INTRODUCTION TO POLLINATION

Hands-on Learning in Agriculture for 4H Clubs and Agricultural Science students in Trinidad and Tobago

This document was prepared to supplement learning materials for Agricultural Science students and 4H clubs, introducing the topic of pollination and its importance to food production.

BES-Net TT project
2021-2024

BES-Net TT Project Introduction to Pollination for 4H Clubs

The United Nations Development Programme (UNDP) implemented the project – Biodiversity and Ecosystem Services Network Trinidad and Tobago project (BES-Net TT) - on behalf of the Government of the Republic of Trinidad and Tobago in 2021-2024. The overall project goal was to conserve globally important biodiversity in Trinidad and Tobago by addressing the science, policy and practice of pollination and pollinator management.

Three major outcomes of the project were given as:

1. Improved scientific knowledge of pollinators and pollination services in Trinidad and Tobago;
2. Improved conservation of pollinators and pollination services through improved plans and policies;
3. The provision of education, tools and support to improve the practice and application of pollinator and pollination science in multiple contexts.

Further background information on the project is available at http://biodiversity.gov.tt/index.php/bes-net/bes-net-tt.html

One of the key project outputs was building public awareness and knowledge of pollinators and pollination. Students in local primary and secondary schools were identified as key audiences with which such knowledge should be built. A Communication Working Group reviewed curricula of certain subjects at both educational levels and selected key sections of these curricula in which information on pollinators would be relevant. The team brainstormed on various ideas which could be developed into content that can be incorporated in curriculum delivery while adding information to inspire students to value and conserve this important segment of our local biodiversity.

The Agricultural Science curriculum provided several entry points for development of relevant learning materials and early in the project, 4H Clubs were recognised as an important audience to share these materials. Communication was held with executive members of the 4H Club platform to discuss opportunities for collaborative work and the idea of developing this resource was explored. The result was development of this resource booklet which can be used in club activities to build knowledge of the important role of pollinators and to enhance skills for sustainable food production.

Each section of the book incorporates a basic introduction, hands-on activities and links to additional resources. At the end of the booklet is a questionnaire for completion by club coordinators/teachers; please send the completed questionnaire to the attention of besnet.tt@gmail.com We hope you find these resources to be useful and your clubs/students enjoy using them!

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Contents

The important role of flowers in plant reproduction

Introduction

Flowers are very distinctive parts of plants and play a major role in a plant's reproductive cycle. In this section, key characteristics of flowers and flower anatomy are provided as a simple introduction to this unique feature and role in flowering plants.

Flowers can be found singly, or in bunches, they can be large or small, they can be elongate or flat, they come in a variety of shapes and sizes. They also come in a variety of colours, some being very bright, and some having more than one colour, or with markings along their petals. Flowers are often visited by animals. What attracts the animals to these flowers? (Ask the group). Animals are attracted to flowers by the colours and the scents of flowers, and the possibility of finding food which provides energy. The food is in the form of nectar, a sugary, liquid food, which is found commonly at the base of the flower and may be found on other locations on the plant structure.

Parts of a flower

A flower is made up of several parts. Even though flowers from different plants may look different, you can take apart a flower from any flowering plant and observe the same parts. In the diagram on the following page, you can see the location and shape of these parts and learn the names of these parts. These are the main roles performed by these structures in a flower:

Sepals: these structures enclose and protect the emerging flower (bud) and are usually green and leaf-like. When the flower is opened, sepals lay flat at the base of the flower, at the top of the *flower stalk* or *pedicel*. Some flowers have modified *bracts* instead of sepals which may be brighlty coloured.

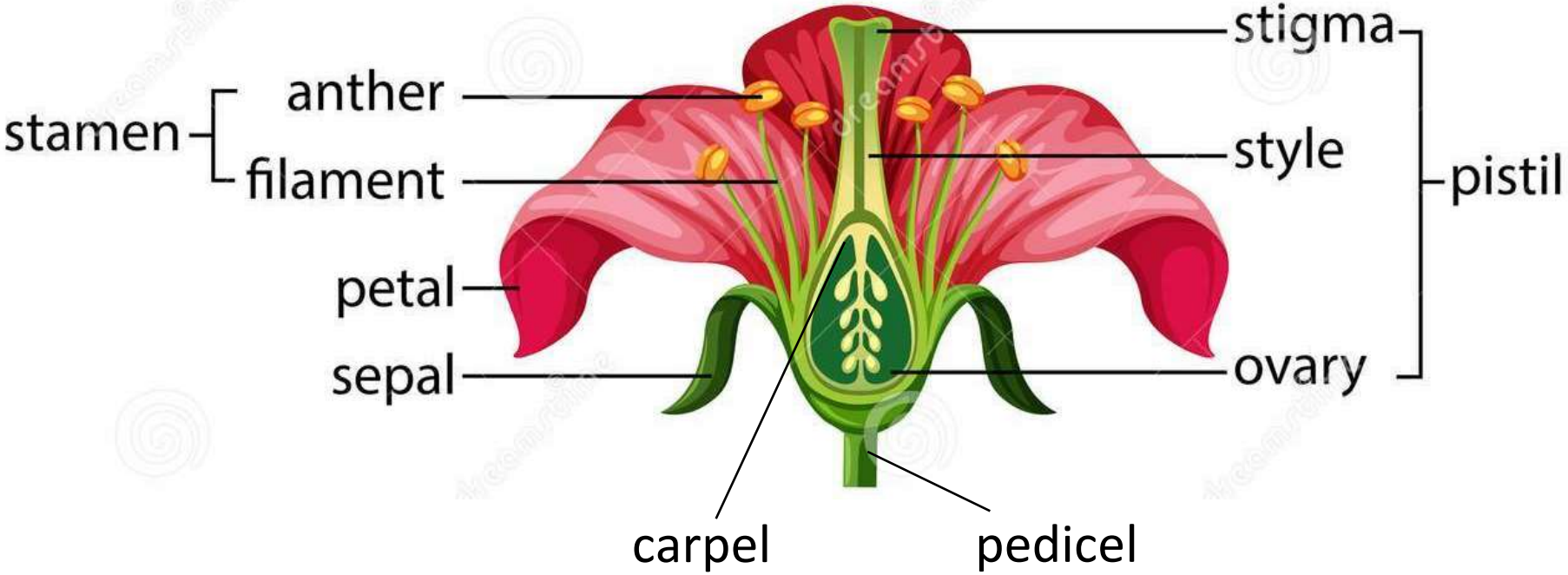
Petals: these are the brightly coloured, showy parts of the flower, arranged in a ring-like fashion, which bring attention to the plant and attract insects and other pollinating organisms. The collection of petals is called the *corolla*. Petals may be numerous or few, layered or fused. Sometimes petals bear coloured or relief lines that radiate outwards from the centre of the flower; these are *nectar guides* and they are common in flowers that are pollinated by bees. The guides direct the insect to the location of nectar stores.

