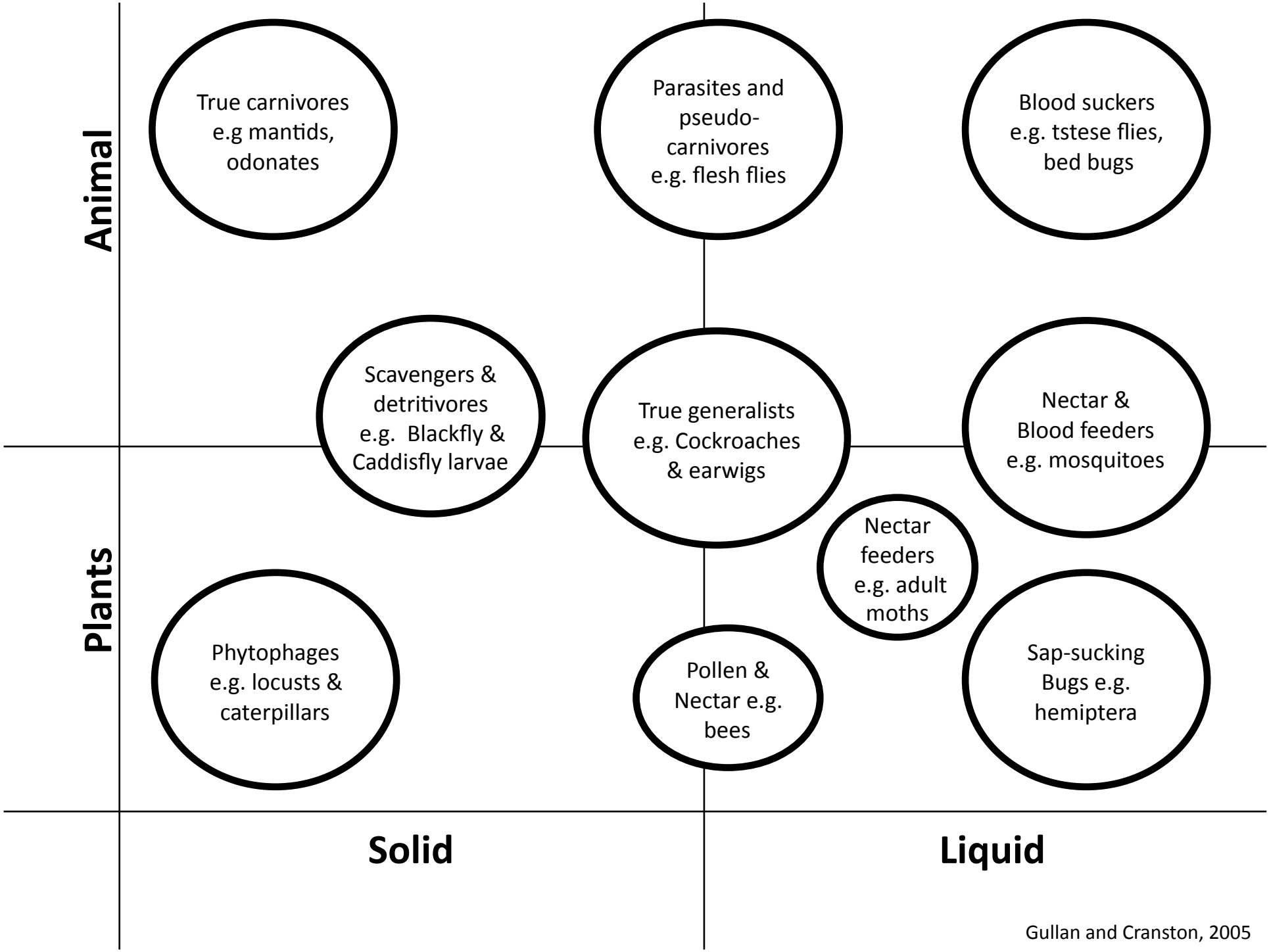
Feeding

What do insects eat?

