

pests (e.g., cutworms, armyworms) and large numbers of detrimental slugs and snails.

Larvae of parasitic insects which attack the larvae of plant-feeding insects, are known as **parasitoids**. They are in turn subject to hyper-parasites, which reduce their effectiveness.

6. Insects in fine arts. Insects produce noises in various ways. Whether their sounds can be called musical is disputable. In Japan, **cicadas** and **crickets** are placed in small cages, like birds, in the houses. In Tokyo, about 50 markets were dealing with them prior to the war. Japanese celebrate an annual function, the '**festival of the singing insects**'.

Beautifully coloured elytra and wings of some Coleoptera and Lepidoptera are used in jewellery and pictures in Central America, in crafts by Indians of America, in embroidery, pottery, baskets, metals, alloys, etc. by Red Indians of America, and in ear-rings by **Jivaros** of Equador.

METAMORPHOSIS IN INSECTS

Transformation of an immature larval individual into a sexually mature reproducing adult of very different form, structure and habit, is called metamorphosis.

Types of Metamorphosis

Insects display 4 types of metamorphosis.

1. No-metamorphosis or ametabolous development. In case of no-metamorphosis, newly hatched creature looks like an adult except in size and differences in armature of spines and setae. Examples : Silver-fish, spring-tails.

2. Incomplete metamorphosis or hemi-metabolous development. In case of incomplete metamorphosis, immature stages are the **nymphs** or **naiads**, which are aquatic and respire by tracheal gills, whereas the adults are terrestrial or aerial and respire by tracheae. Examples : Mayflies, dragonflies, stone-flies.

3. Gradual metamorphosis or paurometabolous development. In case of gradual metamorphosis, the newly hatched

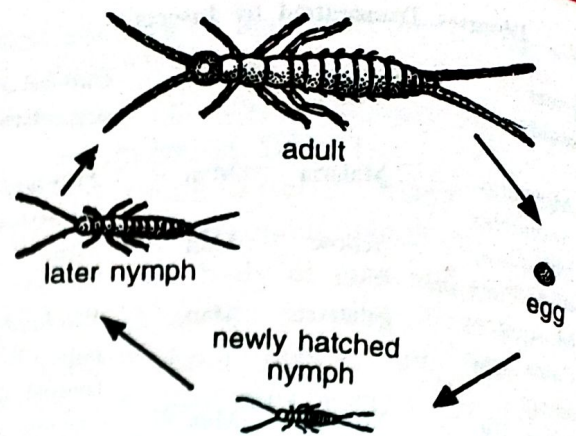
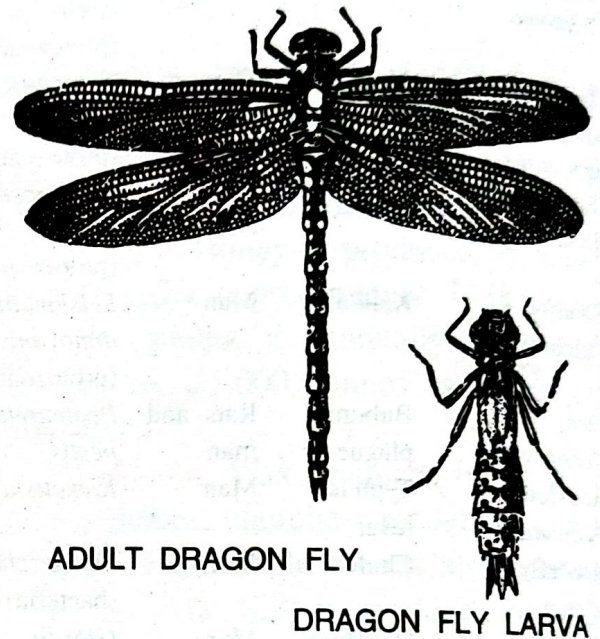


Fig. 3. No metamorphosis (*Lepisma*).



