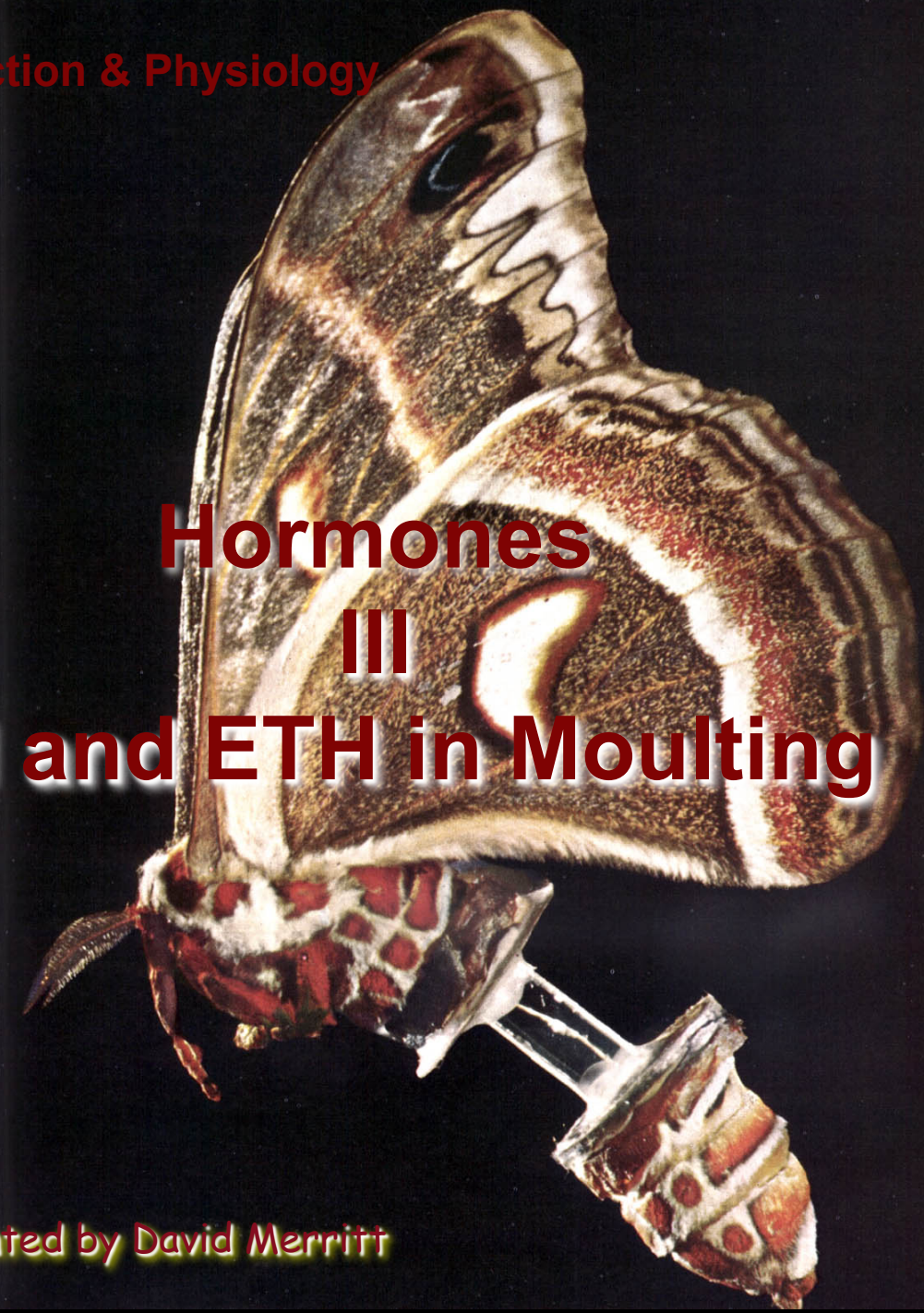


**Hormones
III
EH and ETH in Moulting**



Topics

- Eclosion Hormone: origin and action
- Ecdysis triggering hormone
- History of ETH discovery
- ETH and nervous system fixed action patterns
- Hormones regulating metabolism and homeostasis

Objectives

- Know the roles of eclosion hormone and eclosion triggering hormone in eclosion
- Appreciate the diversity of functions that are regulated by hormonal action

Hormones in Moulting and Metamorphosis

Prothoracicotropic hormone: Released from brain neurosecretory cells, accumulates in CA, prompts the prothoracic glands to release ecdysone

Ecdysone: Released from prothoracic gland targets the epidermis to initiate moulting

I. apolysis

II. enzyme secretion

III. digestion and reabsorption

Juvenile hormone: Secreted by endocrine cells of the corpora allata, widespread targets, maintains juvenile stage

Eclosion hormone: Released from brain (a neuropeptide) through corpora cardiaca (in Manduca through proctodeal nerve NH area from cells with somata in brain) and targets the CNS to produce eclosion (or ecdysis) behaviour.