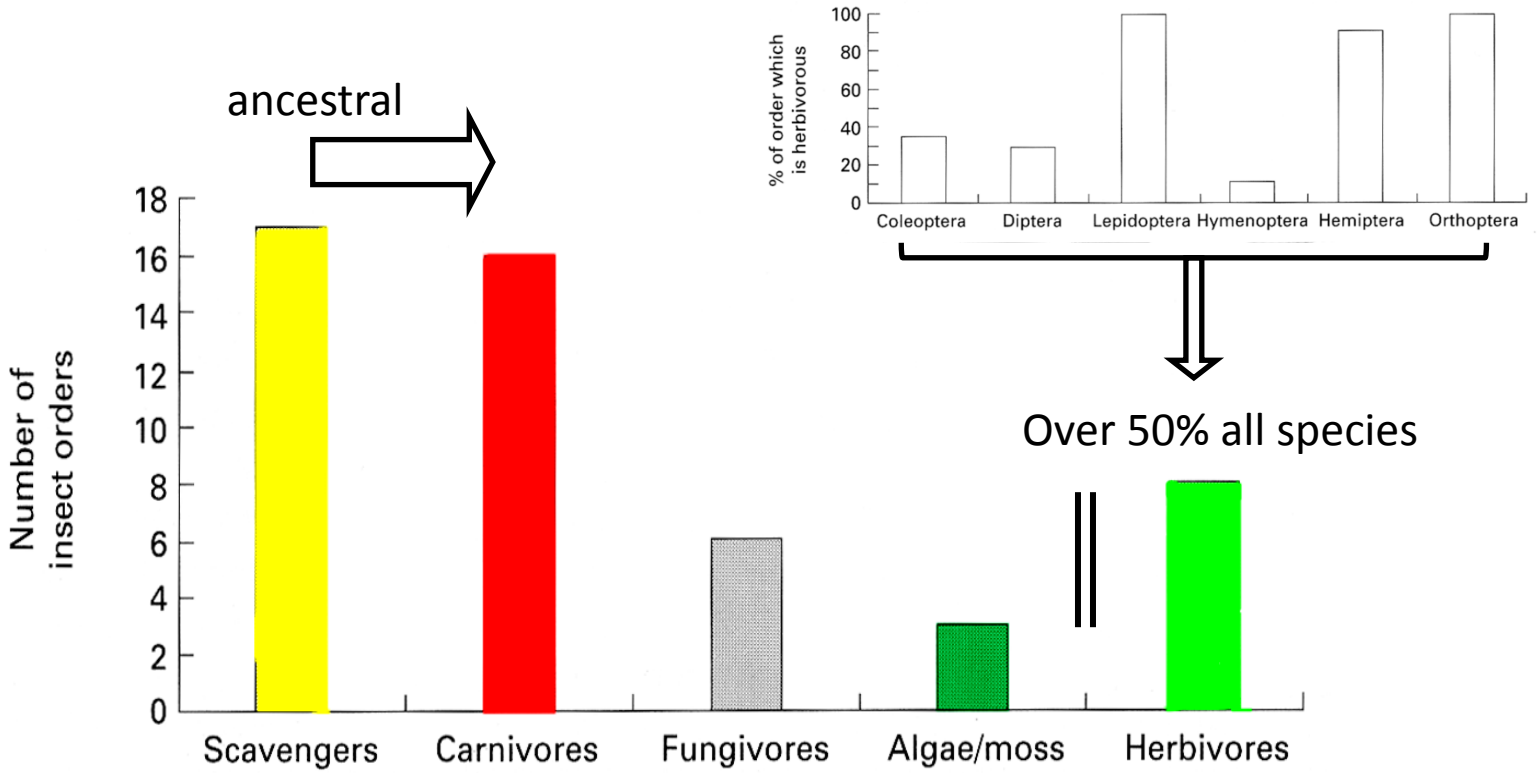
The role of the head in feeding

- Ingestion
  - Mouthparts
  - Sensing of food



Gullan and Cranston, 2005

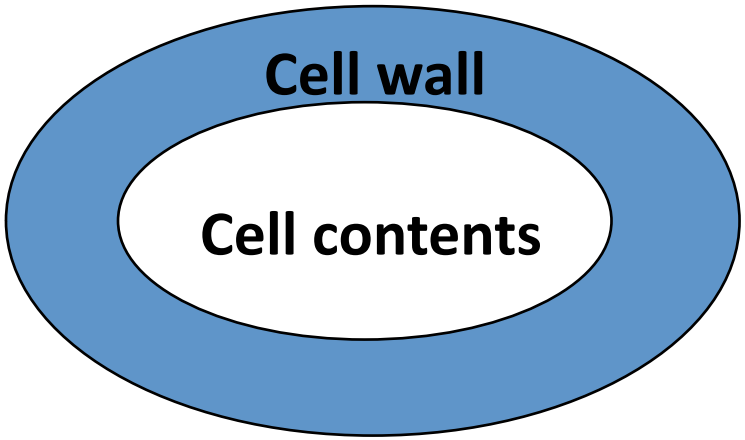
Nutritional sources



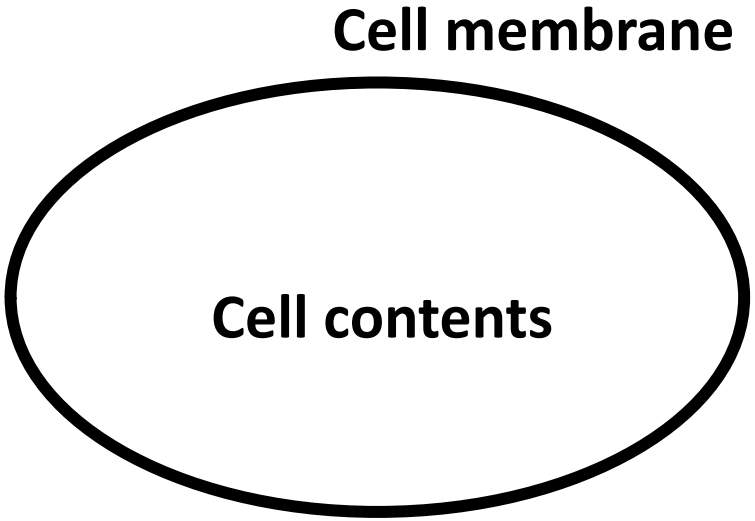
Speight et al. 1999

Plant versus animal cells

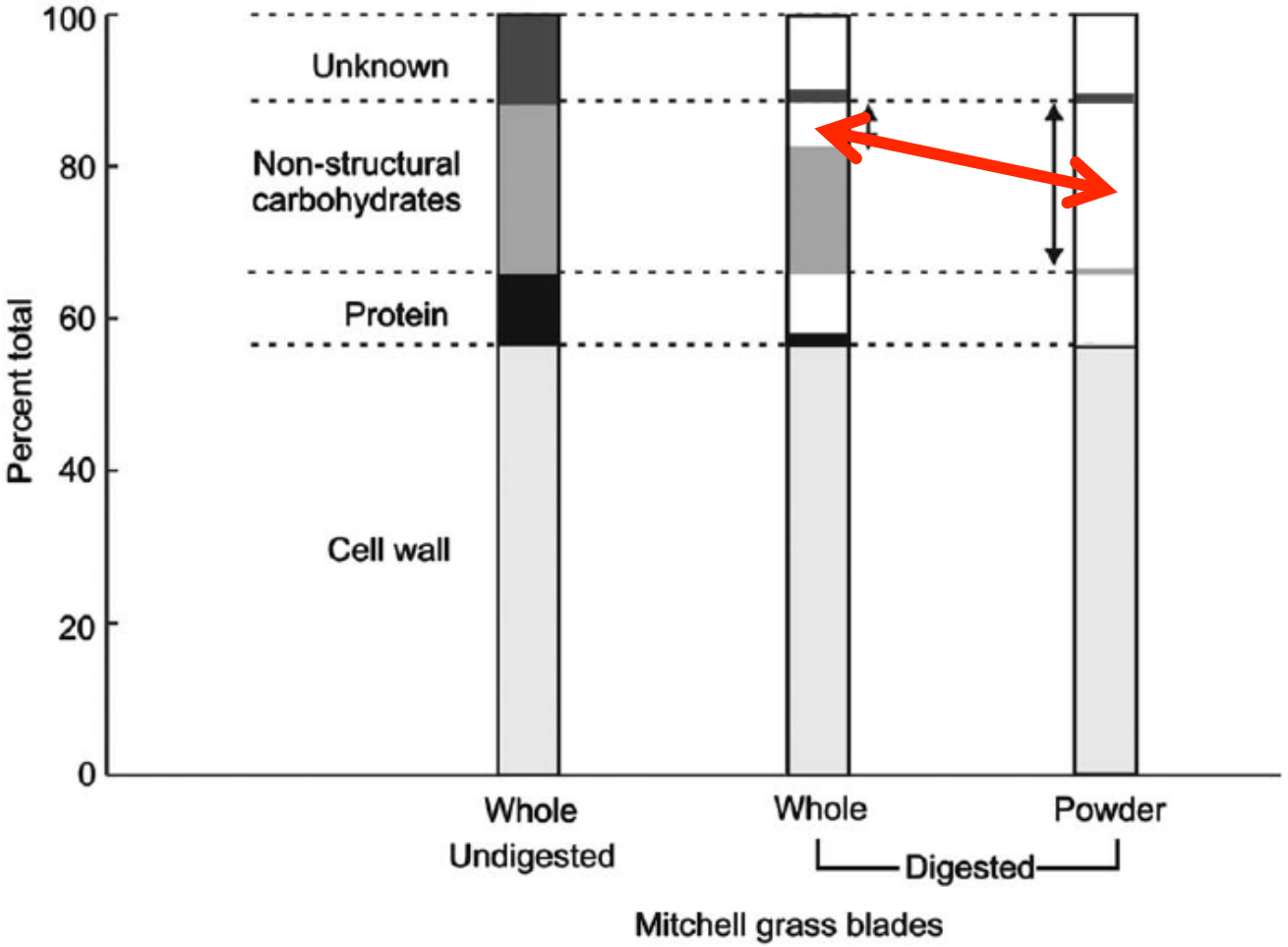
Plant



Animal



Herbivory



Clissold, 2007

Herbivory

