2. ORDER Lepidoptera: butterflies and moths

Etymology: Lepidoptera is derived from the Greek words “lepido” for scale and “ptera” for wings. The name refers to the flattened hairs/scales which cover the body and wings of most adults.

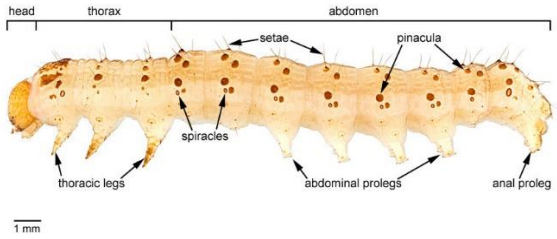
They undergo complete metamorphosis, with four life stages: egg, larva (caterpillar), pupa, and adult. Lepidoptera are a diverse group, with over 180,000 known species, and play a crucial role in ecosystems as pollinators. Third largest order of insects.

Identification features

- Have large front and hind wings clothed by **scales**
- The mouth is an exquisite adaption to resemble a straw called **proboscis** that is kept curled in a coil, when not feeding and can extend to as long as a foot in sphinx moths.
- The adults live entirely upon juices of flowers, over-ripe fruit, honey dew and other liquid substances, but the larvae feed upon vegetable and animal matter.
- Highly co-evolved with flowering plants
- **Wing coupling** apparatus attains high degree of specialisation – frenate, jugate, amplexiform
- Crochets which are tiny, hook-like structures are seen on the prolegs of caterpillars (learn more from https://idtools.org/id/lepintercept/morphology.html)
- Silk gland opens at a median cylindrical organ SPINNERET.
- Many lepidoptera have

Repugnatorial glands (Repugnatorial glands in larvae, also known as defensive or scent glands, are specialized structures that release irritant or distasteful substances to deter predators). They can be connected to the osmeteria or glandular hairs.	
Osmeteria (Singular: Osmeterium a defensive organ found in the larvae of swallowtail butterflies (family Papilionidae) is a fleshy, forked structure. When threatened, the caterpillar can evert, or push out, the osmeterium, releasing a foul-smelling secretion that deters predators.	https://en.wikipedia.org/wiki/Osmeterium
Urticating hairs or glandular hairs or setae. Refers to barbed bristles that cover the surface which can embed in skin or eyes, causing physical irritation	 https://en.wikipedia.org/wiki/Urticating_hair

- Complete metamorphosis is observed and the Eruciform caterpillars have well-developed head with chewing mouthparts and the abdomen has **up to 5 pairs of prolegs.**



Source: https://idtools.org/id/lepintercept/morphology.html

Economic Importance:

- Many Lepidoptera are valued for their aesthetic beauty.
- A few have commercial value such as the silkworms.


The apefly *Spalgius epius* caterpillars feed on mealy bugs

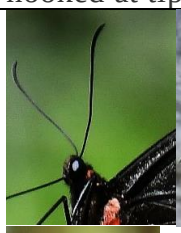
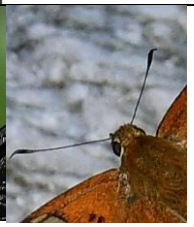
- Several lepidopterans are predacious insects, feeding on lac insects and mealy bugs.
- However, many of the lepidopteran caterpillars are destructive crop pests while some in the adult stage (fruit sucking moths) can cause crop losses.

Fruit piercing moth

- Some lepidopterans are pests of timber and stored products, carpets, clothing, woolen goods and few are destructive to bee culture due to their damage to honeycombs.
- Lepidoptera are also excellent pollinators.

While many features can distinguish moths and butterflies, there are exceptions to each rule. Below are listed some of the common differences -

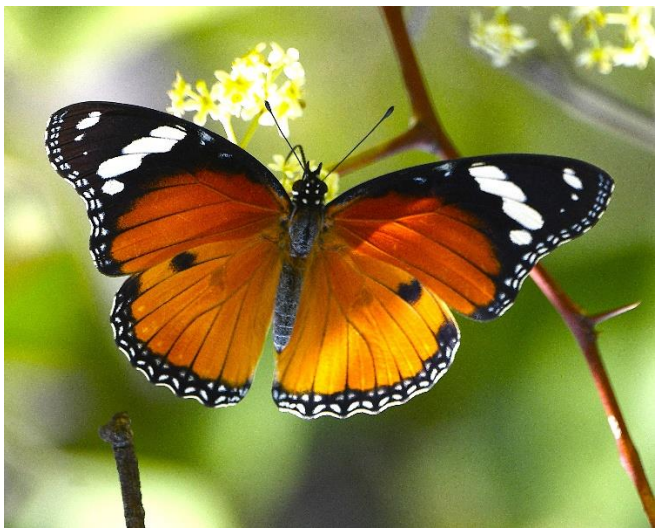
How to differentiate moths and butterflies?