Stamen: this is the male reproductive structure of the plant which is made up of the *anther* and *filament*. The filament is a slender, upright part of the stamen, upon which are borne sac-like anthers. Anthers produce *pollen grains*, which contain male reproductive cells. The filament extends outwards from the flower, to make the pollen grains accessible to pollinating organisms.

Pistil: this stucture is comprised of several parts and constitutes the female reproductive part of the plant. It is swollen at the base within the central part of the flower as the *carpel*, where it encloses the *ovary* which contains female reproductive cells or *ovules*. Extending upwards from the ovary, the pistil narrows into a slender tube known as the *style*, at the top of which is found a sticky pad known as the *stigma*. The stigma's sticky surface is effective in trapping transferred pollen, in the process of pollination.

Pollen that lands on the stigma germinates and grows a pollen tube down the length of the style to arrive at the ovary. There, the male and female cells fuse within the ovary, a process known as fertillization. The fertillized ovary then grows, producing seeds and the carpel is changed into a fruit. Not all flowers are pollinated by animals, some also become pollinated through transfer of pollen by wind currents.

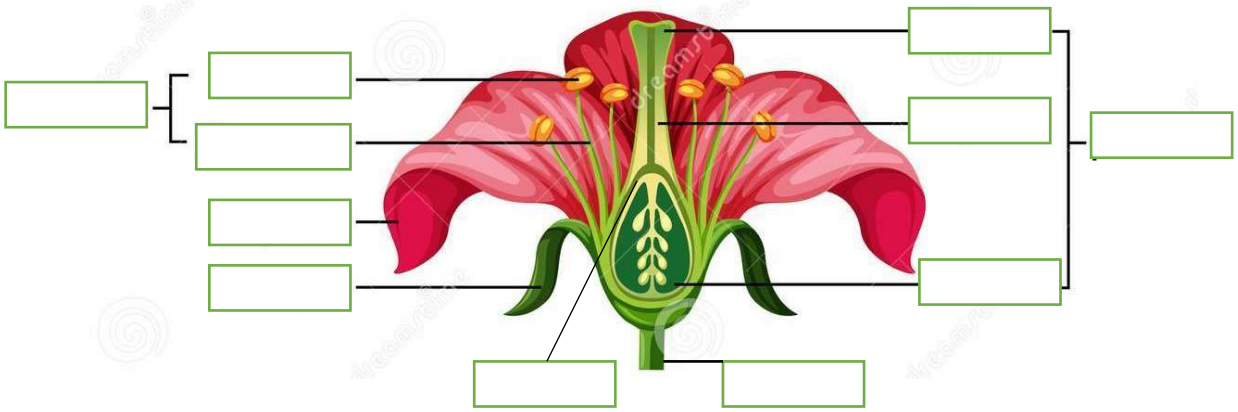
The parts of a flower



From: https://www.vecteezy.com/vector-art/302683-science-of-common-flower-parts

Recap Activity: Fill in the labels with the appropriate word from the list given below.

anther, filament, stamen, ovary, style, stigma, pistil, carpel, petal, sepal, pedicel



Recap Activity: Complete these sentences using words from the word bank below.

1. A flower is usually made up of several parts which are arranged in _____ inside each other.
2. The sepal is the outermost ring. It _____ the flower when it was in bud.
3. The petals of a plant are often _____ _____ to attract _____.
4. The stamens are the _____ parts of the plant which produce the yellow, dust-like _____.
5. The carpel is the _____ part of the plant which produces the _____ once _____ has taken place.
6. A flower can be pollinated by _____, _____ or by _____.
7. When a flower is pollinated by _____ the _____ go to feed on the _____ of the flower.
8. They brush against the _____ and collect the _____. Then they brush against the _____ of the same or different flower and pass on the pollen that way.
9. When a flower is pollinated by _____ the _____ blows the pollen. In this case the flowers usually have small or non-existent petals.
10. The pollen reaches the carpel at the place called the _____. It grows a _____ down the _____ until it reaches the _____ where a _____ is formed.

WORD BANK

animals animals anthers brightly coloured female fertilization fruit fruit insects insects male nectar ovary pollen pollen pollen tube protected rings stigma stigma style wind wind wind water

Pollination and food production

Flowers and pollination

When animals visit flowers and attempt to extract or take away the nectar, they become engaged in a process known as pollination. ***Pollination*** is a very important step in the reproduction of plants and results when pollen grains which are male reproductive cells from anthers of the flower are transferred to the stigma of the same flower or another flower of the same type. The stigma is a sticky structure that is part of the female reproductive structure of the flower.

When the animal is feeding on the nectar of the flower, the body of the animal often brushes against the anthers, where pollen grains shake off or become dislodged and fall onto the animal's body. As the animal leaves the flower, or when the animal enters another flower, the pollen grains can stick onto the stigma, thus completing the pollination process.

