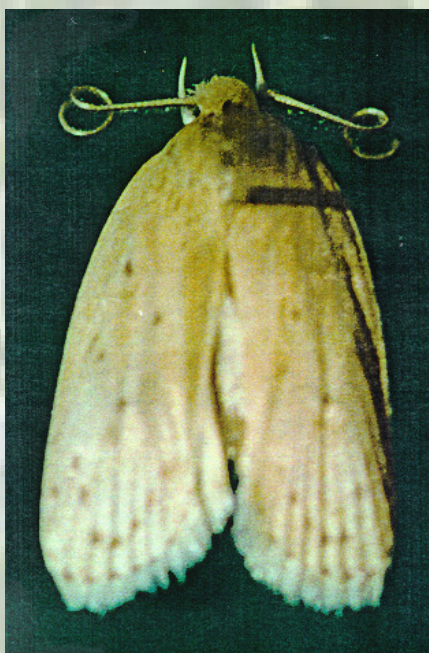


MANUAL OF SURVEY PROCEDURES FOR
***Stenoma catenifer* Walsingham**
(LEPIDOPTERA: OECOPHORIDAE)



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Lima – PERU

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I. INTRODUCTION

Avocado (*Persea americana* Mill) is a tropical crop that can be grown in the coast, inter Andean valleys, and central jungle of Peru, where proper management may allow harvests of the same variety in different seasons of the year, which represents an advantage for the export of fruits to different countries of the world.

The national avocado fruit production reaches approximately 84,450 MT, being the following the most important producing departments: Junin (27,420 MT), Lima (23,378 MT), La Libertad (9,307 MT), Ica (3,713 MT), Ancash (2,032 MT), Moquegua (1,718 MT), and Pasco (2,535 TM). The nationwide harvested surface gets 11,059 hectares, and the national average yield is 9,023 kg/ha (MINAG, 2006).

One of the main constrains for Peru to export avocado fruits constitutes the “avocado fruit borer moth”, *Stenoma catenifer* (Lepidoptera: Oecophoridae), which is restricted to the tropical zones of Junin and Pasco departments. On that respect, SENASA (National Agrarian Health Service), the national authority on phytosanitary issues, deems necessary to carry out permanent Surveys of this species on the avocado-producing areas with export purposes, and on areas with export potential of this commodity. Therefore, supporting data can be available to prove non-occurrence status of this pest whenever requested by NPPOs of other countries.

The Spanish version of this Manual is available at:

www.senasa.gob.pe/sanidad_vegetal/vigilancia_fitosanitaria/manual_stenoma_catenifer.pdf

II. BACKGROUND OF SURVEY METHOLOGIES

Adopting a suitable methodology for surveying *Stenoma catenifer* has been one of the main issues of this program based on the understanding that the higher the quality of the methodology, the more consistent the outputs.

This insect species does not have pheromones to use them along with traps, nor are individuals lured to artificial light, so that light traps were once implemented but then removed from the program based on information from Mexico where light traps are not used. In addition, SENASA conducted a small trial in the jungle of Junin (Chanchamayo), where two light traps were located in avocado farms and no adults were captures for a two-month period during fruiting stage with high fruit infestation levels. It is important to mention that eggs, larvae, adults, and pupae of this pest can be found at the same time in the jungle of Junin and Pasco.

Because no traps could be implemented, and based on the pest biology, Survey methodology was then adjusted to sample Fruits, Peduncles, and Shoots, taking into account that larvae can infest them under natural conditions. These plant organs were evaluated for several years; however, in order to improve the techniques, SENASA took into consideration a research done by Arellano (1998), who worked in Chanchamayo (Junin) on avocado farms and found that avocado fruits with thinner skin and even surface are more susceptible than fruits with thicker skin and uneven surface (irregular) such as Hass avocado. Therefore, SENASA shifted procedures and included fruits from pollinator trees, which bear fruits with

thin skin and regular (smooth) surface, that is, evaluating more susceptible fruits. Besides, SENASA regarded to concentrate efforts on fruits only since under natural conditions shoots and peduncles are rarely infested; conversely, the fruit is the most preferred part of the plant because larvae feed on the seeds.