Feature	**Rhopalocera (butterflies)**	**Heterocera (Moths)**
Antennae	thin antennae knobbed or hooked at tip	thread-like, spindle-shaped, or comb-like feathery antennae
	  	 https://en.wikipedia.org/wiki/Bombyx_mori#/media/File:CSIRO_ScienceImage_10746_An_adult_silkworm_moth.jpg
Wing colour	bright	dark brown, black, or grey
Exceptions	 Evening browns, Rings	 False tiger moths, day flying moths
Wing coupling	Amplexiform	Frenate, jugate, and amplexiform
Habit	Diurnal	Nocturnal
Exceptions	 Evening brown	  By Drkvijay2000 - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=60671147 Pellucid hawk moth Painted handmaiden moth And many others
Wing position at rest	Closed	Open
		 
Scales	Fine wing scales	Large wing scales
Thorax	Thin	Stout

Abdomen	Smooth	Stout and hairy
Pupa	Chrysalis	Silky cocoons

Butterflies

Nymphalidae — Brush-footed butterflies, Milkweed butterflies, Satyrs



This is the largest group of butterflies based on species. The front pair of legs are hairy and resemble a brush – not used for walking. They have brightly-patterned wings. Some of the members of this groups such as tigers and crows are known for migrations. The Monarch butterfly also belongs to this group. Caterpillars have aposematic colouration derived from the toxic substances of their host plants called cardiac glycosides.

Papilionidae — Swallowtail butterflies

They are large butterflies, colourful with tail-like extension in most species. Young caterpillars resemble bird droppings while older caterpillars possess an osmeterium, that emits a strong odour as defence.

Hesperiidae — Skippers

These are small to medium-sized butterflies with quick, darting flight, stout bodies, and large heads. They have antennal club which is hooked at the tip. While most skippers hold their wings closed, some are kept fully or half open at rest. Caterpillars have a constricted neck making them seem big headed.

Pieridae — Whites and Sulfurs.

Adults are predominantly white or yellow with black markings. This group exhibits migration. The cabbage butterfly is a widespread in Brassica crops.

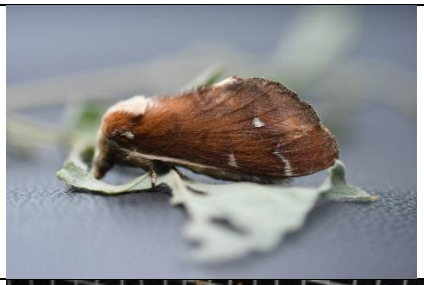
 Common Grass yellow butterfly	 Crimson tip butterfly

Lycaenidae — blues, coppers, and hairstreaks

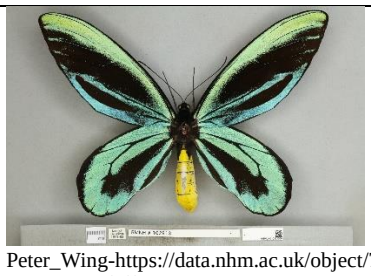
These are small butterflies with often with delicate, intricate wing patterns, and bright iridescent blue or copper colour in wings. Hind wings have small hair-like extensions in many species. The western pygmy blue (*Brephidium exilis*), is one of the smallest butterflies in the world and *Freyeria trochylus*, or the Grass Jewel is one of the smallest in India belong to this group. The caterpillars are grub-like and are unique in their symbiotic relationship with ants.

Moths

Tineidae (clothes moths) — some larvae construct cases and feed on natural fibres. Pests include the webbing clothes moth (*Tineola bisselliella*) and the case-making clothes moth (*Tinea pellionella).*	 **https://en.wikipedia.org/wiki/Tineidae**
Gelechiidae — one of the largest families of micro-lepidoptera. These larvae feed on plants or plant products. Pests include the Angoumois grain moth (*Sitotroga cerealella*) and the pink bollworm (*Pectinophora gossypiella*).	 https://en.wikipedia.org/wiki/Gelechiidae
Sesiidae (clearwing moths) — diurnally active adults mimic wasps. Many pests of fruit and vegetable crops, including the peachtree borer (*Synanthedon exitiosa*) and squash vine borer (*Melittia cucurbitae*).	 https://en.wikipedia.org/wiki/Sesiidae
Tortricidae — fourth largest family of Lepidoptera. Larvae feed inside stems, leaves, and fruit. Contains many pest species, including the codling moth (*Cydia pomonella*) and the oriental fruit moth (*Grapholita molesta*).	 https://en.wikipedia.org/wiki/Tortricidae
Pyralidae (snout moths) — second largest family of Lepidoptera. Pests include the European corn borer (O*strinia nubilalis)*, the Indianmeal moth (*Plodia interpunctella*), and the greater wax moth (*Galleria mellonella*).	
Geometridae — third largest family of Lepidoptera. Larvae are often called inchworms or spanworms. Includes the winter moth (*Operophtera brumata*) and the fall cankerworm (*Alsophila pometaria*).	

