OVERVIEW

Standard 2: Life Science

Core Standard:
Observe, describe, and ask questions about structures of organisms that affect their growth and survival.

4.3.1 Observe and describe how offspring are very much, but not exactly, like their parents or one another.

4.3.2 Observe, compare, and record the physical characteristics of live plants or animals from widely different environments, and describe how each is adapted to its environment.

4.3.3 Design an investigation to explore how organisms meet some of their needs by responding to information from the environment.

4.3.4 Describe a way that a given plant or animal might adapt to changes as the result of human impact on the environment.

Process Standards

The Nature of Science

Students gain scientific knowledge by observing the natural and constructed world, performing and evaluating investigations and communicating their findings. These principles should guide student work and be integrated into the curriculum along with the content standards on a daily basis.

- Make predictions and formulate testable questions
- Design a fair test.
- Plan and carry out investigations as a class, in small groups or independently, often over a period of several class lessons.
- Perform investigations using appropriate tools and technology that will extend the senses.
- Use measurement skills and apply appropriate units when collecting data.
- estimate predictions with multiple trials.
- Keep accurate records in a notebook during investigations and communicate findings to others using graphs, charts, maps and models through oral and written reports.
- Identify simple patterns in data and propose explanations to account for the patterns.
- Compare the results of an investigation with the prediction.

How to avoid to be eaten?
- learning predators and toxic prey

How to avoid to be eaten - learning predators and toxic prey where does it fit?

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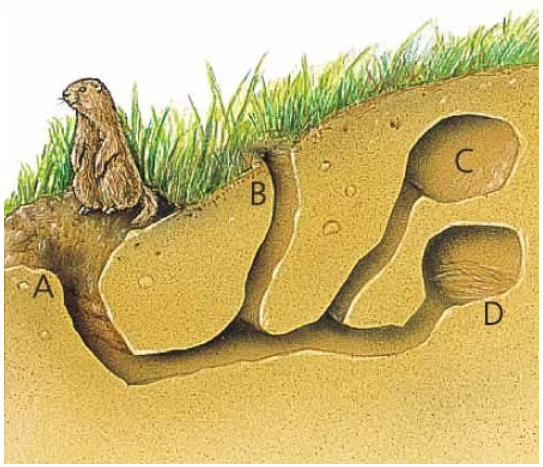
Background*

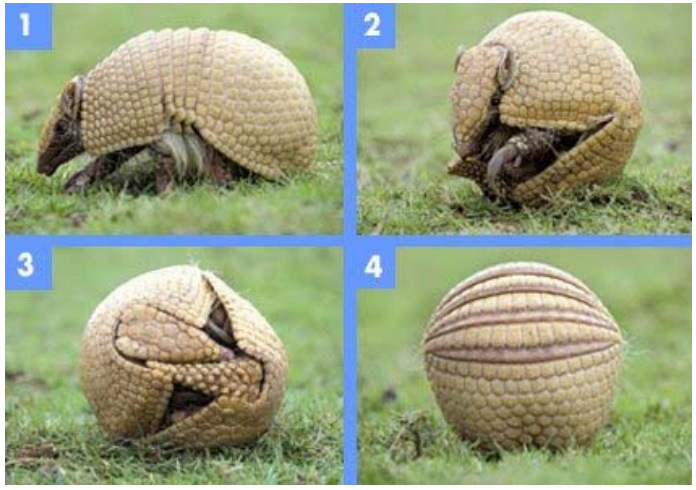
- animals by definition obtain their energy by consuming other organisms
- being eaten alive by someone else is no fun
- what can organisms do to avoid predation? what would *you* do?

How to avoid to be eaten?
- *by escaping!*

How to avoid to be eaten?
- *by hiding (in a refuge)*



How to avoid to be eaten?
- *by hiding (in a shell)*



How to avoid to be eaten?

- by *hiding (in plain sight)*

(aka camouflage or crypsis)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By http://www.kara-inci.nl


www.easyexotics.co.uk

How to avoid to be eaten?

- by *hiding (in plain sight)*

The master of camouflage:
please fasten your seatbelts!

But what if you can’t run away, can’t hide, or have been detected?

What can you do to not become a meal?

