PROJECT O:
Orthoptera and Odonata

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Introduction

The general physical characteristics of most species of orthoptera are large or medium sized bodies (less than 10mm is uncommon, many species exceed 50mm in length), and a wingspan can reach 200mm or more. Orthopterans are hemimetabolous, meaning they undergo incomplete metamorphosis, so the overall body shape varies dramatically depending on the lifestyle of the species. The body color of a particular species resembles the species' immediate surroundings. The hind legs are Saltatorial, or adapted for leaping, while the front and/or middle legs are adapted for walking, but may be modified for digging or grasping. Wings are either fully developed or reduced to various degrees.

Orthopterans are habitually omnipresent. They can be found in virtually all terrestrial habitats and some species can be found in some aquatic habitats. The greatest diversity of the orthoptera is found in tropical forests, both dry and humid. Daytime activity is prevalent in short-horned grasshoppers and locusts, while most species of katydids and crickets prefer nocturnal activity. In temperate zones, a greater proportion of species of crickets and katydids are active during the day than in the tropics, where few species can be found before dusk.

Grasshoppers are generally brown, black, or green in body color. They have large eyes and short antennae. Their name comes from their large hind legs that are specifically for helping them jump long distances. They also have two sets of wings, with slender wings in the front and larger wings in the back. Grasshoppers eat mostly plants (leaves, flowers, stems, and seeds). And while they eat many things, they still have their preferences. They are normally exclusive to such items that contain amino acids, sugars, and vitamins. A female grasshopper will use her abdomen to dig small holes in the ground to lay the egg pods in, and typically lay their eggs in warm weather. In its lifetime, the average female grasshopper will lay around 200 eggs.

Similarly to grasshoppers, crickets vary in body coloration and in length (from 3 to 50 mm), and have hind legs that are modified for jumping. They also have long, thin antennae and two sets of wings. The hind wings are long and membranous and used for flying, while the front wings are more leathery and stiff. The males produce a musical chirp by rubbing these forewings together. These chirps are used for either attracting females or repelling other males. It is also proved that the rate of cricket chirps has a direct relation to the surrounding temperature. As the temperature rises, so does the rate of the chirps. As they prefer a warmer environment, they will often seek out habitats with a temperature of around 82 to 86 degrees Fahrenheit.

Katydids can be easily distinguished from grasshoppers and crickets by their extremely long, threadlike antennae. They have large bodies that are most often green, as they live in trees, bushes, or grasses, and frequently match their surrounding habitat. The presence of wings varies between species. While some have long wings, other common species are practically wingless. Katydids are most abundant in the tropics with roughly 2,000 species. These tropical species can measure over 120mm long and range in color from green to brown. Unlike crickets, these katydids are most notable in that both males and females produce mating call.

The most behaviorally dramatic family of orthoptera is the locust. While locusts are actually solitary insects, they undergo a change that affects their color, size, and amount of aggression. Scientists have discovered that what triggers this change is frequent contact with the hairs on the back of a locust’s leg, which happens as they frequently bump into each other during overcrowding. As the locusts become larger and more aggressive, they begin to swarm, and will eat their body weight every day and search endlessly for food. The desert locust can affect an area that covers northern Africa, the Middle East, and southwest Asia.

However, the single characteristic most frequently associated with grasshoppers and their relatives is their ability to produce sounds. The calls of orthopterans are usually species specific and play a very important role in species recognition. Thanks to the rapid development of recording techniques in recent years, many groups of orthopterans previously believed to be silent appear to employ a number of techniques of substrate communication. The sensors (that record acoustic and environmental data) can continuously gather data over a large area to provide detailed information about different species. This provides a snapshot of the ecological community at a particular time and place, which is an advantage over traditional field surveys. Bioacoustic monitoring could also act as an early warning system to alert managers to changes in species behavior, such as breeding times or population distribution in response to climate change.