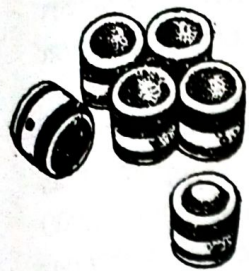
ADULT DRAGON FLY

DRAGON FLY LARVA

Fig. 4. Incomplete metamorphosis (dragonfly).

creature resembles an adult in general body form, but lacks wings and external genital appendages. Young or the **nymph** undergoes several nymphal stages through successive moultings to become an adult, Examples : Grasshoppers, aphids, stink bug, etc.

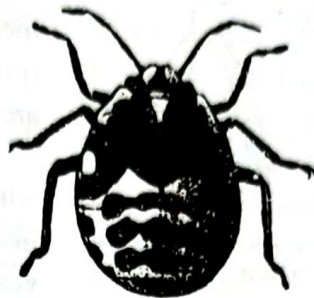
4. Complete metamorphosis or holometabolous development. This type of metamorphosis includes four developmental stages : **egg, larva, pupa** and **adult**. Larva, after hatching, moults several times to become a fully grown one. It later becomes a pupa within a secreted case, called the **puparium**. Pupa differentiates into the young adult that breaks the puparium open and emerges outside. It grows to a mature form. Examples : Housefly, mosquito, butterfly.



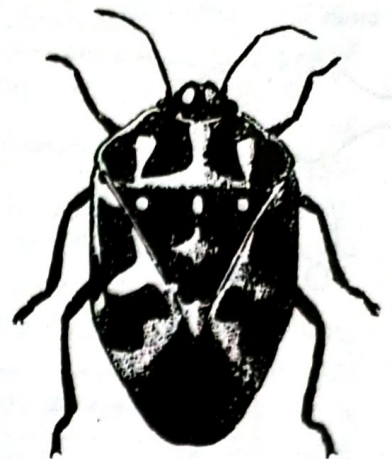
EGGS



YOUNG NYMPH

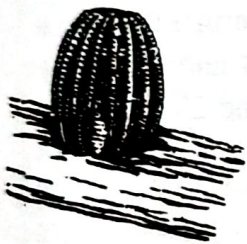


LATER NYMPH



ADULT

Fig. 5. Gradual metamorphosis (stink bug).



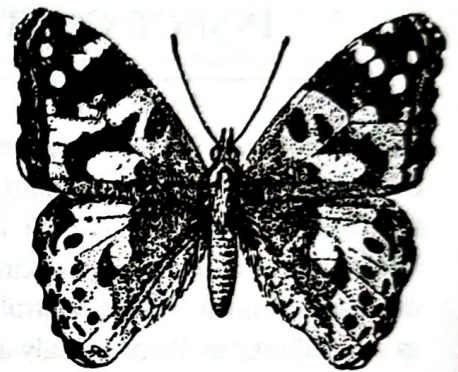
EGG



LARVA (CATERPILLAR)



CHRYSALIS (PUPA)



ADULT

Fig. 6. Complete metamorphosis (butterfly).

HORMONAL CONTROL OF METAMORPHOSIS

Metamorphosis or the post-embryonic growth of insects, as in most higher organisms, is under hormonal control. The various hormones secreted are as follows :

1. Brain hormone (BH). Brain hormone is secreted by the neurosecretory cells of the brain. Chemically it is a lipid. This hormone serves to activate the **corpora cardiaca**, a component of the retro-cerebral complex of the stomatogastric nervous system.

2. Prothoracicotropic hormone (PTTH).

This hormone is secreted by the **corpora cardiaca**, which in turn stimulates the **prothoracic glands**.

3. Prothoracic gland hormone (PGH).

This hormone is secreted by the paired, bilateral sheet of cells in the thorax, constituting the prothoracic glands. Chemically it is **ecdysone**. This hormone is known to trigger moulting as it acts on the tissues to promote all of the changes characterizing a moult.

