



COURSE MANUAL

**Tropical Environments and Society
at La Selva Biological Research Station
COSTA RICA**

March 11th-March 19th 2023

by





Chloe Hawkings

Benjamin Lintner

Lena Struwe

Rutgers University

© the authors, 2023



**Embedded Spring:
Tropical Environments
and Society**

La Selva Biological Station, Costa Rica

Course number: 01:959:422:01

Course name: Tropical Environments and Society

Rutgers Global - Rutgers University

Instructors:

Dr. Chloe Hawkings c.hawkings@rutgers.edu

Dr. Benjamin Lintner lintner@envsci.rutgers.edu

Dr. Lena Struwe lena.struwe@rutgers.edu

TABLE OF CONTENTS

COURSE SYLLABUS	4
CONTACT INFORMATION AND COMMUNICATION	6
SCHEDULE	7
TRAVEL INFORMATION	8
ABOUT OTS AND LA SELVA RESEARCH STATION	10
LA SELVA MAPS	11
LA SELVA INFO	16
PERSONAL FIELD KIT, RESEARCH AND ART SUPPLIES	17
COURSE RESEARCH PROJECTS	20
DATA ANALYSIS RESOURCES	29
INDEPENDENT EXPLORATION PROJECTS	31
iNATURALIST PROJECT – Costa Rica Study Abroad	33
PERSONAL BIOBLITZ	39
NATURE JOURNALING	40
Appendix 1: Example of Independent Exploration Project	50
Appendix 2: Examples of Nature Journaling Pages	51
Appendix 3: Species Nomenclature and Root Words	57
Appendix 4: Flashlight manual (for light in your field kit)	61
Appendix 5: Insect Identification Guide	63

Acknowledgments:

Rutgers University and the authors of this manual gratefully acknowledge financial support from the Winifred M. & George P. Pitkin Foundation to offset course costs for this course, the purchase of field research equipment, the annual Organization for Tropical Studies (OTS) membership fee for Rutgers, and the provision of travel awards for selected students.

We also wish to thank OTS, of which Rutgers University is an institutional member, for assistance and support with course planning and logistics, as well as the opportunity to visit the world-famous La Selva Biological Research station with a faculty-led undergraduate course as part of our study-abroad program. We hope the experiences for our students during this course will be inspiring, significant, and transformative!

COURSE SYLLABUS

Brief Program Description:

La Selva is a world-class 1600-hectare Costa Rican research facility comprising both primary and secondary growth tropical Caribbean humid lowland forest. Founded in 1968 by the Organization for Tropical Studies, La Selva affords us the opportunity to experience the incredible biodiversity of a tropical rainforest environment first hand while also taking advantage of the rich history of scientific inquiry that has occurred, and continues to occur, there. We will also have an opportunity to see some of the environment surrounding La Selva, which encompasses a diverse and ever shifting mosaic of land use, ranging from small farms and pastures to commercial-scale monoculture of bananas and pineapples. Course instructors will guide group research and independent exploration activities with the aim of fostering deeper understanding of the challenges and threats to tropical ecosystems. This includes topics such as climate change, biodiversity loss, and land use transformation, as seen through the local lens of La Selva and its surroundings.

Learning Goals and Objectives:

1. Develop a foundation of knowledge in topics that enable appreciation and exploration of tropical environments.
2. Engage in hands-on, inquiry- and/or curiosity-driven research activities in groups and individually that provide exposure to different methodologies, approaches, or techniques.

Assessment and Expectations:

This program is offered in Spring 2023 as a stand-alone, 1 credit course. The breakdown of assessment is as follows (SEE FURTHER DETAILS BELOW UNDER 'GRADED WORK') :

- 25% Participation
- 40% Research Activity
- 25% Nature Journaling Pages
- 10% Reflection Piece

For the **Participation** component, students are expected to attend and contribute to all program activities, including group and individual research projects. For the **Research Activity** component, students are expected to prepare a short verbal and/or visual presentation on some facet of the course research projects and exploration projects that can be shared with other students and course instructors. For the **Nature Journal** component, students are expected to practice observations and communication skills through nature journaling in a personal journal. For the **Reflection Piece** component, students are expected to prepare and submit a short (~1 paragraph) summary of an experience from our visit. Such reflection pieces could also take other forms, e.g., a posting to a social media platform. SEE FURTHER DETAILS BELOW UNDER 'GRADED WORK'.

In our view, the unique aspect of our program is that we are based at a research facility: in alignment with this research-oriented foundation, we want student participants who embrace the opportunity to ask questions about La Selva's forests and surroundings, and who seek to answer those questions. Costa Rica has countless opportunities for

tourism—indeed, it is a popular destination for many spring breaking college students. Our program is different in the sense that we will be immersed in the rainforest: you will sweat, your boots will get muddy, and you may experience some bug bites, just like the scientists and researchers who work at La Selva. But hopefully you will see these as worthwhile investments for the intimate, first-hand knowledge you will gain from the experience.

Expectations about Behavior:

We want everyone to have an amazing and transformative experience while recognizing that we are guests of Costa Rica and ambassadors of Rutgers. Since you are all adults, we expect you to exercise an appropriate degree of self-discipline. Please work with us to ensure a safe, healthy, and respectful environment for everyone. Please also be courteous and mindful of the staff at La Selva—they do a tremendous amount of work to host us, so let's do our part to assist them whenever possible.

GRADED WORK and INSTRUCTIONS

Participation (25%, 25 pts):

Attendance and contribution to all program activities, including group research and individual exploration projects during the entire trip. Of course, we recognize that issues may arise that preclude participation (e.g., if you feel ill), so just let one of the instructors know if that's the case. Instructors will assign attendance (and other grades) after our return. Attendance grade will be posted on Canvas after the trip.

Research Activity (40%, 40 pts):

This grade is based on the Course Research Project (30%, faculty-led) and your independent Exploration Project (10%). These projects will be done and presented to the class at La Selva. The Course Research Project is a group project, while the Exploration Project can be done individually or in groups of 2-3 students (but grades will be assessed individually). The grade will be based on all components of the research activity - presentation and uploaded summary. Your uploaded summary of these should include components such as research question or similar, methodology, results, and discussion of results; we encourage inclusion of figures, photos, videos, etc.. **Upload presentation file to Canvas for both the Course Research Project and Exploration Project before we leave La Selva**, check with instructors what formats are OK. Grades will be posted on Canvas.

Nature Journaling (25%, 25 pts):

Recording nature observations in text, numbers, and visual drawings in travel journal, including any responses to prompts given by instructors. An introduction to nature journaling and art supplies will be provided by the course instructors. **Select at least 1 page of your nature journal (more are OK to post) and post to Canvas under the Nature Journaling Discussion, then respond to at least 3 other students and their pages with constructive and detailed feedback. This needs to be completed before we leave Costa Rica, since we intend the activity to stimulate interaction and engagement to enrich the experience for everyone.** In your response, avoid comments like 'nice', 'beautiful' or 'ugly' - be specific about what you like and why, explain what inspires you from their work, and explore their methods and ideas together. Grade will be

based on effort, participation, quality of your response to others, and exploration of nature journaling overall, not how 'nice' your journaling page looks like. You may upload more than 1 page to share with other students and get their feedback, but you will not get a higher grade for posting more pages.

Reflection Piece (10%, 10 pts):

Prepare and submit a short summary of a select experience from your trip (~1-3 paragraphs, 100-200 words, not more). Such reflection pieces could also take other forms, e.g., a posting to a social media platform, a video, etc. (blog entry with photographs, TikTok, Instagram, etc.). **For all formats, a copy of the work (or link to a publicly viewable website in a document you submit) should be uploaded to Canvas no later than 1 week after we return from La Selva.** This reflection piece should be different from what you may need to write if you received a travel award or scholarship (this only applies to a few students).

Final Grades will be based on: A (90% or higher), B+ (85-89.9%), B (80-84.9%), C+ (75-79.9%), C (70-74.9%), D (60-69.9%), F (under 60%). Instructors reserve the right to raise the final grades for exceptional work and participation in components of the class.

CONTACT INFORMATION AND COMMUNICATION

Class WhatsApp group: <https://chat.whatsapp.com/Bfb2DCU7iP1FljLCDNEjbP>

Group chat name: RU Global Costa Rica 2023 - La Selva

How to contact the instructors:

Dr. Chloe Hawkings

c.hawkings@rutgers.edu (WhatsApp +1 512 679 8951)

Dr. Benjamin Lintner

blintner@envsci.rutgers.edu (WhatsApp +1 732 801 8228)

Dr. Lena Struwe

lena.struwe@rutgers.edu (WhatsApp +1 609 672 2934)

For social media postings, please consider using the hashtag **#RUGlobalLaSelva**

SCHEDULE

	Morning 9:00 am-12:00 pm	Afternoon 1:00 pm-4:00 pm	Evening >7:00 pm
Saturday March 11 th		Bus from airport to La Selva (departs 2:00 pm)	8 pm - Nature Journaling instruction and demos of sketching and painting methods (Lena)
Sunday March 12 th	Guided Tour with Field Guide at La Selva (8-11 am)	Free afternoon to explore La Selva	7 pm-midnight - Moth Lamps (Chloe)
Monday March 13 th	Field work: Group A (Lena)/ Group B (Ben)	Field work: Group A (Lena)/ Group B (Ben)	7 pm-midnight - Moth Lamps (Chloe)
Tuesday March 14 th	Field work: Group A (Ben)/ Group B (Lena)	Field work: Group A (Ben)/ Group B (Lena)	7 pm-midnight - Moth Lamps (Chloe)
Wednesday March 15 th	Analysis of course research project / Independent Exploration	Cacao Tour (Offsite)	7 pm-midnight - Moth Lamps (Chloe) 7-8 pm - Dennis Tenorio Villegas Presentation
Thursday March 16 th	Analysis of course research project / Independent Exploration	Analysis of course research project / Independent Exploration	8 pm - Nature Journaling student and faculty sharing (Lena) - optional
Friday March 17 th	Presentations of course research project and Independent Exploration	Boating River Tour (Offsite)	
Saturday March 18 th	Return to San José (10:00 am)	Downtown San José visit (Optional)	Group Dinner in San José (Optional)
Sunday March 19 th	Return Flights		

Breakfast: 6.30-7.45 AM
Lunch: 11.30 AM-1.00 PM
Dinner: 6.00-7.00 PM

(Coffee and potable water is always available in the cantina at La Selva)

TRAVEL INFORMATION

Packing

Note that your field kit flashlight contains a lithium battery and should be in your hand luggage, not in your checked luggage. All valuables (incl. laptops) should be in your hand luggage. See Canvas course site for full Packing List.

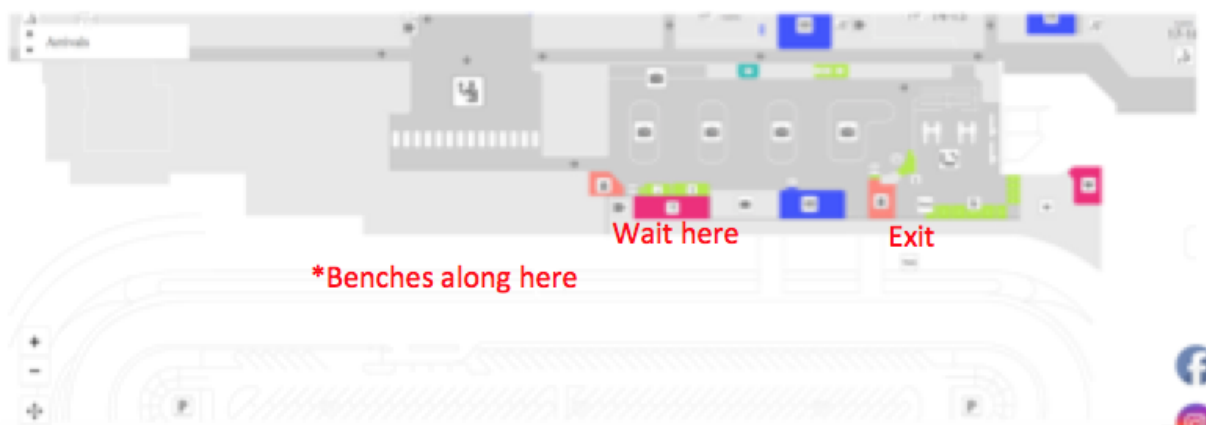
Arrival at airport

Upon arriving at the Juan Santamaria International Airport in San José, you first need to go through immigration (passport control) and customs. In immigration you will likely be asked your occupation, the purpose and duration of your visit, and where you will be staying. (Don't worry: Immigration officers are bilingual!) You can specify that the purpose of your visit is an educational program and that the place you will be staying is La Selva Biological Field Station, which is located near the town of Puerto Viejo de Sarapiquí. In customs, your bags (including backpacks) will be inspected.

Meeting place at airport

After customs, you will see an exit to street level. Immediately outside the exit, many people will be gathered. Turn right upon exiting and walk down the sidewalk to the Restaurante Malinche sign to await the bus. Keep an eye out for a driver with a sign for Organization for Tropical Studies. Program faculty should also be at the airport by noon, as most of you are arriving around that time.

For those who may be arriving in the early morning, you may want to find a more comfortable waiting spot. While options at the airport are limited, since one requires a boarding pass to re-enter the airport, there are benches at the departing passenger drop off that you may find less chaotic.



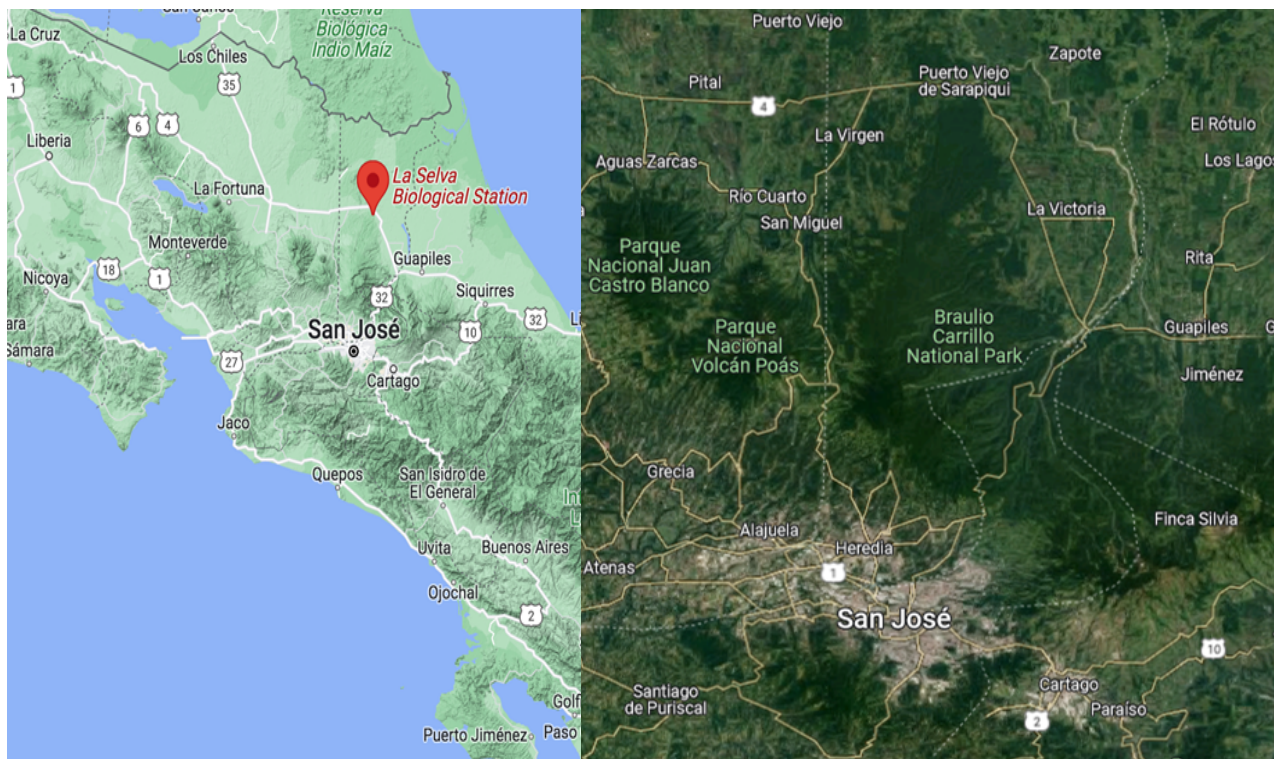
*Possible waiting spot if arriving early. (On top of the parking deck.)



(left picture - group meeting spot at airport)

Where is La Selva?

San José is in the Central Valley and is a very busy urban area surrounded by agriculture and active and dormant volcanoes. La Selva is in the Caribbean lowlands (rainforest) on the eastern side of the Central American mountain range. The bus ride to La Selva (near Puerto Viejo de Sarapiquí) is approximately 2.5 hours from the airport, but this depends on local traffic and weather conditions. We will take route 32 over the mountains, through Braulio Carrillo National Park.



ABOUT OTS AND LA SELVA RESEARCH STATION

“The *Organization for Tropical Studies* (OTS) is a nonprofit consortium of about fifty universities, colleges, and research institutions worldwide. Founded in 1963, OTS’ mission is to provide leadership in education, research, and the responsible use of natural resources in the tropics. The *Organization for Tropical Studies* (OTS) has operations in three countries and research stations and education programs in Costa Rica and South Africa. For the last half century, The *Organization for Tropical Studies* (OTS) has been the world’s leading institution in the study of tropical biology, with more than 360 courses in tropical ecology, conservation and global health and over 8000 students trained, including many of the world’s leading tropical ecologists.”

“Our purpose is to sustain our tropical ecosystems by driving scientific discovery and knowledge, by enriching human perception of nature and by enhancing worldwide policy actions in the tropics.” <https://tropicalstudies.org/>

“OTS established the **La Selva Research Station** in 1968. Before it was under OTS leadership, La Selva was a farm dedicated to sustainable forest research owned by Dr. Leslie Holdridge.

La Selva’s influence on tropical ecology is immeasurable and of great cultural significance, having served as a key training and research site for numerous professional scientists. La Selva Research Station pioneered private forest conservation in Costa Rica, as it was the first of what is now a large network of private forest reserves in the country.

The species richness of La Selva is outstanding, with more than 2,077 species of plants; 125 species of mammals (72 of them bats); 470 species of birds; 48 amphibian species; 87 species of reptiles; 45 species of freshwater fish; and tens of thousands of insects, arachnids, and other arthropods.

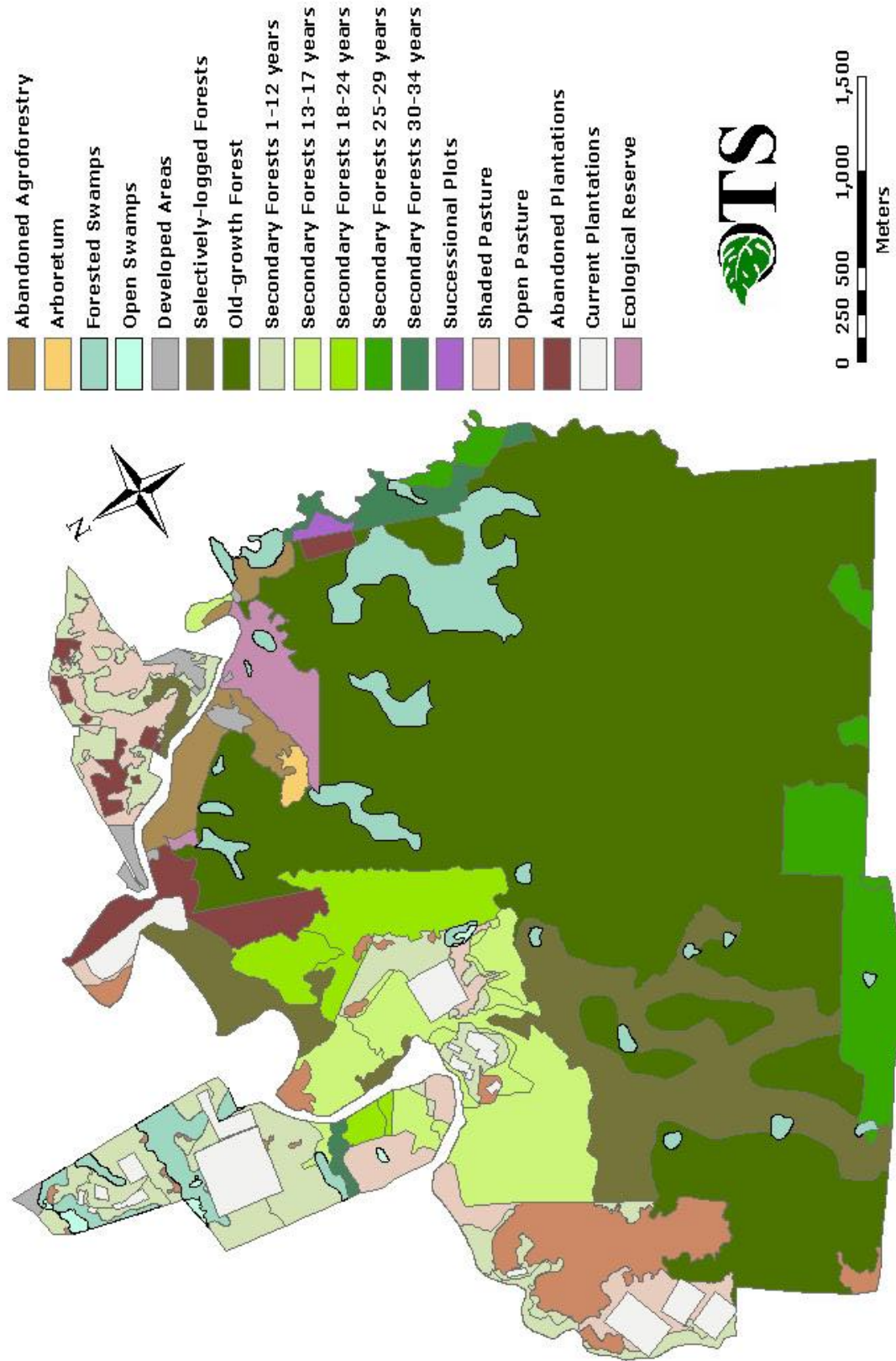
La Selva Research Station offers 1,600 hectares of well-preserved old-growth and recovering wet lowland tropical forest that abuts the Braulio Carrillo National Park. The 4 to 6 km wide forested corridor that connects La Selva at 35 m above sea level to the Barva Volcano at 2,906 m is one of the best-preserved elevational gradients in the tropics.