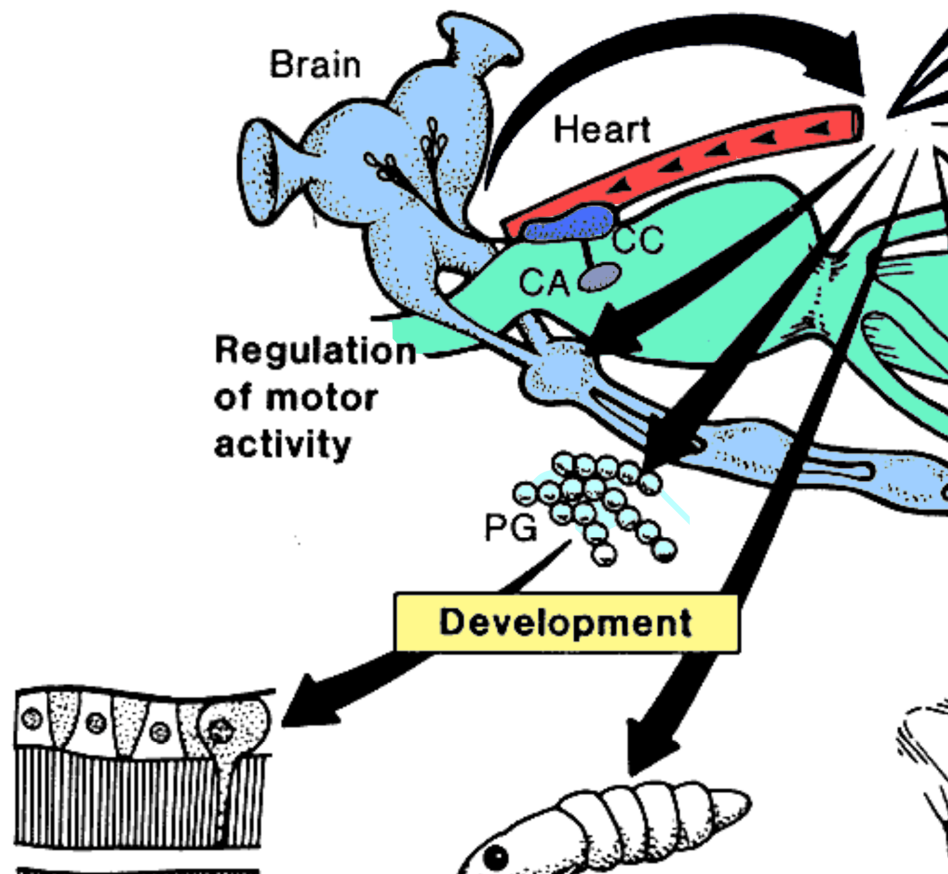
Ecdysis triggering hormone (ETH): Released from peripheral nerve cells associated with the trachea near the spiracles. Trigger the onset of ecdysis behaviour

Bursicon: Released from neurosecretory cells of thoracic and abdominal neuromeres. Targets epidermis to produce sclerotization and melanization of the cuticle