III. AIMS

Execute permanent surveys for *Stenoma catenifer* in avocado production and export areas as well as areas with export potential, in order to develop information that technically support the non-occurrence status of *Stenoma catenifer* on the areas mentioned above.

IV. SCOPE

This ongoing work is executed in the departments of Arequipa, Ica, Lima, Ancash, La Libertad. Additional departments, provinces, and/or valleys may eventually be included in the program if they exhibit export potential for avocado, 'Hass' or 'Fuerte' varieties.

V. FEATURES OF *Stenoma catenifer*

1) Taxonomic position and Common Names

The taxonomic position is as follows:

Class	:	Insecta
Order	:	Lepidoptera
Family	:	Oecophoridae
Sub-family	:	Stenomatinae
Genus	:	<i>Stenoma</i>
Species	:	<i>Stenoma catenifer</i> Walsingham.

Stenoma catenifer is known with the following common names:

- Avocado seed moth (English)
- Barrenador del aguacate (Spanish - México)
- Taladrador del aguacate (Spanish - Venezuela)
- Barrenador del palto (Spanish)
- Polilla del fruto del palto (Spanish)
- Oruga de la semilla del aguacate (Spanish)
- Barrenador del hueso y del tallo del aguacate (Spanish)
- Pasador del fruto del aguacate (Spanish – Colombia)
- Palomilla barrenadora del hueso del aguacate (Spanish – México)
- Chenille de la graine de l'avocatier (French)
- Lagarto do fruto (Portuguese)

2) Plant Hosts

Natural infestation of this insect species is restricted to some plant hosts of the Lauraceae family, among which avocado or aguacate (*Persea americana*) is the

only host with economic relevance, and infestation takes place at fruiting stage. According to CABI (2005), besides avocado, this species has been reported to infest *Persea schiedeana*, *Beilschmedia* sp., and *Chlorocardium rodiedi*, which are deemed as minor hosts; however, no biology and ecology studies have been produced on these plant species.

3) Geographic Distribution

- **North America:** Restricted distribution in both Mexico and US (Hawaii only).
- **Central America and the Caribbean:** Belize, Panama; and restricted distribution in Costa Rica, El Salvador, Guatemala, Honduras, and Nicaragua.
- **South America:** Colombia, Brazil, Ecuador, Peru (distribución restringida), Venezuela, Guyana (CABI, 2005).

CABI's notes on the restricted distribution in Peru:

"SENASA, Peru notified CABI in December 2001 that surveys since 1999 showed that *S. catenifer* is restricted to some avocado-growing areas in Junín and Pasco; it is "absent, never occurred" from Lima, Ica, La Libertad, Moquegua and Ancash." (CABI, 2003; CABI, 2005).

4) Biology, Behavior, and Morphology

In tropical regions this pest can occur year round due to the availability of plant hosts with different flowering periods. Populations are present during vegetative growth; however, the highest infestation levels are reached shortly before harvest (CABI, 2005).

Acevedo (1973) recovered larvae from bored fruits, and they were reared until getting the adult stage. Adults were then fed with a solution based on corn Money and water at the same proportion. They are nocturnal and have an average longevity between 5.7 and 7.0 days.

In oviposition cages, adults mate from 1 to 2 days after emergence. Mating occurs during night time after males show previous short and fast flights to express their excitement.

The pre-oviposition period lasts from 2 to 3 days after adult emergence. Eggs are individually laid mostly in crevices of fruit skin, and less frequently on fruit peduncle. Females oviposit daily from 1 to 100 eggs, and the total number varies from 180 to 240 eggs per female. The egg incubation period lasts from 5 to 6 days, and hatching occurs through one of the egg sides. The male: female rate is 1:1 approximately.

