METAMORPHOSIS AND DIAPAUSE IN INSECTS

Although all insects molt and change body shape through their life, some of them undergo only minor changes while most undergo extreme changes in structure and function. Juvenile insects molt frequently during their journey to adulthood. A few insects exhibit no change in body part proportions or modification of the body after molting, but most insects accompany these molts with simple or dramatic alterations of body form called metamorphosis. These changes may be accompanied by addition and/or subtraction of body parts, or they may simply be alterations of body proportions.

No Metamorphosis

A few insects are ametamorphic and do not exhibit any metamorphic changes. The aphids (Homoptera) are prime examples of this. An aphid is produced when an unfertilized egg hatches inside the mother, grows to a young female that looks exactly like her mother except in size, and the offspring emerges onto the host plant the mother is feeding on. After eating for about a day, the young aphid has molted one or more times, and begins to produce her own offspring – even before she has reached full size or has finished molting. This mode of reproduction is so efficient that under favorable conditions, an aphid colony can multiply to ten times their numbers (1000%) in three days.

Gradual Metamorphosis

The simplest form of metamorphosis is a gradual change in body form that occurs between molts. The juvenile stages of these insects closely resemble the adult stages and only trained entomologists (insect scientists) can distinguish the several stages of their life history. A newly hatched praying mantis (*Mantis religiosa*) or grasshopper looks very much like an adult without wings. It has six legs, of which the front pair are modified to capture food just as in the adult mantis. Antennae, mouth parts, and abdomen are the same as in the adult but their relative proportions differ.

The proportion of the head gradually becomes smaller and that of the abdomen longer with each molt. The reproductive organs and wings of the adult remain inactive as imaginal discs for several molts. When wings begin to develop during the last two molts before the adult molt, they appear first as small external buds, become about one third the adult size with the next molt, and finally reach adult size and function after the last molt at which time, the insect is also reproductively mature.

Incomplete Metamorphosis

A more extensive form of metamorphosis is termed incomplete or abrupt metamorphosis. Insects that use this mode of development pass through several nymphal stages before the nymph molts to the winged adult. These insects are usually aquatic with external gills. At the beginning of life, insects that undergo incomplete metamorphosis, such as aquatic dragonfly and damselfly (Orthopterans) nymphs, called naiads, go through a molting process similar to gradual metamorphosis. These insects have six legs, a head with compound eyes and antennae, and a small abdomen with gills at the posterior end. The head becomes proportionately smaller and the abdomen larger with successive molts. As they approach adulthood, wings appear on the back, much as they do if the animal were to undergo gradual metamorphosis.

As these insects metamorphose, the insect abruptly changes its body form. The gills are lost and wings develop. But the changes in leg form, head shape, abdominal morphology, development of spiracles for air breathing, and reduction in the size of mouth parts, drastically alter the appearance of the insect. Looking at the penultimate naiad and the adult, most naive observers would not guess they were related – never mind being the same individual.

Complete Metamorphosis

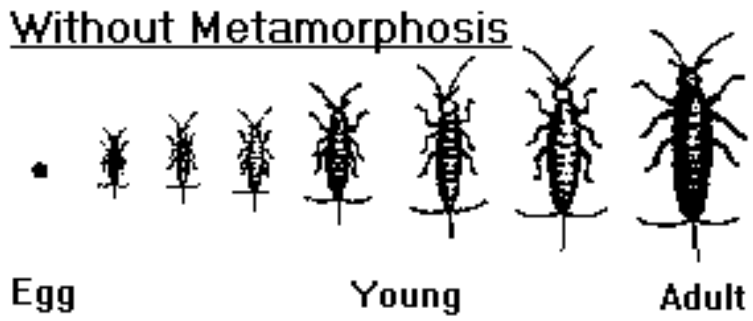
The complete form of metamorphosis involves three very different life stages once the insect hatches from the egg: larva, pupa or chrysalis, and adult or imago. If these insects are aquatic, they may or may not have gills. Those without gills must rise to the surface of the water

to breathe. The larval forms of most insects exhibiting complete metamorphosis is more worm-like than insect-like with tiny or no legs, and often use a worm-like wriggling movement to move. Except for the caterpillars of butterflies and moths and the grubs of some beetles, these larvae usually have a reduced or even absent head definition, often have no eyes or antennae, and sometimes appear to be mostly abdomen with a mouth at one end and anus at the other.