Hormones in Moulting and Metamorphosis

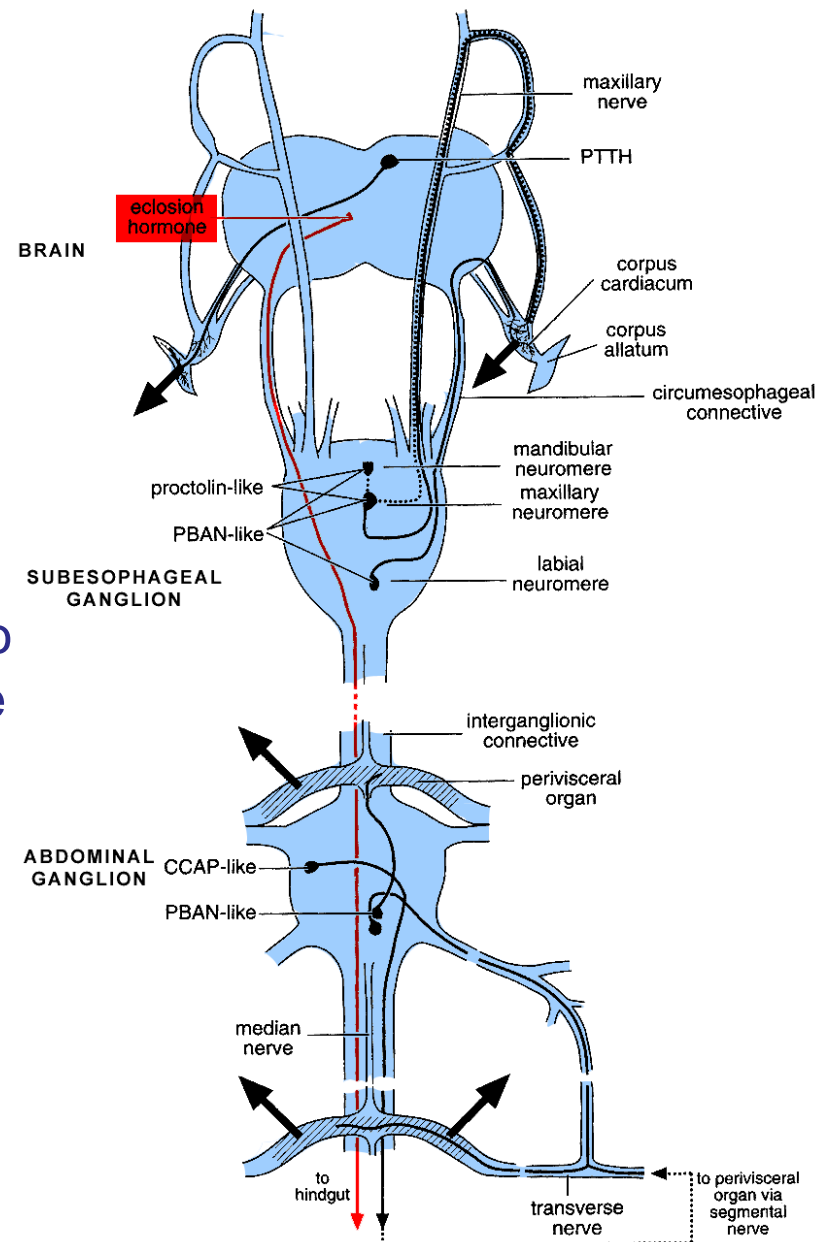
Eclosion hormone

- Released from brain (a neuropeptide)
- targets the CNS to produce eclosion (or ecdysis) behaviour, often timed according to circadian rhythm