After hatching, the first instar larva perforates fruit epidermis and tunnels fruit pulp to advance toward the seed. It has been determined that *Stenomacrus catenifer* presents 5 larva instars, then inactive forms called pre-pupa and pupa, which do not feed and so do not cause damages. The larva spends approximately from 19 to 21 days in the fruit, then abandons it and goes underground as deep as 0.5 to 1.5 cm, where it builds a chamber before pupation. Occasionally, larvae can

complete their cycle inside the fruits and adults then emerge through the same entrance hole.

The biological cycle of *Stenoma catenifer* lasts in average 43.8 days (egg, 5.5 days; larva, 18.5 days; pupa, 14.1 days, and adult, 5.7 days) during warm months. During months with lower temperatures, the cycle lasts for about 48.8 days (egg, 5.5 days; larva, 21 days; pupa, 15.3 days, and adult, 7 days).

In *Persea americana* cv. Margarida, within chambers with controlled conditions (25°C, 60% of relative humidity and a Light: Darkness exposure of 12:12), the average duration of egg, larva, and pupa stages were 6.0, 15.3, and 10.6 days, respectively, while the average egg viability was 81.4, 25.4, and 82.8%, respectively. Females laid an average of 164 eggs. The pre-oviposition period lasted for about 2 to 3 days. Under environmental condition of July and September in Venezuela, the development periods for eggs, larvae, and adults, were 5 to 6, 16 to 33, and 7 to 17 days, respectively. Longevity of adults was from 3 to 7 days. In *Chlorocardium rodiei*, the development durations of egg, larva, pupa, and adult, were 5.0, 13.63, 12.14, and 5.0 days, respectively, and the egg average number per female was 206 (CABI, 2005).

Arellano (1998) has carried out studies under the Peruvian central jungle of Chanchamayo and Satipo, having determined that 5 larval instars are involved, and under laboratory conditions pupa development was about 22.6 days between February and March. According to studies carried out during the 1987 season, he observed infestation degrees in the following avocado varieties at fruiting stage: Bacon (54.07%), Naval (22.22%), Duke 6 (21.94%), Fuerte (11.94%), Hall (8.84%), Collin Red (7.70%), La Molina (4.54%), and Hass (0.00%). Fruits of varieties with uneven fruit surface and thick skin (case of Hass) were less susceptible comparing to varieties with even fruit surface and thin skin.

Description of development stages:

- a) **Egg:** Oval shape, chorion with irregular surface and longitudinal stretch marks. It is from 0.6 to 0.63 mm long and 0.4 mm wide. Initially, it is light green color while chorion is transparent; however, as hours pass it turns into cream white. Shortly before hatching, it shows a coffee color that turns then darker.
- b) **Larva:** When emerged, it is cream white color, with head and cervical shield light gray in color. Both head and prothorax are wider than the rest of the body. Within two days, it can be observed light gray spots on the base of every seta and small coffee-color points all over the body. The thoracic legs are well developed and light gray in color. The pro-legs are short. The second instar larva presents head and cervical shield in light coffee color. The anal plaque of the 10th abdominal segment is dark grey in color. Afterwards, it turns into pink color, which is more noticeable at the third instar larva. The anal plaque is thoroughly esclerotized and turns into dark coffee color. The fifth instar displays a violet coloration dorsally, and greenish blue ventrally. Developed larva reaches between 16.5 and 20 mm in length.



Figures N° 1 & 2 .- *Stenoma catenifer* larvae in the pulp and seed of avocado fruits

- c) **Pupa:** It is Obtecta or Momified, and oval shape. Initially it displays a greenish blue color on its anterior-ventral part, which turns shiny coffee color as the time passes. Presenta ocho pares de espiráculos abdominales, siete de los cuales son visibles. It exhibits a dorsal-transversal incision between the 4th and 5th abdominal segments. The 9th and 10th abdominal segments are fused. On the ventral part of the 5th and 6th abdominal segments, it can be observed a pair of pores on each one. Arellano (1998) points out that pupa is approximately 2 cm long.
- d) **Adult:** Head displays a group of abundant, erected scales that are reddish coffee in color. Eyes are usually shiny black; however, individuals with light gray eyes can be found. Antennae are filiform, yellow or light yellowish gray in color, and with 54 segments for males and 52 for females. Antenas filiformes de color amarillo o gris pajizo con 54 segmentos en los machos y 52 en las hembras. The labial palps are long and stretched out upward, and three segments covered with pale scales. Adults lack ocelli. The thorax is covered with light yellowish coffee colored scales, which are clearer on its ventral part.