- Cell contents are the main source of nutrition
- Mechanical disruption of cell wall
- Are insects “good” at herbivory?
- Does this emphasis change the relative importance of types of “defences”?

Food type eaten

mouthparts

affect gut size & structure

Nutrients acquired = amt. of food * search rate * conversion rate

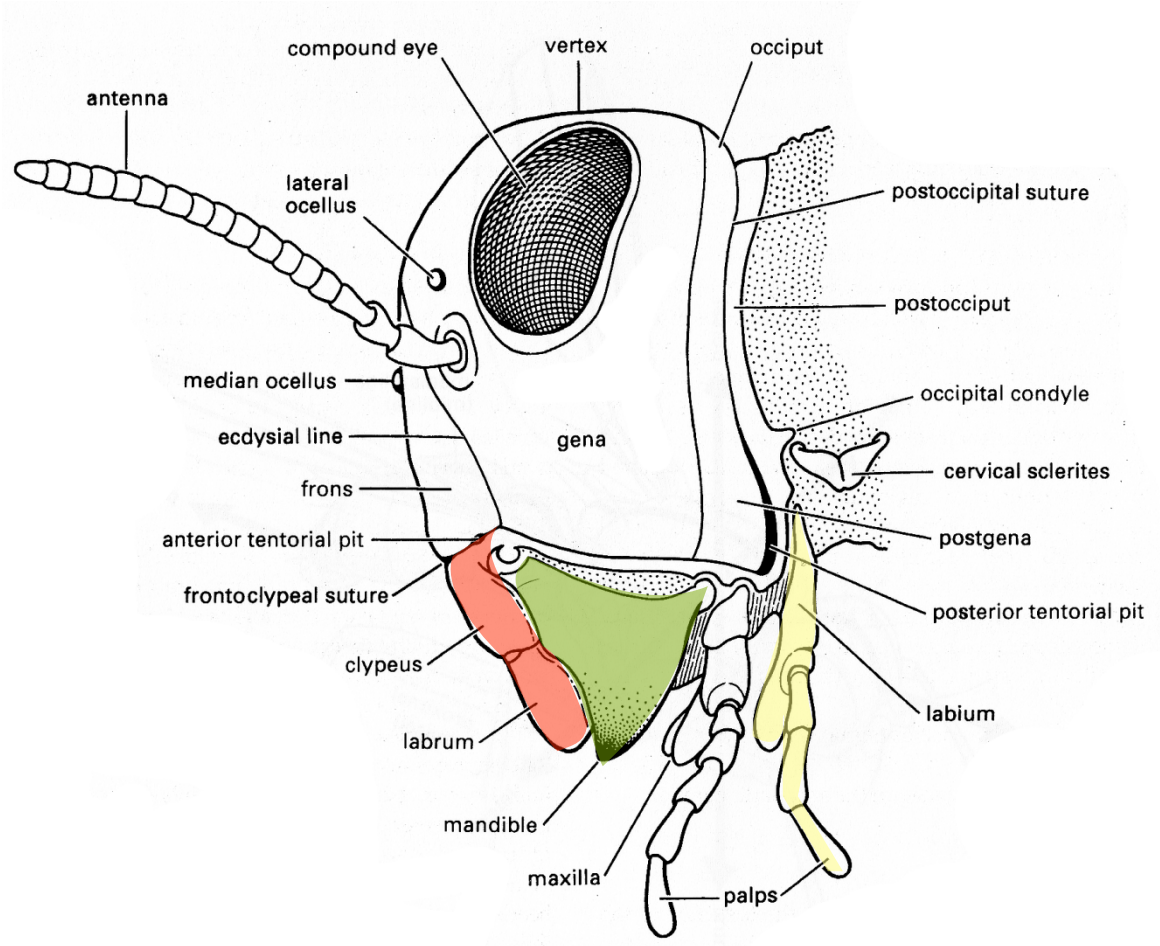
Herbivore	Large	Low	Low
Carnivore	Small	High	High

