SYSTEMS AND METHODS FOR CONTINUOUS INSECT PUPAE SENSING

FIELD

[0002] The present disclosure relates generally to the mass-rearing of insects. More specifically, but not by way of limitation, this disclosure relates to systems and methods for continuous insect pupae sensing.

BACKGROUND

[0003] The mass-rearing of insect larvae can be very labor intensive. A lab technician may manually add a number of eggs or insect larvae to a plastic tray and determine the amount of food and water to add into the tray for the insect larvae. The lab technician may hand carry the plastic tray to a storage area to store the plastic tray. Periodically, the lab technician may perform observations on the insect larvae in the plastic tray or add food and water as needed. After the larvae mature into pupae, they may be moved from the larval rearing environment into another environment where they can mature into adult insects for release into the wild. Each of these steps may involve significant amounts of human labor, such as manually moving and emptying containers, sterilizing reusable components, etc.

SUMMARY

[0004] Various examples are described for systems and methods for continuous insect pupae sensing. For example, one example method includes receiving a flow at a singulator, the flow comprising one or more insect pupae in a liquid medium; singulating the insect pupae into a single-file flow of insect pupae; sensing, using a sensor, insect pupae within the single-file flow of insect pupae; and incrementing a counter based on each sensed insect pupae in the single-file flow of insect pupae.

[0005] One example system includes a channel defining a flow path for a flow of insect pupae in a liquid medium; a singulator positioned within the flow path and arranged to receive the flow of insect pupae within the channel, the singulator configured to singulate the insect pupae into a single-file flow of insect pupae; a sensor positioned and arranged to sense insect pupae in the single-file flow; and a processor in communication with the sensor and a non-transitory computer-readable medium, the processor configured to execute processor-executable instructions stored in the non-transitory computer-readable medium to receive

CLAIMS

That which is claimed is:

1. A method comprising:

receiving a flow at a singulator, the flow comprising one or more insect pupae in a liquid medium;

singulating the insect pupae into a single-file flow of insect pupae;

sensing, using a sensor, insect pupae within the single-file flow of insect pupae; and

incrementing a counter based on each sensed insect pupae in the single-file flow of insect pupae.

2. The method of claim 1, wherein the flow comprises water and the one or more insect pupae.

3. The method of claim 1, wherein the flow is carried by a conveyor belt.

4. The method of claim 1, wherein the sensor comprises a camera.

5. The method of claim 4, further comprising capturing an image of an insect pupa, and determining a characteristic of the insect pupa based on the image.

6. The method of claim 5, wherein the characteristic comprises a sex, a size, or an anomaly.

7. The method of claim 6, further comprising capturing an image of each sensed insect pupae, and determining one or more characteristics of each sensed insect pupae.

8. The method of claim 5, further comprising creating and storing a record for the insect pupa, the record comprising the characteristic and the image.

9. The method of claim 1, wherein the sensor comprises a photodetector.

10. The method of claim 1, wherein the sensor comprises two conductive plates and sensing the insect pupae comprises determining a change in capacitance between the two conductive plates.

11. The method of claim 1, wherein the singulator comprises an hourglass shape having a neck portion, the neck portion sized to allow a single insect pupae

to pass at a time, and wherein singulating the insect pupae comprises applying a substantially constant pressure to the flow of insect pupae.

12. The method of claim 1, wherein the singulator comprises a first and second sheet of material, the first sheet of material positioned below the second sheet forming a wedge arrangement using the first and second sheets of material, and oriented such that a gap between the first and second sheets of material within the wedge arrangement narrows from one edge of the first sheet to the opposite end to a width of a single insect pupae.

13. The method of claim 1, wherein the singulator comprises a channel and an air outlet, and wherein singulating the insect pupae comprises flowing the flow of insect pupae through the channel, and forming one or more bubbles in the flow of insect pupae between inset pupae by outputting puffs of air from the air outlet.

14. The method of claim 1, further comprising receiving the flow of insect pupae at a plurality of singulators in parallel, and at each singulator:

singulating the insect pupae from the received flow of insect pupae into a single-file flow of insect pupae;

sensing insect pupae within the single-file flow of insect pupae; and

incrementing the counter associated based on a number of sensed insect pupae in the respective single-file flow of insect pupae.

15. A system comprising:

A channel defining a flow path for a flow of insect pupae in a liquid medium;

a singulator positioned within the flow path and arranged to receive the flow of insect pupae within the channel, the singulator configured to singulate the insect pupae into a single-file flow of insect pupae;

a sensor positioned and arranged to sense insect pupae in the single-file flow; and

a processor in communication with the sensor and a non-transitory computer-readable medium, the processor configured to execute processor-executable instructions stored in the non-transitory computer-readable medium to:

receive sensor signals from the sensor; and

count a number of insect pupae based on the received sensor signals.

16. The system of claim 15, wherein the flow of insect pupae comprises water and one or more insect pupae.

17. The system of claim 15, further comprising a conveyor belt defining the channel, wherein the conveyor belt is configured to convey the flow of insect pupae.

18. The system of claim 15, wherein the sensor comprises a camera.

19. The system of claim 18, wherein the processor is configured to execute processor-executable instructions stored in the non-transitory computer-readable medium to:

receive an image of an insect pupa, and

determine a characteristic of the insect pupa based on the image.

20. The system of claim 19, wherein the characteristic comprises a sex, a size, or an anomaly.

21. The system of claim 20, wherein the processor is configured to execute processor-executable instructions stored in the non-transitory computer-readable medium to:

receive images of each sensed insect pupae, and

determine one or more characteristics of each sensed insect pupae.

22. The system of claim 19, wherein the processor is configured to execute processor-executable instructions stored in the non-transitory computer-readable medium to create and store a record for the insect pupa, the record comprising the characteristic and the image.

23. The system of claim 15, wherein the sensor comprises a photodetector.

24. The system of claim 15, wherein the sensor comprises two conductive plates and the sensor signals comprises an indication of capacitance, and wherein the processor is configured to execute processor-executable instructions stored in the non-transitory computer-readable medium to:

determine a change in capacitance between the two conductive plates based on the received sensor signals, and

count the number of insect pupae based on the change in capacitance.

25. The system of claim 15, wherein the singulator comprises an hourglass shape having a neck portion, the neck portion sized to allow a single insect pupae to pass at a time, and wherein the system is configured to apply a substantially constant pressure to the flow of insect pupae.

26. The system of claim 15, wherein the singulator comprises a first and second sheet of material, the first sheet of material positioned below the second sheet forming a wedge arrangement using the first and second sheets of material, and oriented such that a gap between the first and second sheets of material within the wedge arrangement narrows from one edge of the first sheet to the opposite end to a width of a single insect pupae.

27. The system of claim 15, wherein the system comprises an air source and the singulator comprises an air outlet, and wherein the singulator is configured to output puffs of air from the air outlet to form one or more bubbles in the flow of insect pupae between inset pupae.

28. The system of claim 15, further comprising a plurality of singulators arranged in parallel to each other, and a plurality of sensors, at least one sensor of the plurality of sensors positioned at each singulator of the plurality of singulators, and wherein the processor is configured to execute processor-executable instructions stored in the non-transitory computer-readable medium to:

receive sensor signals from each of the plurality of sensors, and

count the number of insect pupae based on the received sensor signals from each of the plurality of sensors.

29. The system of claim 15, wherein the processor is a first processor and further comprising a second processor, the second processor configured to receive one or more sensor signals, determine a characteristic of an insect pupa based on the one or more sensor signals, and provide the characteristic to the first processor.