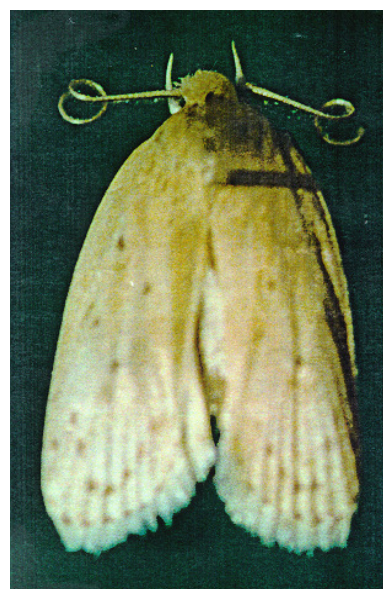
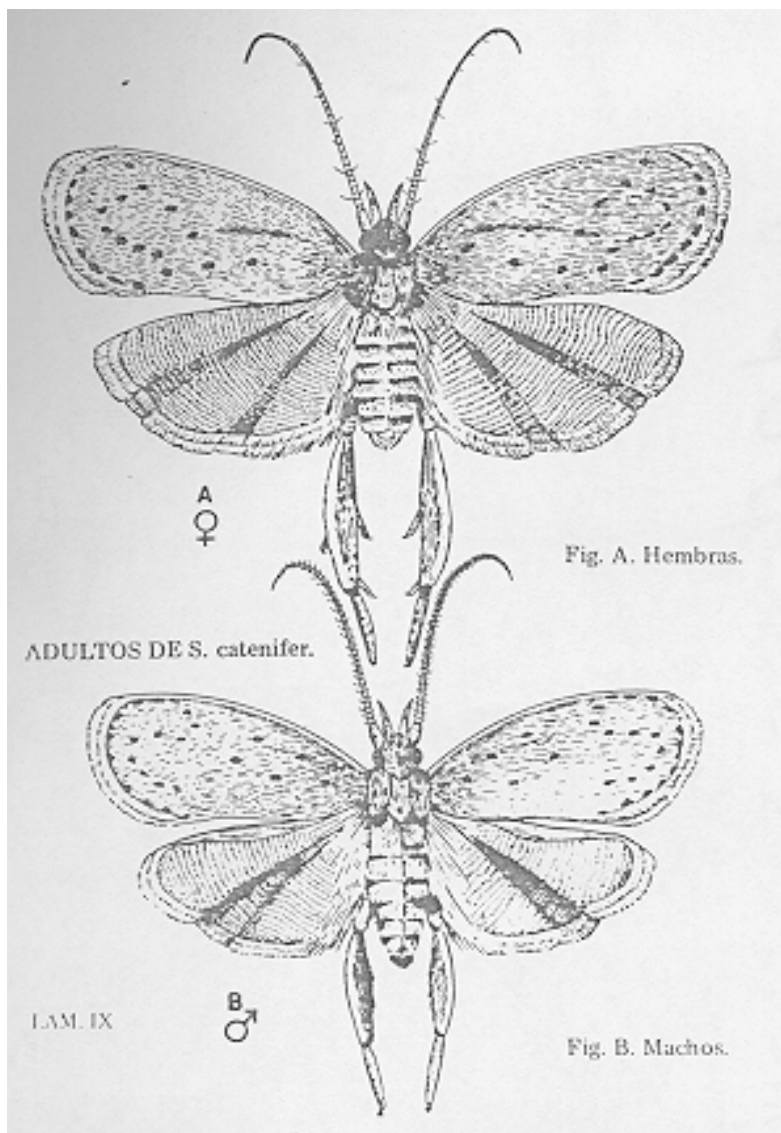
The body is covered with light yellowish coffee colored scales. Every fore wing shows 25 black spots, which are placed forming a laying “S”. The frenulum of wings comprise three long and esclerotized spines in females, and just one in case of males. Arellano (1998) indicates that wing expansion is around 3 cm.