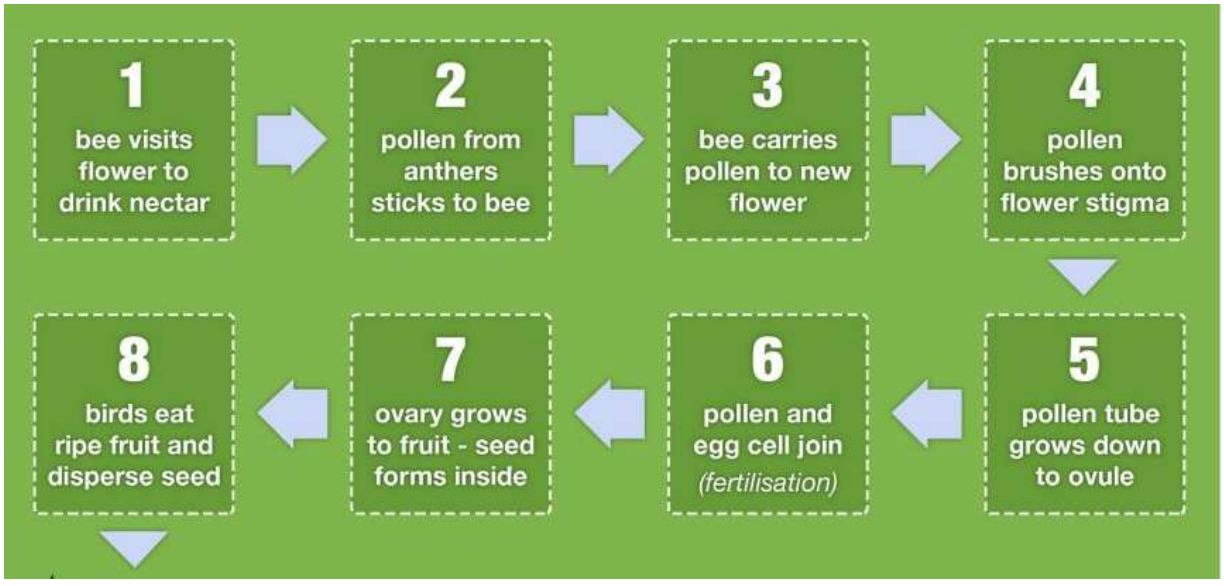
Pollination is the first necessary step in the process of plant reproduction. The flower is therefore an important part of the plant that facilitates the process of plant reproduction.

Fertilization

When pollen grains are delivered to the stigma of the flower, a pollen tube grows down the style to the ovary. Here ***fertilization*** occurs by the joining of the male (pollen) cell with the female (ovule) cell.

The fertilized ovule develops into the fruit bearing the seeds. The seeds can be dispersed after the fruit is eaten by an animal, or if the fruit falls to the ground and rots away. When the seeds germinate in soil, new plants are able to develop and grow.

The flow chart below depicts the steps involved in the process of pollination and fertilization.



As outlined in this flow chart, fertilization of the egg cell by the pollen leads to the development of a fruit and seeds. As we all know, seeds are the starting material for new plants. In the following diagram, the cycle of reproduction of a tomato plant in traced from the very first step of pollination (See Figure 1).

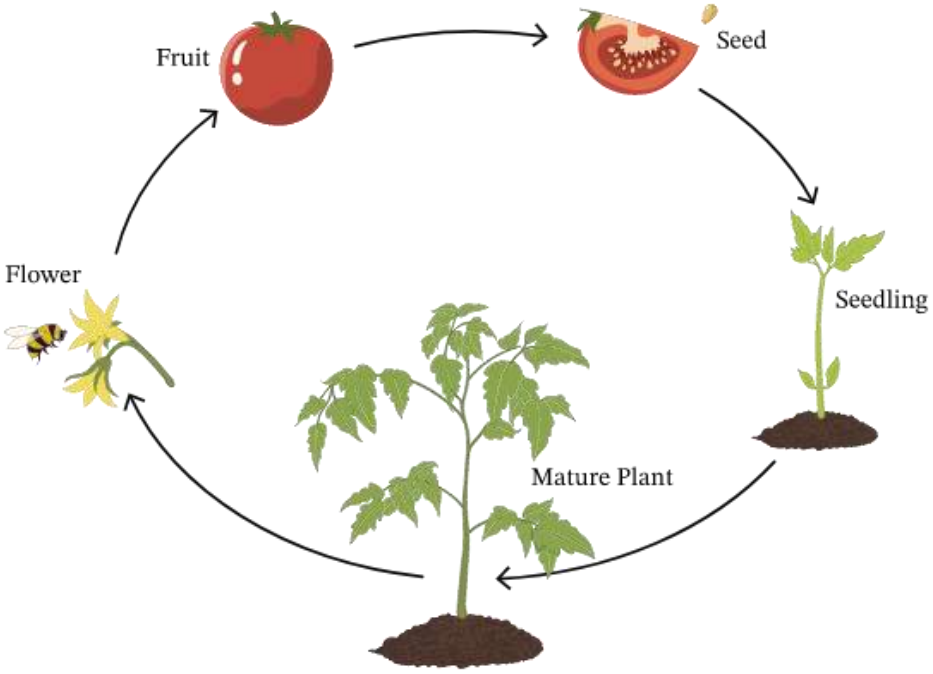


Figure 1. A diagrammatic representation of the reproductive cycle of a tomato plant

Follow-up Activity: Flower, Pollinator, Fruit, Seed

1. Let club members/students visit a farm or school garden and observe crops to familiarize themselves with the appearance of fruit and flowers of the various crops. Let them observe the flowers to note shape, colour and scent and see what animal visitors may be responsible for their pollination. They can record these observations in text and drawings in notebooks to share with the club/ in the classroom.
2. Allow club members/students to harvest the produce from the farm or school food garden (different groups can harvest different fruits). Let club members/students prepare drawings of the fruit and the seeds of each of the samples.

