SIEVING APPARATUSES FOR PUPAE SEPARATION

BACKGROUND

[0001] Generally, a sieve can be formed of a wire or plastic mesh held in a frame. The sieve can be used for straining solids from liquid or for separating coarser objects from finer objects.

[0002] Among those objects that can be separated are insects. Other devices have been designed to separate insects such as a device that includes parallel glass plates. The reasons for separating insects are various. For example, as part of a Sterile Insect Technique (SIT) program, male insects may be separated from female insects. Depending on the program, separation may be performed at one or more stages of insect development. For example, insects having an aqueous pupal stage may be separated while in the pupal stage.

[0003] Use of conventional mesh screens to separate pupae may create challenges given the physiological structures of the pupae. Additionally, use of devices including parallel glass plates may create challenges given their difficulty to operate and required user interaction. These challenges may result in prohibitively low throughput and similarly low yield.

SUMMARY

[0004] Various examples are described relating to sieving devices, systems including the sieving devices, methods for using the sieving devices, and methods for forming the sieving devices.

[0004a] According to a first aspect of the present invention, there is provided a computer-implemented method, comprising: instructing a computer system to execute operations comprising: instructing addition of a population of mosquito pupae to a sieving device by a human operator or by an automated device, the sieving device at least partially submerged in a water held within a first basin, wherein the population of mosquito pupae comprises at least one of different sizes of mosquito pupae, different species of mosquito pupae, or different sexes of mosquito pupae; causing a lifting actuator that is attached to the sieving device to cycle between a first elevation and a second elevation so as to cyclically submerge a sieve surface of the sieving device in the water held within the first basin,

wherein the population of mosquito pupae is separated into a first group of mosquito pupae and a second group of mosquito pupae based at least in part on the cycling; causing a valve to open to drain the water from the first basin, the first group of mosquito pupae disposed in the water; causing a lateral actuator that is attached to the sieving device to move the sieving device from a first position adjacent to the first basin to a second position adjacent to a second basin, the second group of mosquito pupae disposed in the sieving device; when the sieving device is at the second position, causing a rotational actuator to rotate the sieving device about a rotational axis between a first orientation and a second orientation; and when the sieving device is in the second orientation, instructing removal of the second group of mosquito pupae from the sieving device.

[0004b] According to a second aspect of the present invention, there is provided one or more non-transitory computer-readable media comprising computer-executable instructions that, when executed by one or more computer systems, cause the one or more computer systems to perform operations comprising: instructing addition of a population of mosquito pupae to a sieving device by a human operator or by an automated device, the sieving device at least partially submerged in a water held within a first basin, wherein the population of mosquito pupae comprises at least one of different sizes of mosquito pupae, different species of mosquito pupae, or different sexes of mosquito pupae; causing a lifting actuator that is attached to the sieving device to cycle between a first elevation and a second elevation so as to cyclically submerge a sieve surface of the sieving device in the water held within the first basin, wherein the population of mosquito pupae is separated into a first group of mosquito pupae and a second group of mosquito pupae based at least in part on the cycling; causing a valve to open to drain the water from the first basin, the first group of mosquito pupae disposed in the water; causing a lateral actuator that is attached to the sieving device to move the sieving device from a first position adjacent to the first basin to a second position adjacent to a second basin, the second group of mosquito pupae disposed in the sieving device; when the sieving device is at the second position, causing a rotational actuator to rotate the sieving device about a rotational axis between a first orientation and a second orientation; and when the sieving device is in the second orientation, instructing removal of the second group of mosquito pupae from the sieving device.

[0005] In an example, an apparatus is described. The apparatus includes a frame, a sieving device, a basin, and an actuation system. The sieving device includes a sieve surface including a first side and a second side and defining a set of openings to define a set of pathways extending between the first side and the second side. Individual openings of the set of openings are defined by a length dimension measured along a longitudinal axis of the respective opening, and a width dimension measured along a transverse axis of the respective opening. The width dimension corresponds to a cross-sectional cephalothorax width of a representative insect of a predetermined insect type (e.g., mosquitoes or other insects). The length dimension is greater than the width dimension. The sieving device also includes a sieve rim including a first wall defining a volume. The sieve surface is attached to a lower portion of an interior surface of the sieve rim and one side of the sieve surface is exposed

WHAT IS CLAIMED IS:

1. A computer-implemented method, comprising:

instructing a computer system to execute operations comprising:

instructing addition of a population of mosquito pupae to a sieving device by a human operator or by an automated device, the sieving device at least partially submerged in a water held within a first basin, wherein the population of mosquito pupae comprises at least one of different sizes of mosquito pupae, different species of mosquito pupae, or different sexes of mosquito pupae;

causing a lifting actuator that is attached to the sieving device to cycle between a first elevation and a second elevation so as to cyclically submerge a sieve surface of the sieving device in the water held within the first basin, wherein the population of mosquito pupae is separated into a first group of mosquito pupae and a second group of mosquito pupae based at least in part on the cycling;

causing a valve to open to drain the water from the first basin, the first group of mosquito pupae disposed in the water;

causing a lateral actuator that is attached to the sieving device to move the sieving device from a first position adjacent to the first basin to a second position adjacent to a second basin, the second group of mosquito pupae disposed in the sieving device;

when the sieving device is at the second position, causing a rotational actuator to rotate the sieving device about a rotational axis between a first orientation and a second orientation; and

when the sieving device is in the second orientation, instructing removal of the second group of mosquito pupae from the sieving device.