5) Damages and Dispersal Means

At field level, *Stenoma catenifer* infestation can be detected due to the presence of frass or residues (excrements and food debris) on the fruit skin surface. As a consequence of larval activity consisting on penetrating the fruit pulp and feeding on the seed, larvae push these residues out of the fruit using the same entrance hole. Frass then keeps adhered to fruit skin.

Larvae feed voraciously on different parts of avocado fruit, destroying first the skin fruit to penetrate the pulp and using it as a food. Inside the fruit, excrements

and exuviae left by larvae cause fruit decomposing. Larvae develop their main activity on/in the seed, and so sometimes transforming small fruits into feeding debris.



Figures N° 3, 4 & 5 .- Adults of *Stenoma catenifer* Walsingham.

In very susceptible cultivars, fruits may fall down before occurrence of secondary fungus infection. When fruits are absent, larvae may burrow twigs and kill small trees (CABI, 2005). Early infestations may cause fruits to prematurely fall down due to having been injured on their bases (SAG – Chile, 1993). In addition, fruits sometimes show indirect damages because of sap exudation and secondary pathogens, as a consequence of wounds caused by the insect's feeding activity.

Natural dispersal is low since the insect is not capable to fly long distances (SARH, 1981). Also, this pest may be passively dispersed when infested fruits are moved.



Figures Nº 6 & 7 .- Avocado seed damaged by *Stenoma catenifer* larvae (See injure and excrement), and external signs (frass) of infestation on fruit surface. Notice that external signs of infestation are very obvious and may be easily detected during phytosanitary inspections.

6) Control Strategies:

a) Biological Control:

Trichogramma pretiosum and *Trichogrammatoidea annulata* are wasps that parasitize *Stenoma catenifer* eggs, and they can reach as high as 40% of parasitism in Brazil.

Arellano (1998) mentions that under conditions of the Peruvian central jungle, *S. catenifer* has an effective biological control encompassing a complex of five species of Hymenoptera that parasitize larvae, the most important of which are two species of *Apanteles*. Additionally, there are two fly species of Tachinidae family that parasitize pupae.

b) Mechanical Control

Collect and bury fallen infested fruits as deep as 1 m (Franciosi, 1992).

c) Chemical Control

According to CABI (2005), deltametrina, permetrina, and fenvalerato, are recommended insecticides.

However, it is important to highlight that this information should be carefully used since IPM programs are mainly based on biological and cultural

practices. These piretroid insecticides recommended by CABI may seriously damage biological control agents. A reasonable IPM approach for fruit borers like *S. catenifer* should not consider broad-spectrum insecticides as a priority or unique measure, but as the last possibility. Instead, it is advisable to deem early applications of *Bacillus thuringiensis* or Inhibitors of Chitin Synthesis along with other biological tactics (such as releasing of parasitoids and/or predators), and cultural practices.

7) Economic Impact

This is one of the most serious avocado pests, since it not only affects fruits and shoots but also its control is quite difficult. New plantations may be destroyed and become unprofitable (SAG – CHILE, 1993).

VI. SURVEY ACTIVITIES

1) Survey of *Stenomoma catenifer*

According to the pest biology, the whole larval stage develops inside the fruit. Besides, fruits of varieties with uneven fruit surface and thick skin (fruits A) are less susceptible comparing to varieties with more even fruit surface and thinner skin (fruits B), observations that derived from studies of Arellano (1998).

Based on these premises, survey methodology consists of taking fruit samples from pollinator trees (fruits B) and from commercial varieties, 'Fuerte' (fruits B) and 'Hass' (fruits A), and so concentrating effort, resources, and time on more susceptible fruits.