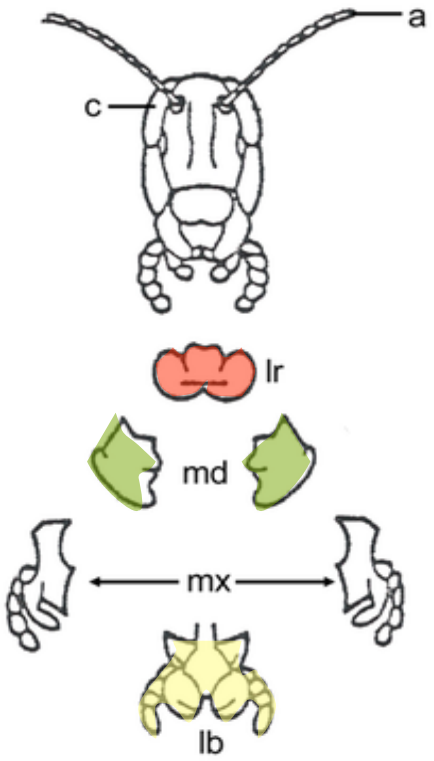
Mouthparts

2 basic types of Ectognathous mouthparts

- solid food feeders – biting/chewing
- liquid feeders – sucking/sponging

Head side view





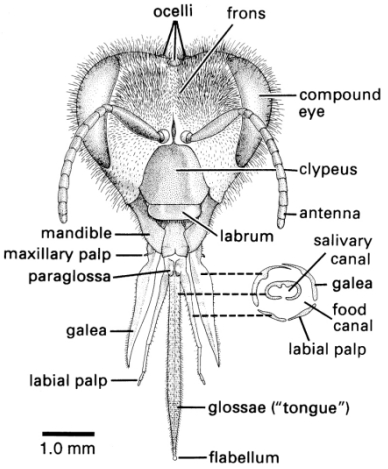
labrum

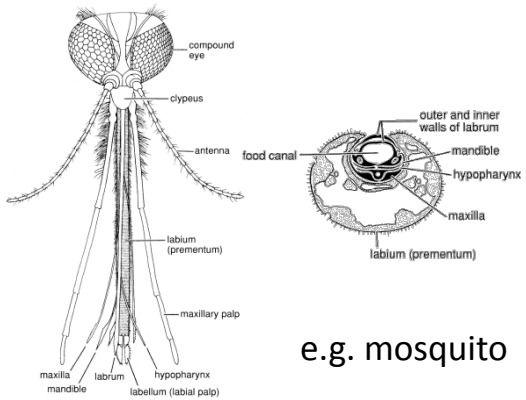
mandibles

maxillae

labium

Gullan and Cranston, 2005



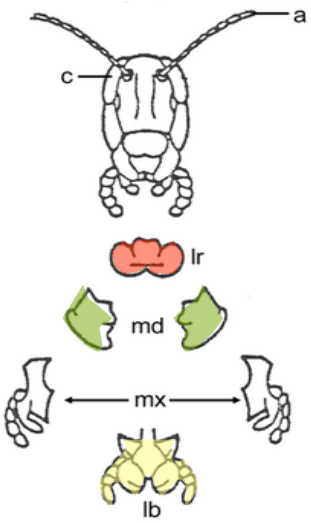


e.g. mosquito

SOLID ⇨ ***LIQUID***

e.g. bee

Piercing and sucking



labrum

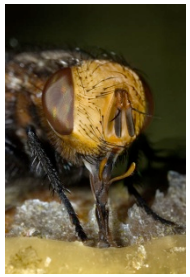
mandibles

maxillae

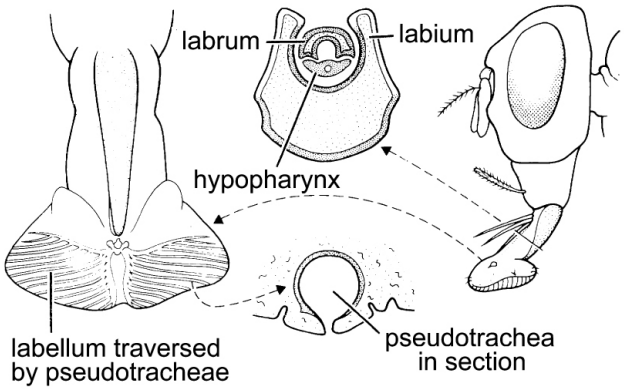
labium

Sponging

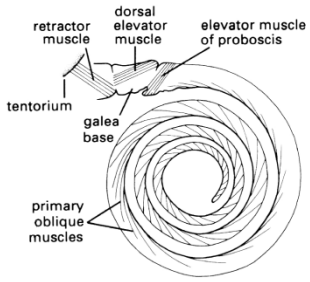
Siphoning

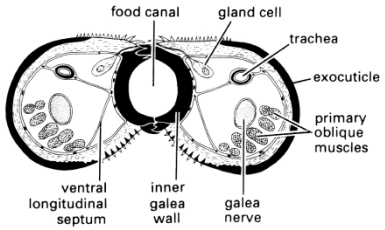


e.g. fly



Ancestral chewing

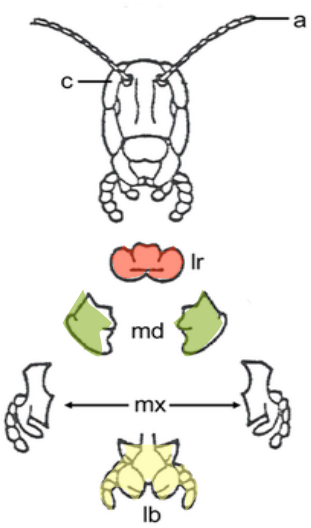




e.g. lepidopterans

Gullan and Cranston, 2010

Mandibles – ‘tools’ vary with type of diet