La Selva sits within a complex biological, socioeconomic, and political landscape that has been significantly transformed over the last 40 years by a continuously expanding agricultural frontier, burgeoning human population, and accompanying major infrastructure. Protected areas, such as La Selva, provide a rich opportunity for studying how natural ecosystems respond to a broader landscape matrix of human uses.

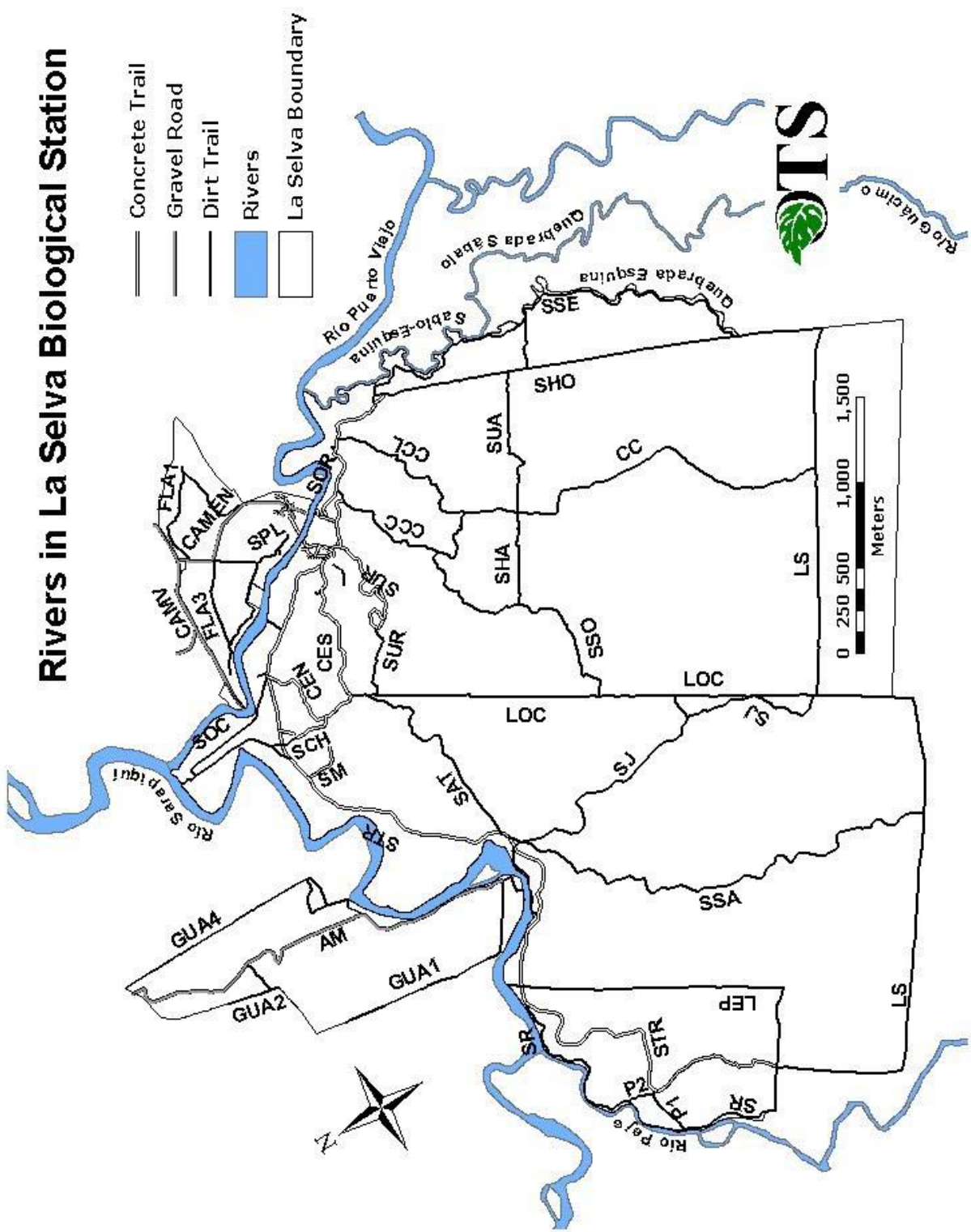
La Selva has some of the longest running ecological data sets in the tropics, spanning up to 40+ years. Long-term research of terrestrial and aquatic ecosystems has generated data on nutrient cycling, plant and animal demography (e.g. birds, trees, frogs, etc.), community interactions, and their responses to a changing climate.”

<https://tropicalstudies.org/portfolio/la-selva-research-station/>

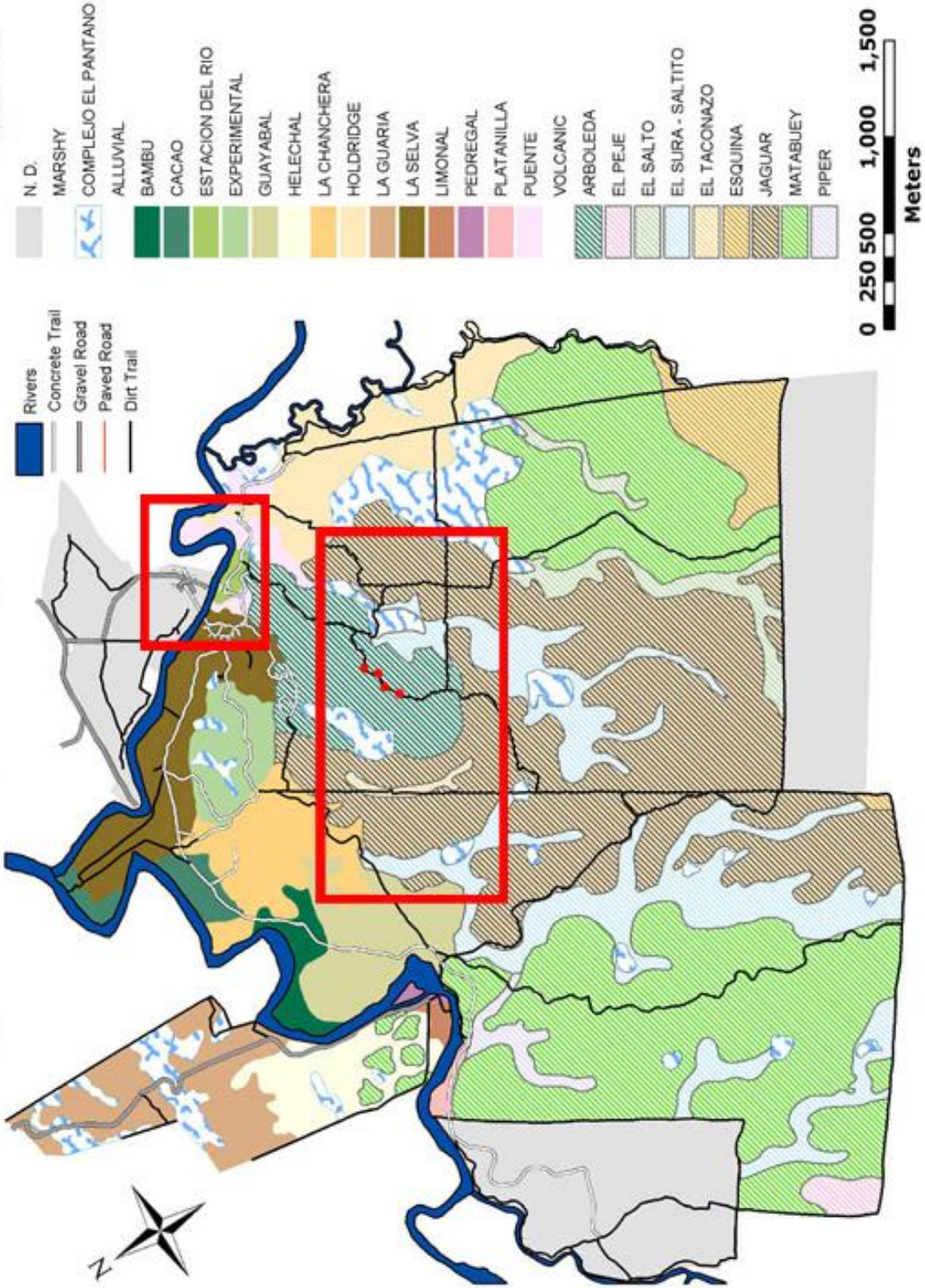
Land use in La Selva Biological Station in year 2000



Rivers in La Selva Biological Station



Soil map units in La Selva Biological Station



LA SELVA INFO



Organization for Tropical Studies

Welcome to La Selva! Researchers and Educational Groups

We hope that you have an educational and enjoyable experience, while taking advantage of the facilities and natural richness of La Selva Biological Station. To make the best of your visit to the Station, please read carefully the following information.

Reception and Gift Shop Schedule: Monday thru Saturday: 7:00 a.m. to 5:00 p.m. Sunday and Holidays: 7:00 a.m. to 4:00p.m.

Dining Room: Meal tickets are available at Reception. Meals are served only during the following hours: Breakfast 6:30 – 7:45 a.m., Lunch 11:30 a.m. – 1:00 p.m., Dinner 6:00 – 7:00 p.m. Please stick to the schedule. If you expect to be late, please ask Reception (ext. 110 for your meal to be saved). If you need a box lunch, please sign for one on the request slips that are available in the dining room 24 hours in advance.

Water: All taps at La Selva supply potable water.

Laundry Service: Please ask Reception about this service.

Telephone Service: For local and international calls, you can request a telephone account at Reception. Calling Cards can be purchased at the Gift Shop. For international collect calls, dial 1175 for the United States and 1116 for the rest of the world. 800 numbers do not work with our phones.

Transportation: Contact Reception for transportation services or mail delivery.

New Researchers: Staff will contact you upon your arrival and give you more information about the Station.

Noise: Please no loud talking or music at any time. Many researchers work at night and sleep during the day.

Hiring Staff: Before hiring any assistant, consult the OTS Human Resources Manual for Researchers or contact the Accounting Office ext. 115. (<http://www.ots.ac.cr/lrghrin>)

Valuables: Please safeguard your valuables. Lockable boxes or drawers are installed in the rooms and padlocks area available at Reception. You can also request storage of valuables in the

safety deposit box at Reception, which is open during office hours only.

Check-in/Out: Check-in is at 3:00 p.m. and check out time is at 12:30 p.m. Before leaving, please return your key at Reception. Do not lose your room key, padlock key or meal ticket; there is an extra cost for their replacement; room key \$50.00, padlock key \$2, and meal ticket \$3.

Lab Services: If you need lab space or equipment, contact the lab personnel, ext. 169.

Allergies: If you are hypersensitive to insect bites, always carry medication with you. Look where you put your hands and be especially careful with the Bullet Ant (Paraponera); its sting is very potent and lasting.

Snakes: Poisonous snakes are relatively abundant and many appear anywhere. Do not walk barefoot or in sandals outside the buildings. Boots are highly recommended at all times, especially at night. Always use a flashlight at night.

Emergencies: There is a Station plan for attending emergencies: Call 119, contact staff, or the Security Guards.

Your support is our most important resource!

The Organization for Tropical Studies receives donations from private foundations and individuals like you to fulfill its mission of providing leadership in education, research and the responsible use of natural resources in the tropics. You can contribute to La Selva's programs for research and education. We invite you to support La Selva Campaign by making a donation at the Front Desk. If you prefer you can send your donation to: OTS-Development Box 90630, Durham NC 27708-0630 tel (919) 684-5774 or OET-Desarrollo Apdo 676-2050, Costa Rica, tel (506) 2524-0607 or by visiting our webpage at: www.gifts.duke.edu/ots

Contributions to La Selva are tax-deductible in the U.S., Canada and Costa Rica. La Selva Biological Station is property of the Organization for Tropical Studies, Inc.

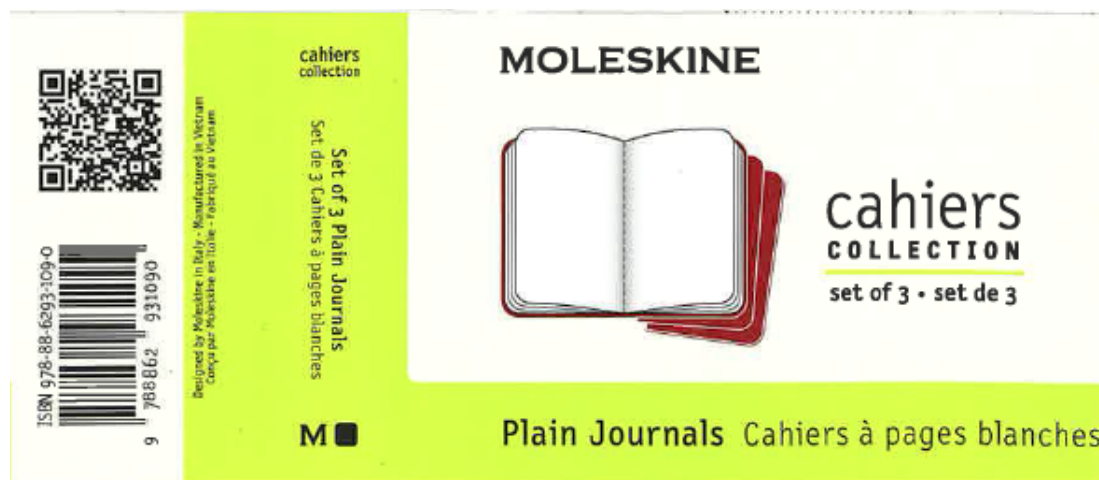
PERSONAL FIELD KIT, RESEARCH AND ART SUPPLIES

This chapter is written by Lena Struwe, Rutgers University.

1. Personal Field Kit

Thanks to a generous donation from the Pitkin Foundation, we will provide all students with a special field research kit that will include the following useful items (see list below).

- **1 ziplock bag** - waterproof, gallon size (you also get all your items in a ziplock bag).
- **A journal** - this will be your travel and nature journaling journal - type: Moleskine Cahier XL, softcover, blank pages suitable for pencil, ink, watercolor. (You can cover the journal in water repellent self-adhesive plastic if you like. The cover is red, and it is up to you to personalize it however you feel like. All students have red journals.)
- **A small field notebook** - type: Rite-in-the-rain, spiralbound on top, gray cover, lined paper. (All students get the same kind and color, this is WATERPROOF paper for writing on with pencil). The ruler is printed on the cover of this notebook.
- **2 pencils** - regular kind, HB/no. 2 hardness
- **1 pencil sharpener** - small, plastic
- **1 kneaded eraser** - type: Prismacolor kneaded eraser. (You might want to put the eraser and the pencil sharpener in the little box your handlens came in.)
- **1 blue pencil** - type Prismacolor Col-Erase - This is used for sketching, is erasable, and will not show when photographed.
- **1 handlens, 10x magnification** - type: metal. (You will get a neckband for this when you arrive at La Selva - all students will have different color neckbands)
- **1 very fancy handheld flashlight** - type: LED, zoomable, USB rechargeable, 7 different light settings, including UV. (Try to find a way to mark your flashlight so you know it is yours, all flashlights are the same. We are bringing White-Out for this purpose - you can add your name to a white area on the flashlight.) THE MANUAL FOR YOUR FLASHLIGHT IS AVAILABLE IN AN APPENDIX TO THIS MANUAL- Please read all precautions and warnings. NOTE, it includes a Lithium battery!



2. Course supplies available to you at La Selva

This is a list of course supplies that we instructors are bringing with us for you to use during the course at La Selva. These are items we will use for the research projects, and some you can sign out for short time periods while at La Selva.

- **Binoculars** (6 of them, Pentax Papilio 8.5 x 21)
- **Kestrel environmental meters** (3)
- **Light meter** (1)
- **Crown densiometer** (1)
- **Measuring tape** (3)
- **Tree height triangles** (3)
- **Clipboards**
- **Small field microscope** (Lena is bringing her private one)
- **Insect nets** (a few)

Moth lamp set up (for course research project)

- White sheets
- 6 white LED light bulbs & 4 blacklight/UV LED light bulbs
- 6 extension cords for outdoor use (grounded, each with 3 outlets at end)
- 6 lamp cords
- 100 wooden clothespins & 6 laundry lines (50 ft each)

3. Class library (1 copy of each)

- Field guide book: **Tropical Plants of Costa Rica: A Guide to Native and Exotic Flora** by Willow Zuchowski
- Field guide book: **A Field Guide to Plants of Costa Rica** by Margaret Gargiullo
- Field guide book: **Birds of Costa Rica** by Richard Garrigues
- Field guide book: **Amphibians and Reptiles of Costa Rica: A Pocket Guide** by Federico Muñoz Chacón and Richard Dennis Johnston
- Field guide book: **Insects and Other Arthropods of Tropical America** by Paul Hanson & Kenji Nishida
- Field guide book: **The Mammals of Costa Rica: A Natural History and Field Guide** by Mark Wainwright
- Field guide book: **Mammals, Amphibians, and Reptiles of Costa Rica: A Field Guide** by Carrol L. Henderson & Steve Adams
- Laminated folded field guides: **Costa Rica Arachnids & Insects**
- Laminated folded field guides: **Costa Rica Reptiles**
- Laminated folded field guides: **Costa Rica Tropical Flowers**
- Laminated folded field guides: **Costa Rica Butterflies**
- Laminated folded field guides: **Costa Rica Tropical Trees**
- Laminated folded field guides: **Costa Rica Tropical Fruits**
- Laminated folded field guides: **Costa Rica Mammals and Tracks**

4. Nature journaling and art equipment (shared use)

- **Watercolor field palettes** (Winsor & Newton Cotman Sketchers' Pocket Box, Half Pans of paints, 12 colors: Lemon Yellow Hue, Cadmium Yellow Hue, Cadmium Red Pale Hue, Alizarin Crimson Hue, Ultramarine, Intense Blue (Phthalo Blue), Viridian Hue, Sap Green, Yellow Ochre, Burnt Sienna, Burnt Umber, Chinese White) [3 palettes available]
- **Watercolor brushes** (mixed sizes and types)
- **Water brushes** (Pentel, mixed types)
- **Mixed media paper** (5.5"x8.5", 200 sheets)
- **Watercolor paper** (cold press, Strathmore 400, 5.5"x8.5", ca. 100 sheets)
- **Ink pens**, Staedler Pigment Liner, permanent, fine ink liners, mixed sizes

5. Apps and software for your phones, tablets, and laptops (optional)

- **Naturalist** (website, Android and iOS app): <https://www.inaturalist.org/pages/getting+started> (make and keep track of biodiversity observations anywhere in the world, join projects, get help with id from experts, suggested ID from image recognition)
- **Seek** (Android and iOS app): https://www.inaturalist.org/pages/seek_app [run by iNaturalist, helps identify species using image recognition, can be synced with an iNaturalist account]
- **Animals of Costa Rica** (app) by Gernot Kunz (Android and iOS): <https://apps.kunzweb.net/acr/> [thousands of species, photos]
- **RockD** (app) by UW Macrostrat Lab at Univ of Wisconsin - Madison: [https://rockd.org/https://rockd.org/](https://rockd.org/) [geology wherever you are]
- **Star Walk** (app) for astronomy (you will see stars at La Selva!)
- **Canvas** (app) - easy access to resources on Canvas for the course.
- **CamScanner** (app): for good photos of documents, journaling pages, and drawings.
- Also, don't forget to download the **app for the airline you fly with** for important information. Many airlines use the app for boarding passes now.