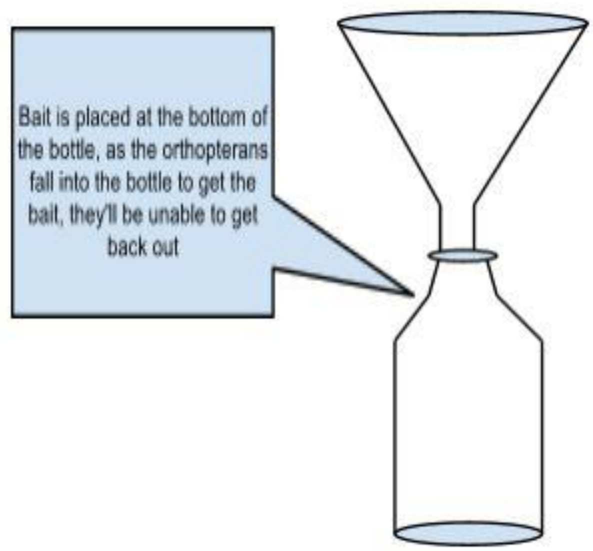
Bioacoustic diversity is a first estimate for species richness and provides baseline data which can be a prerequisite for conservation. Klauss Riede showed that bioacoustic monitoring results can be divided into simple detection of presence/ absence of certain species or an analysis of whole communities, including quantitative data. The community data is used to evaluate habitat quality and deterioration. Acoustic inventorying and monitoring of orthoptera could provide the necessary data for the development of conservation strategies and for monitoring their successful implementation.

Methods

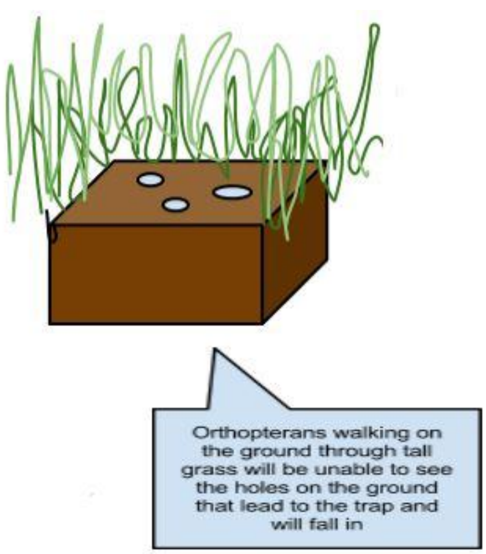
Our bioacoustic survey of Orthopterans in the tropics will give us a chance to do a species inventory in our reserve and allow us to make a correlation between the population and biodiversity of species with the ecological quality of the area. With this information we can target areas of concern, make educated guesses about the future populations and habitat conditions, and come up with solutions to optimize and preserve these areas.

Since we will be creating a database of Odonate and Orthopteran species and Orthopteran stridulations (by species) our data will also help other researchers who were previously confined to only a small percentage of species that have been documented for that area. Our database will expand our knowledge of Rara Avis and its species which will allow for more possibilities for research studies.

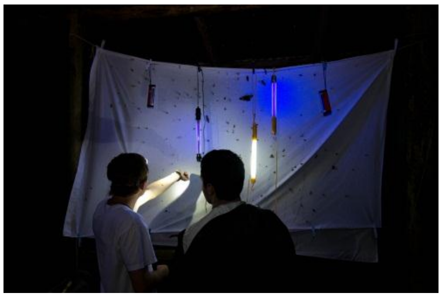
We will be testing multiple methods of capturing and containment for both Odonates and Orthopterans to find out which will be the most effective, efficient, and convenient. For Orthopterans we will be catching by hand, with nets, trapping, and sheeting.



We will be using long-handled mesh nets so that we can reach both Odonates and Orthopterans that are either flying or in a tree. The nets allow us to reach them at high places without hurting them. Some of the traps we will be trying for Orthopterans are funnel traps, where an Orthopteran can easily fall into a trap without easily escaping, and similarly a thin sheet of plastic riddled with holes on the ground over a trap where an Orthopteran can fall into.