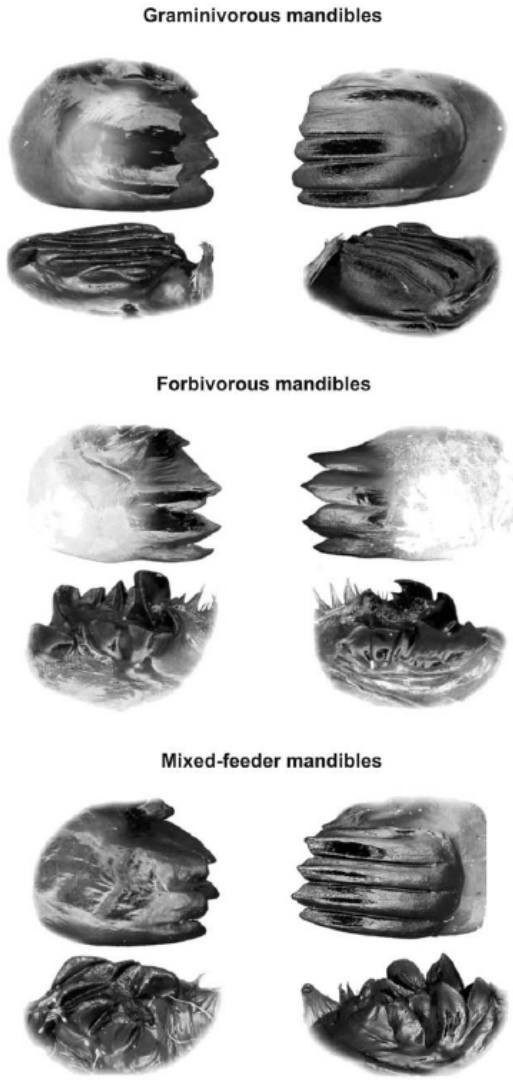
labrum

mandibles

maxillae

labium

Carnivore versus Herbivore



Clissold, 2007

Herbivory and ontogeny

- Larvae often undergo size changes over several orders of magnitude
- Many species exhibit changes to feeding behaviour
- Smaller caterpillars feed differently to larger ones
  - mode of nutrient acquisition

Skeletonising

Leaf snipping

Sensing of food

To eat or not to eat

Sensilla

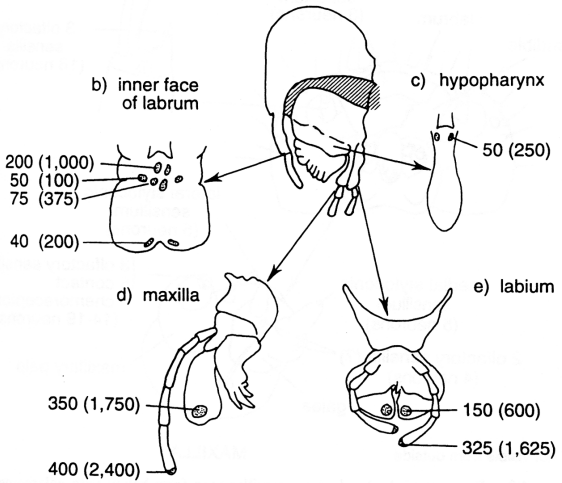
- Chemical - phagostimulatory / inhibitory
- Mechanical - hardness

Sensing of food

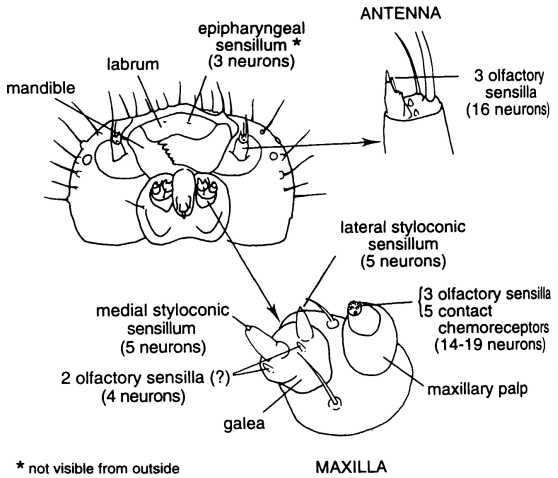
Sensillia

- Chemoreceptors
  - contact with chemicals, on all mouthparts except mandibles
- Mechanoreceptors
  - on tips of mandibles, tip of labium (Aphids) thought to modulate power to muscles
- Olfaction receptors
  - Some planthoppers, tip of rostrum