COURSE RESEARCH PROJECTS

This chapter was written by Ben Lintner, Lena Struwe, & Chloe Hawkings, Rutgers University.

Faculty-led research projects

1. Forest Measurements (Faculty Lead: Ben Lintner)

One key to understanding the biology and ecology of the forest at La Selva is quantifying the environmental conditions present.

Part I (Morning): Microclimates

In Part I of this faculty-led research project, we will explore the concept of microclimates. Microclimate refers to the small scale variations of climate conditions, typically considered in contrast to surrounding areas. Organisms or communities at La Selva may exploit or take advantage of different microclimates even while inhabiting the same general area. Thus, for example, the conditions experienced by frogs living in the leaf litter in the shade beneath a tree may be very different from conditions experienced by a flying pollinator in an adjacent sunlit gap. Your objective is to determine what factors shape the expression of microclimates around La Selva.

For this activity, your group will sample meteorological (temperature, relative humidity, wind) and light conditions along multiple 100 meter (approximately linear) transects in order to characterize microclimate. Ideally, we would have automated continuous measurements of these variables at all sampling points simultaneously along a transect, but we will do this the “old-fashioned” way!

For measuring meteorological conditions, we will use a hand-held Kestrel weather meter. Precise measurements of light intensity require sophisticated (and expensive) equipment; for our purposes, we have an inexpensive light meter that, while unable to provide precise absolute quantitative values, at least allows for relative assessment of light intensity variation. To measure canopy coverage, we will use a simple device known as a crown densiometer, which consists of a concave mirrored surface divided into 24 squares. The densiometer is held upright toward the canopy, and based on visual inspection of leaf coverage appearing in the mirrored surface, a percentage estimate of canopy coverage can be derived. (Ben will provide further instruction on the use of these instruments at the beginning of the activity.)

As a group, decide where and how many transects you wish to sample. To do this, you may want to consult the La Selva land use map on page 11 of this manual to give you an idea of the various categories or types of land use around La Selva. A question to consider is, do you expect that different types of land use may affect microclimates?

You should plan to sample along your selected transects at intervals of at most 10 meters. At each sampling point, use a Kestrel weather meter to take temperature, relative humidity,

and wind measurements, the light meter to estimate light intensity, and the crown densiometer to estimate the overhead canopy coverage. Try to be as consistent as possible in performing your measurements. Record all measured data. Also, record the characteristics of the immediate environment of the sampling site (e.g., *Are you beneath a tree? Is the soil wet or dry? Is there undergrowth?*).

Part 2 (Afternoon): Tree Growth and Carbon Storage

In Part 2 of this activity, we will perform measurements on trees for use as a basis for exploring the concept of carbon storage in the forests of La Selva. This activity will take advantage of trees within the Holdridge Arboretum, a 3.5 hectare plot containing over 1800 tagged trees, some of which have been measured periodically since the early 1970s. This activity will focus on performing measurements on individuals from one species, *Pentaclethra macroloba* (common name: Gavilán), one of the most common tree species found at La Selva (see image below). Of the ~60 tagged Gavilán trees within the Arboretum, your group will be assigned 10 individuals. For each of these, you will measure diameter at breast height (DBH, here standardized to 1.3 meters) and the heights of the canopy base and canopy top; you will also record relevant site data for each tree, such as proximity to other trees—see the sample record table below.



Pentaclethra macroloba. Photos by Orlando Vargas/OTS.

After completion of the field measurements for this faculty-led research project, Ben will provide you with instruction on analysis and interpretation.

Data record for DBH and tree height measurements

Number:			
Variable	Measurement 1	Measurement 2	Measurement 3
DBH (cm)			
Height canopy base (m)			
Height canopy top (m)			
Site Notes (description of the location of the individual, including ground cover, proximity to other trees, etc):			

2. Flowers and Pollinators Project (Faculty Lead: Lena Struwe)

Flowering plants and pollinators have co-evolved physical characteristics that make them more likely to interact successfully, which has in turn led to a great diversity of flower shapes and species in nature. The plants benefit from attracting a particular type of pollinator to their flowers, ensuring that their pollen will be carried to another flower of the same species, hopefully resulting in successful reproduction, and the pollen won't be wasted on the wrong species.

These plant-pollinator interactions are part of co-evolution, which is how mutualism or antagonism can alter plant morphology or pollinator behavior and their morphology. Such changes are predicted from the theory of natural selection, which posits that each member of the interaction is only "looking" to maximize its own fitness. Plants and pollinators do not have the same goals. Plants want to maximize the spread of pollen to new individuals, while at the same time minimizing the energetic costs of producing pollen and nectar to attract pollinator vectors. Pollinators, on the other hand, want to maximize energetic rewards of high quality food in the form of proteinaceous pollen and sugary nectar, while at the same time minimizing the cost of foraging. These seemingly antagonistic goals can result in highly specialized relationships between plant and pollinator animals.

The flower type, shape, color, odor, nectar, and structure vary by the type of pollinator that visits them. Such characteristics are considered “pollination syndromes” and these can sometimes be used to predict the type of pollinator that will aid the flower in successful reproduction. The more specific and specialized the relationship between the flower and pollinator, the more likely the pollen of that species will be successfully transferred and that the plant's pollen will not be wasted on the flower of a different species.

Floral Trait	Bats	Bees	Beetles	Birds	Butterflies	Flies	Moths
Flower Color	Dull white, green or purple	Bright white, yellow, blue, or UV	Dull white or green	Scarlet, orange, red or white	Bright, including red and purple	Pale and dull to dark brown or purple; flecked with translucent patches	Pale and dull red, purple, pink or white
Nectar Guides	Absent	Present	Absent	Absent	Present	Absent	Absent
Odor	Strong musty; emitted at night	Fresh, mild, pleasant	None to strongly fruity or fetid	None	Faint but fresh	Putrid	Strong sweet; emitted at night
Nectar	Abundant; somewhat hidden	Usually present	Sometimes present; not hidden	Ample; deeply hidden	Ample; deeply hidden	Usually absent	Ample; deeply hidden
Pollen	Ample	Limited; often sticky and scented	Ample	Modest	Limited	Modest in amount	Limited
Flower Shape	Regular; bowl shaped – closed during day	Shallow; have landing platform; tubular, c	Large bowl-like	Large funnel like; cups, strong perch support	Narrow tube with spur; wide landing pad	Shallow; funnel like or complex and trap-like	Regular; tubular without a lip

Adapted from: USDA FS,

https://www.fs.usda.gov/wildflowers/pollinators/What_is_Pollination/syndromes.shtml

But are these pollinator syndrome characteristics really indicative of the pollinators that actually come to the flowers? This is what we will investigate.

For each plant species we will investigate their floral morphology and see which proposed pollinator syndrome they fit. Then we will observe which pollinators that visit the flowers for each species (collect research data), gather information about those pollinator groups from literature and observations, and then analyze the following research questions:

- A) Do the pollinator syndrome match the actual pollinator visitor for these plants?**
- B) Can we find any correlations between pollinator types and floral morphology and food availability to the pollinators?**
- C) Are pollinator syndromes real, or oversimplified generalizations?**

1a. Study species and their flowers (Field Work)

We will focus on three kinds of flowering plants at La Selva. These are tentative species, we might have to change species when we arrive at La Selva and discover that they are no longer flowering... (we will adapt!)

Species we plan to investigate (left to right in photos): *Stachytarpheta* sp. (Verbenaceae), *Heliconia* sp. (Heliconiaceae), *Hamelia* sp. (Rubiaceae). We will identify the plants we use to the exact species at La Selva.



For each species we will investigate their floral morphology and see which proposed pollinator syndrome they fit. This will be done the first hour of the field day. Example table:

PLANT DATA			
Variable	Plant Species A	Plant Species B	Plant Species C
Corolla shape			
Corolla tube length (mm)			
Corolla tube width at mouth (mm)			
Flower color			
Odor?			
Pollen amount			
Nectar guides present?			
Nectar present?			
Inferred pollinator syndrome type based on flower morphology			

1.2 Plant-pollinator interactions (Field work)

By observing which pollinators (animal groups) and how many of each group that visit each plant species we will collect data on **actual pollinators** (we will ignore night pollinators for this study, as well as very specialized pollinators). You only will need to ID pollinators to their larger animal group (see insect guide at the end of this manual).

We will set up an observation schedule where we take turns at each plant and observe pollinators for timed 15 min periods when we record the number of ALL pollinators and their types for each plant species. You will work in groups of 2-3 students and rotate among the plants.

In between the set observation periods you will transport yourself (walk) to the next plant to be investigated. Each team gets binoculars and a clipboard and will be responsible for their data collection.

Example of observation schedule with 6 observation periods and 3 student teams:

SCHEDULE (date: _____)	Plant Species A	Plant Species B	Plant Species C
10.30-10.45 AM	team A1	team A2	team A3
11.00-11.15 AM	team A3	team A1	team A2
1.30-1.45 PM	team A2	team A3	team A1
2.00-2.15 PM	team A1	team A2	team A3
2.45-3.00 PM	team A3	team A1	team A2
3.15-3.30 PM	team A2	team A3	team A1

When you collect the pollinator data at each plant for each time period, you will tally up the number of pollinator visits from each pollinator group in a table like this, one table per plant and time period:

PLANT - POLLINATOR INTERACTION DATA / Team: _____		
Time period: _____ Date: _____	Plant Species _____ Count of pollinators (below)	Total count for time period (sum)
Hummingbirds		
Other birds		
Butterflies, Lepidoptera		
Flies, Diptera (all kinds)		
Waspy things, Hymenoptera (bees, wasps, etc.)		
Beetles, Coleoptera		
	Total visits:	

1.3 Pollinator types (Analytical Component)

Based on literature and observations you will fill in this table to see if the capabilities and features of the pollinator groups fit the features of the flowers they visited.

POLLINATOR DATA			
Variable	Pollinator group 1	Pollinator group 2	etc.
Average tongue length (mm)			
Average head width (mm)			
Eats nectar?			
Sees red color?			
Eats pollen?			

1.4 Analysis and results

All data should be entered into several Google Sheets for analysis (all data from all groups go into the same Google Sheets, we will be using cumulative student-collected data). Think about your research questions and how to use your data and evaluate each question. Don't evaluate all data at once, instead think about one variable at the time (to make it easier for you). You can select from the raw data the relevant variables you think are worth evaluating.

Produce graphs and diagrams to compare your plant species, your pollinator groups, and how certain pollinators might be connected to the features of the flowers of the plants. How you make the graphs and what detailed questions you investigate is up to you, but make sure to look at your initial study questions again. You may add additional analyses to evaluate new research questions that have come up as you did the project.

See grading for how this will be presented and submitted for the class.

(Some text in this project was derived from a Lab Manual of Fundamentals of Evolution Lab, Rutgers University, written by Lena Struwe and several teaching assistants.)

3. Night Visitors (Faculty Lead: Chloe Hawkings)

Many nocturnal organisms, such as moths, are attracted to (artificial) light sources (positive phototaxis). It is theorized that moths (or other insects) may use natural light sources like the moon or stars for orientation or navigation, so it is possible that artificial light sources stimulate comparable behavior responses; however, it appears to be more complicated than this (see, for example, the Science Friday discussion linked here: <https://www.sciencefriday.com/articles/why-moths-are-attracted-to-light/>). In any event, here we will take advantage of positive phototaxis as a means of attracting a gallery of night visitors. Our interest is to explore some of the factors that determine which organisms (most likely insects) visit artificial light sources deployed around La Selva.

Each setup will consist of a pair of white background sheets, with one sheet featuring a white light source and the other an ultraviolet (UV) “blacklight” source. The use of two different light sources per pair of sheets is to enable comparison of preference for the type of artificial light source.

As you may recall, light represents a component of the electromagnetic (radiation) spectrum. Components of the electromagnetic spectrum can be distinguished based on the wavelength and/or frequency of the radiation—the electromagnetic spectrum encompasses everything from gamma rays and X-rays (very short wavelengths) to infrared radiation and radiowaves (very long wavelengths). What we call light (by which we usually mean “visible light”) can actually be further differentiated, e.g., red light is characterized by longer wavelengths (or lower frequency) than blue light. Depending on sensory anatomy or physiology, organisms may have different sensitivities to the electromagnetic spectrum—one organism may be able to see radiation in a portion of the spectrum that another organism cannot. Thus, for example, while the short wavelengths of UV are beyond the visual perception of humans, many insects can perceive UV.



We will place three of the setups around La Selva to sample different background conditions: in the open near the cantina, somewhere along the forest edge, and within the forest. (Site selection will be determined on our first full day at La Selva.) Pairs of students will be responsible for visiting these set ups and surveying (and recording) what organisms are present. Photos of insects may be uploaded to iNaturalist for species identification (and added to our class project!), but students will be responsible for counting the number of individuals of each insect order for each survey time point. Surveys should be

performed on the hour, from 8:00 pm through at least midnight. Surveys will be undertaken over multiple nights. Be sure to take note of conditions, e.g., Is the moon visible? Is it cloudy or rainy?

DATA ANALYSIS RESOURCES

1.1 Data and statistics overview

Graph:

A graph is a visual representation of data; as used here, the term is equivalent to chart or plot. Common types of graphs encountered in data analysis include scatterplots (an “x-y” plot of two sets of values), bar graphs (plots with bars of different heights indicating data values), and pie charts (a circular plot with data indicated as wedges or “slices”). Microsoft Excel provides many options for graphing data.

Pivot Table:

A pivot table is a way of aggregating or grouping information extracted from a more extensive table, usually by some category. Pivot tables can be easily generated in Microsoft Excel and allow for the application of transformations (e.g., sums, averages) and statistical manipulations.

Mean, median, and mode:

Mean, median and mode are common ways of summarizing characteristics of a data set: the mean is the average of all values; the median is the middle value in an ordering of the data, and mode is the most frequently occurring value.

Significance test:

A significance test is a (statistical) procedure for evaluating a hypothesis about data. There are many types of significance tests; the selection of a particular test depends on the application or the underlying nature of the data evaluated. For example, a t-test may be used to test whether the means of two data samples are distinct.

Standard deviation:

The standard deviation is a measure of the dispersion of data relative to the mean value.

1.2 Statistics Tutorials and Information to explore:

- **Statology** - <https://www.statology.org/tutorials/>
- **Statistics How To:** <https://www.statisticshowto.com/statistics-basics/>
- **Google Sheets Help Info:**
https://support.google.com/docs/topic/9054603?hl=en&ref_topic=1382883
- **Create pivot tables in Google Sheets:**
https://support.google.com/docs/answer/1272900?hl=en&ref_topic=9055396
- **Types of charts & graphs in Google Sheets:**
https://support.google.com/docs/answer/190718?hl=en&ref_topic=1361474

1.3 Online statistics tools for analysis

- **Fisher's exact test** for 2 x 2 tables:
<https://www.statology.org/fishers-exact-test-calculator/>
- **Chi-square test** for small and larger tables:
<https://www.statology.org/chi-square-test-of-independence-calculator/>

1.4 Raw Data resources

- **OTS Plant Database** (herbarium collections at 3 field stations, incl. La Selva):
<https://bixa.tropicalstudies.org/plantdatabase/index.php>
- **La Selva Digital Flora** (in Spanish, plants found at La Selva):
<https://sura.ots.ac.cr/florula4/>
- **Species Lists for vertebrates at La Selva:**
<https://sura.ots.ac.cr/species/vertebrates/index.php>
- **OTS information resources**, links to several documents regarding the Arboretum at La Selva: <https://tropicalstudies.org/portfolio/information-resources/>
 - **Arboretum Plant List**
 - **Historic Records for the Arboretum**
 - **Information Pamphlet** about Arboretum
- **iNaturalist data** (you can download data from searches, use filters to reduce the amount of data you download - if in a Project, click on Observations, then Export Observations, then select the data you want - will be exported as a CSV file that can be opened in Google Sheets or Excel; in a project click on species to see which species that are most commonly reported, they will be first in the list)
 - **2023 Costa Rica class project:**
<https://www.inaturalist.org/projects/rutgers-in-costa-rica-spring-break-2023>
 - **La Selva project:**
<https://www.inaturalist.org/projects/flora-and-fauna-of-la-selva-research-station-ots-costa-rica>

INDEPENDENT EXPLORATION PROJECTS

This chapter was written by Ben Lintner, Lena Struwe, & Chloe Hawkings, Rutgers University.

These projects are intended to be of short duration, i.e., completed within a few hours, either individually or in groups of 2-3. We have allocated time in the schedule for you to do a project of your choosing. Note that your project may not involve human subjects (except yourself), physical collection, removal, or displacement of specimens (dead or alive), or any destructive sampling of nature; observational projects are fine.

We encourage you to do something that is not “too easy” and, to the extent possible, to collect and analyze some quantitative and qualitative data. Your exploration may not work out as intended, but that’s OK! :)

Below are some suggested ideas, but we encourage you to consider other projects that may be of interest to you. (For projects not listed below based on your own ideas, please discuss with one of the faculty before you start.) **Faculty are more than happy to assist you with project scoping, experimental design, and analysis!**

General approach:

Note: Depending on your choice of topic, not all of the following may apply.

- **Decide the central question or topic you would like to explore.** Try to formulate a testable hypothesis you can address, or, if you are doing exploration of patterns and diversity in nature, then think about what kinds of data you need to collect to find those patterns. For example, in experimental biology the hypothesis is often primary, but in pattern-based biology (such as biodiversity, inventories, taxonomy, morphology, anatomy) studies the initial step is to first get the data and see what patterns are present, and then to come up with logical reasons that explains the patterns you have found.
- **Determine an experimental design/strategy for data collection.** Where, when, and how often will you collect data? What will you measure or observe? How many samples/replicates are needed? Do you need to sample in one place or several? How will you write down your data?
- **Collect your data!** Be sure to record any helpful notes, drawings, observations, or comments, along with the data themselves.
- **Analyze and ponder your data and observations, evaluate your methodology, and determine conclusions.** Does your analysis support your hypothesis? If your results are inconclusive, would further data collection be helpful? If your methodology failed, what improvements do you suggest? If you encountered problems, how would you overcome these if you redid your project?
- **Prepare a short verbal or visual summary for group discussion.** Upload a summary of your exploration project to Canvas for grading (several formats possible, written text, presentation slides, movie, etc., discuss with instructors. Grading will be based on both

your execution of the project at La Selva, your presentation to fellow students, and the uploaded summary.

List of suggested exploration projects, but these are only examples of some possibilities (note that you cannot remove or disturb anything, only observe):

- Leaf cutter ant foraging behavior
- Ant visits to extrafloral and floral nectaries
- Hummingbird territories and competition
- Frog habitats and preferences
- Howler monkey vocalization and movement
- What (or who) is in the leaf litter?
- What climbs up tree trunks in the night?
- Comparison of types of epiphytes on palm and fern leaves
- Flower and inflorescence diversity in Heliconia plants
- Bark and trunks, stems and branches - comparison of different tree architectures
- Mushrooms and other fungi - a new world of hyphae
- Fruits, seeds, and their dispersal methods
- Epiphytes - plants on plants, does the host plant matter?
- Weeds in the rainforest? Do they exist?
- Biodiversity assessment in square meter plots
- La Selva Herbarium (incl. virtual data) - plant biodiversity in the tropics
- Ecotourism and sustainability at La Selva
- The invasive geckos at La Selva, problem or not?
- Human behavior based on iNaturalist observation patterns at La Selva
- Morning, noon, and afternoon activity changes in animals
- How does rain fall in the rainforest, where does it not get wet?
- The opening of flower buds and shedding of pollen
- How do orchid bees collect pollen, when and from what plants?
- Plant parts we eat in the cantina and why.
- Do animals behave differently if it is a cloudy day/night or not?
- Who lives on the Stone Bridge?
- How do lianas get up into the trees? A field study.

iNATURALIST PROJECT – Costa Rica Study Abroad

This chapter was written by Lena Struwe, Rutgers University.

During March 2023, two different study abroad classes from Rutgers will visit Costa Rica, and we will jointly run this iNaturalist project to share what we see. This project is optional but HIGHLY recommended. There is also a small competition with this: Which course (=all students in each course) will see the most species and upload the most observations? And which student (in each course) will see the most species and/or upload the most observations? Simultaneous with this the Personal Bioblitz is also running at Rutgers, so you can participate in both very easily, just join both iNaturalist projects and upload the same observations to both.

Our iNaturalist Project website for the Costa Rica trips (bookmark it):

<https://www.inaturalist.org/projects/rutgers-in-costa-rica-spring-break-2023>

Learning Goals: To observe, report and identify wild and naturalized species in Costa Rica, while practicing ‘seeing’ everyday biodiversity around you, using iNaturalist as an observation database, biodocumentation, and species identification tool, and interact with other community scientists worldwide.