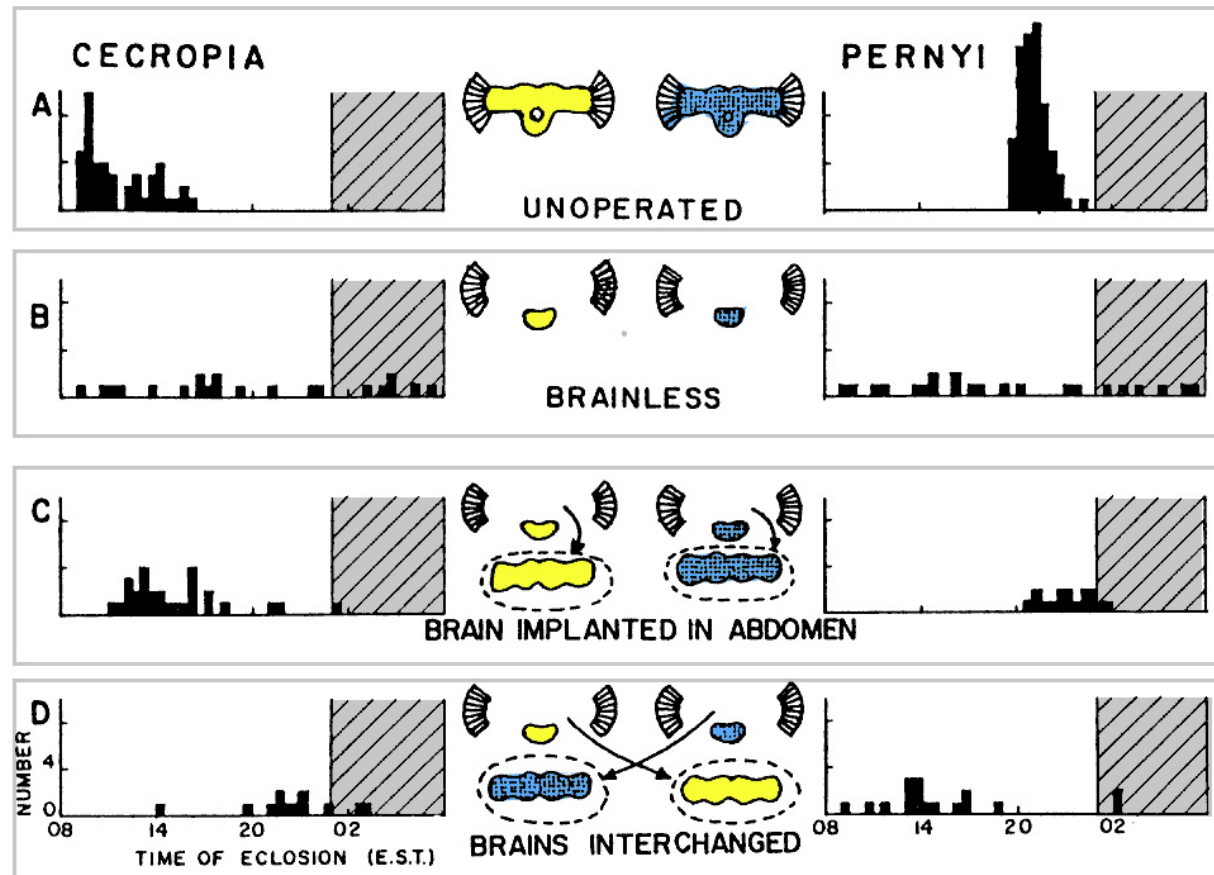


Origin & Release of EH

- Neuropeptide of 62 amino acids, released from VM cells in brain (2 neurons per side).
- 80% sequence similarity between *Manduca sexta* and *Bombyx mori*.
- VM neurons have very long axons that run through the thoracic and abdominal ganglia and out the proctodeal nerves to a neurohemal area. Stimulation of these neurons causes release of EH.
- The neurons accumulate secretion between moults and release it in a single, massive bout, demonstrated by immunostaining and electron microscopy.
- EH switches CNS central pattern generator on: a neural “program”.



- A. Circadian rhythm of eclosion in adult silkmoths.
- B. Brain removal: eclosion rhythm becomes “free-running”
- C. Brain re-implantation: eclosion rhythm is restored to reflect the day-night regime experienced by the implanted brain
- D. Cross-species implantation: resulting eclosion rhythm is characteristic of the brain donor species

