Objectives

- Describe the four successive stages of insect evolution.
- Define ametabolous, hemimetabolous and holometabolous, and the similar terms regarding wing development.
- Describe the theories of insect wing evolution.

Fossil Record

<table>
<thead>
<tr>
<th>Era</th>
<th>Period</th>
<th>Approximate Time</th>
<th>Life Forms Originating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cenozoic</td>
<td>Quaternary</td>
<td>10,000,000 to 2,500,000</td>
<td>Plants, Fishes, Mammals, Birds, Insects</td>
</tr>
<tr>
<td></td>
<td>Tertiary</td>
<td>2,500,000 to 65,000,000</td>
<td>Grasses, Mammals, Insects</td>
</tr>
<tr>
<td></td>
<td>Mesozoic</td>
<td>65,000,000 to 280,000,000</td>
<td>Reptiles, Dinosaurs, Mammals</td>
</tr>
<tr>
<td></td>
<td>Paleozoic</td>
<td>280,000,000 to 350,000,000</td>
<td>Fishes, Dinosaurs, Insects</td>
</tr>
<tr>
<td></td>
<td>Precambrian</td>
<td>350,000,000 to Present</td>
<td>Plants, Fungi, Animals</td>
</tr>
</tbody>
</table>

Metamorphosis Terms

- ametabolous
- hemimetabolous
- holometabolous

Metamorphosis

1. ametabolous
2. hemimetabolous
3. holometabolous

Reading

(modified from Ettinger, 2000, pg. 117)
Evolution Stages

The thick lines of the tree represent actual fossils that have been found while the thin lines represent gradual changes in insects that have yet to be found in the fossil record.

(Modified from Elzinga, 1997, pgs. 334-335)

Apterygote

The first stage of insect evolution is referred to as the apterygote stage. This term when broken down means "without wings" (-ptery means wings).

(Modified from Elzinga, 1997, pgs. 334-335)

Apterygote

Silverfish

Paleopterous

Paleo means "ancient or old" and the root word ptery- means "winged."

(Modified from Elzinga, 1997, pgs. 334-335)

Paleoptera refers to "old wing" from paleo-(old) and -ptera (wing).

Examples of Neopterous Wings

The new wing had a flexon, or the ability to bend at the base.

Neopterous stage meaning "new wing" from neo-(new) and -ptera (wing).

(Modified from Elzinga, 1997, pgs. 334-335)
Think about this question for a minute. Why do you think a wing flexon is advantageous over a paleopterous wing that can only be held straight out or straight back? Do you think it is because:

a) Insects with a wing flexon could now spray a pheromone that kept predators away.
b) Insects with a wing flexon could now crawl into crevices or under rocks to hide from predators.
c) The flexon now let them flap their wings quicker to attract more mates.

The answer is "b) Insects with a wing flexon could now crawl into crevices or under rocks to hide from predators."

Complete Metamorphosis

Stop for a moment and jot down some of your thoughts.

Ametabolous Hemimetabolous Holometabolous

Why do you think it was advantageous for an insect to have holometabolous development over hemimetabolous or ametabolous development?

The answer is: c) Holometabolous - insects can be more successful because the larval form can be more specialized.

Development Advantages

Do you think it is because:

a) those with holometabolous development won't have to go through as many molts to get to the adult?
b) holometabolous insects can attract more mates, thus increasing the genetic diversity within their population?
c) holometabolous insects can be more successful because the larval form can be more specialized?
d) holometabolous insects will develop quicker?
Development Review

Holometabolous Larvae: specialized for eating and growing

Holometabolous Adult: specialized for reproduction.

Hemimetabolous insect body: not specialized

Insect Flight

- Apomorphy - n. a derived state (apomorphic - adj.)
- Plesiomorphy - n. an ancestral state (plesiomorphic - adj.)
- Synapomorphy - n. shared derived state
- Symplesiomorphy - n. shared ancestral state
- Homeoplasy – n. a character that is shared by multiple species due to a cause other than common ancestry.

Wing Evolution/Adaptation

Set aside some time to read through the articles associated with this lecture. You will be presented with different theories and hypotheses on how insect wings first developed. While reading, write down or highlight points that will help you in the assignment for this unit.

Wing Development

Some questions to address as you read are:
Where did wings originate?
What adaptive functions could small, proto-wings serve?

Main hypotheses for wing origins
- Paranotal-lobe hypothesis
- Exite-endite hypothesis
- Trachael gill hypothesis

Wings evidently evolved only once; there weren't various groups of insects that developed wings at separate times. We know this because the place where the wings attach to the body, called articulatory sclerites, are similar among all the winged insects.

Assignment - Wing Evolution Project

Now that you have studied the various theories and hypotheses regarding the origin of insect wings, you are to discuss which theory seems the most valid to you. In your discussion please compare the different theories with one another and justify why the theory you chose seems to be the most valid. Be sure to give support for your chosen hypothesis and list the problems with that theory. This assignment should be between ½ and one page typed single space.

Post your assignment as "wing evolution/adaptation".

Learning Game Placeholder

Learning Game: Choices
Title: U2 Review Quiz
Conclusion

We have discussed insect metamorphosis, the stages of insect evolution, and wing adaptations. Be sure to review all of the unit objectives and complete your journal entry. This concludes unit 2.