What is iNaturalist? From the iNaturalist website: “iNaturalist is an online social network of people sharing biodiversity information to help each other learn about nature. ... iNaturalist provides a place to record and organize nature findings, meet other nature enthusiasts, and learn about the natural world. ... iNaturalist is a joint initiative of the [California Academy of Sciences](#) and the [National Geographic Society](#).”

HOW TO GET STARTED

- **Sign up** for a free iNaturalist account: <https://www.inaturalist.org/> (you may have any user name, if you already are a user on iNaturalist use your existing account). Students, staff, and faculty may participate.
- **If you are a beginner, visit** the ‘Getting Started’ page on iNaturalist and check out their instructions and videos: <https://www.inaturalist.org/pages/getting+started> &
- <https://www.inaturalist.org/pages/video+tutorials>
- Check out the iNaturalist **Community Guidelines**, they are very much common sense: <https://www.inaturalist.org/pages/community+guidelines>
- **Join the Rutgers in Costa Rica – Spring Break 2023 project** on iNaturalist, click on button on top right while signed in to Join Project:
<https://www.inaturalist.org/projects/rutgers-in-costa-rica-spring-break-2023>

(you can only add observations to the project after joining the project). Only students in our study abroad classes in Costa Rica may be members.

- **When you arrive in Costa Rica, start photographing and observing species that you see around you and upload them to iNaturalist.** You do not need to know what species they are when you upload them.
- (optional) **Download the iNat app** to your smartphone. Remember that there are things you can't do on the app, but you can easily upload new observations with photos and GPS coordinates. If you have joined the project (on the phone or on the web) you can select the project you want to add your observation to before you upload it on the app. Suggestion – upload while on Wi-Fi, so set it to NOT sync observations from your phone while on cell phone network (saves data on your cell phone plan, and uploads are sometimes rather slow).
- (optional) **SEEK, the new companion app:** iNaturalist's free app SEEK can help you find the species you are looking for and give identification suggestions quickly on your smartphone. You can use SEEK to find a species, and if you log into your iNaturalist account within SEEK you can upload your observation directly to iNaturalist. You can use it to hold up your camera and it will tell you what it think it is that you are looking at – remember that these identifications are suggestions, not necessarily the correct species or taxonomic group. But it can be a really good tool. You can also search for a species or taxon in the app and see on a map where other people have seen it and go to that place to look for it.

SOME BASICS ABOUT INATURALIST

- **One observation is one individual organism**, not photos of several different organisms.
- **Follow up** if someone leaves comments or IDs; reply in a friendly way. Everyone is trying to be helpful.
- **Identify the observation as well as you can** – it is OK to just say 'Plant' if you are completely unsure what it might be. Or list the family or larger group.
- Remember that the **automatically suggested species** in the dropdown menu on iNaturalist might be incorrect. The suggestion algorithm uses AI and machine learning from uploaded photos, so use this tool with a critical mind. Research the suggestions to make sure they are reasonable, possible, and logical.
- Don't agree with **identification suggestions** from others without checking if suggestions are OK and reasonable. **Beware, some automatic suggestions may be somewhat insane.**
- Anything you write and upload on iNaturalist is **public and global**, and the data is being fed into global research databases and used by people all over the world for science, so act professionally.

- If you **misbehave** on iNaturalist (upload joke pictures, plagiarize photos, enter fake data, etc.), you can get reported and banned by iNaturalist admins. Just don't do it.
- Check out your **Life List**, it builds up automatically and counts and organizes all species you have reported. You can start now and continue to use iNaturalist for the rest of your life. Your observations will just be added to iNaturalist as a whole, and you then can add specific observations to various projects you are part of.
- Species should be seen outdoors as **whole and wild organisms**, not in a place where they are for sale, in a museum, or in a market. Wild organisms seen indoors are OK if they are not pets or indoor houseplants (such as ants, geckos, house sparrows at the airport...) Antlers, feathers, fallen and floating fruits, animals tracks, etc. that are found in nature are OK. Cultivated plants outside are OK to include but then you must mark those observations as 'captive/cultivated'.
- Observations need to have proper and correct location data. This is automatically added if you use your phone app (make sure you let iNaturalist have access to your location), but if you take photos and upload them later you might have to add location manually using a Google map interface within iNaturalist. (Rare species automatically have locations obscured.)
- Cultivated plants and pets need to be marked as **cultivated/captive** in iNaturalist.
- If you have to **fix and edit observations**, it is a lot easier to do this in the **web interface** on a computer than in the app (and some things are impossible to do in the app).
- Use the **help page** for quick answers: <https://www.inaturalist.org/pages/help>

WHAT TO DO FOR THIS CLASS PROJECT:

- Make sure all observations have **good enough photos** for ID. Observations need to have acceptable photos of a variety of features, including whole plant photo, leaves, stems, flowers and/or fruits, or similar so that species identification is possible. Make sure you are close enough to what you photograph (or crop photos), show both details and the whole of the organism, from above/side/under if you can, include information in the notes.
- You can also make sound recordings and upload them.
- Observations of birds and mammals are acceptable without photos and sounds, since they are a bit fast and flighty.
- You should have seen your observations **during Spring Break 2023**, but you have **until April 1 to upload** your observations.
- **Help classmates** identify and confirm their species identification by looking at what others in class have seen in the class project, agree with the species ID if you think they are right, or suggest new identifications. (It does not matter if your observation reaches Research Grade or not.)

- After April 1, Lena Struwe and Lauren Adamo will calculate the totals for each class and we will see who won
- There will be small prizes for the students that report the most species or most observations.
- It is not unlikely that you might upload a photo of an insect and the world expert on that group might reply, and it might even be an unknown species. This has happened! So much tropical biodiversity is unknown. But you need great photos for good species identification.

Happy species hunting!

Project leaders and contacts:

- **Lena Struwe**, Chrysler Herbarium, Rutgers University
lena.struwe@rutgers.edu (@vilseskog on iNaturalist)
- **Lauren Adamo**, Geology Museum, Rutgers University,
lnetzke@eps.rutgers.edu (@rugeomuseum on iNaturalist)

The screenshot shows the iNaturalist website interface. At the top, there is a search bar and navigation links for 'Explore', 'Your Observations', 'Community', and 'More'. The main header features a large image of tropical foliage (ferns and palm trees) with the project title 'Rutgers in Costa Rica - Spring Break 2023' and a red 'ADD OBSERVATIONS' button. Below the header, there is a 'Stats' section with a green sidebar on the left showing 'Totals' for Observations, Species, and People, all with a count of 0. To the right of the sidebar are three columns: 'Most Observations', 'Most Species', and 'Most Observed Species', each with a placeholder icon and the word 'Unknown'.

iNaturalist WEBSITE NOTES

Clicking on the **iNaturalist logo** in the top left will bring you to your **Home Page**.

Observer is the person that uploaded an observation to iNaturalist

Identifiers is anyone that has suggested an ID on an observation by anyone.

Users are all observers and identifiers.

How to search in iNaturalist - use **EXPLORE** on the top bar and search for a species (can be larger taxon group too) and/or location (geographic area). Results can be shown in **map**, **list**, or **grid** format (see little icons). Click on **Filters** for more refined and detailed searches (by date, observer, project, type, etc.)

To find your own observations - use **YOUR OBSERVATIONS** on the top bar. Click on **Filters** for more refined and detailed searches (by date, observer, project, type, etc.)

The top tab **COMMUNITY** includes links to active **Users**, leaderboards (the most...), **Projects** (around the world, you can make these for your projects; a list of recent projects you are part of is also here), journal posts, and iNat **Forum** (questions and bug reports).

The top tab **IDENTIFY** leads you to a page that lists all the observations that need identification help. You can select and search for a species (or larger taxonomic group) and location, or look at anything from anywhere that people have reported. Observations show up here as long as they are marked **Needs ID**. You can help by searching for observations from your area or species groups you know and add your comments and identifications on those. You can also use the Filters to find just specific groups of observations. Click on an observation and you can select **Add ID**, **Comment**, or **'Agree'** with a previous ID. Please comment in English. **'Reviewed'** means you have seen the observation, you don't have to ID or comment on something for it to be marked as Reviewed.

Under the **More** top tab are general information about species (**Taxa Info**), field guides to species of a certain taxon group and area (**Guides**), information about place names used in iNaturalist (**Places**), statistics, **Help** pages, **Video Tutorials**, how to **Manage Projects**, and **Teacher's Guide**.

You can **message users** from their account page, but you cannot e-mail them. Some are anonymous and have a pseudonym. Be nice, especially to beginners, explain and show them how it is done right. Remember that all activity is public, everyone can see everything (messages are private).

Top right shows a **message icon** if you have gotten unread messages, a **comment icon** (numbers and recent activity is shown in a dropdown menu, and your **Account** to the very top right.

Click on your **Account image**, and you will get a long dropdown menu for things related to your account, observations, and activity.

Dashboard shows you recent comments on **Your Observations**, observations uploaded by people you follow, and other activity.

Here you get to your **Edit Observations** page (very useful, especially the **Batch Edit** option, to edit many observations at once and to fix errors).

There is a **Calendar** that shows which dates in the past you have reported things for. Clicking on a date will get you to a page that shows everything you saw that day.

Identifications shows what you have identified for others (not your own observations).

Lists give you options of several lists of your observations; the **Life List** and **Favorites List** are automatically generated.

Journal is like a blog where you can write things.

Favorites are all observations you have marked as favorites, your own and others. Projects are a list of all projects you have joined or are an administer for.

Profile is your own information – upload a photo representing you, write a bio about who you are, and you and all others can see this and your activity statistics.

Account Settings is your private user settings page, where you add the text for your bio, set your user name, add your real name (display name, visible to others), and set your e-mail (this is hidden to others). Important – you can set your **Language** here too, this will only change the language for the menus and such. You can also turn on and off **Notifications** here, and much more.

The e-mail account for the helpdesk for iNaturalist is help@inaturalist.org.

iNaturalist Youtube account (includes tutorials) -
<https://www.youtube.com/@inaturalist9514>

PERSONAL BIOBLITZ



WANTED

**All the wild species you can see
in your everyday life.**



Join Rutgers' 10th PERSONAL BIOBLITZ 2023

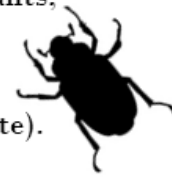
When? 76 days, 1 March to 15 May 2023, 24/7, anywhere on Earth.

How? Discover, see, listen, photograph, identify and learn (and get help to identify, beginners welcome!), upload to iNaturalist and our project.

Why? Learn more about what lives right around you - birds, plants, microbes, algae, fungi (molds!), insects, mollusks, mammals...

Who? Anybody associated with Rutgers University in any way (incl. friends and family of Rutgers' people and more, see website).

What? Any wild species anywhere in the world that you personally experience (special rules apply, see website). Explore the total global wild biodiversity around you.



All species observed as part of this project on iNaturalist will be added to the growing amount of community science observations that are being used for global biodiversity science and new discoveries.

Find out more and sign up for free here:

2023 Project Webpage: <https://tinyurl.com/PBinfo2023>

About the Personal Bioblitz: <http://tinyurl.com/RUPBabout>

Join our mailing list: <https://tinyurl.com/RutgersBioblitzMailNEW>

iNaturalist Project, *Personal Bioblitz 2023*: <https://tinyurl.com/PersonalBioblitz2023>

Facebook page: <http://tinyurl.com/RutgersBioblitzFB>



iNaturalist



Questions? E-mail Dr. Lena Struwe, lena.struwe@rutgers.edu

NATURE JOURNALING

This chapter was written by Lena Struwe, Rutgers University.

As part of your course syllabus and your grade you will learn about and explore nature journaling while in Costa Rica. This is a way to practice observations and communication skills through nature journaling in a personal journal. In your personal field kit is a red journal you will use for this, but you can also use that for other activities, such as a travel diary, notes, information, or whatever you want. But at least some pages in your journal will be nature journaling, and you should upload at least one page to Canvas at the end of the course for grading (your Nature Journaling activities are worth 25% of your grade; this is not an optional project).

What is Nature Journaling?

- Nature Journaling is Curiosity, Wonder, and Attention (as per JML)
- A way to collect and save information, memories, impressions, and experiences on paper by hand (non-digital).
- You will use your hands, eyes, ears, noses, legs, to explore and take notes (using words, numbers, sketches).
- It is personal, all pages by all students will look different. Everyone has different styles and different preferences in what media (pens, paints, paper) that they use.
- You are nature journaling for YOU, not to show off or get a high grade or to compare your page with others. It is a way of being, of seeing, of creating memories and enhancing experiences.
- *Nature journaling is NOT about fine art or if you can draw pretty or not - it is completely different.*
- Nature journaling is related to, but not exactly the same as Journaling, Urban Sketching, Green Sketching, Scientific Illustration, Sketch Noting, and Nature Art (feel free to google these words)

Through nature journaling you will:

- Develop observation skills valuable through life.
- Learn a new way of seeing, discovering, and thinking.
- Master how to ask questions, be curious, and figure things out. Let the questions come to you after you have seen something new.
- Develop skills in how to connect the dots, make new connections, synthesize information.
- Explore and improve your innovative and creative skills.
- Get experience of using various techniques to communicate information, both visual and written, quantitative and qualitative, and explore art media types such as pencil, ink, watercolor, etc.
- Increase your respect for differences in how we see and do things.
- Start a conversation within yourself, and maybe with others.
- Realize that nature and biodiversity is everywhere, wherever you are.

- Realize that nature journaling is part of a practice that can improve mental health, reduce stress, make you feel ‘in the moment’ or ‘flow’, and get you outdoors into fresh air and nature.

This class is inspired by and follow John Muir Laws’ (JML) curriculum and methods, see insert (please also visit his website for inspiration, videos, how to instructions, virtual meet-ups, supplies, and free webinars(<https://johnmuirlaws.com/>)).

The “**rules**” of what should be included on your page (as per JML, see box on right from JML)

1. **text, numbers, and images**
1. “**I notice**” – observe, seeing, hearing
2. “**I wonder**” – questions, thinking
3. “**It reminds me of**” – connect to previous experiences and knowledge, build on what you know and your memories
4. **title or heading - a place, a feature, an organism, anything**
5. **metadata: your name, date, place** (+ time), **weather**, etc. to create a strong memory of where you made the page outdoors and what the conditions where (this also creates a connection to a place for you, called a ‘sense of place’)

I NOTICE...

Be specific. Use words, pictures, and numbers.

I WONDER...

Who is, was, will it be?

What happened, is happening, happens next?

Where is, was, will it be?

When (did, will) it happen?

How does it work?

Why is it this way?

IT REMINDS ME OF...

things you have learned, seen, or feel.

Some suggestions and advice:

- Simple drawings rule! This is not scientific illustration or fine art. This is field sketching and note taking. Quick, unfinished sketches are great.
- Include words - words can bring images and emotions and memories: examples - crimson red, sharp thorns, stormy sea, creaky dead tree, sulphury stinky smell
- Write the words and numbers in various fonts and sizes – express yourself. (Sketch-noting is great, try it.)
- Count, measure, describe, diagrams, graphs, – a lot or a little, how far, how much, how many?
- Include questions without answers: It is not about being right or having right answers. It is not about knowing it already. Any observations and questions are OK and valuable. Questions also lead to more questions, this is great.
- Don’t plan out your exact page before you start – let it develop as you notice things. You can plan a little, to make sure you fit the components you want to include.
- If it doesn’t fit, move to a new page... stretch it over several pages.
- Leave pages ‘unfinished’, doesn’t have to be perfect!
- Don’t write essays in your journal. Mix words, sketches, and numbers.
- Only use plain (blank) paper. Ruled, dotted, or squared paper will not work as well.
- Bulleting information is fine. Incomplete sentences are great.

- Go outside. Sit down. Bring water (and hat, if sunny). Talk to yourself. Allow all impressions in and onto the page.
- You are in control of your page, you make it, you own it. Relate it to yourself and people you know.
- How do you draw a sound, smell, feeling? Explore it!
- You can include leaf rubbings, pressed plants, glued on sand, and other mixed media.
- Include smell and feel descriptions, use your senses.
- Maps, landscapitos, and skyscapitos are amazing components on a page!

After your introduction to Nature Journaling at La Selva, feel free to continue in any way or type of journaling you want. You do not need to stick to the John Muir Laws type of nature journaling.

Suggested Supplies

- Journal or other blank paper
- Pencils and Blue Col-erase pencil (erasable, will not show up in photographs, for initial sketching)
- Pencil sharpener
- Eraser (preferably kneaded eraser) and
- Other pens (ballpoint, water soluble and permanent ink pens, white gel pens, etc.)
- Watercolors or watercolor pencils plus brushes. Water container or water brushes.
- Ruler (mm/cm preferred, it is what we use globally and in science)

Resources

- John Muir Laws website (videos, how to, downloads, free webinars):
<https://johnmuirlaws.com/>
- John Muir Laws Youtube channel: <https://www.youtube.com/c/JohnMuirLaws>
- Marley Peifer website: <http://marleypeifer.com/>
- Marley Peifer Youtube channel:
<https://www.youtube.com/channel/UCmzSZyj2zg80pjI3zI8ri3Q>
- Facebook group: Nature Journal Club:
<https://www.facebook.com/groups/naturejournalclub/>
- There are many great books on this topic– by John Muir Laws, Cathy Johnson, Clare Walker Leslie, Roseann Hanson, Rosalie Hazlett, etc.
- For species ID, use printed or digital field guides, also recommended is iNaturalist and SEEK app.



In-depth nature journaling exploration, some methods to choose from:

Most of these assignment ideas have been developed by Lena Struwe and Mary Nucci at Rutgers University as part of their Nature Journaling teaching. Some are strongly built on assignments and ideas by others, such as John Muir Laws and Emilie Lygren. We have tried to provide credit wherever possible to the originator of the ideas, even if we developed them further.

A Nature Walk

Instead of sitting down in a spot and doing a journaling page, this week we want you to first take a walk in a natural area for at least half a mile. Take it all in while you walk, your experience of moving your legs and feet, the sights, smells, sounds, and feeling of air on your skin. Be observant, stop if you see something that catches your interest (a moving animal? a tree fungus?), and then walk to the end.

When you get to the end (and don't wait until you get home), then you stop and do journaling about your experience while walking. While walking, try to keep the focus in your mind on the IMPRESSIONS that nature makes on you, and what you observe. Pull from those experiences to make your journaling page. The main point for this exercise is that you WALK first, and then journal it right after. You can take notes and sketches while walking, that is OK, but the final page is done after the walk. Hint: Put away your phone while walking, only use it for a few photos if you must. :)

Animals in Motion

Make sketches of movement in an animal as part of a Nature Journaling page. Observe a bird, mammal, insect, anything that moves and sketch the animal in several different quick sketches. Practice your skills at trying to quickly jot down the main angles, the feel of movement. Think about how the skeleton (endo- or exoskeleton) limits the movements, sets the angles of the body parts, and creates structure in an animal body.

(Partially based on John Muir Laws's *Nature Drawing and Journaling*)

Change over Time

Follow the change in a variable, place, or organism over a couple of days and make a nature journal page. This could be the sky, clouds, sun/moon, weather (temperature, wind, rainfall), animal behavior, the opening of a flower bud, decay of a fruit or mushroom, a small creek's water levels, leaves falling from a tree, etc. Anything that shows change within a few days.

Make a nature journaling page that includes visual descriptions of the amount of change. Include graphs or other visualization of quantitative or qualitative data shown over time. Think about how the small changes you observe might be part of geographically larger and longer-term patterns.

(Partially based on John Muir Laws & Emily Lygren's *How to Teach Nature Journaling*)

Fear of Nature

You will journal something you fear in nature--it can be an organism (spiders, bears, bees, trees, etc.), a concept (walking in a dark woods, getting lost, etc.), or a natural phenomena (thunder, tornado, deep water, etc.). You should use the questions--I notice, I wonder, It

reminds me of--to look for positive attributes of this thing that frightens you. You may use images from the internet as visual inspiration to journal this assignment unless you have access to the real thing to observe your choice. Do not use any negative words on this page.

Geologic Rocks and Landscape Features

Place: A place outdoors with rocks (cliffs, loose rocks, or sediments), can be urban or not, but must include natural rocks and/or sediments.

Description of assignment: You are going to make a nature journal page of a geological setting in a landscape with visible rocks (cliffs, hills) or sediments (such as sand or a shore). Look at the place - really look at it. How does it look and feel like? Is it loose or part of bedrock? How does it fit into or influence the landscape? Was it always here, or did it come from somewhere else? Think about the 'life' and 'fate' of this landscape or rock through its 'life time', and how it fits into the biotic (living) world in the past and today. Imagine the place or object back in time, do some mental time travel. (Partially based on John Muir Laws's *Nature Drawing and Journaling*)

Human Detritus (Leftovers from the Anthropocene)

For this assignment, you will be journaling something that includes manmade 'leftovers', the detritus of our lives. The important part here is that we are no longer just focusing on natural objects - now you are putting manmade objects in the center. There are three options below, pick one.

Option 1: Journal some of the garbage (things you throw in the trash) that you produce during a week, from a meal, or similar event.