(See suggested recording sheet on following page)

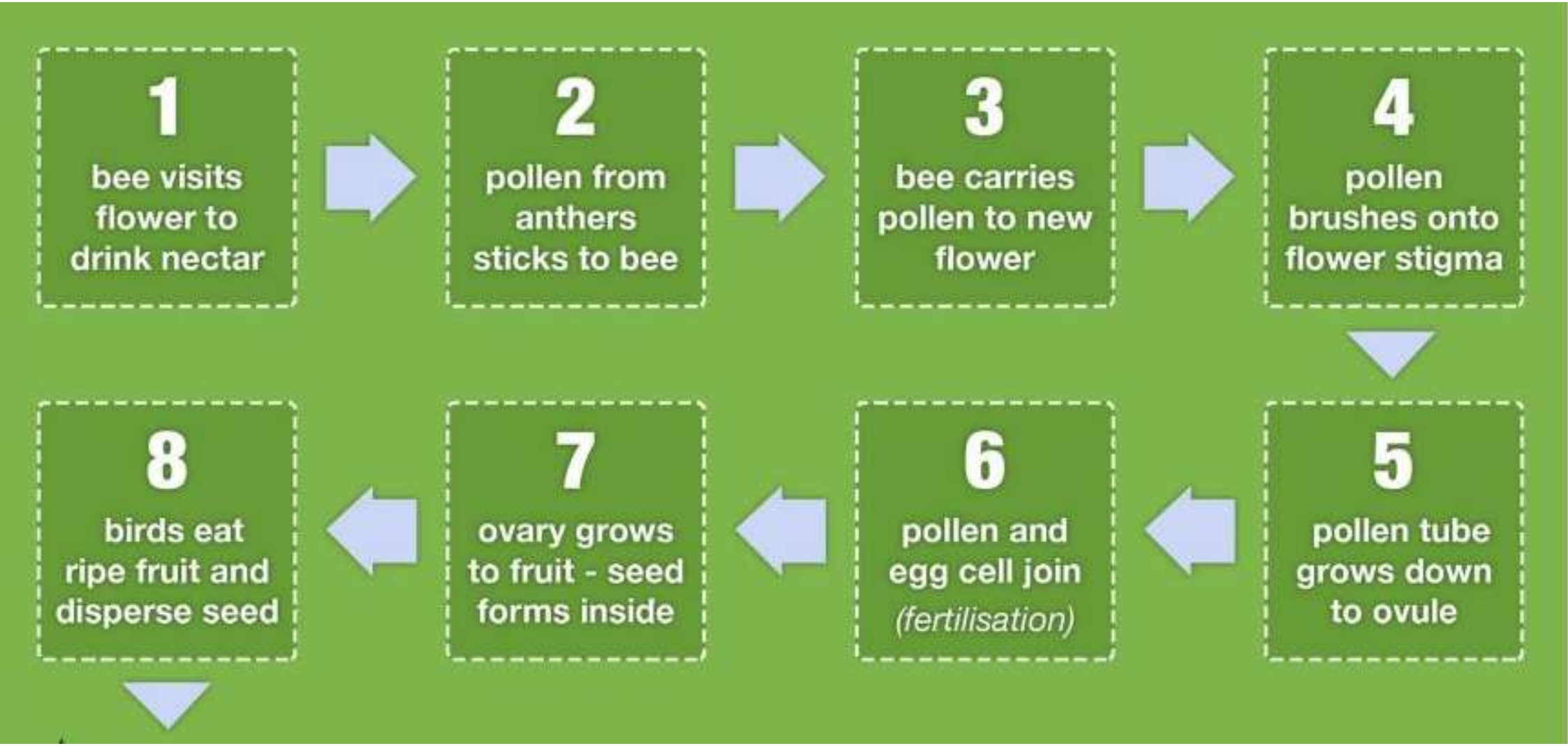
Recap Activity: Following the Processes

An enlarged version of the flowchart of pollination and fertilization processes is provided as well as a set of images depicting these steps (See pages 7 and 8). Make colour copies of each page (You can make several copies if you have a large club/class). Laminate the copy of the flowchart (Page 7). Cut out the images (Page 8) and laminate them individually to make a full set. Share the flowchart and a set of images with a group of club members/students and ask them to place the images in order on the flow chart provided, so that they can understand the steps involved in pollination and fertilization.

Crop Record Sheet: Flower, Pollinator, Fruit, Seed

	Name of Crop	Flower description/drawing	Possible pollinators (observed on flower)	Fruit description/drawing	Seed description/drawing

The Processes of Pollination and Fertilization in Flowering Plants



From: https://englishthroughgardening.org/wp-content/uploads/2021/01/ETG-BEE-4A-WORKSHEET-Bees-and-Flower-Life-cycles.pdf

From: https://englishthroughgardening.org/wp-content/uploads/2021/01/ETG-BEE-4A-WORKSHEET-Bees-and-Flower-Life-cycles.pdf

Life cycles of insects

All insects begin their lives as eggs and then go through several changes to become adults. The eggs of insects are laid by adult insects in various places. Here is a list of insects with which you are probably familiar; indicate where these insects usually lay their eggs.

Name of Insect	**Location where eggs are laid**
Mosquito	
Butterfly	
Bee	
Cockroach	

The growth and development of the eggs into adult insects is marked by many changes, including changes in appearance and in the food they eat (diet). When the egg of an insect hatches, the next stage of development is known as the larval stage or larva.

The larva or young stage may look very different from the adult, or closely resemble the adult in form.