1.1. Sampling of Fruits from avocado pollinator trees

Personnel of SENASA's Executive Offices in conjunction with avocado producers, through an agreement and previous training, must survey three pollinator trees per hectare, observing fruits located on the medium part of the three canopies. Fruits will only be extracted from plants if they show suspicious external signs of *S. catenifer* infestation as were described above.

1.2. Sampling of Fruits from trees of commercial avocado varieties

Fruit sampling procedures to be applied on this case corresponds to that described in Manuals of the SMFPF (Fruit Fly and Phytosanitary Projects Section) of the Plant Health Division. This part of the survey is carried out jointly between SENASA's personnel executing fruit fly survey and personnel carrying out phytosanitary surveillance (or another one assigned by the official responsible of plant health).

1.2.1. Procedures to be considered in areas under sampling

- a) A fruit fly trap must be the point of reference, around which and within a 200-meter radius from this trap, samples of 4 fruits must be taken from 1 to 3 different points.

- b) The points indicated above must be selected by using the criteria of host presence and plant phenology.
- c) Inspectors must proceed to extract fruits from the plant only if they display suspicious *S. catenifer* infestation.
- d) Fruit fly inspectors must check the trapping routes on a weekly basis while rendering fruit sampling.

1.2.2. Required equipment and materials for sampling

Personnel in charge of collecting samples should have the following:

- a) Cooter or knife
- b) Box of sampling (Container for transporting collected fruits)
- c) Bags of 2-kg capacity
- d) Labels to identify samples
- e) Forms of Official Sampling Register (ROM)
- f) Field notebook, pencil, and blue pen
- g) Map indicating the sector that corresponds to every collector
- h) Vehicle

1.2.3. Procedures for taking samples

At field level, fruits from the plant as well as those fallen on the ground will be taken at 60 and 40% respectively; the following should be considered:

A. Sampling of fruits from plants

It should be a representative sample, that is, fruits from different levels (low, medium, and high) of the Canopy should be included in the samples.

B. Sampling of fruits on the ground

Fruits that apparently have recently fallen down and display suspicious perforations, should be collected.

1.3. Packing of Samples

Every sample must be kept in 30 x 40 cm transparent plastic bags, on which a label must be incorporated with respective data for identification. These labels must be filled up by using a carbon pencil, including all the data for the identification process. These bags should then be kept in a container made of isolating material, samples properly packed and labeled should be transported through collection routes, so that they do not become directly exposed to sunlight, which may provoke death of larvae due to suffocation and, as a result, adults will not probably be obtained from them.

1.4. Sampling Frequency

Sampling will be carried out on a weekly basis ('Hass' or 'Fuerte'), and every 15 days for pollinator trees. The SMFPF renders sampling at the same place and at least every fifteen days since samples are not taken from the same place every week.

2. Recovery of adults:

At the Executive Office's facilities, collected suspicious fruits must be placed in **Boxes for Recovering Adults** (Figure N° 8), which contains a small metallic basket or screen for allowing larvae to pass through and move downward in order to pupate. In addition, sawdust or refined sand is put on the bottom of every box for simulating a natural material where the insects will pupate. Every box must have a code initiating with PSC followed by the correlative number; for example, PSC-001, PSC-002, PSC-003, PSC-004, etc.

If an adult moth emerges before the 30-day period, it will be placed in a killing jar (with Cyamide), and then sent to SENASA's Plant Health Laboratory according to the Protocol for sending samples. After 30 days, the sand will be checked and if no pupa is found, the work will have finished. The information regarding the non-occurrence of the pest must be also registered on the Forms corresponding to the SMFPF (Fruit Fly and Phytosanitary Programs Section), so that the data will be entered the SIIMF (Integrated System of Fruit Fly Information). Cleaning and conditioning the Box will follow in order to have it ready for another sample. If pupae are found, they must have to stay in the box until emergence of adults. Suspicious adults must be sent to the Plant Health laboratory for identification.