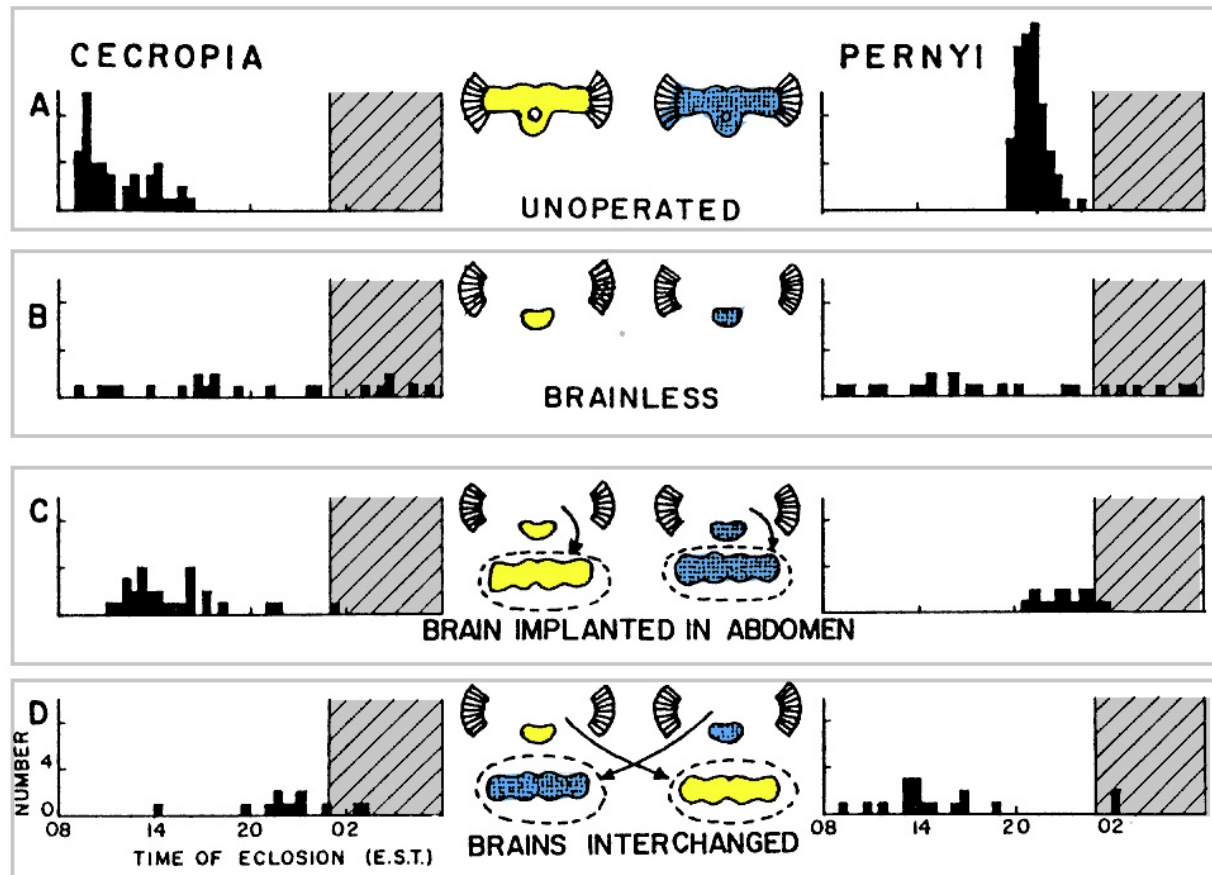


Conclusions

A brain-centred component (=EH)

A pre-programmed ventral ganglia-associated component (motor patterns)

A circadian clock restricts EH release to a certain time of day (a “gate” in time).