The larvae of insects that look similar to the adult, are known as nymphs. Nymphs eat similar foods to their adult forms and go through a series of moults as they grow in size, until they develop into adults. (In moulting, the body covering or exoskeleton is shed).

The larvae that look very different from the adult insect go through a phase in which the body becomes encased in a sac and rests while it goes through a further change in form. This stage is called a pupa.

The larvae of insects that look different from the adult usually eat differently from the adult also. Think about some young stages of some insects and state whether they eat the same food as the adult or a different food type.

Name of Insect	**What adult stage eats**	**What larval stage eats**
Bee		
Butterfly		
Cockroach		
Mosquito		

FUN FACTS

The series of changes is called metamorphosis from the Greek words:
meta = change, morphe = form

Egg to larva to pupa to adult = Complete Metamorphosis

Egg to nymph to adult = Incomplete Metamorphosis

Activity: Bee/Butterfly Life Cycle

The butterfly has a life cycle which demonstrates Complete Metamorphosis.

In this activity, the student is able to construct the life cycle of the butterfly as a craft project.

Materials:

- Four life cycle stages: egg on a leaf shape; larva; chrysalis or pupa; adult butterfly
- A template with a pre-printed shape to cut out
- Pen or marker
- Glue

Instructions:

1. Cut along the printed shape (Page 11) to obtain the template for construction of the life cycle.

2. Fold the template in half (with the printed side inward) so that the shape becomes two mirror image pieces.

3. Fold each half (outwards) so that the curved portions line up as mirror images.

4. Unfold the template and lay flat, with the printed side upwards.

5. Cut out life stages (below). Using the glue, glue the life stage pieces in the correct sequence, between the arrows.

6. Allow the glue to dry (about 5-10 mins).

7. Label the life stages (above or below each glued piece) using the pen or marker.

8. The template can be folded carefully as indicated in steps 1 and 2 above after the glue has dried.

9. You now have your personal copy of the butterfly life cycle… in the shape of a butterfly!

Images from: https://www.thebestideasforkids.com/butterfly-life-cycle-craft/

TEMPLATE

(see cutting instructions below)

THE LIFE CYCLE OF A BUTTERFLY

Instructions – cut around the butterfly shape (including around head and antennae) and along the dotted lines

Planting your garden with pollinators in mind

Understanding the important role of pollinators in food production, effort should be made to protect them in the agricultural setting. Within the life cycle of some pollinators, the larval stages feed on vegetation; this presents a problem as damage to the growing plant may impact the plant's ability to perform at its best potential.

The larvae that cause damage to the plant are termed "pests" and control of pests is a regular undertaking in agriculture. The use of chemical pest-control is commonplace on farms, but this becomes a problem when the chemicals kill not the just main pest target, but also other organisms that are beneficial to the crop, among these, pollinators.

The chemicals may, however, create problems when they are not applied properly; excess materials may enter water courses and groundwater and affect animals that live in these places. If the chemicals are applied without the use of protective equipment, the person applying them runs the risk of becoming very ill.

If farmers must use chemicals on their farms, the following recommendations are given:

- Select the right pesticide for targeted use.
- Use environmentally safe chemicals.
- Apply chemicals correctly while using personal protective gear.
- Safely dispose of pesticide containers.
- Use safer alternatives for pest control.

Another way of addressing the problem of chemical pollution and harm is to alternatively use natural pest control. Natural pest control involves the use of another living organism to manage pests. Sometimes the known predator of the pest can be introduced into the crop to reduce pest populations. Also, if the pests can be identified, certain plants may be introduced among plants of the main crop which are able to deter or repel the target pests.

In order to fully use and benefit from the use of natural pest control, two key things must be known, i) the identity of the pests and ii) the natural predators or pest-deterrent plants for the specific pests.

In another section, a tool which can help in the identification of pests (and beneficial pollinators) will be introduced. The following gives some insight into helpful plants that can be used to counter agricultural pests.

Pollinator attractants

Some plants are attractants for beneficial pollinators due to their colour and scent. Consider planting these plants near your crop beds to bring in pollinators.



(Left to right)
Sunflower
Bachelor button
Zinnia

Trap crops

Trap crops are plants which draw pests away from vegetables. The pests will instead move to these trap crop plants, and then the trap crop can be uprooted and removed from the field. Consider these:

Sage – Plant this near to eggplant and pepper plants to help with flea beetles and around brassicas to help with the cabbage butterfly.

Zinnias - These act as a trap crop for Japanese beetles, drawing them away from food crops.

Figure 1. Sage from joegardener.com/how-do-i-grow-herbs

Pest repelling plants

Pest repelling plants keep your crop plants pest free. They usually have volatile chemicals which the pests detect and cause the pests to turn away from the field. Consider these plants to keep pests away:

Marigold - great for repelling pests such as cucumber beetles, cabbage worms, thrips and hornworms.