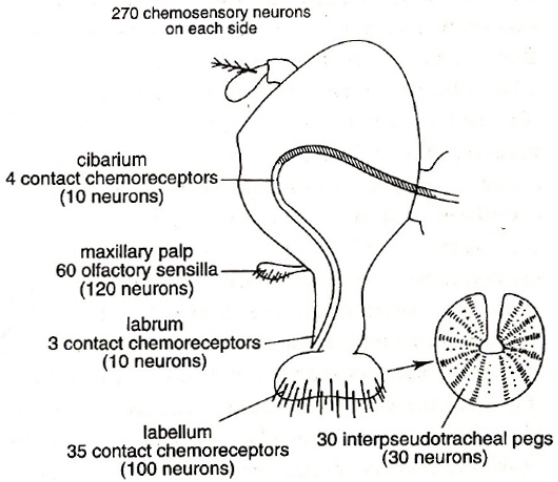
grasshopper



caterpillar



fly



Number of sensilla (number of chemosensory neurons) [sensilla are contact chemoreceptors unless otherwise stated]

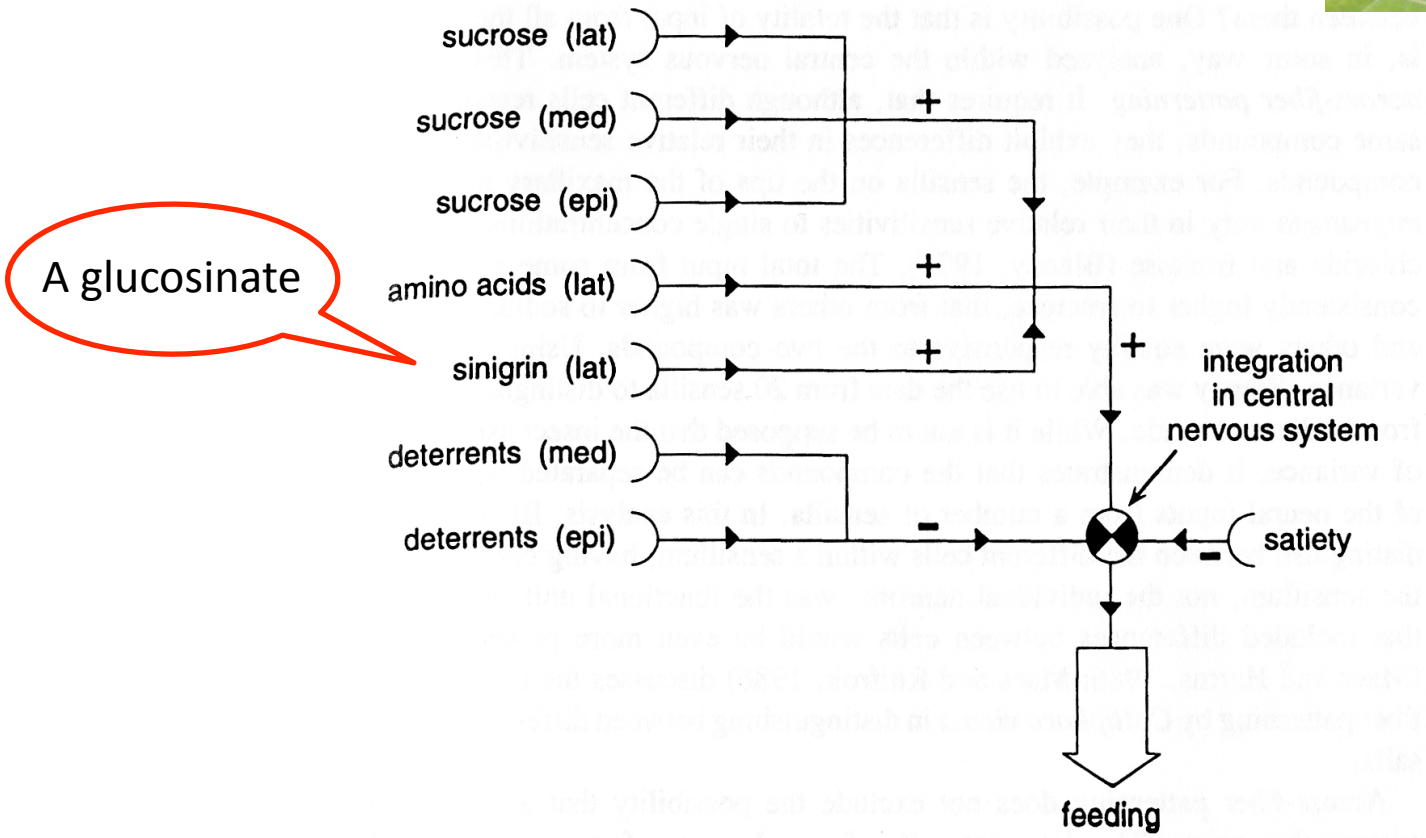
Most on the maxillary palps

Chapman, 1998

Pieris brassicae (cabbage butterfly)

