Companion Guide to *Andrena a Mining Bee*

Introduction:

It is now official! There are over 20,500 bee species in the world. Most are solitary and 64 % of these solitary species nest in the ground. Solitary ground-nesting bees are active in their surroundings for a very short time - often just 10 days to 2 weeks. Within that time, a female digs a nest, protects it from predators, lays her eggs and forages for food for her larvae. She does all the work by herself. Not like honey bees that have to rely on help from worker bees.

The word *Andrena*, means “buzzing insect” in Greek and is one of the largest bee genera in the world with about 1500 species. They are found everywhere in the world except South America, Australia and Antarctica. *Andrena* species emerge early in the spring, but there are mid and late summer emerging species, too.

Objectives: students will be able to:

- Identify the anatomy, adaptations, life cycle and habits of ground nesting bees, including *Andrena*.
- Understand the dangers that bees and other pollinators face.
- Demonstrate an understanding of the importance of bees and other pollinators in the ecosystem.
- Take part in a Field Study, collect and analyze data.
- Design a pollinator/ make a flip book
- Undertake a project that could support pollinators.

A. **Reading the book *Andrena a Mining Bee***
Materials: the book Andrena a Mining Bee (author/illustrator Elaine Sedgman)

- Were you surprised by anything in the story that the author regarded as scientifically accurate?
- Describe Andrena's excavation plan. Did she follow the plan?

B. **Videos of a mining bee and other ground nesting bees**

Andrena mining bee digging a nest. Watch here.

Viewing questions:
What surprised you in this video?
How do ground nesting bees hide their nests?
Where do *Andrena* prefer to nest?

Mining Bees Ralf Jochmann: Watch here
Viewing questions:
Before emerging from the nest what adaptation did the bee use to check out its surroundings?

C. ***Research and presentation:***

In the book *Andrena a Mining Bee*, what three insect to insect interactions threatened Andrena? (*Leucophora, Bombylius*, *Nomada*.) Have students research these insects and their life cycles.

The author implies that certain human actions are harmful to ground nesting bees and other pollinators. What are they? Have students expand on these. (G*ardening and farming practices)*

D. Adaptations
What adaptations does Andrena have that help her build and protect her nest? (p.7)
Have students research these adaptations and present their findings to the class. Links to some sites and videos are attached.

- **Mandibles**

- **Spurs**

- **Tongue** (Different bee genera have long or short tongues.)
  Which bees have long or short tongues?
  Video: Teddy Bear Bees Stab Flowers to Steal their Nectar: watch here.

Bee tongues tell a tale of climate change

- **Dufours gland**

- **Pygidial plate**
  There is not much online information on how this structure is used. Find information below:
  The Solitary Bees Biology, Evolution, Conservation
  Danforth, Minckley and Neff, 2019 Princeton University, p.116.
  "Bees that nest in the soil are master excavators." They have a "well developed pygidial plate on the on the female T6 [the last segment of the abdomen] that is used to pack soil along the length of the burrow and within the brood cells. Think of the pygidial plate as a trowel used to tamp the soil as bees excavate their tunnels and brood cells. The triangular impressions of the pygidial plate can sometimes be seen in recently completed brood cells of soil-nesting bees."

- **Facial fovea**
  There is not much online information on how this structure is used. Find information below:
  The Solitary Bees Biology, Evolution, Conservation
  Danforth, Minckley and Neff, 2019 Princeton University, p.145.

  Generally, facial foveae are larger in female bees than male bees. Fovea are indented patches of shiny or velvety hairs found along the inside edge of the compound eye of a bee. Studies in 1993 using electron microscopy found that facial foveae are connected to secretory glands (glands that discharge a substance) located beneath the surface of these hairs.
  "We suspect that these glands play a key role in intra-nest communication in bees. When two bees encounter each other in the nest…the first thing their antennae are likely to contact will be the face of the other individual. Recognizing whether the individual is a nest mate or not or whether it is a potential brood parasite or nest usurper is extremely important."

What adaptations does Andrena have that help her collect pollen and nectar? (p 9-10)

- **Compound eyes that see ultraviolet light**
  What do bees see and how do we know?

- **Hairs on her antennae**

- **Scopa**

- **Hairy tongue** (see above)

- **Nectar stomach**
  How do bees drink nectar exactly? Access video here

- **Electrically charged scopa hairs**
  Bees can sense electric fields
  Electric bees

- **Scrabbling** : in this video, the bumble bee scrabbles and then uses a buzz pollinating mode. To Buzz or to Scrabble? To Foraging Bees, That's the Question?

  Viewing questions: On page 29 the author states that Andrena can buzz pollinate, yet on page 10, Andrena scrabbles. What is the difference between these 2 ways of collecting pollen?
  Head banging is another method of collecting pollen: banging by an Austalian blue-banded bee.

- **Bee flight**
  How do bees fly?
  The clip from Richard Hammond's Invisible World reveals the aerodynamics of bee flight while also discussing their flight patterns. Watch here.
  Viewing question:
  What is the secret of bees' wings that allows them to fly? (*Flexible wings, choppy strokes, rapid rotation, fast wing beat frequency)*

  The Flight of a Bumblebee - **Animal Camera Description:** Animal Camera host Steve Leonard describes bees' flight abilities and behaviors and takes viewers through the advanced technology used to capture bee flight.
  Viewing questions: What bumble bee observations surprised you? Why do you think the bees avoided the canola field? One reason was given but do you think there might be other reasons? (*Perhaps the canola was not as nutritious? Or the bees preferred native flowers?*) Why is it important to bees to fly in straight lines to forage?