4. Juvenile hormone (JH).

This hormone is secreted by another component of the retro-cerebral complex, the **corpora allata**. Chemically it is an unsaponifiable, non-sterolic lipid. This hormone regulates morphogenesis and so promotes

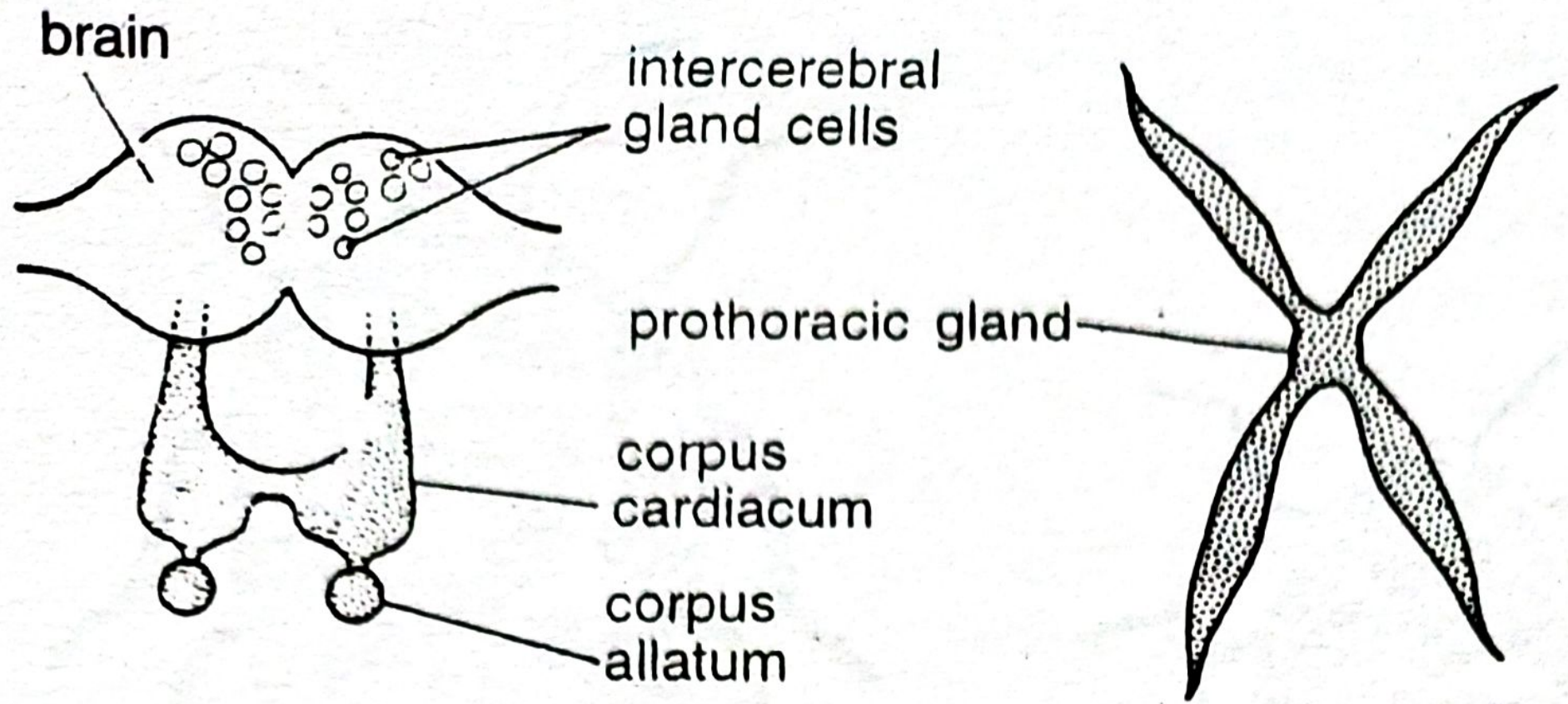


Fig. 7. Endocrine glands of insects.

metamorphosis, that is, development of the larva into adult through pupal stage.