The taxonomic identification is done by using the moth adult stage. Identification at family level is done by observing wing venation. Every fore wing shows 25 black spots placed forming a laying "S", which is a reliable characteristic for identification of *Stenoma catenifer*; however, wing scales are sometimes removed, and consequently, genitalia analysis for a reliable identification is required. The final identification can only be officially reported by SENASA's Plant Health Laboratory.

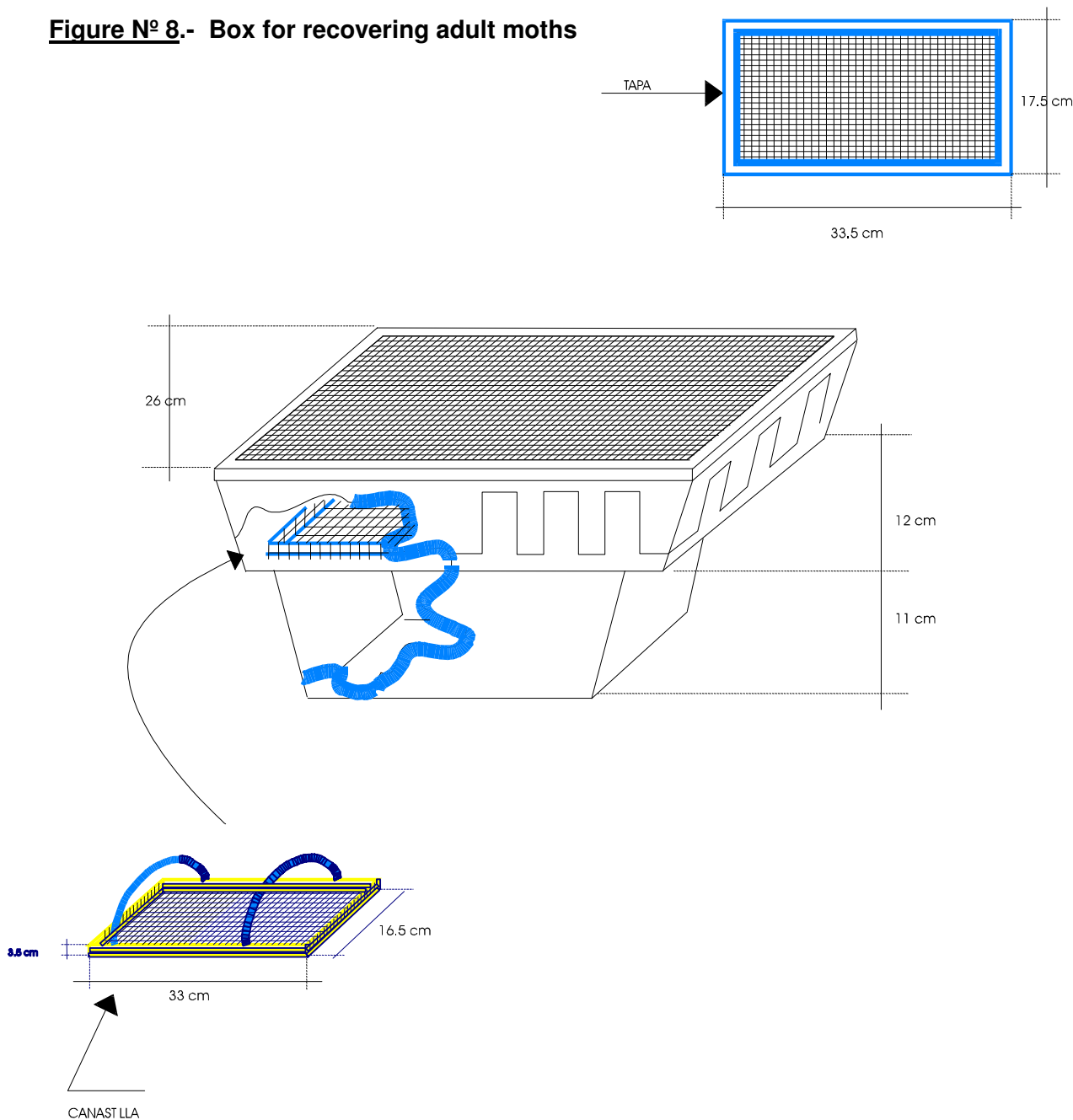
3. Registration of Information

3.1. Pollinator Trees

The field information must be first registered in the **FORM DSV/SARVF-01-PSC** corresponding to the **FORM FOR AVOCADO GROVES AND FOR SAMPLING OF FRUIT FROM POLLINATOR TREES**.