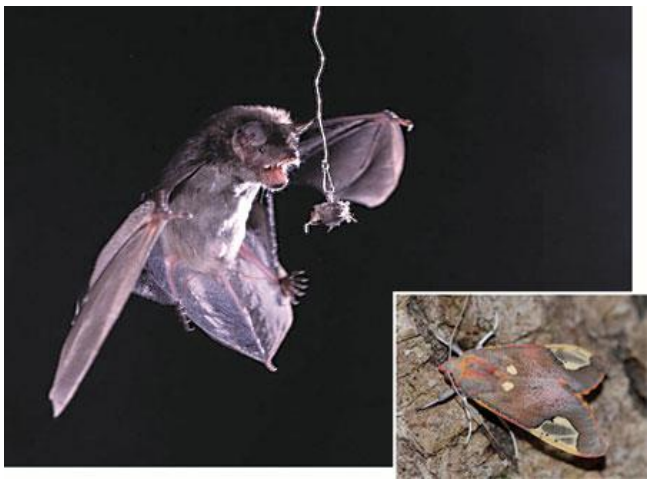
Lasiocampidae (lappet moths) — larvae feed on the leaves of trees and some spin large webs or tents on the foliage. Pests include the eastern tent caterpillar (Malacosoma americana) and the forest tent caterpillar (*M. disstria).*	
Saturniidae (giant silk moths) — large, colourful moths. Larvae feed on a wide range of trees and shrubs. Well-known species include the cecropia moth (*Hyalophora cecropia*) and the luna moth (*Actias luna*).	
Sphingidae (hawk moths) — medium to large adults with long proboscis for collecting nectar. Larvae are frequently called hornworms. Pests include the tobacco hornworm (*Manduca sexta*) and tomato hornworm (*M. quinquemaculata).*	
Erebidae (underwings, tiger moths, tussock moths, ctenuchid moths, and others) — This is an extremely diverse family of moths that is currently divided into 16 subfamilies.	
Noctuidae (loopers, owlet moths, and cutworm moths) — this is the largest family in the Lepidoptera. Larvae are leaf feeders and stem borers. Many species are pests, including the fall armyworm (*Spodoptera frugiperda*), the black cutworm (*Agrotis ipsilon*), and the cabbage looper (*Trichoplusia ni*).	

Interesting Facts about Lepidoptera

• The Queen Alexandra's birdwing (*Ornithoptera alexandrae*) is the largest butterfly in the world.	 Peter_Wing-https://data.nhm.ac.uk/object/73c3e8f5-fee1-493b-b08e-35a8afeffe7e/1571875200000

• Himalayan golden birdwing (*Troides aeacus*) is India's largest butterfly.	 https://en.wikipedia.org/wiki/Troides_aeacus
• The largest moth in India and the world is the atlas moth (*Attacus atlas*).	 By Quartl - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=15223711
• Kaiser-i-Hind (*Teinopalpus imperialis*) known as the "Emperor of India," is highly prized for its striking beauty and rarity, making it the most coveted specimen by collectors. This butterfly is found in a limited range, primarily in the Eastern Himalayas, making it difficult to find and collect.	 https://en.wikipedia.org/wiki/Teinopalpus_imperialis
• Many butterflies are endangered species due to collection depletion or due to loss of habitat. *Morpho menelaus*, known for its iridescent blue colouration is collected extensively	 By Didier Descouens - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=15789967

Bat echolocation and moth behaviour



Insectivorous bats emit ultrasonic sounds of 20–200 kHz, usually inaudible to humans.

When the sound waves bounce back as echo, bats are able to determine the location, size, and movement of insects like moths. Adults of most Noctuidae and Arctiidae have “ears” or Tymphanum in the thorax that help them detect and evade echolocating bats. When they detect ultrasonic signals, they either drop suddenly to escape or zigzag or spiral unpredictably and sometimes stop flying to reduce detection. Some species of Arctiidae produce high-pitched sounds / clicks that confuse the bats. Tiger moth *(Bertholdia trigona)* is

the only known animal that can jam bat sonar effectively. Some moths like the luna moth, have wing structures that absorb sound, making them harder to detect.

Source: https://www.science.org/content/article/moths-block-bats-sonar

Alkaloid feeding butterflies

Some butterflies, particularly those in the belonging to Nymphalidae such as crows, tigers, and others feed on plants containing alkaloids, especially **pyrrolizidine alkaloids**.

The process of feeding on plant alkaloids is called **pharmacophagy**.

The butterflies use these alkaloids for chemical defence against predators and as precursors for producing sex pheromones.

Pic credit: Ravi Kiran

Mud puddling in butterflies

It is a behaviour where large groups of butterflies of same or mixed species gather on damp soil where animals have urinated or on dung/ scat or even or sweaty humans or decaying flesh. The behaviour is mainly to drink mineral-rich fluids and observed especially in observed in male butterflies. This intake is essential for acquiring sodium and amino acids, which are then transferred to the female during mating.