Option 2: Journal an interaction between an organism (a tree, weed, fungus, or animal) and a human-made structure, such as building, asphalt, roof, garbage can, wall).

Option 3: Journal your findings of human-made detritus (trash, garbage, leftovers, broken manmade things etc.) that you find in a place in nature or urban environment.

Landscape Map and Transect

Place: You will use an outdoor area that is at least half an acre - that is about 2000 square meters/2400 square yards. A square of 50 x 50 m is 2500 square meters, and if you take LONG steps you can probably take steps that are nearly a meter/yard long (normal steps are shorter, depending on leg length). The area boundary can be rectangular or square, no other shape. Avoid selecting an area that includes a building, and definitely do not include buildings in your transect (Part 2). Roads and other manmade transportation structures and landscaping features may be included.

Part 1. MAPPING THE LANDSCAPE. Using your defined area, you will make a 2D (from-above-view) map of the landscape features, including any water bodies, roads, hills, big trees, vegetation, etc. - anything that is permanent (so not moving animals). Include a legend, a small table that explains any symbols/colors you used.

Part 2. SLICING THE LANDSCAPE. On your map you will now mark a line from one side to the other, and then you will draw a schematic 2D drawing called a transect of how the landscape looks as if you sliced it along this line (so this is a from-the-side-view). Show elevation differences, water (if present), rock outcroppings, big trees, (if present), roads, etc. You may spread this out on two facing pages in your journal if you need more than 1 page (so, you can photograph it as ONE photo). (See videos by John Muir Laws about

making a map and making a transect for guidance.

(Partially based on John Muir Laws & Emily Lygren's *How to Teach Nature Journaling*)

Landscapitos

For this assignment, you will be drawing landscapitos. A landscapito or 'little landscape' is a great way to capture areas of interest without getting tired of trying to fill the whole page. Making several landscapitos is often a better memory stimulus than one big image, and can be more fun than one giant image.

To make a landscapito:

1. make a box with your hands to frame and compose your drawing (like this)
2. draw the shape of the frame on your page (keep it small)
3. lay out the major elements first
4. draw your landscapito--do not overwork it. Only use broad strokes or changes in value (dark to light). No details are needed. Text observations or more landscapitos can be done on the rest of the page.



Play with format--landscapitos do not need to be the same size or orientation (long horizontal, or tall vertical is fine). Think about the use of arrows to guide the viewer.

Modular structures in plants - tree branches

Focus on a branch of a tree outdoors and make a Nature Journaling page about it. Think about how the branch is shaped, twisted, rounded, shaded, and angled. You may include a small zoom-out image of the whole tree, but the main focus should be a single branch, large or small.

(Partially based on John Muir Laws's *Nature Drawing and Journaling*)

Natural History Collections - your own

Nature journal at least three objects you have of the same kind (such as three leaves, shells, feathers, dried fruits, dried flowers, fossils, etc.). Make sure they are all the same type, but they can be collected at different times and places. Treat your three objects as if they were natural history specimens with scientific value and part of your own personal collection. The objects should NOT be alive (so no pets, houseplants, aquarium fishes, etc.). Make a journal page comparing the three items, their features, their origin (if you know), their sizes and the organisms they are from. You can also try to identify your objects to species or larger group and add information you find out about them. Draw from the specimens you are holding in your hands, look closely and note details.

(Partially based on John Muir Laws & Emily Lygren's *How to Teach Nature Journaling*)

Natural History Collections - digital

Go to the website for the national iDigBio online specimen portal, look for three natural history specimens of the same kind that are collected in the same geographic area, that have media (photos or sounds), and map point (geographic coordinates). (There are museum specimens of plants, fungi, insects, lichens, skeletons, fossils, mosses, algae, and more; you can pick any type of collection, up to you). Make a journal page about these

specimens - compare the three collections, draw sketches, talk/think about the place, time, and person who collected the organism/object. (Information is available in the collection label and in the database record of the specimen. You can zoom in on the photo to see details.)

Not Home Alone

For this you will be journaling something that represents the biodiversity in an indoor home or other building. This includes fruits and vegetables, spices and herbs, houseplants, meats and fish (within reason), any arthropods and similar 'house pests', BUT NOT PETS (so no cats, dogs, or aquarium fish).

Option 1: Make a journal page where you focus on one vegetable or fruit, or other food organism. You could use a whole shrimp or egg, but do not use prepared or ready-made food, and do not use just a piece of meat. Your object should be an unaltered part of or whole organism. Include a dissection (cross-section or similar) of the object as a zoom-in image, so cut it up, look at the inside, its construction, and its parts.

Option 2: Make a journal page about all the arthropods and other animals you can find inside your home, such as insects, spiders, mice, etc. You will have to really go and look for them, and consider posting them to iNaturalist. Fungi and wild plants might be included if they showed up uninvited. Do not include pets or houseplants or food organisms.

Option 3: Focus on one or several houseplants and journal their environment - include a 'landscapito' of their place in your room, make zoom-in of details of the plants' morphologies. Look up their natural origin and environment (see database in readings), and compare and contrast their place in your home with their own 'home environment'.

Sit Spot

The Sit Spot exercise is a 10 min (or more) focused observing where you sit still in a place and let nature come to you. Silence your phone and put it away (feel free turn on a timer]. You select the spot anywhere you want outdoors where there are living organisms, and we ask you to sit for at least 10 min (but remember you have unlimited time). Sit, and just start to notice what is around you: what is moving, living, changing? After a while, start taking notes and make sketches and notes on your journal page about what you see and notice while sitting there outdoors. What do you notice, what questions pops into your mind, where do those thoughts lead you on? Don't take photos (your phone is put away, right?), just notice and SEE, and get your observations and thoughts onto your journal page in whatever format or style that suits you.

(Partially based on John Muir Laws & Emily Lygren's *How to Teach Nature Journaling*)

Skyscapitos

Skyscapitos are like Landscapitos, but instead you look up and into the sky - look for sky colors, cloud patterns, sunrise and sunset, and weather phenomena. Small, very generalized drawings will tell a lot. These are especially fun to do over several days with the same sky view but to see how it changes over time.

String Safari

Materials needed: A piece of string about 3-5 feet (1-1.5 m) long, or a hula hoop. A hand lens if you have one.

Place: Any place that has dense ground cover, can be a lawn, meadow, field, stream edge, garden area, etc. Look for a place with objects of various sizes, and loose items like cones, feathers, and tree leaves, as well as moving animals can be included.

Description of assignment: Knot your string together so you get a large circle. Place the string as a circle (or use a hula hoop) on the ground so you have a variety of species inside the circle. This circle is your focus now. Start to observe what is inside the circle, what kind of biodiversity you can see. Use journaling to record observations about as many species as you can within the loop. Use numbers to record sizes, abundance, and other quantitative data. Is there evidence of organisms that are no longer inside your circle? Are there organisms you can't see? It is not important to have the right taxonomic name on things, instead try to journal the diversity and abundance of what you see in the circle.

(Partially based on John Muir Laws & Emily Lygren's *How to Teach Nature Journaling*)

Visual Accessibility Page

First make a regular nature journaling page, then write a description of the page in words as if for someone who is visually impaired and can't see your page and not what you saw in nature. This is harder than it sounds, and a great exercise to better understand accessibility issues.

Zoom-in Zoom out

Getting close to a subject reveals different details than those you see from a distance. Close up, micro textures and fine details stand out. Standing back from a subject in nature, you begin to notice where it is in the environment, its relationship to other things around it, and its overall shape.

a. (Life size) Your journal should include a view or portion of your subject that is exactly life size. If the object is larger than your page, only draw part of it.

b. (Zoom in) Choose some part of the subject that you find interesting, and 'zoom in' to observe it in detail. To show this view, draw a circle around that part of your drawing. At the side of the paper, draw a larger circle and draw a magnified view of that same area showing details that are too small to be shown in the life-size picture. Include written notes and questions.

c. (Zoom out) Step back and make a final sketch, this time zoomed out to show the organism within its whole environment or as part of an ecosystem. You could show a side view of the subject, or a small map of its overall shape and where it is in the environment.

(Partially based on John Muir Laws & Emily Lygren's *How to Teach Nature Journaling*)

PERCENT COVER

EXPLORATION QUESTIONS

Form: What is it like? Patterns: Is there a pattern here? What is behind the pattern?

Function: How does it work? Perspective: What are the points of view?

Causation: Why is it like this? Reflection: How do I know? What is my evidence?

Change: How is it changing? What was it before? What will it be next? Responsibility: What is my responsibility?

Connection: How is it connected to other things?

DEGREES OF ARC

ESTIMATING NUMBERS

BIOMETRICS

boot length = _____ knee height = _____

one step = _____ navel height = _____

10 steps = _____ total height = _____

10 meters = _____ arm span = _____

100 feet = _____

BEAUFORT WIND SCALE

<p>0 Calm <1 mph (< 1 km/h) Smoke rises vertically. Flat, glassy water.</p> <p>1 Light air 1–3 mph (1.1–5.5 km/h) Smoke drift indicates wind direction. Leaves and wind vanes are stationary. Ripples without crests.</p> <p>2 Light breeze 4–7 mph (5.6–11 km/h) Wind felt on exposed skin. Leaves rustle. Wind vanes begin to move. Small wavelets. Crests have glassy appearance, not breaking.</p> <p>3 Gentle breeze 8–12 mph (12–19 km/h) Leaves and small twigs constantly moving, light flags extended. Large wavelets. Crests begin to break; scattered whitecaps.</p> <p>4 Moderate breeze 13–17 mph (20–28 km/h) Fairly frequent whitecaps. Dust and loose paper raised. Small branches begin to move. Small waves with breaking crests.</p> <p>5 Fresh breeze 18–24 mph (29–38 km/h) Branches of a moderate size move. Small trees in leaf begin to sway. Moderate waves of some length. Many whitecaps. Small amounts of spray.</p>	<p>6 Strong breeze 25–30 mph (39–49 km/h) Large branches in motion. Whistling heard in overhead wires. Umbrella use becomes difficult. Empty plastic bins tip over. Long waves begin to form. White foam crests are very frequent. Some airborne spray is present.</p> <p>7 High wind, moderate gale, near gale 31–38 mph (50–61 km/h) Whole trees in motion. Effort needed to walk against the wind. Sea heaps up. Some foam from breaking waves is blown into streaks along wind direction. Moderate amounts of airborne spray.</p> <p>8 Gale 39–46 mph (62–74 km/h) Some twigs broken from trees. Cars veer on road. Progress on foot is seriously impeded. Moderately high waves with breaking crests forming spindrift. Well-marked streaks of foam are blown along wind direction. Considerable airborne spray.</p> <p>9 Strong gale 47–54 mph (75–88 km/h) Some branches break off trees, and some small trees blow over. Construction/temporary signs and barricades blow over. High waves whose crests sometimes roll over. Dense foam is blown along wind direction. Large amounts of airborne spray may begin to reduce visibility.</p> <p>10 Storm, whole gale 55–63 mph (89–102 km/h) Trees are broken off or uprooted, structural damage likely. Very high waves with overhanging crests. Large patches of foam from wave crests give the sea a white appearance. Considerable tumbling of waves with heavy impact. Large amounts of airborne spray reduce visibility.</p>
--	---

©2014 John Muir Laws

Note - rulers will not be accurate in image, not printed at 100%, use your real ruler. © John Muir Laws.

NATURE JOURNALING TIPS

Image/Illustration

- decorate
- map
- color
- texture
- describe
- icons/symbols

I NOTICE
I WONDER
IT REMINDS
ME OF
- J.M.L

Note: You don't have to finish a page, just leave it as it is and go on to the next one.

Stay in the now.

No pressure, no to-do-list.

Finish if you want to.

Melinda Nakagawa

IT DOESN'T HAVE TO BE PERFECT

NUMBERS

- distance
- measures
- no of individuals
- legend
- time
- date

TEXT

- labels
- descriptions
- explanations
- informative details
- observations
- questions
- possible answers
- smell & feel
- emotions
- associations
(it reminds me of...)
- poetry
- lists
- check box for follow-ups
- add key for symbol
- carton bubble
- weather
- location
- add headers
- organise your thoughts

Appendix 1: Example of Independent Exploration Project

LEAF CUTTER ANTS

General information:



Leaf cutter ants. © Lena Struwe

The term “leaf cutter ant” is generically applied to any of 47 species of ants from two genera, *Atta* and *Acromyrmex*, that harvest leaves used for cultivating a fungal food source. *Atta* ants have three pairs of spines and a smooth exoskeleton on the upper surface of the thorax, while *Acromyrmex* ants have four pairs and a rough exoskeleton. Seven species of leaf cutter ants are found in Costa Rica (out of 600 total species of ants described throughout Costa Rica!), including *Atta cephalotes*, which is very common at La Selva.

Example Questions:

Some of the questions below are adapted from *Ant Foraging Behavior: A field exercise for student groups studying leaf cutter ant behavior at BFREE*

(<https://www.bfreebz.org/wp-content/uploads/2018/03/Leaf-Cutter-Ants-Field-Study.pdf>) Amy Treonis, Department of Biology, University of Richmond, Richmond, VA



- *How does the distribution of leaf cutter ant presence vary with forest openness?*
- *What is the spatial relationship between plant leaf sources and leaf cutter ant nesting sites?*
- *Do leaf cutter ants have different foraging behavior on different plant species? Are the leaf fragments cut by the ants uniform or do they vary with factors such as tree species and distance from mound?*
- *Does ant foraging behavior vary with time of day, with temperature, or when it’s raining? How do conditions affect the density of ants on the trails? Do conditions affect the properties of leaf fragments carried by ants?*
- *Is there a relationship between ant body size and the size (area, density, thickness) of harvested leaf pieces?*
- *How fast do leaf cutter ants move along their trails? Does the size of a harvested leaf piece influence the rate of movement along a trail by an ant?*

Materials You May Need:

- Tape measure • Ruler • Calipers • Masking Tape • Camera
- Kestrel environmental meter • Stopwatch or other timing device • Notebook

Appendix 2: Examples of Nature Journaling Pages


The Raritan River
 New Brunswick, Middlesex Co., NJ
 viewed from Antillean Field
 (40.4874, -74.4345) ± 4m, a.H. 17m
 Ryan J. Schmidt

15 December 2021
 13:15 - 14:00
 55°F


THE BANKS

Lands and Landscapes: Take II.....
 Are these reminiscent of (or reflective of) topography? → soil depth?
 ↑
 They do not allow parallel lines to one another
 ↑
 It is interesting how the tree lines look from a distance
 odd for a conifer to have low apical control

long-distance plant ID is a much fun!
 ↑
 Pines strobus poking through the canopy
 ↓
 high apical dominance but low apical control

real upland seems to start about here (1/2 way)


Q. *Quercus coccinea* flagging red
 ↓
 upland species
 ↓
 drier site
 ↓
 very quick transition

This area (conifer scrub/shrub wetland) is interesting
 ↓
 why no *Phragmites* here?
 ↓
 how is *Acer negundo* isolated to this area?

will the *Phrag* spread to this area?
 zoom in

zonation patterns extremely evident from a distance
 ↓
 can view flooding frequency easily from this far up

Long-distance scaling probably not.
 ↓
 using *Phrag* as a scale...
 ↓
 Salix is probably 8-10ft. tall
 Acer negundo is 6ft. tall
 Salix babylonica is 230ft. tall
 Platanus occidentalis is a 60 ft. tall

here is where trees can establish
 ↓
 definitely different hydrology but is there also a different soil type here?
 ↓
 Mostly *Platanus occidentalis* here so definitely wet but soil can be variable

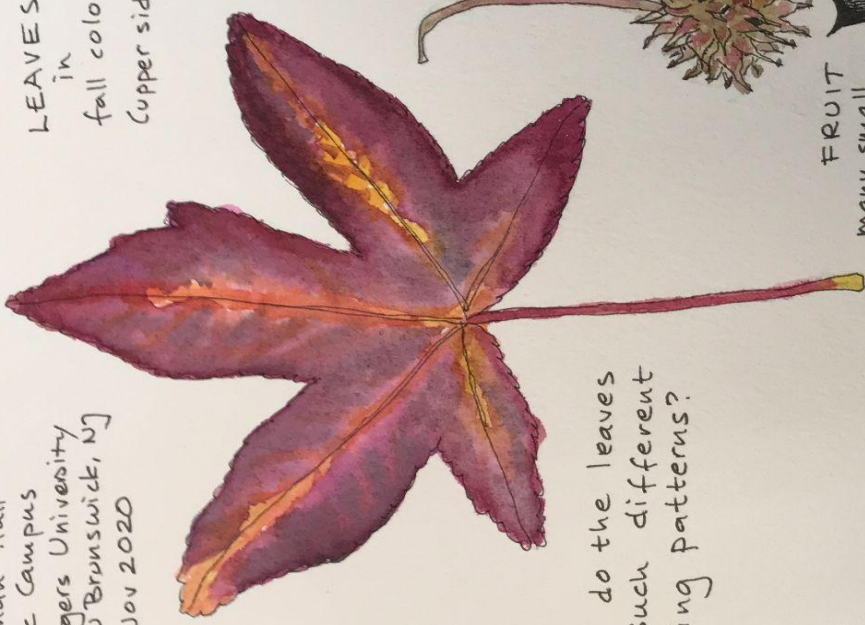
are the *Salix* roots causing a buildup?
 ↑
 are these two unrelated?
 ↑
 if so, why is there also wreckage building up at the end of this?
 ↑
 drainage from upland into the river?

cut through in *Phrag*. here looks like a small stream

© Ryan Schmidt, Rutgers student. Used with permission.

Sweetgum in November

Lipman Hall
Cook Campus
Rutgers University
New Brunswick, NJ
17 Nov 2020



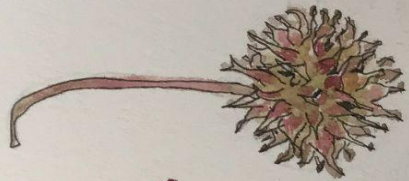
LEAVES
in
fall color
(upper sides)

Liquidambar styraciflua

-like liquid, red-purple amber
poured into the
leaves every
fall.



? WHY do the leaves
get such different
coloring patterns?



FRUIT
many small
capsules from
many flowers
fused together
= MULTIPLE FRUIT

above



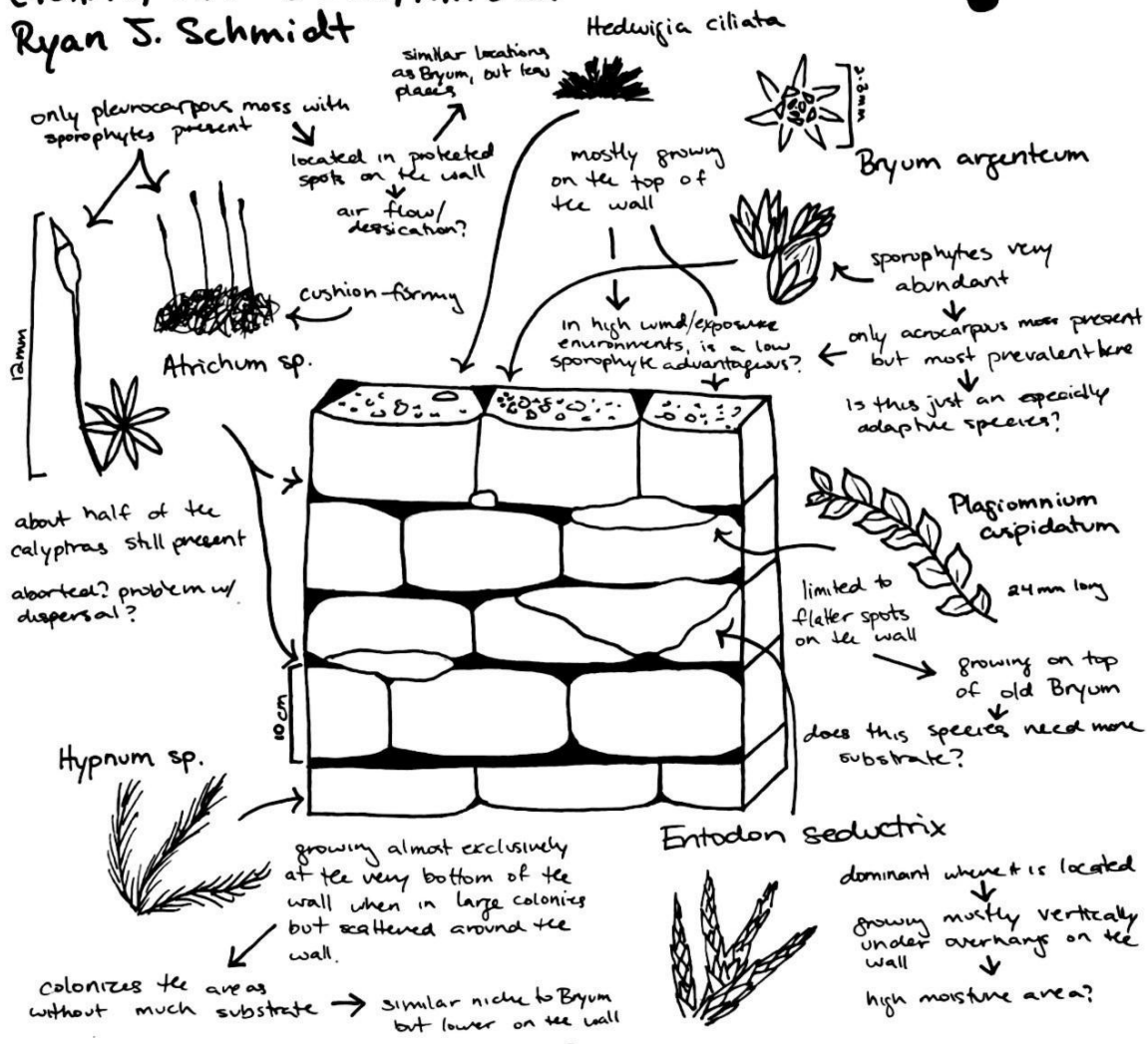
side



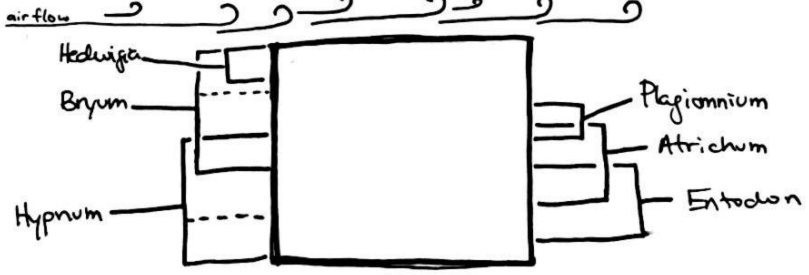
CLOSE-UP OF FRUIT

Newell Apartments
 New Brunswick, Middlesex Co., NJ
 courtyard outside of PAL Building
 (40.9179, -74.4315) ± 4m, Alt. 34m
 Ryan S. Schmidt

14 November 2021
 12:26-13:15



MOSS ZONATIONS



© Ryan Schmidt, Rutgers student. Used with permission.