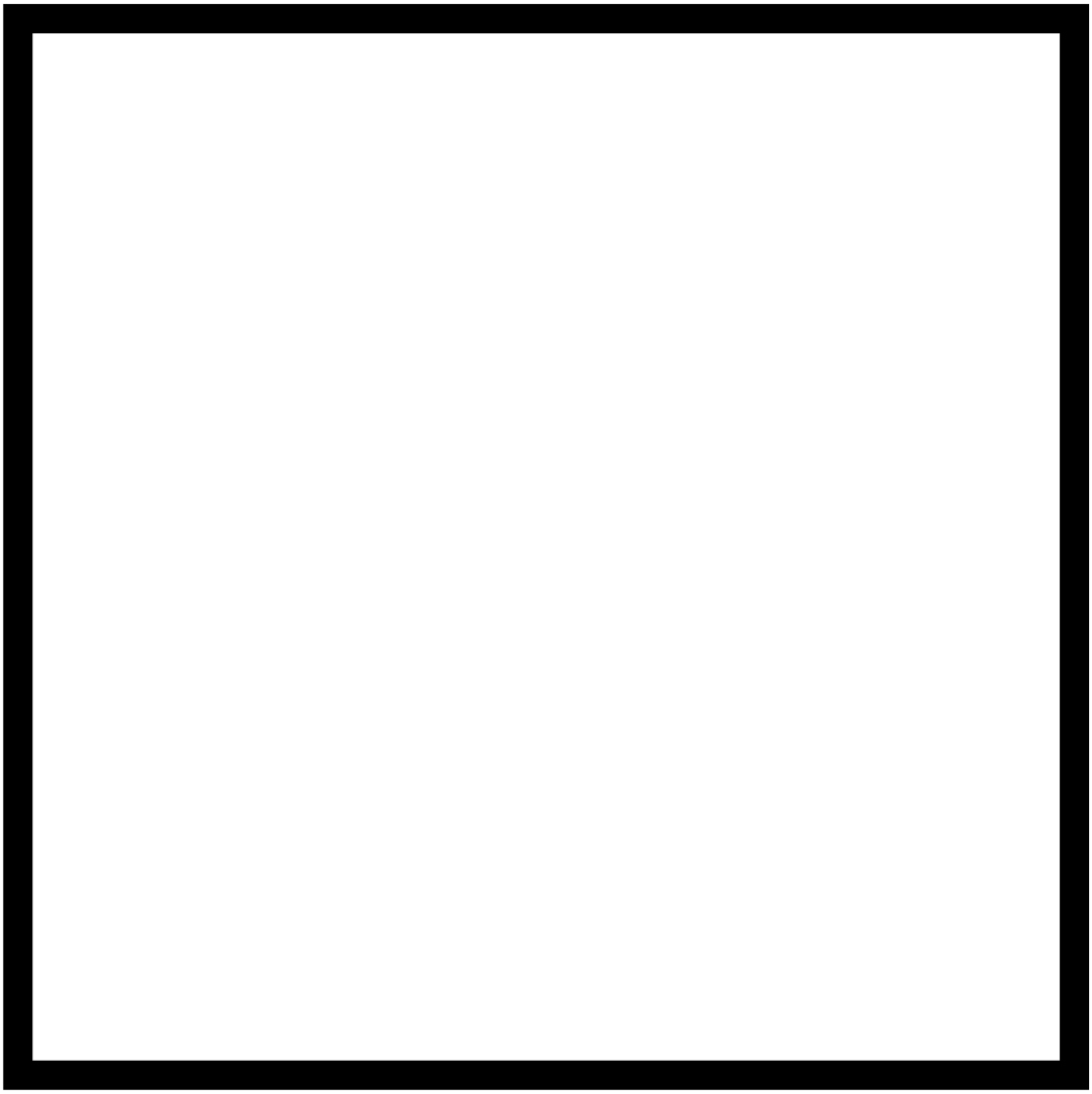
Garlic, Chive – these belong to the allium family and repel aphids and slugs. They are also edible and function as companion crops which yield beneficial produce apart from their repellent properties.

Figure 2. Garlic from joegardener.com/grow-garlic

As you can see, there are some overlaps, with some plants performing dual functions. Now plan your garden with natural control and pollinator-attraction in mind!

Activity: Planning your garden layout

Imagine that you have a plot of land measuring 20m x 20 m on which you can practice agriculture. Decide on the crops you wish to rear on the land. Design a plan for this garden, incorporating plants which can attract pollinators, repel pests and provide edible produce. Draw the design of your garden in the space below, labelling each crop at its location in the garden.



iNaturalist – Pollinators and Pests in T&T

The Biodiversity and Ecosystem Services Network Trinidad and Tobago project (BES-Net TT) wa undertaken by the Ministry of Planning and Development with the support of the United Nations Development Programme (UNDP) from 2021 to 2024. The objectives of the project centered on improving the management of local pollinator species through improved practice, science and policy for pollinator management. The project supported an early initiative undertaken by the Ministry's Environmental Policy and Planning Division, which allowed citizens to contribute to the development of an online database of pollinator species on the iNaturalist online platform: https://www.inaturalist.org/

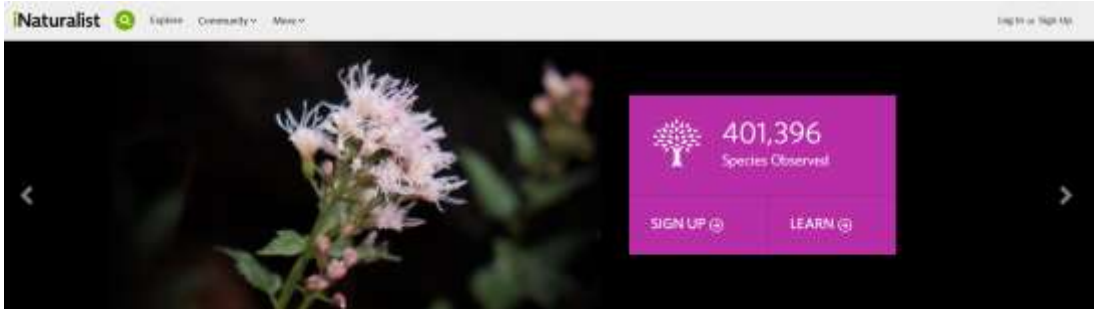
The iNaturalist platform is a global service which provides the average person an opportunity to be engaged in citizen science, contributing information to a body of knowledge of worldwide as well as local benefit.

Persons can photograph living organisms and upload these photographs to iNaturalist where a team of experts from around the world can propose and agree on the identity of the organism. A Trinidad and Tobago species listing on iNaturalist was created to capture information from the two islands, and a project which captures a listing of pests and pollinators of Trinidad and Tobago. 711 species have been identified through the project and the BES-Net TT team wishes to continue to promote use of the platform to increase data collection locally.

