has mouth parts which only allow the consumption of liquids. In nature they eat nectar from flowers and in captive rearing programs tend to be given sugar water.

SUMMARY OF THE INVENTION

The present embodiments relate to automating the handling of the insects from the pupa stage until release as adults.

Automatic handling may include loading of pupae into a tank or trays and then into cartridges, and the cartridges are placed in magazines. The cartridges are characterized by removable water and a net, so that the same cartridges may serve for the underwater pupa stage and the dry land adult stage, and propeller-free pumps to move the insects from, to, in and between the cartridges.

Automatic handling may further include an X- Y distribution device that holds cartridges in queues within magazines and presents the magazines to an emptying machine or expulsion unit. Thus the magazines are structured devices that hold cartridges ready for release. A structure in the cartridge may facilitate robot feeding of the adult insects with sugar water and the like.

Suction may be used to insert or transfer insects into the appropriate cartridge or box.

The cartridge may be loaded with pupae which subsequently hatch into adults, or alternatively the cartridge may be loaded with adults after hatching. Filling a cartridge with adult insects may involve suction or blowing, and a wall of air may be used on a cage of mosquitoes by directing the wall to different parts of the cage, to push insects into a collecting tube. In addition, small boxes may be independently filled and then connected together to make larger cartridges. This is useful because small boxes are easier to fill, whereas larger cartridges are easier to handle subsequently.

Embodiments also include suction of insects while they are cold and inert.

According to an aspect of some embodiments of the present invention there is provided apparatus for loading of pupae into cartridges for growing, hatching into adults and dispersal to the outside of the adults for contact with wild insects, comprising:

a source of pupae in liquid; at least one cartridge configured to receive said pupae from said source, and to hatch the pupae into adults, the at least one cartridge further for placement in a dispersal machine for dispersal of the adults to the outside, the cartridge having at least one drainage hole covered in netting at a lower end; a filling robot configured to extract a measured number of pupae from said source and to transfer said measured number of pupae to each of said at least one cartridge; and a water tray to hold the cartridge; and wherein the cartridge is configured to support a liquid phase for the pupae, wherein the cartridge, when filled with pupae may be placed in the water tray to retain

keeping closed first ends away from the trays of the respective cartridges over said pupae, second ends of the cartridges towards said trays being opened;

allowing said pupae to emerge as adults into the cartridges;

closing doors at said second ends of the cartridges; and

removing the cartridges with said adults therein.

In accordance with an aspect of the disclosure, there is provided an apparatus for loading of pupae into cartridges for growing, hatching into adults and dispersal to the outside of the adults for contact with wild insects, comprising:

a source of pupae in liquid;

at least one cartridge configured to receive said pupae from said source, and to hatch said pupae into adults, the at least one cartridge further for placement in a dispersal machine for dispersal of said adults to the outside, said cartridge having at least one drainage hole covered with a closure at a lower end;

a filling robot configured to extract a measured number of pupae from said source and to transfer said measured number of pupae to each of said at least one cartridge; and

a water tray to hold said cartridge; and wherein said at least one cartridge is configured to support a liquid phase for said pupae, such that said at least one cartridge, when filled with pupae may be placed in said water tray to retain water in said cartridge, and wherein, following hatching of said pupae, said at least one cartridge is drainable via said at least one drainage hole to provide a dry environment for said adults; and

an expulsion mechanism configured to open said cartridge and apply a wave of air pressure along said open cartridge to expel insects therefrom to the outside for contact with wild insects.

Unless otherwise defined, all technical and/or scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which the invention pertains. Although methods and materials similar or equivalent to those described herein can be used in the practice or testing of embodiments of the invention, exemplary methods and/or materials are described below. In case of conflict, the patent specification, including definitions, will control. In addition, the materials, methods, and examples are illustrative only and are not intended to be necessarily limiting.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

Some embodiments of the invention are herein described, by way of example only, with reference to the accompanying drawings. With specific reference now to the drawings in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of embodiments of the invention. In this regard, the description taken with the drawings makes apparent to those skilled in the art how embodiments of the invention may be practiced.