(inside of house)
Old Bridge, NJ
9/30/22
10/2/22

Temp: 78-82°F Hum.: 40-60%

* Observing how isopods influence the decay of dandelion greens

reminds me of my week 1 journal!

w/ isopod assistance!

the DECAY of DANDELION leaves

characteristics of the dandelion leaf
• approx. 6 in. segment of leaf given (L); 2.5 in. (W)
• greens are at least 1.5 weeks old (leftover lizard food)
• leaf + enclosure were sprayed w/ water on Days 1 + 3; could have sped up decay?



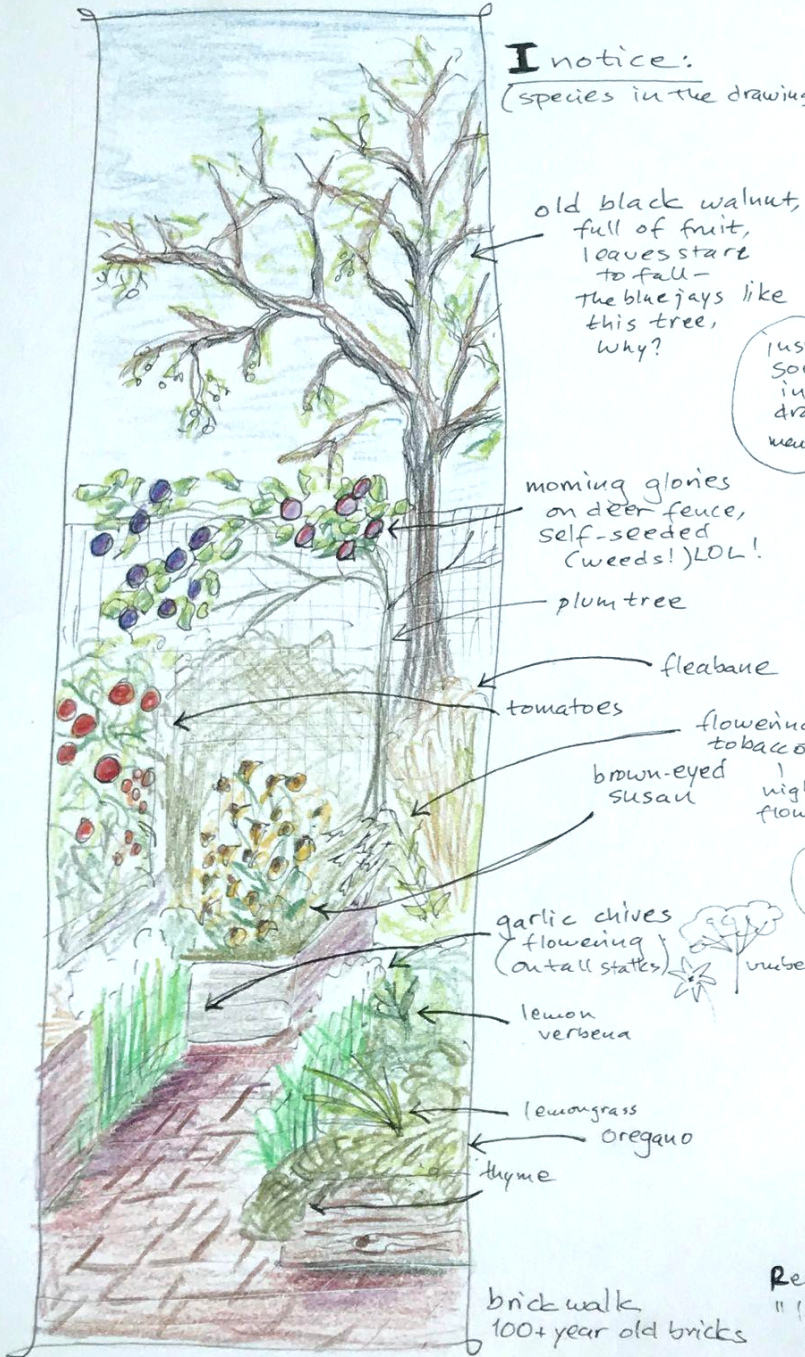
DAY 1 (9/30/22)	DAY 2 (10/1/22)	DAY 3 (10/2/22)
<p>bright green present after one day</p>	<p>leaves beginning to dull in color</p> <p>babies starting to move in on rotten leaf</p>	<p>adults on Day 3 when food is the most available?</p> <p>why are there less adults on Day 3 when food is the most available?</p> <p>adulthood isopods working on yellow leaves</p> <p>stems is brown & soft, easy to eat</p> <p>hundreds of baby isopods!</p>

A VERTICAL SLICE OF MY WORLD

? I wonder where most of the native pollinators are, pushed out by non-natives, more susceptible to pesticides or disease, or no food plants for their larvae?

Kitchen garden
Sourland Mountain
Skillman, NJ
12 Sep 2021
9:50 AM
sun/cloud mix
blue sky, high clouds
fresh air, a bit hazy
75°F low breeze

I notice:
(species in the drawing)



old black walnut
full of fruit,
leaves start
to fall -
the blue jays like
this tree,
why?

morning glories
on deer fence,
self-seeded
(weeds!) LOL!

plum tree

fleabane

tomatoes

flowering tobacco

brown-eyed susan

night flowering

garlic chives
(flowering out all states)

verbena

lemon verbena

lemon grass

oregano

thyme

brick walk
100+ year old bricks

SOUNDSCAPE:

- incessant buzz of late summer grasshoppers and katydids
- a frog calls, hesitantly
- buzzing hummingbird, visited morning glories
- chickadees
- crickets chirping
- woodpecker call
- blue jays

insert sounds in drawing naturally

SEEN

- tufted titmouse
 - honey bees TTTT 1+
 - small bumblebees TTT TTTT 1+ were
 - European honey bee
 - hummingbird (ruby-throated)
 - cabbage butterfly
 - chickadee
 - Polistes wasp
 - goldfinch (love the yellow and black!) * = nonnative
- ! forgot my binoculars - now the birds are showing up after 20 min!

insert where ever

Reminds me of:
"If you build it, they will come", but here it is about sitting still and wait.



- crickets chirping
- bird "warning alarm"
- chipmunks in bushes
- the Parkway: (< 1 mile east)

Chelsea State Park
(Matawan, NJ)

12:45 PM

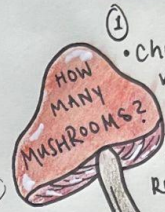
September 18, 2022

78°F

Anya DePalma

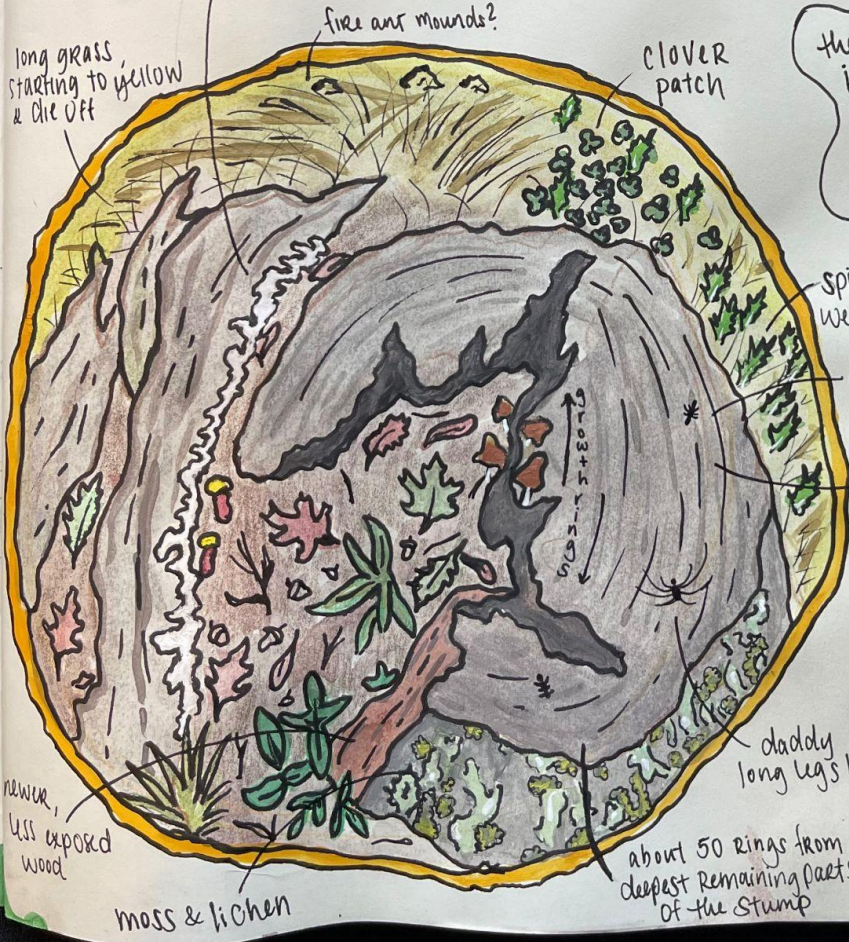
KEY CHARACTERISTICS OF AREA

- little canopy cover (≈ 10%); a lot of sun ☀
- open patch in relatively dense forest
- about 20 ft. from water source (lake)
- other fallen trees in the area



- ① • chunky red stem w/ puffy yellow top
- ② • skinny stem w/ light brown round top
- ③ • white/brown baenacle-like
- ④ • tiny clusters of white buttons
- ⑤ • *not in circle # golden bunch w/ long stems & pancake-tops

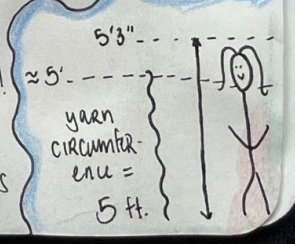
mushrooms that reminded me of baenacles on docks; growing in straight lines & shaped like clam shells



the leaf litter on the interior of the stump consists of:

- acorns (intact & broken apart; squirrels & chips. ?)
- twigs
- maple leaves
- oak leaves
- decaying chunks of wood

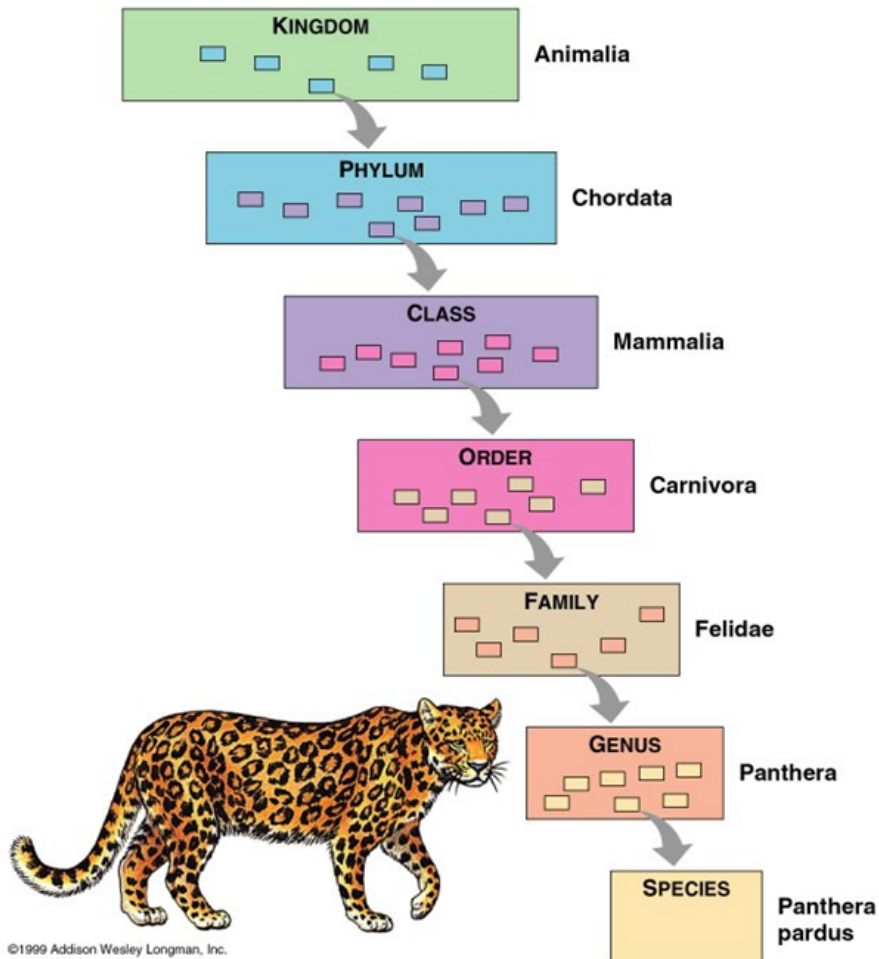
REFERENCE



Appendix 3: Species Nomenclature and Root Words

Chapter written by Lena Struwe, Rutgers University.

All species in the world are classified into taxa (groups), and these groups have different names and rank (the level of the group, family, kingdom, genus, etc.).



SCIENTIFIC NAMES - These were in the past often called Latin names, but not all names are based on Latin words.

There should be unique **binomial names, scientific species names**, for all species.

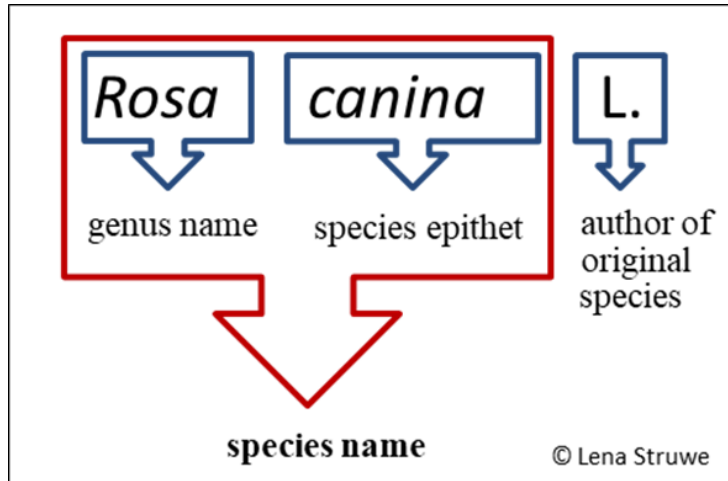
(Binomial = Genus + Species epithet).

The species name is both words, not just the species epithet, because it is the combination that makes the species. Many species epithets are used in many different genera, but all genus names are unique. (Exception: sometimes an animal and a plant have the same genus name.)

Note, **genus** is **genera** in plural.

Species is **species** in both singular and plural.

The groups in taxonomy are called **taxon**; example of a taxon could be Panthera, Felidae and Chordata. **Taxon** in singular, taxa in plural.



Each species should have a **unique scientific name**. (Exceptions are that sometimes a plant species and an animal species may share a name; and sometimes fungi have two names, one for their sexual form and one for their vegetative reproducing form.)

Genus plus species epithet is italicized in regular text. Never capitalize the species epithet (old texts sometimes have capitalized epithets but that is outdated.)

Species names can be accepted or, if not accepted, is a synonym - it is now included inside another species.

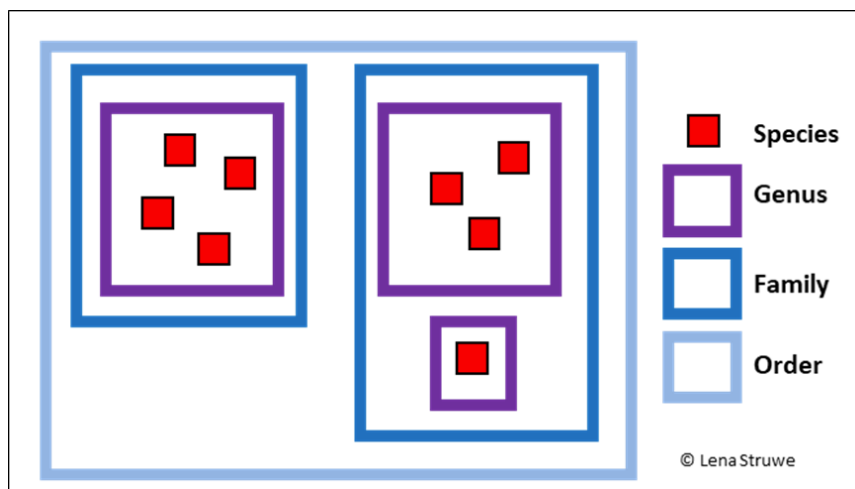
Species can be subdivided into smaller units, and these can be of three kinds. Subspecies has higher rank than variety, and variety has higher rank than form.

Species and groups are circumscribed based on biology, then named according to nomenclature rules.

Systematics figures out what is a species or not, and how they should be classified into groups, then nomenclature does the naming (according to very special rules outlined in the codes of nomenclature)

Biological classifications use a nested hierarchy system (box-in-a-box).

COMMON NAMES - Names in local languages, not universal, may be the same for different species, or a species may have many common names, even wit.



