Origin of insect wings: Gills (I), Spiracular Flaps (II), & Fins (III)

I. Gills

II. Spiracular flaps (better location than gills)

Ill. Fins (terrestrial origin, with secondary return to water)

Phylogenetic distribution of wings vs. aquatic immatures: support for gills as wing precursors?

Origin of insect wings: IV. from Paranota

"Trees Down" (paranota): Epigamic Model (Brown)

"Trees Down" (paranota): Thermoregulatory Model (Kingsolver)

"Ground Up" (gills or paranota): "Floating" & "Jumping" Models (Wigglesworth and others)

Crustacea? Myriapoda?

Collembola

Protura

Diplura

Archaegnatha

Zygentoma

Ephemeroptera

Odonata

Plecoptera

Paurometabola

Endopterygota (Holometabola)

Paraneoptera (hemipteroids)**

Entognatha

'Apterygota'

'Paleoptera'

Dicondylia

Hexapoda

Insecta

Pterygota

complete metamorphosis (** 'Exopterygota')

Polyneoptera**

(Eumetabola)

Neoptera

= aquatic immatures

Orthoptera

Plecoptera

Polyneoptera**

Neoptera

Orthoptera

Thysanoptera (thrips)

Orthoptera

Jumpers: Orthoptera

Floaters: Thysanoptera (thrips)
Ground Up (gills): “Skimming” Model (Marden & Kramer)

Plecoptera (stoneflies)

Possible problem for the “skimming” model

Ontogeny of the endopterygote wing

Ontogeny of the exopterygote wing

“Skimming” model: support from phylogeny

Orthoptera

Imaginal discs of Lepidoptera

Imaginal discs of Diptera
Prerequisites for a functional wing:
I. A surface with support (stiffness)

II. Some sort of articulation with the body
Paleoptera (no wing-folding)
Neoptera (wing-folding)

IV. Passive mechanisms for generating lift
A. Tilt
B. Twist
C. Camber

Camber – an example from Schistocerca (Orthoptera)