How to avoid to be eaten?
- by *fighting back and defending yourself!*

How to avoid to be eaten?
- by *fighting back and defending yourself!*

But what can you do if you are not big and strong and have sharp teeth?

How to avoid to be eaten?
- by *fighting back and defending yourself!*

at least make it really unpleasant to get to you...

How to avoid to be eaten?
- by *fighting back and defending yourself!*

...or be downright toxic!

How to avoid to be eaten?

- by *fighting back and defending yourself!*

But here is the problem: engaging in fights is dangerous for both sides, costs energy, and at least wastes a lot of time. Are there ways for animals to avoid unproductive aggressive interactions before they even start?

How to avoid to be eaten?
- by *advertising that you mean business!*

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http://www.pnas.org/content/suppl/2007/05/09/0703627104.DC1/03627Movie1.mov

How to avoid to be eaten?
- by *advertising that you mean business!*

How does it work exactly?

1) Prey is toxic and advertises toxicity through *aposematism* (bright color, threatening sound, bad smell...)

2) Predator tastes prey, rejects it, forms association between appearance and distastefulness and avoids it in the future; prey is protected

3) There is also some evidence for innate (as opposed to learned) recognition of warning signals

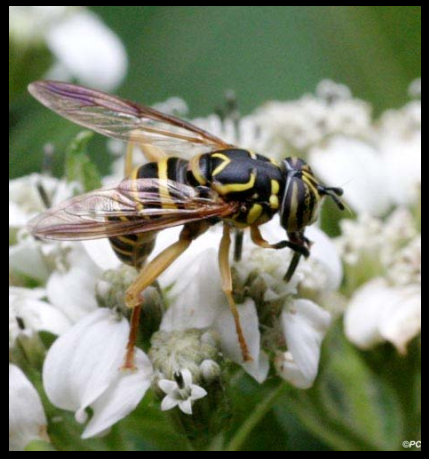
Prelude: Today's exercise will examine several issues, one of which is whether you (the fierce predator) can learn to avoid the toxic prey

OK, one last strategy:
How to avoid to be eaten when.....?

....you have cannot hide, blend in, have no claws, venom, teeth or anything to defend yourself with. i.e. when you are a yummy tasty morsel everyone can see?

The least you can do is *pretend* as if you are toxic!