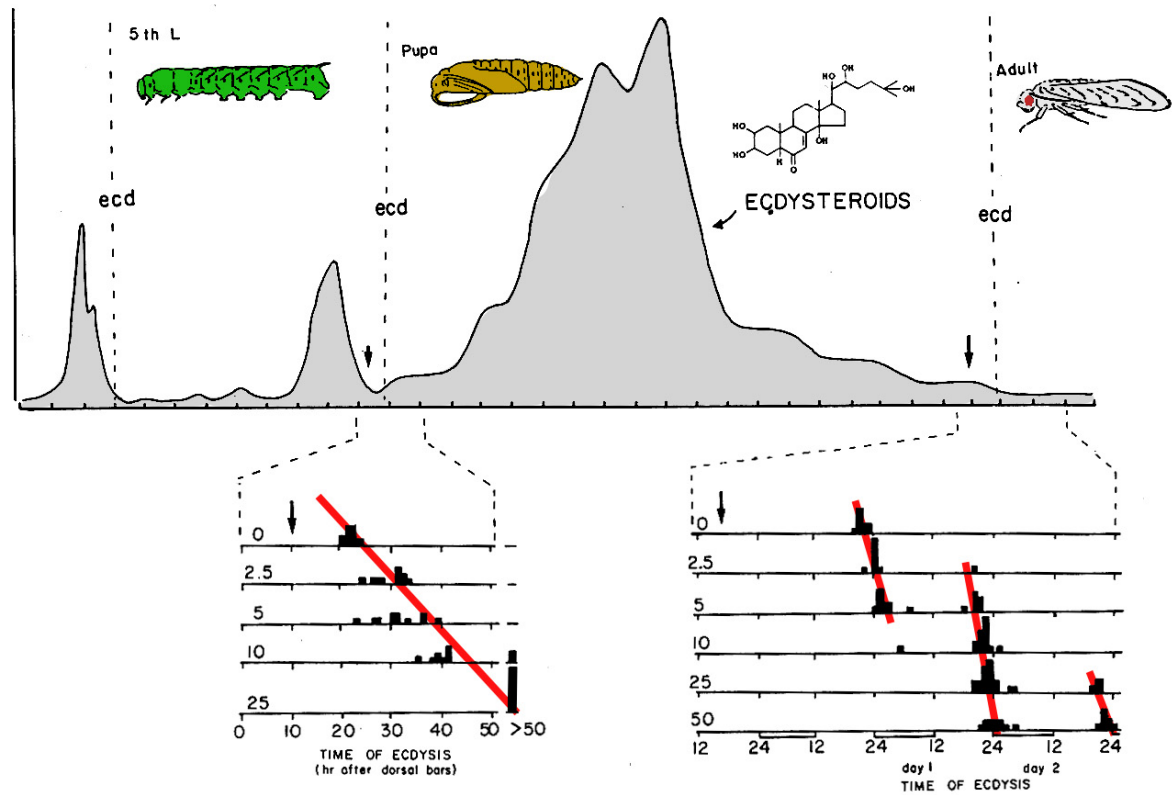


Origin & Release of EH

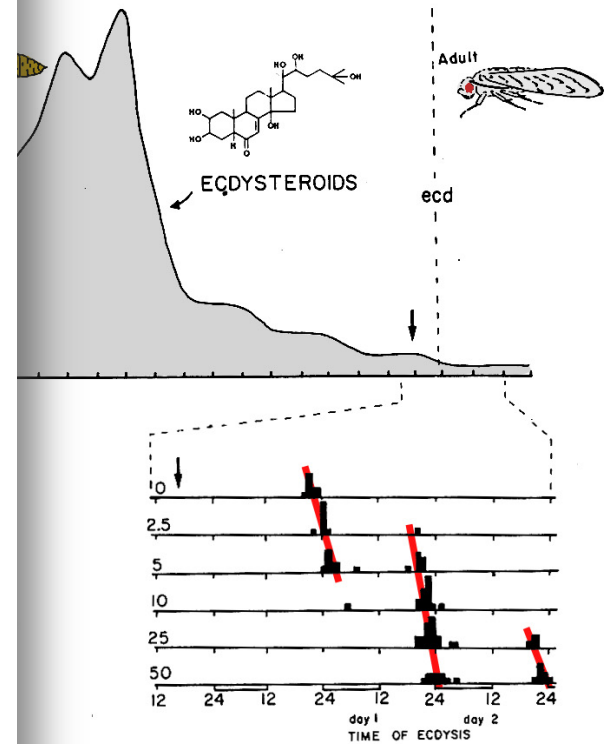
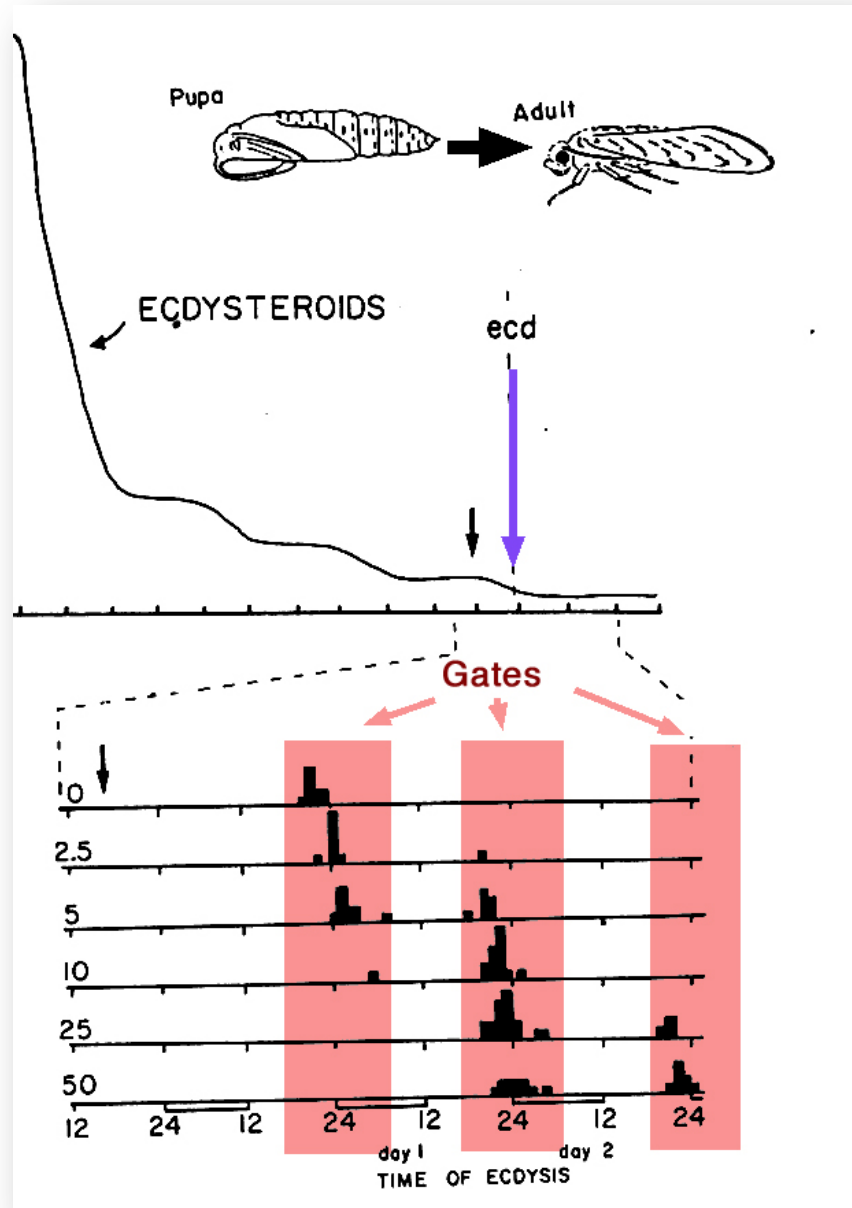
Timing of EH release is determined by the time of ecdysone release.

EH is released in response to the *dropping* phase of the ecdysteroid titre

- The larva-pupa transition is delayed linearly by injection of ecdysteroid.
- The pupa-adult transition delay is gated according to the day-night regime, i.e. over-ridden by a circadian rhythm.



Origin & Release of EH



Origin & Release of EH

Two release sites (1) within the CNS, and (2) the proctodeal neurohaemal area.