E. Why bees and other pollinators are important to our ecosystem.

Power of pollinators – wild bee species. Watch here.
Viewing questions:
Were you surprised by anything in the video?
Are honey bees native to North America?
What is a solitary bee?
Why is pollination important?
What other animals pollinate?
What can we do to support pollinators?

F. Bee habitat

WFSU ecology

Help Nesting Bees by Learning to Love Dead Plants and Bare Soil

Viewing questions:

What do you think are the most important things that we can do to support pollinators?

G. Field study: Exploring good pollinator habitat.

Students will learn about pollinator habitat by looking, observing, questioning, writing and drawing.

Does our neighbourhood have good pollinator habitat?

Materials: Pencils, pens, clip board or substitute, pollinator survey sheet can be found on the Resource page.

The pamphlet *Common Bees of the Southern Interior of BC* created by the Thompson Shuswap Master Gardeners can be found on the Resource Page. Please note that *Bombus bifarius* is now called *Bombus vancouverensus.*

Before setting out:

1. **Select a suitable area for a field study preferably with flowering plants.** Mark off the site into areas suitable for 20 minutes of observation.
2. Decide how students will use the observation sheet: as individuals, in pairs or a small team. Will you need other adult help?
3. Prepare the participants to be good observers by discussing the types of things they should be watching for. Let them make suggestions. Ask the following questions to bring out ideas.
   - What makes good pollinator habitat? What would you look for?
   - What types of wildlife might you see in or around flowers?
   - How might the pollinator move on the flower- by scrabbling, buzzing, hovering, pausing on the flower? How many seconds might it stay on the flower? How can we easily keep track of the time? (*By counting slowly*.)
   - Is the animal collecting pollen or nectar?
   - What is the flower's shape? Flat? Petals forming a cup? Tubular? Clusters of flowers? What is its colour?
4. Hand out the pamphlet "Common Bees of the Southern Interior of BC". Discuss.
5. Distribute the Survey Sheet. Explain to the students how you want them to use the sheet. Explain how to count seconds slowly.

The survey sheet divides insects into functional groups:

Honey bees carry pollen as a moist clump in a pollen basket (corbicula) on their back legs.

Bumble bees – much bigger and fuzzier than honey bees but carry pollen the same way in a corbicula on their back legs.

Pollen Pants bees: These are ground nesting bees that carry dry loose pollen on their back legs.
Hairy Belly Bees: These are usually cavity nesting bees and carry dry loose pollen on the underside of their abdomens.
Flies: Flies have 2 ski-goggle eyes, 2 short antennae, a thick waist and 2 wings.
Wasps: Wasps have spindly, hooked legs, a narrow body, 4 wings and no pollen collecting hairs.
Others: beetles, ants, butterflies, moths, hummingbirds

6. Walk to the observation site. Divide into individuals or "teams." Go over instructions again:
   - Participants record each pollinator observation with a check mark.
   - write a description of the flower (colour, shape, amount of pollen) or draw the flower.
   - Describe the pollinator/flower interaction. (Number of seconds on the flower; whether it hovers, scrabbles, buzzes, pauses for nectar; is it bothered by other bees around it?)
   - Observe within the marked off area for 20 minutes

Return to class & have individuals or groups record and compare their data on a larger pollination survey sheet and reflect on and analyze their observations.

H. Hands on activity: Design your own pollinator

Purpose: Students will design and create a pollinator that has the correct anatomical features using foliage and flowers that they have collected.
Materials: heavy art paper, foraged plant materials
Introduce the artist **Raku Inoue** through the video and photographs from the Guardian article.
Method: Talk about what various plant materials could be used to make up an insect. What would you use for eyes? Antennae? Wings? etc.
Forage (respectfully, as Inoue suggests) for leaves and twigs – not much is really needed.
This art work is supposed to be ephemeral, so have students take a photograph with their cell phones from above as Inoue does.
Print the pictures and create an exhibition.

Hands on activity: make a flip book

Materials: Use blank index cards with 2 holes punched on the edge (as in the video) and binder clips to hold the cards while working. Brass fasteners (office supplies) can be used to hold the cards together permanently. Drawing tools: pens, pencils and coloured pencils will be required along with a light source such as a window.
Purpose:
After watching the video, how to make a flip book, have students discuss what pollinator actions would make good flip books. (Flight? Scrabbling? Bee approaching a flower? etc)

I. Project: Creating Pollinator habitat

Thompson Shuswap Master Gardeners has created a brochure "Gardening for Pollinators" that can be found on the Resource Page.
Choosing native plants to your regional ecosystem is highly recommended.
Pollinator Partnership Canada Planting Guides can be found here online.
American planting guides can be found here online.

A school habitat project can be quite daunting. This excellent guide to help you through the process can be found on the Resource Page.
Organic site preparation for Wildflowers published by Xerces can be found here online.
You can also do simple things such as Providing Nesting and Overwintering Habitat as suggested in this Xerces publication found online.

Start small! Every little bit of habitat counts. Partner with others. E.g.: a storefront bed, a raised bed at the school entrance, entrance to a park, a retirement community.

J Post Assessment

Objectives: To determine what students have learned about the ground nesting bee, *Andrena*.
In small groups have students brainstorm the following questions:
What do we know about bees?
Why do you think bees are important to the ecosystem?
What adaptations to their bodies do bees have that make them such important pollinators?
What adaptations does Andrena have to her body that allows her dig a nest in the ground?