Examples of wasp/bee - mimicry



Examples of wasp/bee - mimicry

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Examples of ant- mimicry

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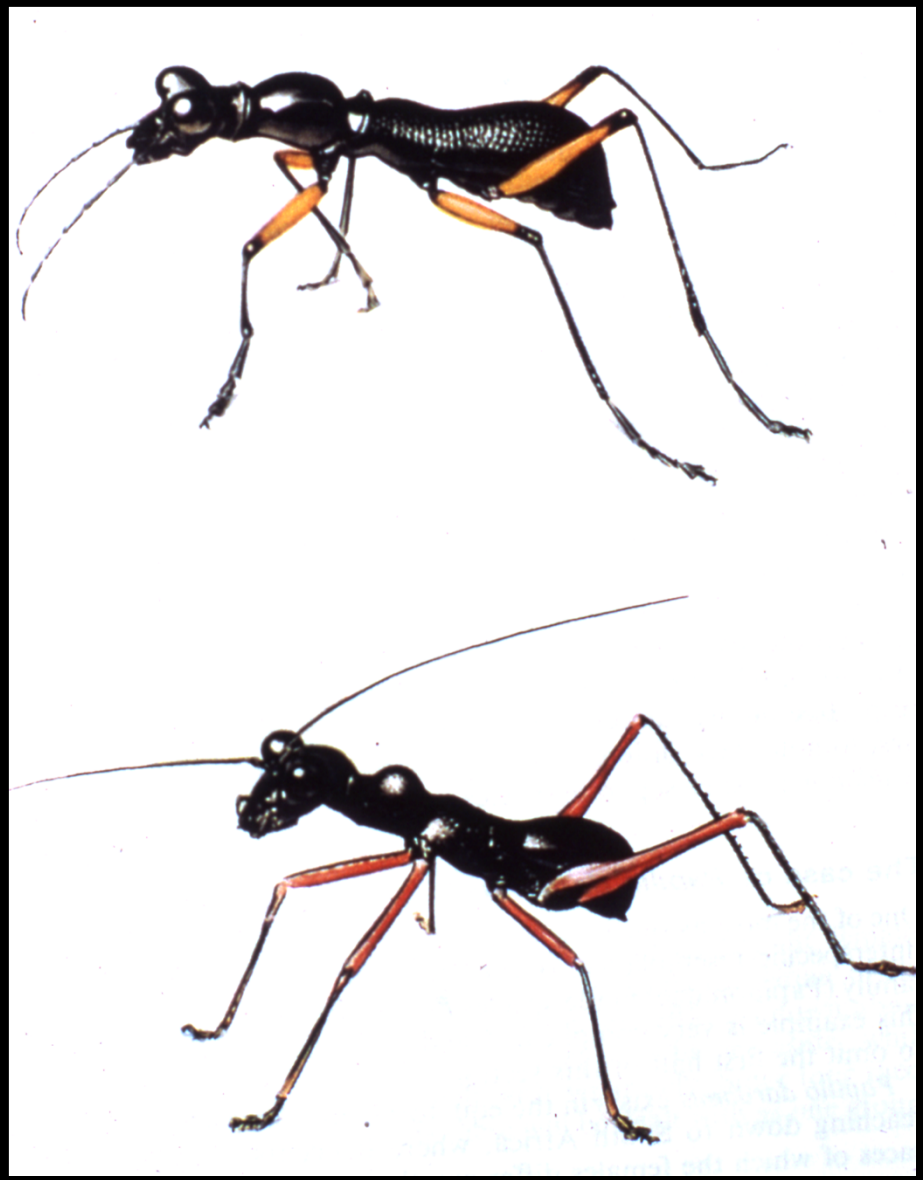
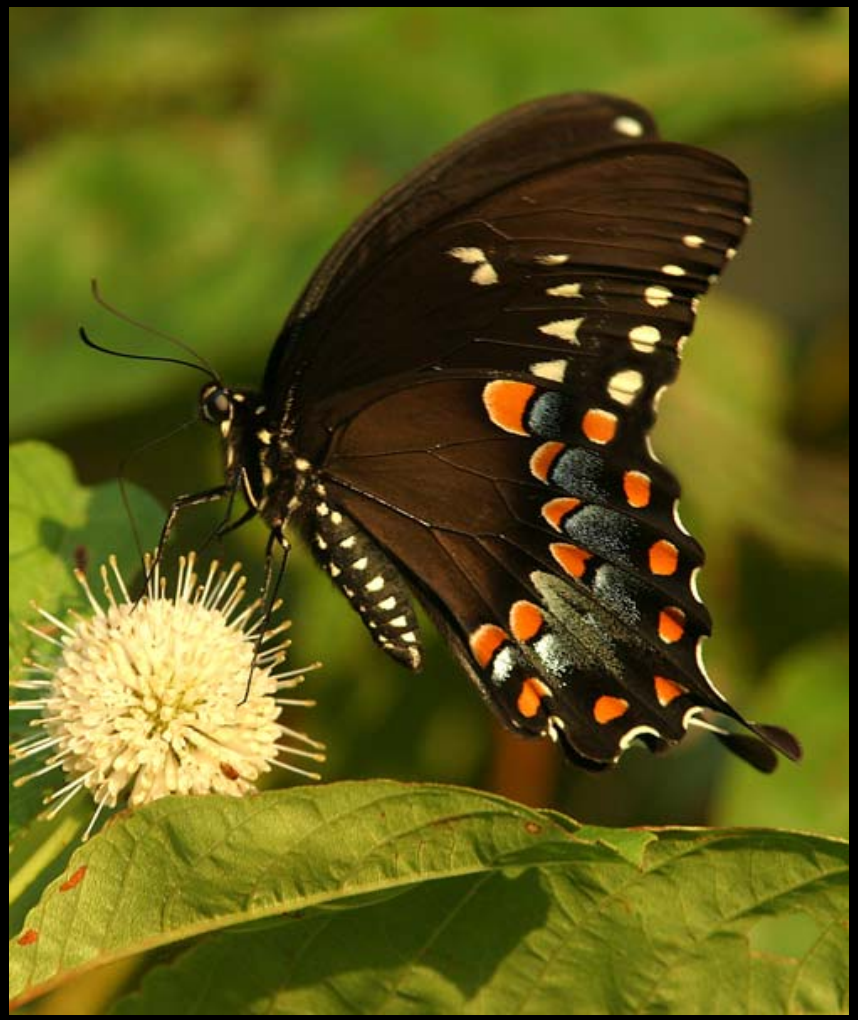