Neuropeptide release in the CNS in the thoracic and abdominal ganglia is responsible for eclosion behaviour.

Peptide released from the neurohemal area has an influence on glands and perhaps other sites such as muscles.

Isolated abdomens show aspects of the eclosion behaviour when injected with EH

Isolated nervous system showed associated electrical activity (but only when trachea present) (Truman '78 JExpBiol 74:151).

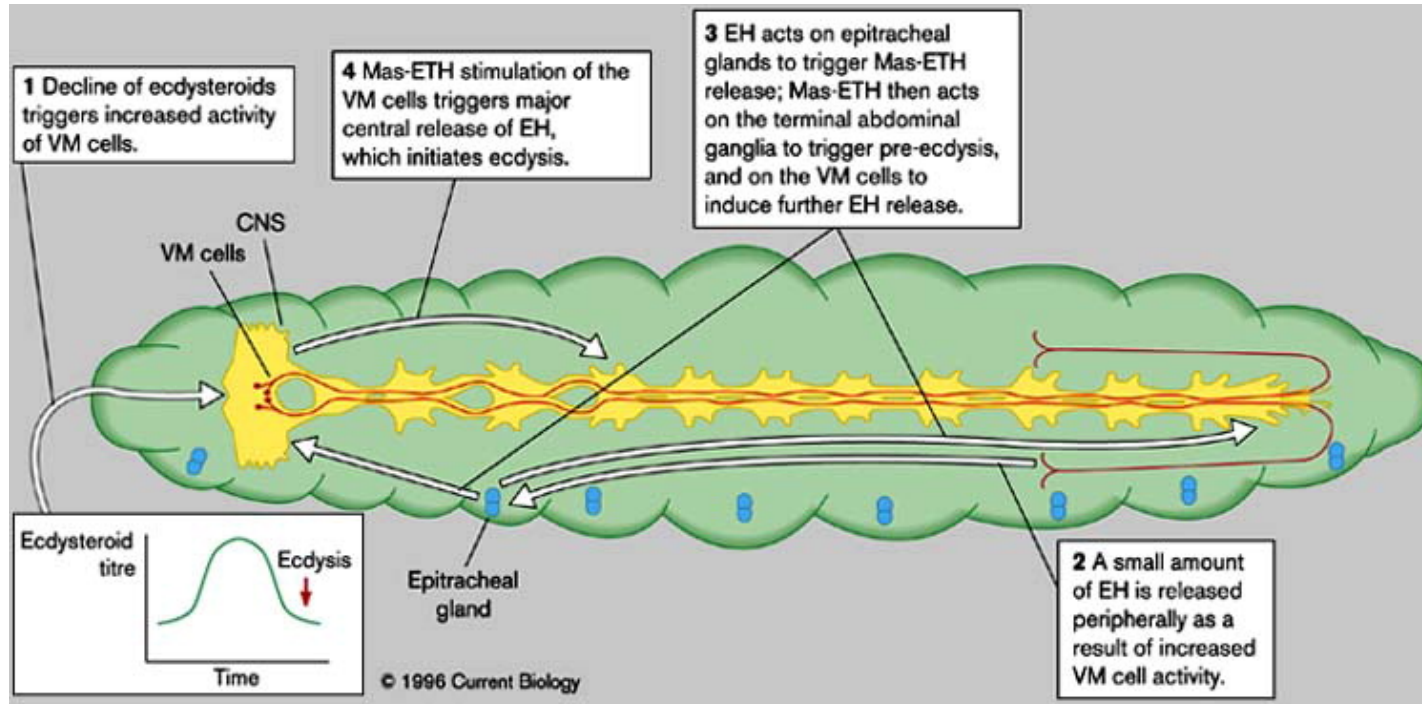
Ecdysis Triggering Hormone (ETH)

Discovered 1996: until then, it was thought that EH was solely responsible for eclosion behaviour.