For preparing the monthly report, the data must be stated on the **FORM DSV/SARVF-02-PSC** corresponding to the **MONTHLY CONSOLIDATED OF FRUIT SAMPLING FOR POLLINATOR TREES**. Only will this Form be sent to the Plant Health Division at SENASA's headquarters, on a monthly basis.

Figure N° 8.- Box for recovering adult moths



3.2. Trees of commercial varieties (Hass, Fuerte)

The information must be entered the Integrated System of Fruit Fly Information (SIIMF), from where the SARVF (Risk Analysis and Phytosanitary Surveillance Section) will obtain the monthly reports and whenever required.

VII. SUPERVISION OF SURVEY WORKS

The involved SENASA's executive offices must supervise survey activities for *Stenomacrus catenifer* carried out by the private sector personnel, who have been previously trained within an agreement framework. As a result, the executive office must prepare a monthly report about the supervisions.

The SENASA's headquarter as well as the Executive Offices, if applicable, may implement any additional procedure to ensure accomplishment of activities presented in this manual.

VIII. TRAINING

The SARVF will organize in conjunction with the Executive Offices, training sessions directed towards involved field personnel from Lima, Ica, La Libertad, Arequipa, Ancash, and Moquegua. After being trained, SENASA's personnel will receive a Certificate of Participation only if they have replicated the training to personnel of their corresponding Executive Offices, for which a list of people who received the training along with their respective signatures must be submitted to SENASA's headquarters. The training replication must comprise both theory and field sessions.

IX. REFERENCES

- Acevedo, 1973. El barrenador del hueso y la pulpa del aguacate. Tesis para obtener la maestría en Ciencias en la Escuela Nacional de Agricultura – Chapingo. Publicado por la Comisión Nacional de Fruticultura de México.
- Arellano, G. 1998. El barrenador del fruto del palto *Stenoma catenifer* Walsh y su control natural en Chanchamayo y Satipo. Revista de la Asociación Peruana de Ecología. Vol 1, N°1, pag. 55. Universidad Nacional Agraria La Molina. Lima, Perú.
<http://www.lamolina.edu.pe/ciencias/ecologia/>
- Boscán de Martínez – Godoy. 1985. Observaciones Preliminares sobre la Biología de *Stenoma catenifer* Walsingham (Lepidoptera: Stenomatidae) Taladrador del Aguacate (*Persea americana* Mill.) Agronomía Tropical 34 (1-3):205-208.
http://www.redpav-fpolar.info.ve/agrotrop/v34_1-3/v343a016.html
- Crop Protection Compendium. 2005. CAB International. United Kingdom.
- MINAG. 2003. Estadística Agraria. Dirección General de Información Agraria. Ministerio de Agricultura, Lima-Perú. Disponible en:
http://www.minag.gob.pe/info_agri/infoagricola02.shtml
- Secretaría de Agricultura y Recursos Hidráulicos SARH. 1981. Principales plagas del Aguacate. México.
- Servicio Agrícola y Ganadero (SAG) de Chile. 1993. “*Stenoma catenifer*”. Informativo Fitosanitario. Año X – N° 03. Departamento de Diagnóstico y Vigilancia. División de Protección Agrícola.
- Tijero, M. 1992. El Cultivo del Palto en el Perú. Ed. FUNDEAGRO. Lima, Perú.

X. ANNEXES

- FLOW CHART
- FORM: DSV/SARVF-01-PSC
- FORM: DSV/SARVF- 02-PSC

FLOW CHART