A) Batesian mimicry

Example 3: butterflies

MODEL: *Battus philenor* (pipevine swallowtail, Papilionidae)

MIMIC: *Limenitis arthemis* (red-spotted purple, Nymphalidae)



Mimicry is common in vertebrates, too

- coral snakes and their mimics -

Western Coral Snake

Mexican Milksnake

Scarlet Kingsnake

Mountain Kingsnake

Mimicry takes places in all dimensions of sensory perception

Example: non-toxic moths mimic ultrasound threat display produced by toxic moths

http://www.pnas.org/content/suppl/2007/05/09/0703627104.DC1/03627Movie1.mov

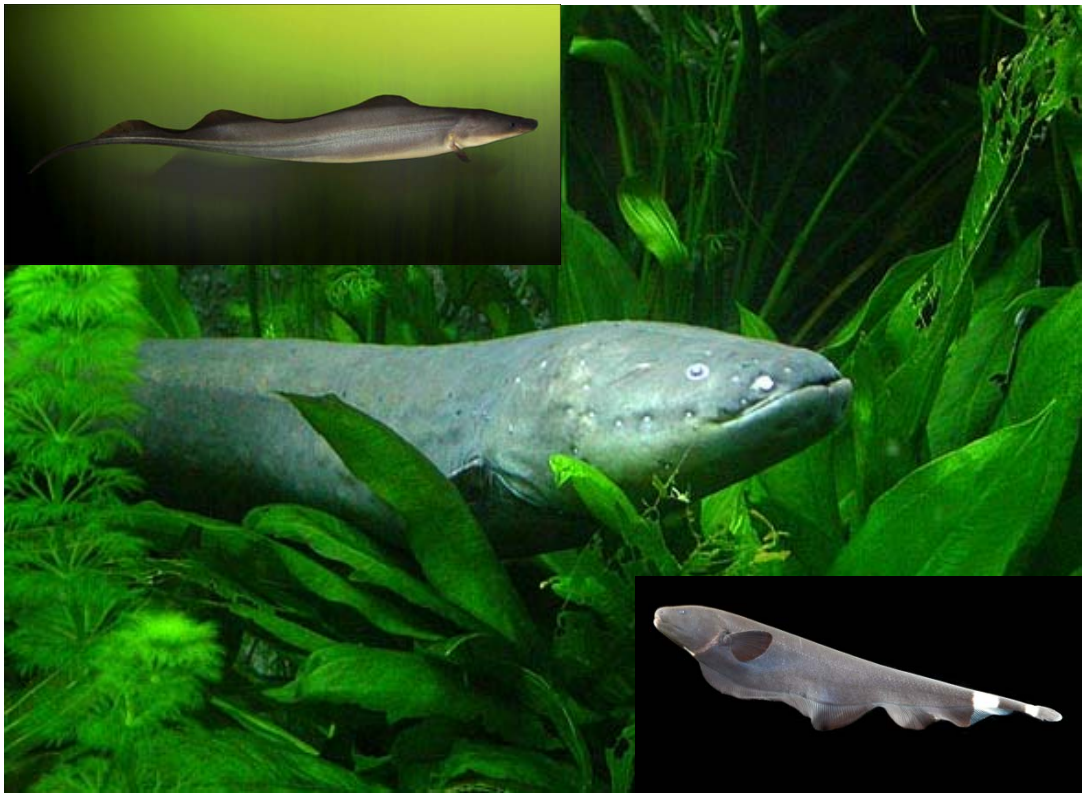
Mimicry takes places in all dimensions of sensory perception

Model: electric eel;

- hunts by discharging large amounts of electricity
- has characteristic base-line discharge pattern when at rest (think humming loudspeaker)

Mimic: weakly electric fish

- use electricity solely for orientation and communication
- immitate eel's resting discharge



How best to hide depends on who is hiding and who is looking…..