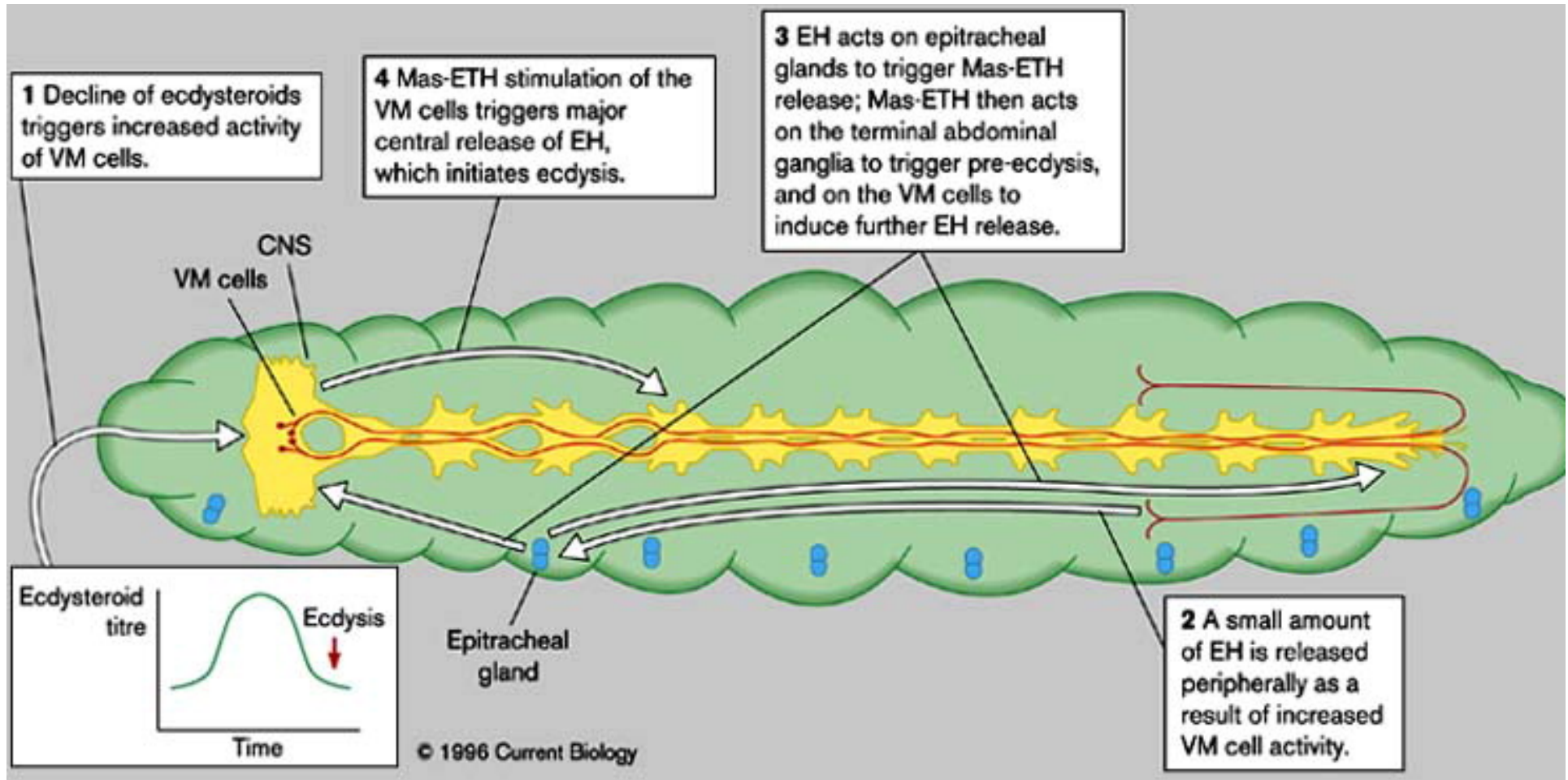
Manduca sexta ETH (23 amino acid polypeptide) shown to initiate pre-eclosion and eclosion behaviours upon injection of extracts with a shorter latency than with injection of EH.

Originates in large peripheral secretory cells associated with the trachea near the spiracles (called Inka cells).

These glandular structures was known beforehand but their function was unknown.



Ecdysis Triggering Hormone (ETH)



2. Hormones in Metabolic activities and homeostasis

Adipokinetic hormone: Polypeptide of 8-10 amino acids. AKH acts on fat body (site of lipid and glycogen storage) to release lipids for flight etc. Released from intrinsic cells of corpora cardiaca

Diuretic hormone: In *Rhodnius*, stretch receptors in abdomen monitor abdominal stretch following gluttonous meal, leads to increase in urine production. Proximal portions of abdominal nerves are the neurohemal organs for DH. Antidiuretic hormones have the opposite effect

Proctolin: Neuropeptide both a neurotransmitter and neurohormone. Induces muscle contractions in the gut

A pentapeptide

Also neuromuscular junction neurotransmitter

Cardioactive peptides: released from perivisceral organs

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Hesterlee, S. and D. B. Morton (1996). Insect physiology: The emerging story of ecdysis. *Current Biology* 6(6): 648-650.

Nijhout, H. F. (1994). *Insect Hormones*. Princeton, Princeton University Press.

Truman, J. W. (1981). Physiology of insect ecdysis. II. the assay and occurrence of the eclosion hormone in the Chinese oak silkworm, *Antheraea pernyi*. *Biol. Bull* 144: 200-211.