Integration of inputs from the mouthpart receptors

with the CNS to regulate feeding



Chapman 1995

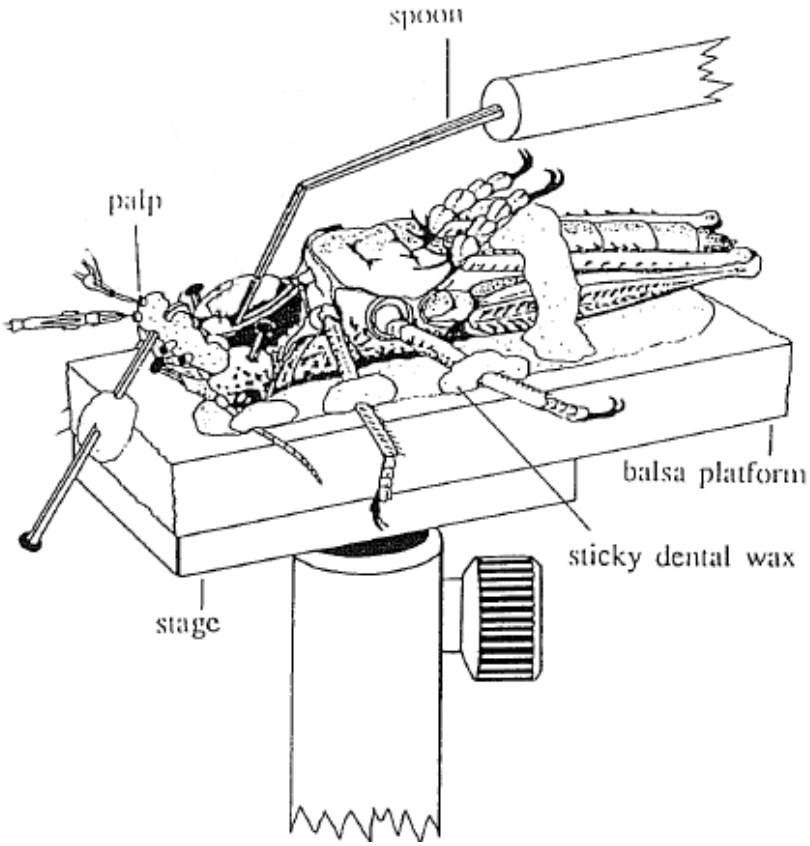
Pre-treated

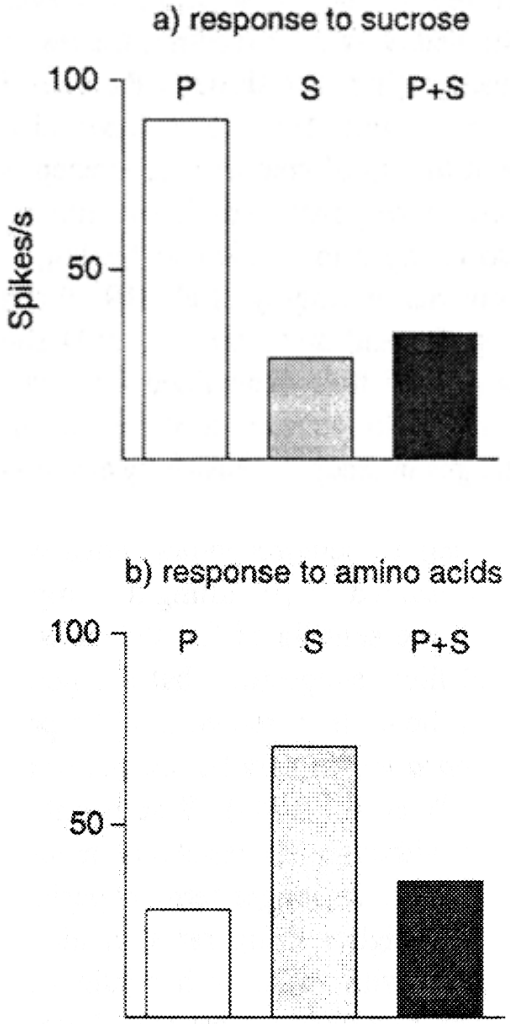
Protein 4h

Carbohydrate 4h

Protein & Carbohydrate 4h

Responses of sensilla on maxillary palp



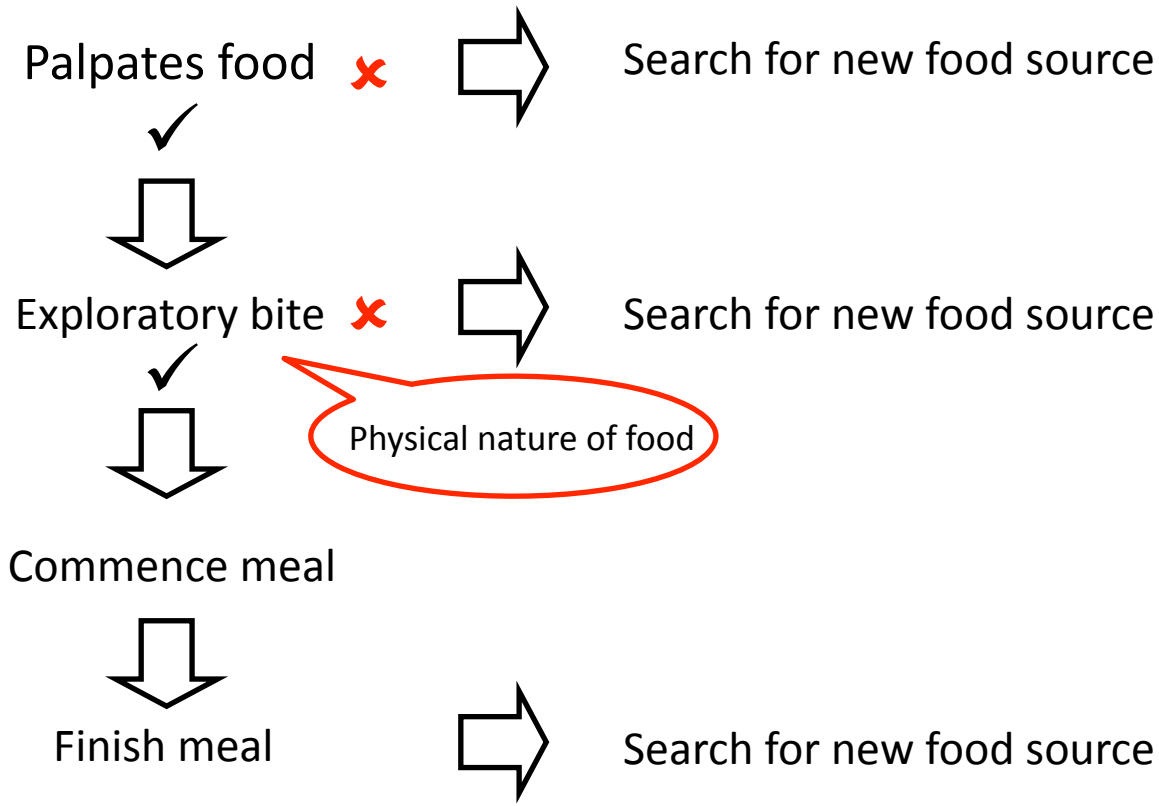


Chapman 1995

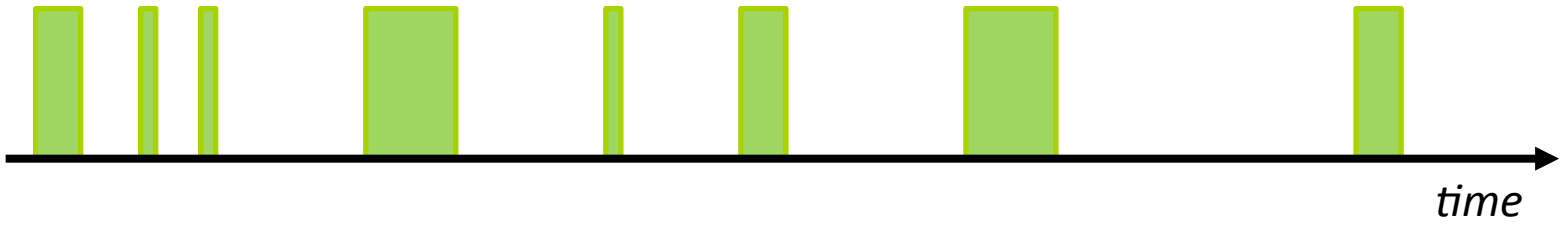
Sensing of food

To eat or not to eat

e.g. grasshopper



Pattern of feeding



Food eaten = meal size x number of meals

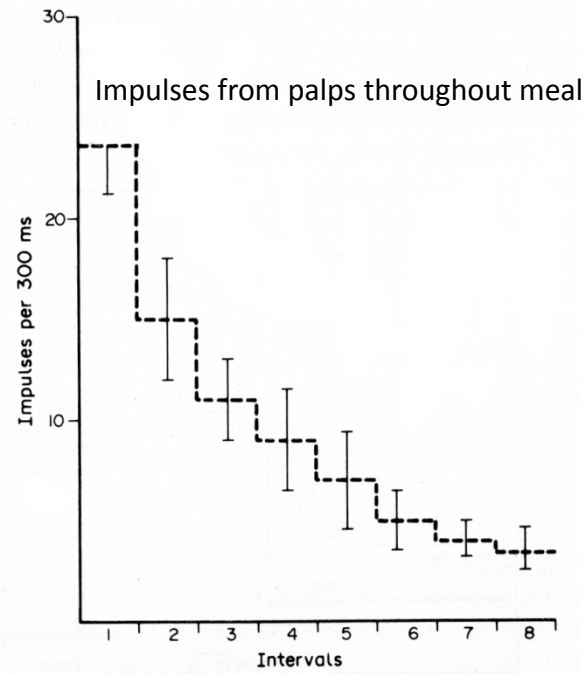
So what regulates

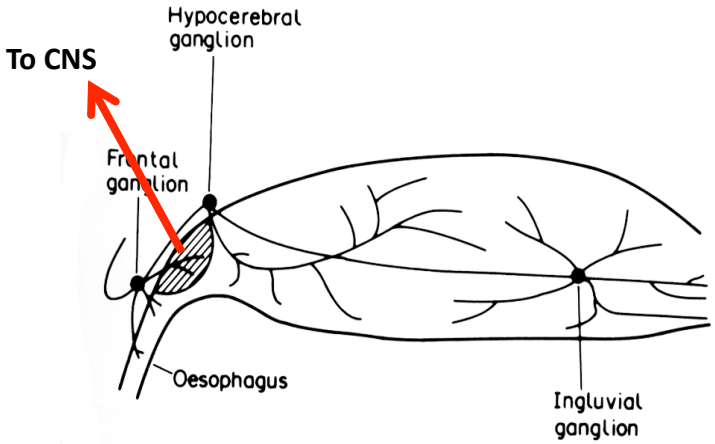
1) meal size
2) the time between meals

Regulation of a meal

Feedback

- Sensory +/- (phagostimulants increase meal size while deterrents may reduce meal size)
- Volumetric – via stretch receptors in the gut
- Haemolymph composition – osmolarity, concentration specific nutrients





Bernays, 1985

Regulation of intermeal duration

Depends on both internal and external factors that govern the

‘central excitatory state’

Excitation increases with time since the last meal

Is associated with

Movement of food through the gut

The sensitivity of the mouthpart sensilla increases with time

Size and nutrient composition of last meal

longer intermeal durations when feeding on protein rich material

shorter intermeal durations when feeding on diluted diets

and is further elevated by

Food odour

Photophase, more food is ingested during ‘lights on’ than ‘lights off’

Summary

What insects eat

range of food sources exploited by insects

'tools' required – mouthparts

When they eat and what they chose to eat

factors affecting

food selection

meal duration

Further reading

Chapman, 1998; Ch 1 & 2

Chapman & de Boer 1995; Ch 1,2 & 4

Chown & Nicolson, 2004; Ch 2

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