How to avoid to be eaten?
- by *pretending that you are toxic*

How does it work exactly? – let's recap!

1) Model is toxic and advertises toxicity through *aposematism* (bright color, threatening sound, bad smell...)

2) Predator tastes prey, rejects it, forms association between appearance and distastefulness and avoids it in the future; prey is protected

3) Mimic is tasty but imitates (copies, fakes, mimics) aspects of the appearance of the toxic model

4) Predator confuses mimic with model; mimic benefits from model's protection

Technically we distinguish two types of mimicry..

A) Batesian mimicry

model: toxic

mimic: palatable

mechanism: predator forms association between model's appearance and its unpalatability; mimic is protected by disguising itself as model

implications:

- only works if mimic is relatively rare
- otherwise predator less likely to form association
- the more frequent the mimic the more detrimental it is to the model
- if mimic is common, model may be forced to "evolve away"from it's mimic!

B) Muellerian mimicry

model(s): toxic

mimic(s): toxic

mechanism: models and mimics are all distasteful and benefit from looking like each other as predators learn from tasting a single individual

implications:

- distinction between mimic and model becomes ambiguous ("co-mimics")
- works even if mimics are common
- evolution favors convergence of appearances onto one type
- often involves many species in so-called mimicry rings

Hands-on exercise to examine toxic defenses and mimicry!

The questions:

(a) Is distastefulness an effective adaptation against predation?

(b) Is mimicry an effective adaptation against predation?

The hypotheses:

(i) Neither distastefulness nor mimicry are effective

(ii) Only distastefulness is effective

(iii) Only mimicry is effective

(iv) Both are effective

Hands-on exercise to examine toxic defenses and mimicry!

The players:
(1) The predator: YOU!

(2) The prey:
7 species of fruit loops!
(each with the same abundance (25 pcs/color))

Hands-on exercise to examine toxic defenses and mimicry...

Hands-on exercise to examine toxic defenses and mimicry...

The rules:

1) 7 species of prey, each with a different color, some may be (much) tastier than others

2) Your are one vicious predator. When I ask you to you go to the table, quickly select one fruit loop, return to your seat, look at it briefly and eat it!

3) You are a lone hunter! No communication with your neighbors of any kind!

4) We will repeat predation events several times, then record the number and color of fruitloops that are left

Hands-on exercise to examine toxic defenses and mimicry...

But before we get started...

What are our hypotheses and predictions?

(i) Neither distastefulness nor mimicry are effective

all colors should be eaten roughly at the same frequency

(ii) Only distastefulness is effective

only distasteful color should be eaten less frequently than other colors

(iii) Only mimicry is effective

only mimic should be eaten less frequently

(iv) Both are effective

both model and mimic shoud be eaten less frequently

Hands-on exercise to examine toxic defenses and mimicry...

Hypotheses and Predictions:

(i) Neither distastefulness nor mimicry are effective
-> *all colors* should be eaten at the same frequency

(ii) Only distastefulness is effective
-> *only distasteful color* should be eaten less frequently than other colors

(iii) Only mimicry is effective
-> *only mimic* should be eaten less frequently

(iv) Both are effective
-> *both model and mimic* shoud be eaten less frequently

Color	dred	lred	yellow	purple	blue	rgang	green	
# at start	25	25	25	25	25	25	25	
# at end	14	8	7	7	3	7	2	
# eaten	**11**	**17**	**18**	**18**	**22**	**18**	**23**	

RESULTS!!

Hypotheses and Predictions:

(i) Neither distastefulness nor mimicry are effective
-> *all colors* should be eaten at the same frequency

(ii) Only distastefulness is effective
-> *only distasteful color* should be eaten less frequently than other colors

(iii) Only mimicry is effective
-> *only mimic* should be eaten less frequently

(iv) Both are effective
-> *both model and mimic* shoud be eaten less frequently

Color	1	2	3	4	5	6	7
# at start	25	25	25	25	25	25	25
# at end							
# eaten							

which hypothesis is supported – why or why not?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Thank you!


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