Scientific Root Words, Prefixes, And Suffixes

a-, an-	not, without, lacking, deficient	centi-	hundredth	-escent	becoming
ab-	away from, out from	centr-	center	eso-	inward, within, inner
-able	capable of	cephal-	head	eu-	well, good, true, normal
ac-	to, toward	cerat-	horn	eury-	widen
-aceous	of or pertaining to	cerebr-	brain	ex-	out of, away from
acou-, acous-	hear	cervic-	neck	extra-	beyond, outside
ad-	to, toward	chel-	claw	-fer-	bear, carry, produce
aden-	gland	chem-	dealing with chemicals	ferro-	iron
adip-	fat	chir-	hand	fibr-	fiber, thread
aero-	air	chlor-	green	-fid, fiss-	split, divided into
agri-	field, soil	chondr-	cartilage	-flect, -flex	bend
-al	having the character of	chrom-, -chrome	color	flor-	flower
alb-	white	chron-	time	flu-, fluit-, flux	flow
alg-, -algia	pain	-chym-	juice	foli-	leaf
alto-	high	-cid-, -cis-	cut, kill, fall	fract-	break
ambi-	both	circa-, circum-	around, about	-gam-	marriage
ameb-	change, alternation	cirru-	hairlike curls	gastr-	stomach
amni-	fetal membrane	co-	with, together	geo-	land, earth
amphi-, ampho-	both	cocc-	seed, berry	-gen-, -gine	producer, former
amyl-	starch	coel-	hollow	-gene-	origin, birth
ana-	up, back, again	coll-	glue	-gest-	carry, produce, bear
andro-	man, masculine	coni-	cone	-glen-	eyeball
anemo-	wind	contra-	against	-glob-	ball, round
ang-	choke, feel pain	corp-	body	gloss-	tongue
angi-	blood, vessel, duct	cort-, cortic-	outer layer	gluc-, glyc-	sweet, sugar
ante-	before, ahead of time	cosmo-	world, order, form	glut-	buttock
anter-	front	cotyl-	cup	gnath-	jaw
antho-	flower	counter-	against	-gon	angle, corner
anti-	against, opposite	crani-	skull	-grad-	step
anthropo-	man, human	cresc-, cret-	begin to grow	-gram, graph	record, writing
-ap-, -aph-	touch	crypt-	hidden, covered	grav-	heavy
apo-, ap-	away from	-cul-, -cule	small, diminutive	-gross-	thick
aqu-	water	cumul-	heaped	gymno-	naked, bare
archaeo-	primitive, ancient	cuti-	skin	gyn-	female
-ary, -arium	denotes a place for something	cyan-	blue	gyr-	ring, circle, spiral
arteri-	artery	-cycle, cycl-	ring, circle	-hal-, -hale	breathe, breath
arthr-	joint, articulation	-cyst-	sac, pouch, bladder	halo-	salt
-ase	forms names of enzymes	cyt-, -cyte	cell, hollow container	hapl-	simple
aster-, astr-	star	dactyl-	finger	hector-	hundred
-ate	verb form – the act of	de-	away from, down	-helminth-	worm
anther-	fatty deposit	deca-	ten	hem-	blood
-ation	noun form – the act of	deci-	tenth	hemi-	half
atmo-	vapor	deliquesc-	become fluid	hepar-, hepat-	liver
audi-	hear	demi-	half	herb-	grass, plants
aur-	ear	dendr-	tree	hetero-	different, other
auto-	self	dent-	tooth	hex-	six
bacter-, bactr-	bacterium, stick, club	derm-	skin	hibern-	winter
barb-	beard	di-, dipl- (Latin)	two, double	hidr-	sweat
baro-	weight	di-, dia- (Greek)	through, across, apart	hipp-	horse
bath-	depth, height	dia- (Latin)	day	hist-	tissue
bene-	well, good	digit-	finger, toe	holo-	entire, whole
bi- (Latin)	two twice	din-	terrible	homo- (Latin)	man, human
bi-, bio- (Greek)	life, living	dis-	apart, out	homo- (Greek)	same, alike
-blast-	sprout, germ, bud	dom-	sleep	hort-	garden
brachi-	arm	dors-	back	hydr-	water
brachy-	short	du-, duo-	two	hygr-	moist, wet
brady-	slow	-duct	lead	hyper-	above, beyond over
branchi-	fin	dynam-	power	hyph-	weaving, web
brev-	short	dys-	bad, abnormal, difficult	hyphno-	sleep
bronch-	windpipe	ec-	out of, away from	hypo-	below, under, less
cac-	bad	echin-	spiny, prickly	hyster-	womb, uterus
calor-	heat	eco-	house	-iae	person afflicted with disease
capill-	hair	ecto-	outside of	-iasis	disease, abnormal condition
capit-	head	-elle	small	-ic	(adjective former)
carcin-	cancer	-emia	blood	-chthy-	fish
cardi-	heart	en-, endo-, ent-	in, into, within	ign-	fire
cam-	meat, flesh	-en	made of	in-, il-, im-, ir-	not
carp-	fruit	encephal-	brain	in-, il-, im-, ir-	to, toward, into
carpal-	wrist	enter-	intestine, gut	in-	very, thoroughly
cata-	breakdown, downward	entom-	insects	-ine	of or pertaining to
caud-	tail	-eous	nature of, like	infra-	below, beneath
-cell-	chamber, small room	epi-	upon, above, over	inter-	within, inside
cen-, cene-	now, recent	-err-	wander, go astray	intra-	between
cente-	pierce	erythro-	red	-ism	a state or condition

iso-	equal, same	oo-	egg	saur-	lizard
-ist	person who deals with	ophthalm-	eye	schis-, schiz-	split, divide
-it is	inflammation, disease	opt-	eye	sci-	know
-ium	refers to a part of the body	orb-	circle, round, ring	scler-	hard
-kary-	cell nucleus	-orium, -ory	place for something	-scop-	look, device for seeing
kel-	tumor, swelling	omith-	bird	-scribe, -script	write
kerat-	horn	orth-	straight, correct, right	semi-	half, partly
kilo-	thousand	oscu-	mouth	-sept-	partition, seven
kine-	move	-osis	abnormal condition	-septic	infection, putrefaction
lachry-	tear	oste-	bone	sess-	sit
lact-	milk	oto-	ear	sex-	six
lat-	side	-ous	full of	-sis	condition, state
leio-	smooth	ov-	egg	sol-	sun
-less	without	oxy-	sharp, acid, oxygen	solv-	loosen, free
leuc-, leuk-	white, bright, light	pachy-	thick	som-, somat-, -some	body
lign-	wood	paleo-	old, ancient	somn-	sleep
lin-	line	palm-	broad, flat	son-	sound
lingu-	tongue	pan-	all	spec-, spic-	look at
lip-	fat	par-, para-	beside, near, equal	-sperm-	seed
lith-, -lite	stone, petrifying	path-, -pathy	disease, suffering	-spher-	ball, round
loc-	place	-ped-	foot	-spir-, -spire	breathe
-log-	word, speech	-ped-	child	-spor-	seed
-logist	one who studies	pent-	five	stat-, -stasis	standing, placed, staying
-logy	study of	per-	through	stell-	stars
lumin-	light	peri-	around	sten-	narrow
-lys, -lyt, -lyst	decompose, split, dissolve	permea-	pas, go	stern-	chest, breast
macr-	large	phag-	eat	stom-, -stome	mouth
malac-	soft	pheno-	show	strat-	strat
malle-	hammer	-phil-	loving, fond of	stereo-	solid, 3-dimensional
mamm-	breast	phon-, -phone	sound	strict-	drawn tight
marg-	border, edge	-phore-, pher-	bear, carry	styl-	pillar
mast-	breast	photo-	light	sub-	under, below
med-	middle	phren-	mind, diaphragm	super-, sur-	over, above, on top
meg-	million, great	phyc-	seaweed, algae	sym-, syn-	together
mela-, melan-	black, dark	phyl-	related group	tachy-	quick, swift
-mer	part	-phyll	leaf	tarso-	ankle
mes-	middle, half, intermediate	physic-	nature, natural qualities	tax-	arrange, put in order
met-, meta-	between, along, after	phyt-, phyte	platin	tele-	far off, distant
-meter, -metry	measurement	pino-	drink	telo-	end
micro-	small, millionth	pinni-	feather	terr-	earth, land
milli-	thousandth	plan-	roaming, wandering	tetr-	four
mis-	wrong, incorrect	plasm-, -plast-	form, formed into	thall-	young shoot
mito-	thread	platy-	flat	-the-, -thes-	put
mole-	mass	pleur-	lung, rib, side	-thel-	cover a surface
mono-	one, single	pneumo-	lungs, air	therm-	heat
mort-	death	-pod	foot	-tom-	cut, slice
mot-	move	ply-	many, several	toxico-	poison
morph-	shape, form	por-	opening	top-	place
multi-	many	port-	carry	trache-	windpipe
nut-	change	post-	after, behind	trans-	across
my-	muscle	pom	fruit	tri-	three
myc-	fungus	pre-	before, ahead of time	trich-	hair
mycel-	threadlike	prim-	first	-trop-	turn, change
myriad-	many	pro-	forward, favoring, before	-troph-	nourishment, one who feels
moll-	soft	p[roto-	first, primary	turb-	whirl
nas-	nose	pseudo-	false, deceptive	-ul-, -ule	diminutive, small
necr-	corpse, dead	psych	mind	ultra-	beyond
nemat-	thread	pter-	having wings or fins	uni-	one
neo-	new, recent	pulmo-	lung	ur-	urine
nephro-	kidney	puls-	drive, push	-ura	tail
-ner-	moist, liquid	pyr-	heat, fire	vas-	vessel
neur-	nerve	quadr-	four	vect-	carry
noct-, nov-	night	quin-	five	ven-, vent-	come
-node	knot	radi-	ray	ventr-	belly, underside
-nom-, -nomy	ordered knowledge, law	re-	again, back	-verge	turn, slant
non-	not	rect-	right, correct	vig-	strong
not-	back	ren-	kidney	vit-, viv-	life
nuc-	center	ret-	net, made like a net	volv-	roll, wander
ob-	against	rhag-, -rrhage	burst forth	-vor-	devour, eat
ocul-	eye	rhe-, rhea	flow	xanth-	yellow
oct-	eight	rhin-	nose	xero-	dry
odont-	tooth	rhiz-	root	xyl-	wood
-ond	form, appearance	rhodo-	rose	zo-, -zoa	animal
olf-	smell	roto-	wheel	Zyg-	joined together
oligo-	few, little	rubr-	red	zym-	yeast
-oma	abnormal condition, tumor	sacchar-	sugar		
omni-	all	sapr-	rotten		
onc-	mass, tumor	sarc-	flesh		

Appendix 4: Flashlight manual (for light in your field kit)



Specifications:

Light Source	SST-20-W, COB Light, 395 UV LED
Power Input	MAX 5V, MAX 1000mA
Waterproof Level	IPX5
Zoom Mode	Zoom In/ Zoom Out
Switch Mode	High/Low/SOS/UV/WHITE COB/RED COB/ RED & WHITE Flash
Batteries	18650 Lithium Battery
Charging Time	2-3 Hours
Material	Aluminum Alloy
Feature 1	With Strong Magnet
Feature 2	One-Step Shutdown

Structure Diagram



Operation and use

One. Precautions Before Use

1. Please confirm the following items in the package before use:

1. If you buy 2Packs flashlight
Please confirm the following
items in the package before
use:

2 x USB Flashlight
2 x USB cable
2 x 18650 battery
1 x instruction manual



2. If you buy 1Pack flashlight
Please confirm the following
items in the package before
use:

1 x USB Flashlight
1 x USB cable
1 x 18650 battery
1 x instruction manual



If you are missing, please contact us in time. Please check whether the portable battery is normal before using the flashlight. The battery can be used normally only when the battery is checked normally. If it is abnormal, please do not charge or use the flashlight, and contact us in time to get a new battery.

2. Button shutdown function

One-button off function, designed for better use of flashlights!



Long Press For 1-3
Seconds Turn of all Right

Two. About Charging

1. Please use qualified standard charger to charge the flashlight. Flashlight charging limit voltage 5V, limit current 1000mA.
2. Do not use the flashlight while it is charging.
3. Do not charge the flashlight in a high temperature environment (on a hot raft or near a stove), and avoid placing it in a soot-steamed environment.
4. Do not charge the flashlight in a low temperature environment (less than minus 10°C).
5. Do not charge the flashlight in a humid environment.
6. Do not charge a flashlight with a non-rechargeable battery.

Three. About Use

1. Do not use overpressure, the battery voltage of the flashlight should not exceed 4.2V;
2. Please place the battery positive and negative correctly, otherwise the flashlight will not work.
3. Do not use the flashlight in a sealed, tight space.
4. If the battery is very hot during use, remove the battery immediately and stop using it.
5. If you do not use the battery for a long time, you should fully charge the battery and recharge it once in about three months.
6. When pressing the button, do not use excessive force; do not force or hit the flashlight button.
7. Prevent your kid and anyone any direct eye contact with the emitting light as it will have an effect on your eyes.

Four. Notes On Use

1. Do not touch the flashlight with sunlight, water, chemicals and corrosive gases for a long time to avoid damage to the flashlight protective layer.
2. Check the battery: Make sure the battery is charged and load the battery in the correct direction. Old and new batteries cannot be mixed.
3. Keep the flashlight clean. Never wipe the lens and the translucent sheet with metal or a hard object. Remove the stain on the lens and the translucent sheet. Wipe it gently with a cotton cloth.
4. If you do not use the flashlight for a long time, please take out the battery (one month or longer) to avoid chemical corrosion;
5. If you use a flashlight in rainy or snowy weather, you must remove the battery, and dry the water on the surface of the flashlight, ensure that there is no water stain inside the flashlight before you can charge the flashlight.
6. According to the charging speed of the charger, remove it as soon as the indicator light changes. Do not leave the flashlight charged. The first charge should also be taken out in time according to the change of the charger indication, without charging.
7. Prevent your kid and anyone any direct eye contact with the emitting light as it will have an effect on your eyes.

3

Five. About Usage Scenarios



Six. About Flashlight Maintenance

1. Do not use overpressure, the battery voltage of the flashlight should not exceed 4.2V;
2. Please place the battery positive and negative correctly, otherwise the flashlight will not work.
3. Do not use the flashlight in a sealed, tight space.
4. If the battery is very hot during use, remove the battery immediately and stop using it.
5. If you do not use the battery for a long time, you should fully charge the battery and recharge it once in about three months.
6. When pressing the button, do not use excessive force; do not force or hit the flashlight button.

6

About the Battery

1. Adapted Battery Model

Various Brands of 18650 Lithium Battery, Battery voltage does not exceed 4.2V, such as Pointed battery and Flat head battery.



2. Battery Maintenance:

- ①、Should avoid complete discharge.
- ②、Lithium batteries should be stored in a cool, dry, and safe environment.
- ③、Avoid placing the lithium battery near heat, open flames, flammable or explosive gases, liquids, which may cause battery leakage, heat, smoke, fire, and explosion.
- ④、When not in use for a long time, remove the lithium battery and store it in a cool dry place. Do not freeze to avoid moisture erosion. Avoid use in high temperature cars. If it is stored for a long time, put the battery to 40% and place it.

7

About Disclaimer

It is important that you read and understand this manual all instructions carefully before use. We can't assume the responsibility, even financial compensation, if the user is using operations prohibited by this manual cause any unnecessary loss or injury. We do not bear any financial compensation and any compensation. Our disclaimers include but are not limited to the following:

1. Remove the insulation sheet before using.
2. Do not soak in water.
3. Different models and voltage batteries must not be used at the same time.
4. All pictures shown are for illustration purpose only. If there is inconsistency between the image and the actual product, the actual product shall govern.

About After-sales Service

Thanks for choosing Our Rechargeable flashlight. This manual provides you with THE BEST QUALITY, BEST PRICE & BEST SERVICE.

After receiving the package, if you have any concerns about the product, or it is damaged, missing parts, Please contact our after-sales customer service via your order ; Or contact our Dealer After-sales Customer Service Center (Contact way can be found on the Dealer Profile). Our dealers will give you a 100% satisfactory response.

The final interpretation of this user manual belongs to the company.

8

Appendix 5: Insect Identification Guide



This chapter was written by Chloe Hawkings.

This guide can be used as a reference when identifying common orders of insects you might find during the week. You are encouraged to examine insects in nature to attribute them to the correct order. This is particularly important during the nighttime survey activities.

Part I: Arthropod diversity

Costa Rica is home to many arthropods other than insects. There are straightforward ways to differentiate between arthropod groups.

Observe an arthropod. Characterize and identify different classes of arthropod using common features or characteristics you notice

	Common name examples	Number of Body Segments	Number of legs	Antennae	Eyes
Arachnida					
Crustacea					
Chilopoda					
Diplopoda					
Insecta					

Part II: Insect Anatomy

Understanding the fundamental insect body plan can help us identify specialized characteristics that belong to each group. Grasshoppers are excellent models to learn the general physiology of insect internal and external anatomy, and understand the relative functions of specialized body parts

External Anatomy

Figure 1: Head and Mouthparts

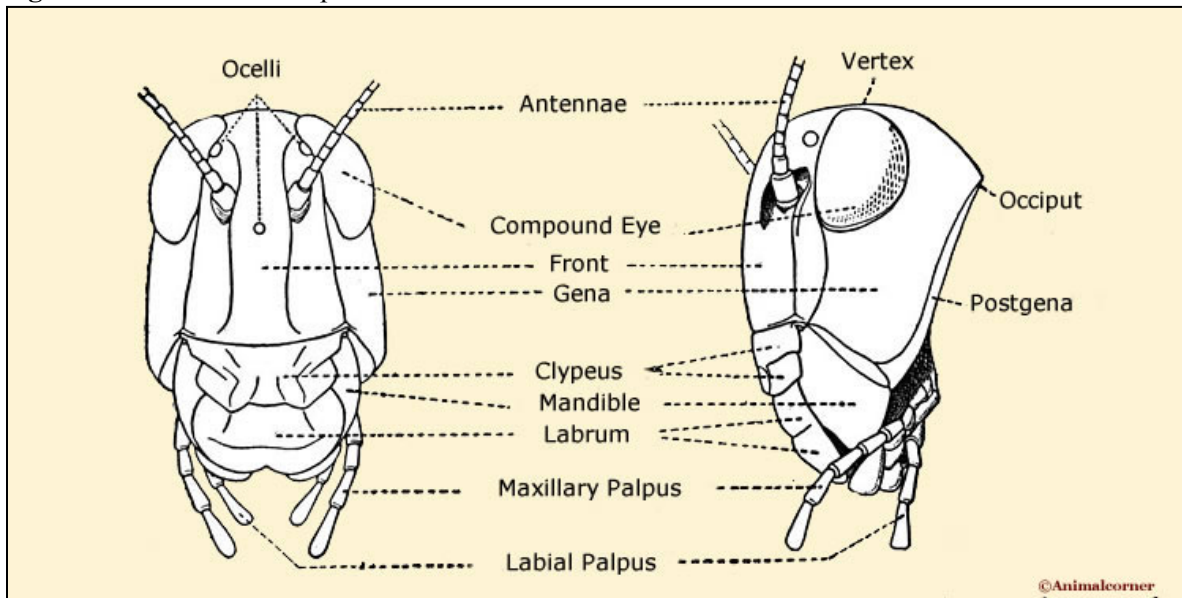


Figure 2: Whole body (external)

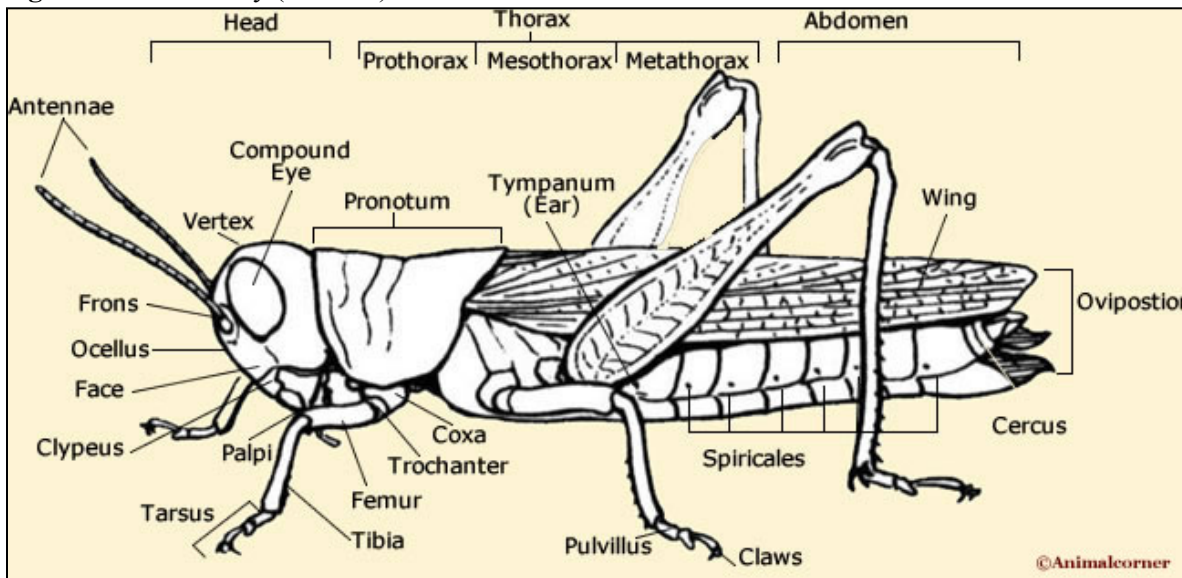


Figure 3: Actual grasshopper specimen: lateral view

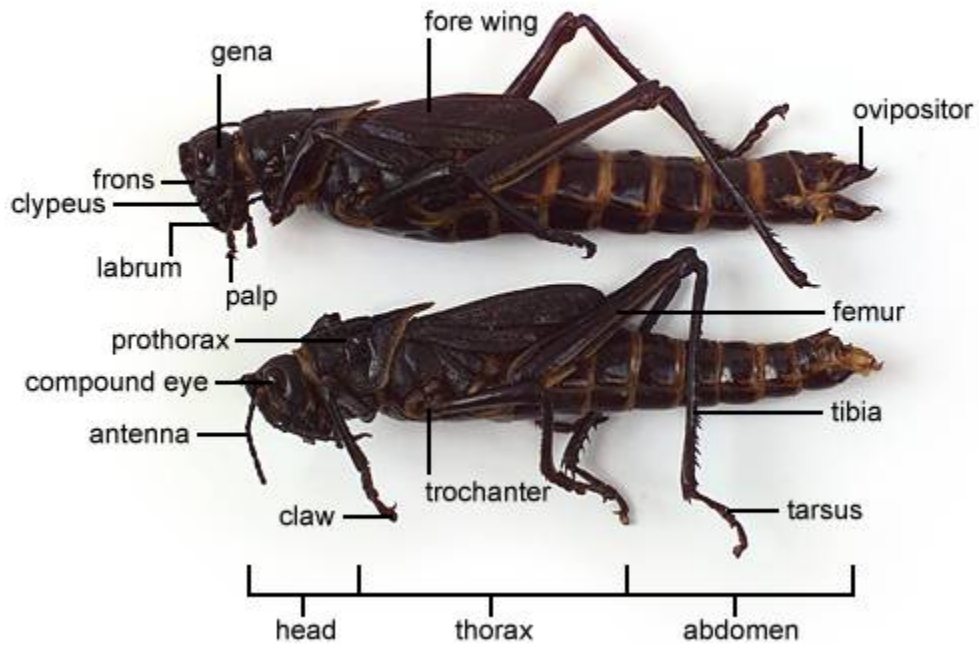


Figure 4: Head and body of actual grasshopper specimen



Notes:

Part III: Common Insect Orders

Distinguishing the key characteristics and morphological traits of the following insect orders and be able to distinguish between their characteristics:

1. Odonata: Dragonflies and Damselflies

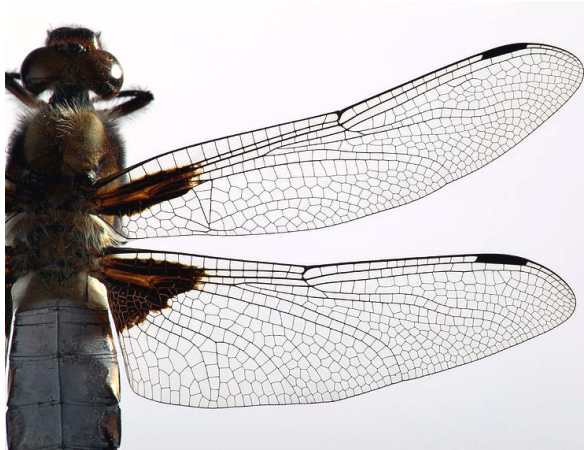


Figure 5: Odonata wing morphology

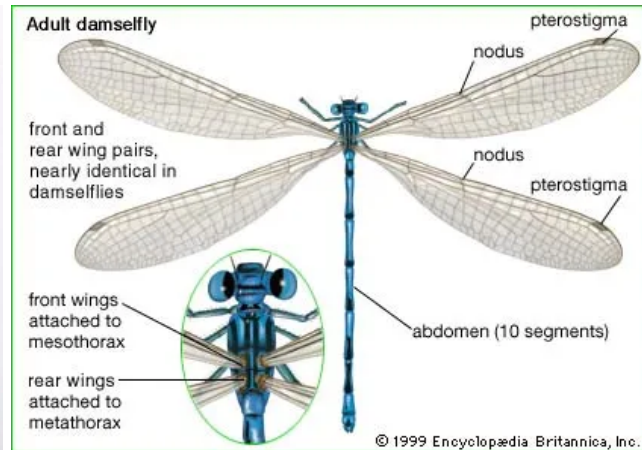


Figure 6: Diagram of Odonata characteristics

Odonata Characteristics:

- Elongate membranous wings not folded over body at rest
- Numerous veins and crossveins in both fore and hindwings
- Large compound eyes
- Reduced antennae appearing as small hairs at front of head capsule
- Highly mobile head
- Small prothorax
- Move primarily by flight (do not walk on surfaces)

Notes

2. Blattodea: Cockroaches & Termites

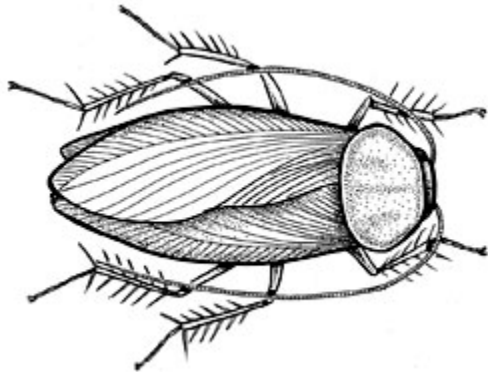


Figure 7: Sketch of cockroach

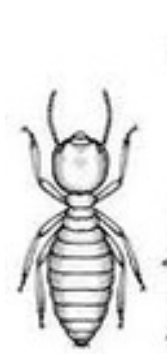


Figure 8: Commonly observed cockroach species

Cockroach characteristics:

- Dorsoventrally flattened
- Legs modified for running
- Numerous spines found on legs
- Head concealed by pronotum when viewed from above
- Forewings leathery
- Long antennae

Notes



(a) Worker



(b) Soldier



(c) Reproductive/ Queen

Figure 9: Caste members in a termite colony

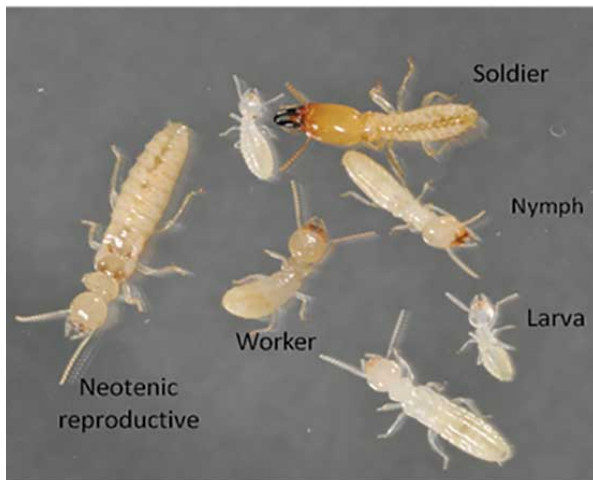


Figure 10: Termite castes



Figure 11: Termite workers on wood



Figure 12: Termite colony observed in Costa Rica

Termite Characteristics:

- Social insects found in decomposing wood or other organic materials
- Pale color
- Small, without eyes or wings
- Soldiers may have elongate mandibles or sclerotized head capsule
- Winged females and males have wings of equal size but are shed after mating

Notes

3. Orthoptera: Grasshoppers, Katydid & Crickets

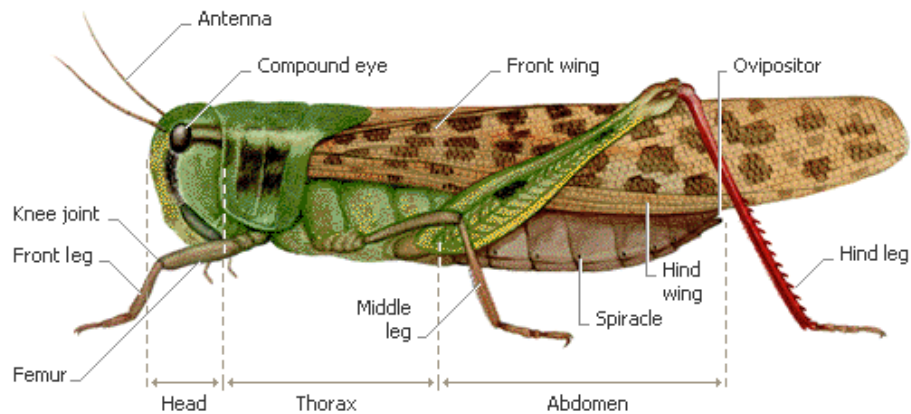
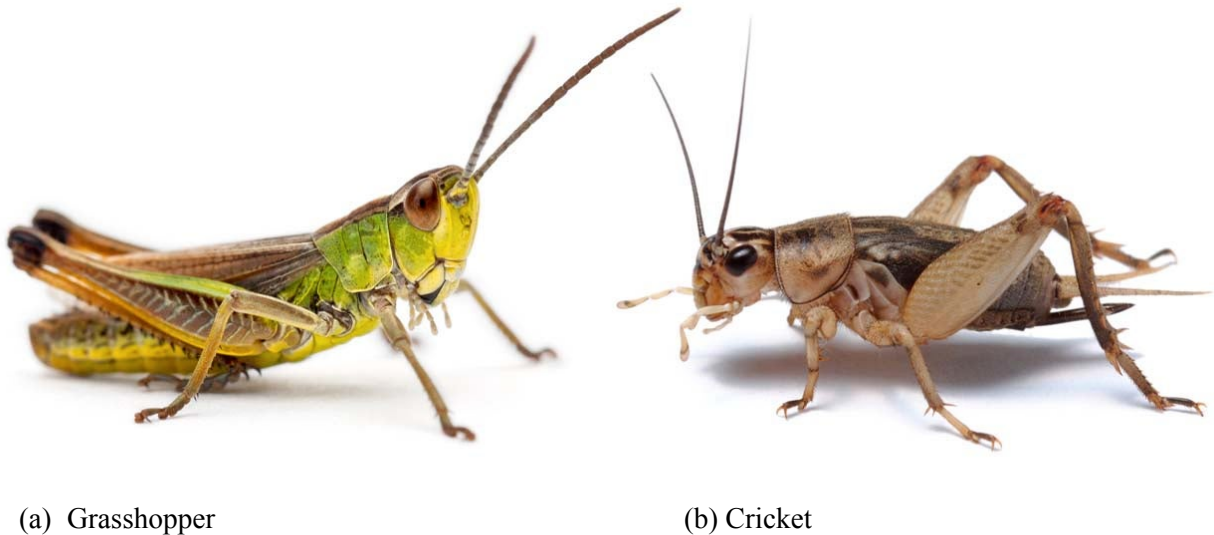


Figure 13: Diagram of grasshopper morphology



(a) Grasshopper

(b) Cricket

Figure 14: Actual picture of Orthoptera suborders

Orthoptera characteristics

- Hindlegs modified for jumping
- Well developed ovipositor in crickets and relatives
- Forewings leathery
- Antennae can be short or as long as body length
- Chewing mouthparts
- Well developed pronotum

Notes

4. Hemiptera: Cicadas, Planthoppers & True bugs

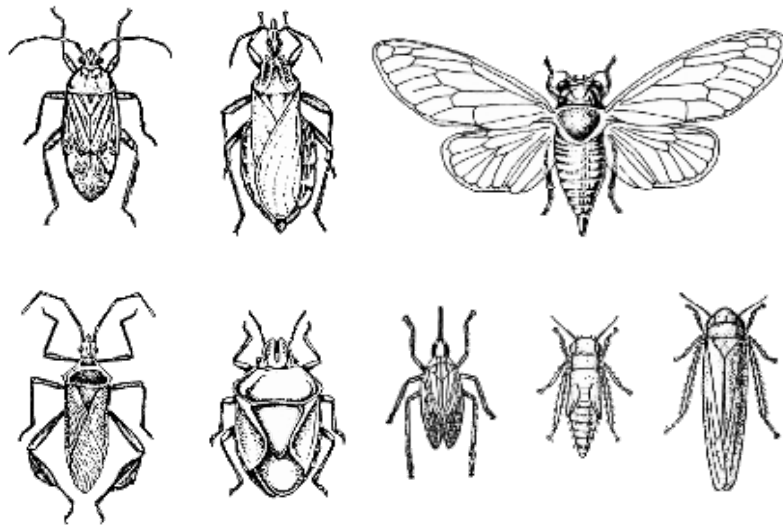


Figure 15: Common Hemiptera insects

Figure 16: Plant hopper found in Costa Rica

Hemiptera Characteristics:

- Mouthparts modified to piercing sucking stylet
- Wings variable between suborders
- Antennae reduced in size or number of segments
- May superficially resemble beetles

Notes

5. Coleoptera: Beetles

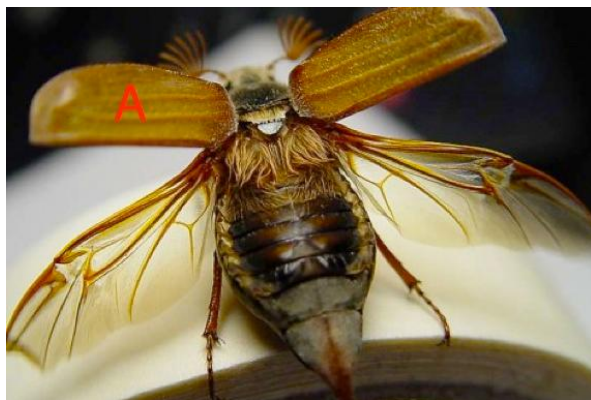


Figure 17: Coleoptera Elytra (A)

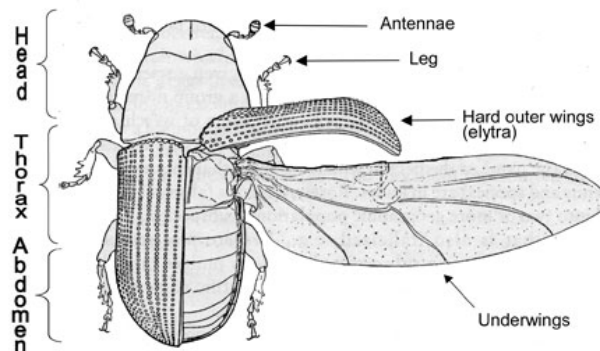


Figure 18: Diagram of Coleoptera morphology

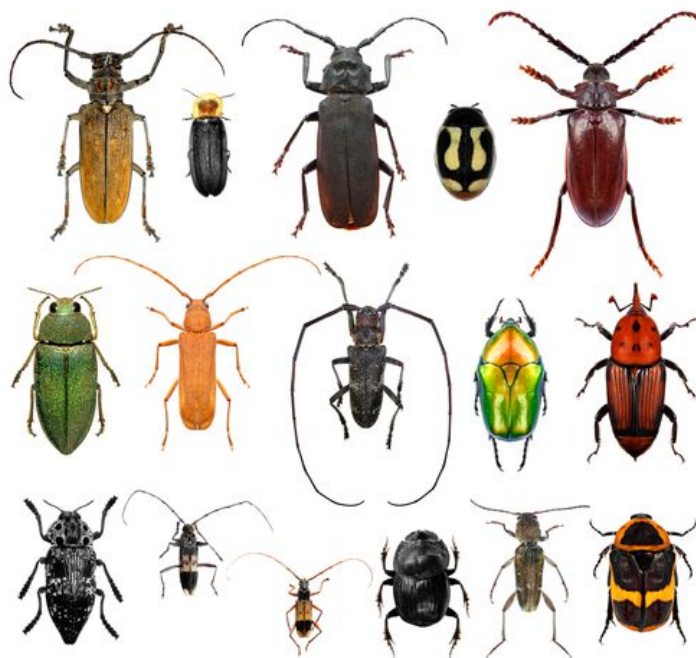


Figure 19: Photograph of diversity of morphology within Coleoptera

Coleoptera characteristics

- Highly variable morphology
- Forewings hardened into elytra which cover hindwings and abdomen
- Antennae variable

Notes

6. Diptera: Flies, Mosquitoes, Midges, etc

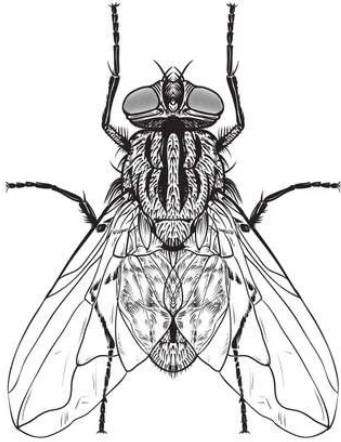
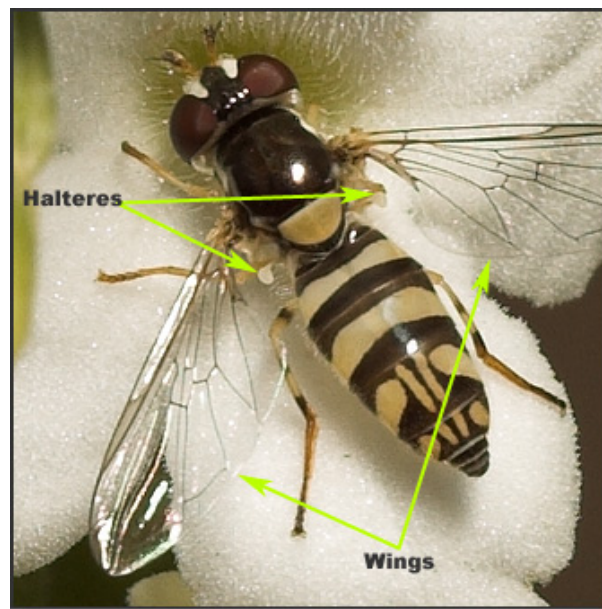


Figure 20: Illustration of Diptera



Figure 21: Curated necrophagous Diptera



© Thomas L. Webster 2005

Figure 22: Diptera with two observable wings and halteres

Diptera characteristics:

- Mouthparts adapted for feeding on fluid
- Hindwings reduced giving the appearance of only a single pair of wings
- Antennae long or reduced to few small segments

Notes

7. Lepidoptera: Butterflies & Moths

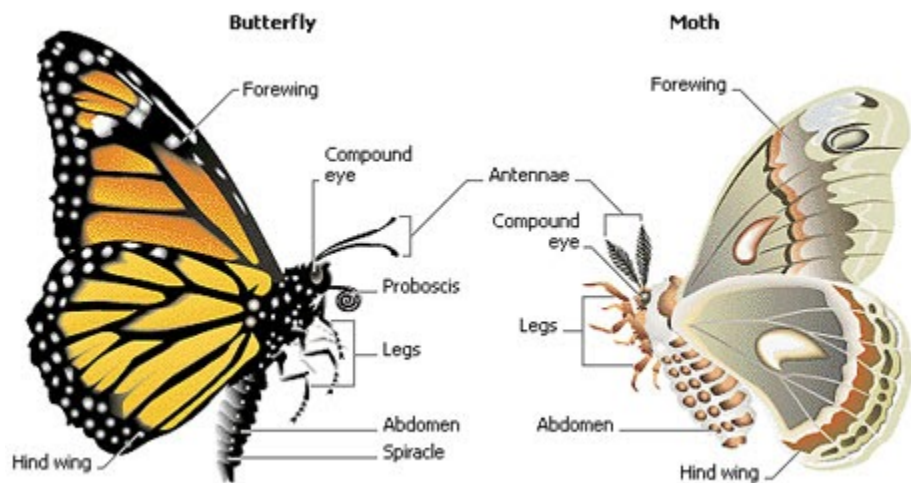


Figure 23: Illustration of Lepidoptera morphological traits



Figure 24: Lepidoptera specimen



Figure 25: Characteristic coiled proboscis

Lepidoptera characteristics:

- Mouthparts modified into elongate proboscis
- Wings covered in scales
- Antennae variable; either threadlike or plumose in males

Notes

8. Hymenoptera: Ants, Bees & Wasps

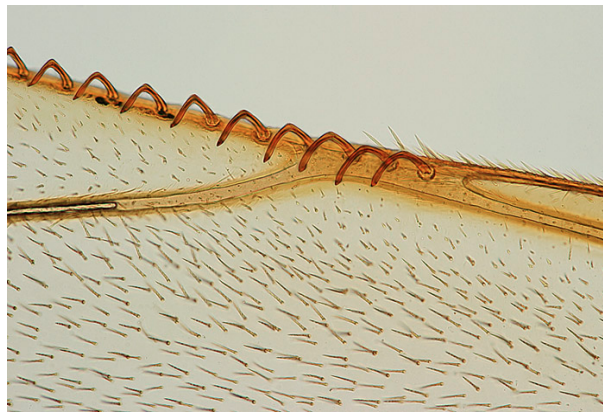
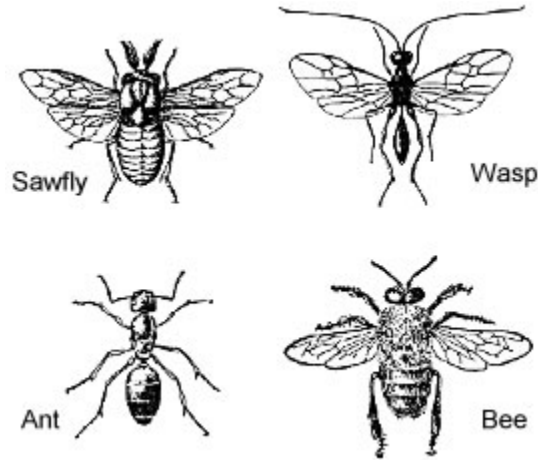


Figure 26: Illustration of Hymenoptera taxa

Figure 27: Characteristic hamuli of Hymenoptera wings



Figure 28: Common Hymenoptera groups: ants, bees, wasps

Hymenoptera characteristics:

- Hindwing and forewing joined by series of hooks (microscopic)
- Abdomen constricted at interface with thorax
- Often with yellow or black coloration
- Can sometimes sting
- Some mouthparts modified to chew and feed on liquid

Notes

EXTRA NOTETAKING PAGE for crazy ideas, scribbles, silly jokes or just general awesome ideas.