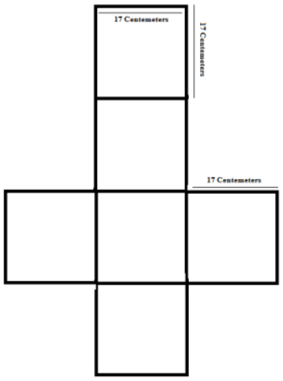


The traps will be placed in a variety of different habitats to capture as many different species. Some examples would be in dry grassy fields, areas around a source of water, trees, etc. They will also be set during both day and night to capture nocturnal species as well. Another capture method for Orthopterans to capture nocturnal species is the sheeting method also used by the Moth Team. A white sheet of cloth will be hung at night and lit up with lights. The lights will attract the nocturnal species and they'll cling to the sheet



Since this is a no-kill project, after catching a specimen they will be held in a clear light weight plastic container until all the data we need has been collected and we can release them. All containers will be assigned a number that will correspond with a data sheet so that we don't get the species confused with one another.

Each Orthopteran that we catch will also be carefully identified with the use of a field guide. Once they have been identified and documented on the datasheet they will be placed in a sound box so that their chirp can be recorded and catalogued into the database that we will be creating. The sound box will be made using ¼ inch foam poster board. On the board we measure out the template using dimensions of 17x17x17 centimeters. Using a straight edge razor we cut on the outer lines of the template and score the inner lines of the template on the opposite side of the board, cutting only halfway through the board so that it folds but does not break apart. We then fold the board into a cube, with a lid that can open and close easily, and secure it with duct tape or another simple but durable adhesion. We're going to soundproof the inside of each box with half-inch foam in order to limit any sound pollution during each recording.



Using a directional microphone accessory to a Zoom H2 digital recorder that we will put in our sound box we will record the stridulations of each sample and organize them by species. We will then put these recordings into a computer and analyze them with Raven sound analysis software that will display the recordings as spectrograms. These spectrograms can be used for species-specific sound identification using rhythmic patterns, frequency, and number of stridulations. Once we've created a database of species-specific stridulations we can then identify species by comparing a spectrogram of recordings we collect in the field with our previous recordings. This makes the process of identification less tedious, more efficient, and more convenient. To ensure that the recordings don't get confused with each other we will organize each one carefully not just with data sheets and a digital archive but also by speaking into the microphone and stating the species, location, date, time, etc. to preserve important information.

All of our information will be organized through four different data sheets. There are sheets for Orthoptera, Odonata, and aquatic sampling, as well as a daily weather log. We are keeping a weather log because we want to see if there's any correlation between the weather and what we find. The conditions that the weather logs address are date, sunrise/sunset, moon cycle, and multiple times a day we will record the temperature, humidity, wind speed, precipitation, canopy, cloud cover, and finally, barometric pressure. By keeping a weather log and recording the conditions multiple times a day we can use it as a reference for the times that are recorded on our other sheets for Orthoptera, Odonata, and aquatic sampling.

Our most thorough data sheet is for Orthoptera because they have the most identifying features that need to be addressed. Two species can differ from each other from something as minor as antennae length or ovipositor shape. We will be keeping careful notes on the wing spans, the body length, the antennae length and shape, body color, Pronotum description, number of spines on legs, ovipositor or cerci length and shape, head shape, plus basic weather notes, date and time, GPS coordinates, and the family, genus, and species. We will also be taking at least one picture of each specimen and writing down the number of the picture's file on the computer as well as the track number of the stridulation recording.

Each day our team will meet up to keep copious notes of the day's information that was gathered, keep a log of everything we did that day and double check all identifications.