As young agriculturalists, you may see some organisms in your gardens and not be certain whether these organisms can bring harm to the crops or whether they can be helpful as pollinators; iNaturalist can help you to determine which, by helping you to identify the organism. Here are the simple steps to follow:

1. The BES-Net TT team has posted to its You Tube channel the recording of a webinar that gives a guided tour of the iNaturalist platform. The Club is invited to view the recording as a group.

2. Visit iNaturalist at https://www.inaturalist.org/ to explore the platform.



3. Sign up for the platform (or your club coordinator can sign up).

The activity can be done by the Club as a group or individually in the school garden, in an at-home garden, or at a farm.

1 Use a record sheet during this activity so that each time you go out to the field, you can document the date, the location, and general notes about the animals/plants seen. A simple template is provided (below) but you can also draw up records in a notebook (See an example of a recording template below).

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2 Conduct observation of the flowers in the chosen area to determine which flowers are being visited by animals.

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3 Note the particular type of animal present. This can include bees, wasps, butterflies, ants, other types of insects, birds and even lizards.

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4 Take a good photograph of the flower visitor when at the flower. A good photograph will have the following elements:

a. The entire body of the organism is captured within the frame of the photograph.
b. When the photograph is taken, the true colours of the organism are captured; adjust angle of camera as needed so that the lighting of the image does not alter colour.
c. As far as possible, capture a dorsal (overhead) shot and a lateral (side) image of the organism, and if possible, a photograph of the underside (in butterflies) as there may be colour differences at each angle that may help in identification of the organism.

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5 It is useful to capture as many photographs of the organism as possible in the field from which the best can later be selected.

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6 For safety reasons, it is not recommended that organisms are captured. However, if appropriate equipment is available, under an adult's supervision the organism can be captured, photographed against a plain background, and then released back into the environment (may be best to limit this to butterflies captured with a sweep/butterfly net which will cause little injury to the insect).

Student iNaturalist Record Sheet

Date	Location	Flower Visitors Observed	Photographs taken (Yes/No)

Instructions - After field visit

1. After returning from the field, it is advisable that the photographs are quickly downloaded to a computer/laptop/hard drive.

2. Review the images captured and select those that meet the requirements of a good photograph.

3. *Optional:* You may decide to rename the file names of each of these selected photographs using a code that gives the general name of the organism and the date of capture. For example, a butterfly photographed on November 5th 2022 can be recorded as 1_Butterfly_001_051122. A different angle of the same butterfly can be recorded as 1_Butterfly_002_051122. Then, if a different butterfly was recorded on the same day at the same location, that photograph can be recorded as 2_Butterfly_001_051122. A photograph of a bee can be recorded 1_Bee_001_051122.

4. When you have made your selection of images, you can begin to upload these to iNaturalist. Log in to the platform and follow Step 4 in the first section, that is, go to the Community tab, select Projects, search for Pollinators and Pests of Trinidad and Tobago, then add observations (upload your images) to the project.

5. You will need to put in a name for your observation. If you know this is a butterfly, you can put 'butterfly' in as the name, but you can also put in 'insect' if you are unsure . When unsure, use a more generic term like 'insect'.

6. You will need to add a location for your observation. There is a map to guide your selection of location, but you may also just put in a main town or village, like California, but ensure that the country is also put in: Trinidad and Tobago.

7. You will receive an e-mail notification when an identification is proposed by one of the many experts around the world that view your photograph. When three experts agree on the identification, you have greater certainty of the identification. If your photograph is of good value as a reference image for future research or identification, you will see the tag "research grade" added to your observation!

Enjoy this short, animated clip on the BES-Net TT project's TikTok channel, on why using iNaturalist is so useful.

Apiculture with Stingless Bees

Beekeeping has been practiced in Trinidad and Tobago for many years and there are several experienced beekeepers in the islands. The bees that are managed in hives are called honeybees, with the scientific name *Apis mellifera*. In Trinidad, these bees are the Africanized variety, which are very aggressive, while in Tobago the bees are known as European bees which are milder in behaviour.

Lesser known are the native stingless bees, also known as the Meliponini. Globally, there are almost 500 species of stingless bees. They are found in most tropical and subtropical regions of the world. In Trinidad and Tobago, eleven (11) species of stingless bees have been recorded. Stingless bees have co-evolved with native plants and local crops and are very important pollinators of many of the crop plants that produce our food. The eleven species of stingless bees recorded locally are listed below, with scientific names and common names provided; images appear on the iNaturalist platform.

<table>
<tr>
<td> 
Cephalotrigona capitata</td>
<td> 
Frieseomelitta paupera
“Petite angel”</td>
<td> 
Lestrimelitta limao
“Lemon Cab”</td>
</tr>
<tr>
<td> 
Lestrimelitta spinosa</td>
<td> 
Melipona favosa
“Erik” or “Moko Chiquita”</td>
<td> 
Melipona trinitatis
“Guanot” or “Moko Grande”</td>
</tr>
<tr>
<td> 
Nanotrigona testaceicornis
“Irai”</td>
<td> 
Partamona nigrior
“Petite Pegone”</td>
<td> 
Plebeia sp.
“Mirim”</td>
</tr>
<tr>
<td> 
Trigona amalthea
“Pegone”</td>
<td> 
Trigonisca sp.</td>
<td></td>
</tr>
</table>

Management of stingless bee colonies

Stingless bees, like honeybees, are very important pollinators and some stingless bees like honeybees, produce a type of honey which is used for medicinal purposes. In Trinidad and Tobago, certain species of stingless bees are reared in artificial hives and their honey – which is usually much less in volume that that produced by honeybees – is collected.