In the drawings:

Fig. 1 is a photograph showing manual filling of cartridges as commonly done today;

Fig. 2 is a view from above showing manual filling of cartridges as commonly done today;

Fig. 3 is a simplified flow chart showing a high level view of an automated insect rearing process according to the present embodiments;

Fig. 4 is a simplified view of the process according to the present embodiments from pupa tray to flow of filled cartridges;

WHAT IS CLAIMED IS:

1. Apparatus for loading of pupae into cartridges for growing, hatching into adults and dispersal to the outside of the adults for contact with wild insects, comprising:

a source of pupae in liquid;

at least one cartridge configured to receive said pupae from said source, and to hatch said pupae into adults, the at least one cartridge further for placement in a dispersal machine for dispersal of said adults to the outside, said cartridge having at least one drainage hole covered with a closure at a lower end;

a filling robot configured to extract a measured number of pupae from said source and to transfer said measured number of pupae to each of said at least one cartridge; and

a water tray to hold said cartridge; and wherein said at least one cartridge is configured to support a liquid phase for said pupae, such that said at least one cartridge, when filled with pupae may be placed in said water tray to retain water in said cartridge, and wherein, following hatching of said pupae, said at least one cartridge is drainable via said at least one drainage hole to provide a dry environment for said adults; and

an expulsion mechanism configured to open said cartridge at first and second opposite ends and apply a wave of air pressure along said open cartridge to expel insects therefrom to the outside for contact with wild insects.

2. Apparatus according to claim 1, further comprising a suction tube connected to said source of pupae to suck pupae from said source for filling said cartridge, or comprising a suction tube connected to a robot arm to direct said suction tube to said pupae, or comprising a scoop configured to scoop up said pupae from said pupae source, or comprising a measuring cup configured to collect pupae from said suction tube, thereby to fill a measured dose of said pupae into said cartridge, or comprising a measuring cup having a sensor for detecting when said cup is full.

3. Apparatus according to claim 2, wherein said sensor is one member of the group consisting of: a weight detector, a proximity detector, an ultrasonic sensor, a capacitive sensor and a camera, or wherein said suction tube comprises one member of the group consisting of a propeller-free pump, a Venturi pump, a pipette and a piston.

4. Apparatus according to any one of the preceding claims, wherein said cartridge comprises at least one feeding hole, said feeding hole containing a liquid absorbent material for holding sugar water, wherein said pupa source comprises water holding said pupae and an air current mechanism configured to blow across said water to concentrate said pupae for collection, or wherein said pupa source comprises water holding said pupae and a net configured to move across said water to concentrate said pupae at one side of said pupa source for collection.

5. Apparatus according to any one of the preceding claims, wherein said dispersion machine comprises:

a cartridge expulsion mechanism, said cartridge expulsion mechanism comprising a funnel, an air pressure source and an outlet, the expulsion mechanism configured to provide a wave of air pressure along each cartridge when an opening of a respective cartridge is in front of said expulsion mechanism; or

an opening mechanism to open doors of a cartridge at two opposite ends and provide a wave of air pressure to expel insects from within said cartridge via an outlet for dispersion; or

a plurality of cartridges placed together in a magazine, and a pupa filling robot configured to direct pupa from a pupa source to succeeding ones of said cartridges, thereby to fill all cartridges of said magazine with pupae, or comprising a closing robot configured with a door contact and a latch contact, to close and latch upper doors of said cartridges after filling of respective cartridges and an opening mechanism to open doors of a cartridge at two opposite ends and provide a wave of air pressure to expel insects from within said cartridge via an outlet for dispersion.

6. Apparatus according to any one of the preceding claims, further comprising a feeding robot, said feeding robot comprising a liquid dispenser for dispensing sugar water to said cartridges, said feeding robot configured to direct said liquid dispenser to feeding holes in successive cartridges to dispense sugar water for each cartridge.

7. Apparatus according to any one of the preceding claims,

wherein said expulsion mechanism is slidably mounted for controllable travel along a height to reach respective ones of said successive cartridges.

8. Apparatus according to any one of the preceding claims further comprising a suction tube, a sensor, and a pick up robot, said sensor configured to detect pupae or clusters of pupae in said pupa source, and said robot being configured to align said suction tube with said detected

pupae or clusters, and said suction tube applying suction when aligned, thereby to pick up pupae from said source to place in a respective cartridge.

9. Apparatus for loading of pupae into cartridges for growing, hatching into adults and dispersal to the outside of the adults for contact with wild insects, comprising:

a source of pupae in liquid;

at least one cartridge configured to receive said pupae from said source, and to hatch said pupae into adults, the at least one cartridge further for placement in a dispersal machine for dispersal of said adults to the outside, said cartridge having at least one drainage hole covered with a closure at a lower end;

a filling robot configured to extract a measured number of pupae from said source and to transfer said measured number of pupae to each of said at least one cartridge; and

a water tray to hold said cartridge; and wherein said at least one cartridge is configured to support a liquid phase for said pupae, such that said at least one cartridge, when filled with pupae may be placed in said water tray to retain water in said cartridge, and wherein, following hatching of said pupae, said at least one cartridge is drainable via said at least one drainage hole to provide a dry environment for said adults; and

an expulsion mechanism configured to open said cartridge and apply a wave of air pressure along said open cartridge to expel insects therefrom to the outside for contact with wild insects.