggs, a number of mosquito larvae and a number of mosquito pupae;
   a frame provided to support the plurality of trays such that the trays are provided one on top of another and a space is provided above each tray;
   a collection container provided below the plurality of trays;
   a board provided at a distance from the plurality of trays and configured to receive thereon the contents of each tray and to channel the contents of each tray into the collection container;
   a support structure on which the frame, the board and the collection container are mounted, and
   a tilting mechanism provided to simultaneously tilt every tray such that the contents of every tray simultaneously flows onto the board and into the collection container when the tilting mechanism is activated.

2. The mosquito rearing rack of claim 1, wherein the frame is pivotable about a horizontal axis relative to the support structure and the tilting mechanism pivots the frame supporting the plurality of trays about the horizontal axis when tilting every tray.

3. The mosquito rearing rack of claim 2, wherein the horizontal axis is located near or at a centre of gravity of the frame supporting the plurality of trays.

4. The mosquito rearing rack of claim 2, wherein the horizontal axis is located at a bottom portion of the brim of the frame and a bottom portion of the brim of the frame pivotably engages the support structure about the horizontal axis.

5. The mosquito rearing rack of any one of claims 2 to 4, wherein the board is attached to the frame and rotates together with the frame supporting the plurality of trays.

6. The mosquito rearing rack of claim 1, wherein each tray is pivotable about a distinct horizontal axis relative to the frame and the tilting mechanism pivots every tray about its distinct horizontal axis when tilting every tray.

7. The mosquito rearing rack of claim 6, wherein the distinct horizontal axis for each tray is located at a first portion of the brim of each tray and a second portion of the brim of each tray opposite the first portion of the brim is moved downwards when the tilting mechanism is activated.

8. The mosquito rearing rack of claim 6, wherein the distinct horizontal axis for each tray is located at a second portion of the brim of each tray and a first portion of the brim of each tray opposite the first portion of the brim is moved upwards when the tilting mechanism is activated.

9. The mosquito rearing rack of claim 6, wherein the distinct horizontal axis for each tray is located near or at a centre of each tray.

10. The mosquito rearing rack of any one of the preceding claims, wherein the tilting mechanism is configured to allow simultaneously tilting of every tray to be performed manually.

11. The mosquito rearing rack of any one of claims 1 to 9, wherein the tilting mechanism is motorised to automatically and simultaneously tilt every tray when activated.

12. The mosquito rearing rack of claim 11 wherein activation of the tilting mechanism is configured to be performed by a human user.

13. The mosquito rearing rack of claim 11 wherein activation of the tilting mechanism is programmed to be performed at at least one predetermined time.

14. The mosquito rearing rack of claim 13 wherein the at least one predetermined time comprises preset intervals of time.

15. The mosquito rearing rack of any one of the preceding claims, further comprising a releasable locking mechanism provided to prevent activation of the tilting mechanism.

16. The mosquito rearing rack of any one of the preceding claims, further comprising at least one light source provided to aid larva growth.

17. The mosquito rearing rack of claim 16, wherein the at least one light source is provided on the support structure opposite the board to stimulate larva movement towards the board.