The natural hives of stingless bees are found inside hollows of trees, drill pipes and even the bricks of man-made buildings. Unfortunately, they are prone to destruction when harvested, being vulnerable in the wild, since the bees, having no sting, do not offer much defense to large intruders. In addition, when trees are removed, the bees do not swarm and relocate in a new space as they are not nomadic. For these reasons, management of stingless bees in artificial hives is the next ideal, to secure colonies.

The hive boxes used in rearing/managing stingless bees are different in design from honeybee hives, and there is some variety of design among the species which are reared, namely, *Melipona favosa* ("Erik" or "Moko Chiquita"), *Melipona trinitatis* ("Guanot" or "Moko Grande"), *Frieseomelitta paupera* ("Petite Angel") and *Trigona amalthea* ("Pegone").

Stingless bee management as an agri-business venture

- Like honeybees, the hive products of stingless bees are used for various purposes: honey for medicinal use, pollen for nutritional use, propolis for apitherapy.
- Apart from the harvesting of hive products for personal use or for sale, the sale of hive boxes and/or colonies of stingless bees can be seen as a small or emerging market locally.
- Spin-off income streams are also envisioned for those supplying materials and tools for stingless bee beekeeping such as supply of hive boxes, tutorials, value chain products and crop pollination services.
- Established hives may also be a source of additional income through apitourism activities in which visitors can view hives and bees, sample and purchase hive products and tour supporting pollinator gardens as a unique tourism product.

Follow-up activity

Learn more about stingless bees by viewing the BES-Net TT video resources at the following links:

- Introduction to Stingless Bees - Professor Christopher K Starr (ret.) in Workshop 3 of BES-Net TT Workshop Series 2022. Video length: 39 min, 20 sec
- Introduction to Stingless Bees - Mr. David Rostant, Stingless Bee Beekeeper. in Workshop 3 of BES-Net TT Workshop Series 2022. Video length: 44 min, 53 sec (Time code - 0:42:35 – 1:27:28)
- Splitting and Harvesting of Stingless Bee Hives - Mr. David Rostant, Stingless Bee Beekeeper in Workshop 4 of BES-Net TT Workshop Series 2022. Video segment: 1 hour 3 min (Time code – 0:00:00-1:02:43)
- Building Pollinator Habitats – Mr. David Rostant, Stingless Bee Beekeeper, In: Workshop 5 of BES-Net TT Workshop Series 2022. Video length: 52 minutes.

Steps in managing a stingless bee colony

1. Rescue the colony in a tree which has to be cut down or identify a colony to be relocated from a built structure (e.g. in a brick wall).

2. Determine the species of bee by consulting with an expert (the Trinbago Stingless Beekeepers Network is a source of information).

3. Determine the type of hive box required for the particular species of bee.

4. Identify a safe, sheltered location for the colony.

5. Transfer the colony to the hive box. Ensure that the colony is placed at the proper location inside the box. (For *Melipona sp,* colony is near to hive entrance, for *Frieseomelitta paupera*, the colony is furthest from hive entrance)

6. Provide starting food material for the colony.

7. Install traps inside and outside of the hive to capture phorid flies (main pests).

8. Secure the covering of the hive (clear plastic) and then place and secure the removable cover.

9. Monitor the health of the hive daily and remove any pest maggots that may occur inside the hive.

10. If honey is to be harvested, follow recommended harvesting practice.

    (For *Melipona sp*, harvest from pots on one side of the brood only, then harvest at the other side on the next collection visit. For *Frieseomelitta paupera*, all pots should be removed at harvest and processed outside of the hive)

Partamona nigrior colony on a classroom wall

Melipona trinitatis colony in new hive box

Phorid fly traps containing apple cider vinegar

Honey in honey pot of *Melipona sp* hive

Additional Resources

The BES-Net TT project compiled several of its communication products on the Resources tab of the BES-Net TT webpage (https://biodiversity.gov.tt/index.php/bes-net/resources.html). You can scroll through the page for appropriate materials for the Club/student group.

Newspaper articles

YouTube videos

Resources for Teachers:

- The flower says thank you (A story for pre-schoolers)
- Primary School Science Teacher Resource Booklet
- Secondary School (NCSE) Teacher Resource Booklet

Resources for Students:

- Why do we love our pollinators?
- A story about VIPs and VAPs
- Questions for story about VIPs and VAPs
- 8 tips and takeaways for Pollinator Gardens

Newsletters

We hope you enjoyed engaging with the contents of this booklet, and that the material serves to build knowledge of young agriculturalists of the importance of protecting our local pollinator species.

Please provide feedback on the use and value of the booklet by completing and sending in the feedback form on the last page of the booklet.

Feedback

Dear 4H Club Coordinator/Agricultural Science Teacher,

The developers of this resource booklet hope that you were able to make optimum use of it with your Club/class and that the Club members/students enjoyed learning new information and taking part in the activities. Please send in your feedback on the usefulness of this resource together with any other constructive comments you wish to share, by using this feedback form. We suggest that you copy the form, complete your responses on the copy and send to the following address: besnet.tt@gmail.com

1. Have you/your club/students used any of the activities in this booklet? Yes No

2. Were the activities relevant to the curriculum of the Club/students? Yes No

3. Was the Club/Were students able to fully complete the activity/activities? Yes No

If no, cite the activity and explain what was/were the barrier/s to completion (Tick all that apply)

Activity: _____

Barriers:

Instructions were unclear	☐	Did not have required materials	☐
Students were uninterested	☐	Insufficient time to complete	☐

Other: _____

4. Was the theoretical information supplied sufficient for Club/student needs? Yes No

5. Were the hands-on activities useful for uptake of knowledge? Yes No

6. Do you intend to use this material with other groups? Yes No

7. What was the most liked aspect of the booklet? _____

8. What was the least liked aspect of the booklet? _____

Please share any recommendations you may have for improvement of this resource:

_____

_____

_____

Thank you for your assistance. Your feedback will help us to improve our educational materials.

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