At some point in their development, these insects molt to form a “resting” stage called a pupa or chrysalis. This is a stage incapable of coordinate locomotion. Feet, antennae, and wings (when present) are closely attached to the animal's outer surface and, although appearing for the first time, are nonfunctional.

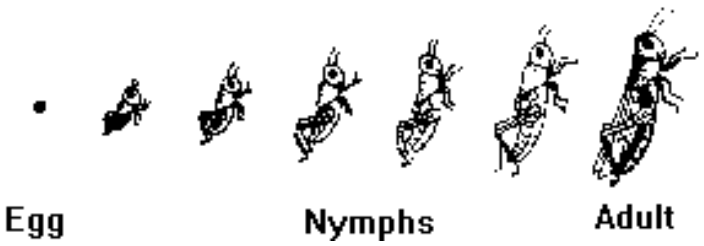
The metamorphosis from the pupa to the imago is sometimes as dramatic as the metamorphosis of an insect with incomplete metamorphosis. The relatively inactive pupal shell splits and the adult draws itself out of the pupal shell. The adult then, as in those with incomplete metamorphosis, pumps body fluids and air into its extremities, causing them to swell and transform to the adult form. After a period of hardening, when the antennae are capable of supporting themselves and the wings and legs can support the insect in flight and walking, the insect walks or flies off to feed, find a mate or mates, and reproduce.

Metamorphosis of Various Insects



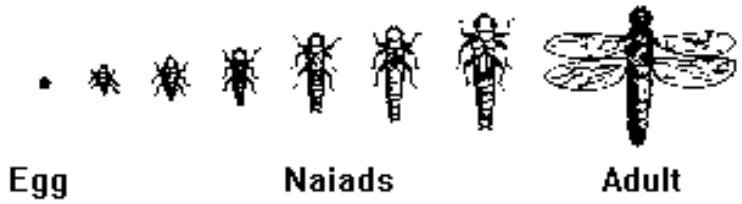
Examples	Orders
Silverfish	Collembola
Springtail	Collembola
Chewing Lice	Mallophaga
Sucking Lice	Anoplura

Gradual Metamorphosis



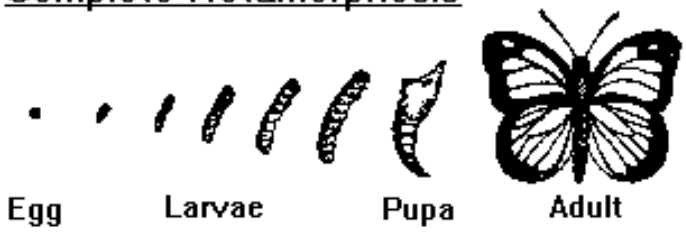
Examples	Orders
Grasshoppers	Orthoptera
Termites	Isoptera
Booklice	Psocoptera (Corrodentia)
Thrips	Thysanoptera
True Bugs	Hemiptera
Aphids	Homoptera
Earwigs	Dermaptera

Incomplete Metamorphosis



Examples	Orders
Mayflies	Ephemeroptera
Dragonflies	Odonata
Stoneflies	Plecoptera

Complete Metamorphosis



Examples	Orders
Lacewing	Neuroptera
Beetles	Coleoptera
Scorpionfly	Mecoptera
Coddisfly	Trichoptera
Moths, Butterflies	Lepidoptera
Flies	Diptera
Fleas	Siphonaptera
Wasps, Bees	Hymenoptera