Capturing methods

We tested many capturing methods while in Costa Rica. The simplest one was grabbing the Orthopterans with our hands. While this method is generally successful, it should be used as a last resort since there are other more effective methods usually available. Also, there are dangers with blindly thrusting your hand into the rainforest, such as razor grass and other animals you can't see. Sheeting proved to be very inefficient. During our trials we only caught one specimen using sheeting. We recommend future teams abandon the sheeting method. Nets proved to be the best method for capture. They allowed for the greatest range and eliminate the risks present when catching with bare hands. Trapping was not tested because of the amount of effort it would have taken to try any of our proposed methods. However, since we ended up catching specimens faster than we could process, without the use of traps, there is no reason for future teams to test them since we already have sufficient capture systems in place that are less complicated.

Recording methods

CtR vs RtC

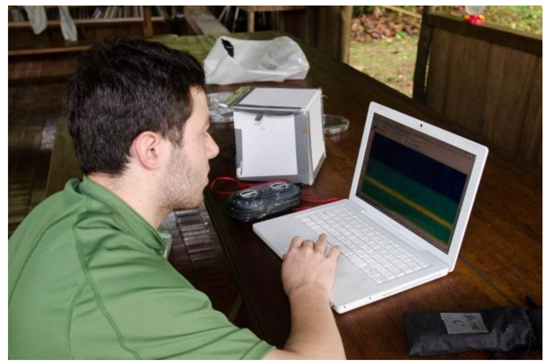
We tried two different recording techniques. The first was to capture first and then record the specimen. We would enter the field, search for crickets, capture them, and then bring them back to the lab to be recorded. We would then record them either using the box method, or the cricket cage method.

The second technique we tried was to record first and then capture the specimen. With this technique we would enter the field with our recorders. We would approach a study plot that we had designated during the day and crouch, waiting for a specimen to chirp in the area. If this happened, we would use the recorder to take document the sound, and then capture the specimen that had produced it.

Capture then record

Soundbox

Our first method of recording was suggested to us by Cornell University. They suggested that we use a “soundbox” to try to record the stridulations of the Orthopterans. We devised multiple experiments to test this method.



Before we devised these tests we ran several preliminary tests to get a feel for the equipment and to enable us to make educated decisions about which direction to go. In addition, we performed several base line tests once we devised the experiments to enable us to find the right sound settings. We also performed several control tests. While formulating our hypotheses we took multiple variables into consideration those are as fallows; Plants in box (yes/no), size of box (fixed in our situation), speaker location (inside outside), audio level (volume), gain, sound proofing (yes/ no), number of trials, length of test, male vs. female. In addition, we noted time of day and weather which was taken every hour. We tested each hypothesis a minimum of three times using a minimum of three individuals. The results are as follows:

Experiment 1:

Hypothesis-If we playback an individual’s call from outside the empty sound box while the individual is inside the box, then we will successfully record the individuals response.

Result-we were not able to successfully record a response.

Experiment 2:

Hypothesis-If we play a recording of a different individual (male) of the same species to an individual (male) inside the empty sound box from the outside than we will successfully record the individual in the boxes recording

Result-we were not able to successfully record a response.

Experiment 3:

Hypothesis-If we increase the playback length from experiment one and add leaves or vegetation similar to where the specimen was found than we will successfully record the male cricket responding to himself.

Result-We were not able to successfully record a response.

Experiment 4:

Hypothesis-If we increase the playback length from experiment one and add leaves or vegetation similar to that near where the specimen was captured than we will successfully record a male cricket responding to another male cricket of the same spices.

Result-We were not able to successfully record a response.

Experiment 5:

Hypothesis-If the speakers are inside the sound box and there are leaves or vegetation similar to where the specimen was found than we will successfully record the male cricket responding to himself.

Result-We were not able to successfully record a response.

Experiment 6:

Hypothesis-If the speakers are inside the sound box and there are leaves or vegetation similar to that near where the specimen was captured than we will successfully record a male cricket responding to another male cricket of the same spices.

Result-We were not able to successfully record a response.

Although this year we never succeeded in getting the soundbox to work, we still believe the concept is viable and provides merits that other methods do not. Some of the variables we were not able to test under the time constraints were time of day, barometric pressure, weather, and moon phase. We hope in future years that groups will continue to explore the box method by testing these variables.