2. The computer-implemented method of claim 1, wherein the sieve surface comprises a first side and a second side, wherein a set of openings is formed in the sieve surface so as to define a set of pathways extending between the first side and the second side, individual openings of the set of openings defined by:

a length dimension measured along a longitudinal axis of the respective opening; and

a width dimension measured along a transverse axis of a respective opening, the length dimension greater than the width dimension.

3. The computer-implemented method of claim 2, wherein a value of the width dimension of the individual openings is less than a cross-sectional cephalothorax width of a representative female mosquito pupa of the second group of mosquito pupae.

4. The computer-implemented method of claim 1, wherein instructing removal of the second group of mosquito pupae from the sieving device comprises causing a rinse nozzle to spray the sieving device, the sieving device disposed between the rinse nozzle and the second basin when in the second position.

5. The computer-implemented method of claim 1, wherein:

the valve is a first valve in fluid communication with a second valve via a drain pipe, a portion of the drain pipe comprising an opening extending into a manifold, the water draining via the opening and through the manifold; and

the method further comprises, after causing the first valve to open, causing a second valve to open to obtain access to the first group of mosquito pupae, the first group of mosquito pupae prevented from passing through the opening.

6. The computer-implemented method of claim 1, wherein the sieving device comprises a sieve rim to which the sieve surface is attached, the sieve rim forming a wall portion of the sieving device, with the sieve surface forming a bottom portion of the sieving device opposite an open portion of the sieving device.

7. The computer-implemented method of claim 6, wherein:

in the first orientation, the sieve surface is disposed below the open portion; and

in the second orientation, the sieve surface is disposed above the open portion.

8. One or more non-transitory computer-readable media comprising computer-executable instructions that, when executed by one or more computer systems, cause the one or more computer systems to perform operations comprising:

instructing addition of a population of mosquito pupae to a sieving device by a human operator or by an automated device, the sieving device at least partially submerged in a water held within a first basin, wherein the population of mosquito pupae comprises at least one of different sizes of mosquito pupae, different species of mosquito pupae, or different sexes of mosquito pupae;

causing a lifting actuator that is attached to the sieving device to cycle between a first elevation and a second elevation so as to cyclically submerge a sieve surface of the sieving device in the water held within the first basin, wherein the population of mosquito pupae is separated into a first group of mosquito pupae and a second group of mosquito pupae based at least in part on the cycling;

causing a valve to open to drain the water from the first basin, the first group of mosquito pupae disposed in the water;

causing a lateral actuator that is attached to the sieving device to move the sieving device from a first position adjacent to the first basin to a second position adjacent to a second basin, the second group of mosquito pupae disposed in the sieving device;

when the sieving device is at the second position, causing a rotational actuator to rotate the sieving device about a rotational axis between a first orientation and a second orientation; and

when the sieving device is in the second orientation, instructing removal of the second group of mosquito pupae from the sieving device.

9. The one or more non-transitory computer-readable media of claim 8, wherein the sieve surface comprises a first side and a second side, wherein a set of openings is formed in the sieve surface so as to define a set of pathways extending between the first side and the second side, individual openings of the set of openings defined by: a length dimension measured along a longitudinal axis of the respective opening; and a width dimension measured along a transverse axis of a respective opening, the length dimension greater than the width dimension.

10. The one or more non-transitory computer-readable media of claim 9, wherein a value of the width dimension of the individual openings is less than a cross-sectional cephalothorax width of a representative female mosquito pupa of the second group of mosquito pupae.

11. The one or more non-transitory computer-readable media of claim 8, wherein instructing removal of the second group of mosquito pupae from the sieving device comprises causing a rinse nozzle to spray the sieving device, the sieving device disposed between the rinse nozzle and the second basin when in the second position.

12. The one or more non-transitory computer-readable media of claim 8, wherein: the valve is a first valve in fluid communication with a second valve via a drain pipe, a portion of the drain pipe comprising an opening extending into a manifold, the water draining via the opening and through the manifold; and

the operations further comprise, after causing the first valve to open, causing a second valve to open to obtain access to the first group of mosquito pupae, the first group of mosquito pupae prevented from passing through the opening.

13. The one or more non-transitory computer-readable media of claim 8, wherein the sieving device comprises a sieve rim to which the sieve surface is attached, the sieve rim forming a wall portion of the sieving device, with the sieve surface forming a bottom portion of the sieving device opposite an open portion of the sieving device.

14. The one or more non-transitory computer-readable media of claim 13, wherein:
in the first orientation, the sieve surface is disposed below the open portion; and
in the second orientation, the sieve surface is disposed above the open portion.