Cricket cage

Because of the trouble we were having with the soundbox and the sheer amount of time spent waiting for each trial, we developed an alternative method to inspire the specimens we caught to chirp. This was the Cricket Cage Method. The Cricket Cage Method consists of taking a small mesh cage, placing an external microphone and an Orthopteran inside, hitting record and leaving the entire apparatus (the cage and a tripod-mounted recorder attached to the mic) on the forest edge to see if the specimen would call. We tried to fine tune this method by adding leaves and natural materials from the surrounding area into the cage in hopes that the specimen would feel more comfortable, as though it were in its natural habitat. Unfortunately, in the end, no matter how home-y we made the cage we were never able to prompt any Orthopterans to chirp. We eventually retired the cricket cage because we decided we would get better results either by using the soundbox or by recording the Orthopterans we could already hear.

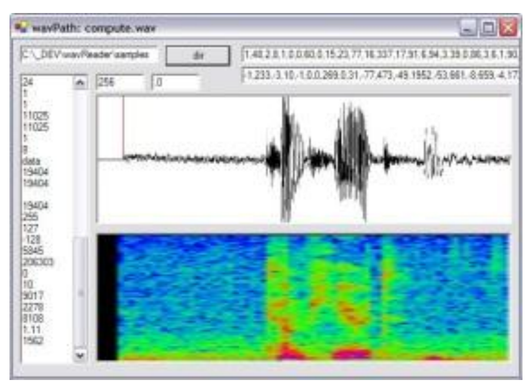
Record then capture

We finally figured out the most effective way to get recordings was to record specimens we already could hear and then capture them.

1. Set up plots
2. Crouch, wait, and listen
3. Record the specimen
4. Visual confirmation
5. Catch it

Bioacoustics

Using bioacoustic technology, such as Raven, provides many benefits. We can use recordings to assess the biodiversity of an area. It doesn't take long to count how many species are chirping on a recording. Also, in the future, with a large enough database, we could identify the species in an area without having to visually confirm by comparing chirps we hear with ones we have already identified. Lastly, bioacoustics can be used to track the biodiversity of an area over time. We have a theory that every location has its own bioacoustic make-up, meaning each night in a given area there is a symphony of animal noises specific to that place based on what species inhabit it. We took recordings on the soccer field at Rara Avis two nights apart. When we later looked at the spectrograms side by side they were almost identical. It is our hope that next year's team will take recordings in this same location and compare them to the ones we got this year.



Other Results

While in the rainforest, we were able to process 80 individual Orthopterans. This is a great start to our species inventory and we are in the process of identifying the species of each individual. However, there is no field guide to Orthopterans in Costa Rica or any of the other areas in Central America so we have our work cut out for us. Hopefully with the help of Dr. Piotr Naskrecki we will be able to identify as much as we can, and maybe even discover some new species that we can name after ourselves.

After making many changes to our methods we found that the most effective way to successfully record a specimen and be 100% sure that it was their call, was to go out in the field with a recorder and wait for it to call. Trying to get the individual to chirp while in captivity did not produce any positive results, and it took much more time to reenact the crickets natural habitat.

In the end, we we're able to identify the stridulations of two species before we came home. They were both katydids in the family Tettigoniidae and the subfamily Conocephalinae. Even more so we're pretty sure that one of them is the Meadow Katydid of the tribe Conocephalini. We visually confirmed (while recording) three specimens of each specie calling, one of which was the video you saw earlier. I then compared the sound files using Raven which are the screenshots being projected now. We are currently in the process of organizing our data so it can be sent to Cornell in May.

Future Goals/Suggestions

In future years we hope that Project O groups will more strongly consider the following things: barometric pressure at the time of capture, which seems to have an effect on calling patterns. The weather, or presence of a storm which also changes the chirping patterns. In addition, they should consider working in teams no larger than two when in the field because it becomes too cluttered and is not as effective when searching for chirping individuals. Lastly, we look forward to the species inventory growing each year for many years to come.

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