The Insect Gas Exchange System

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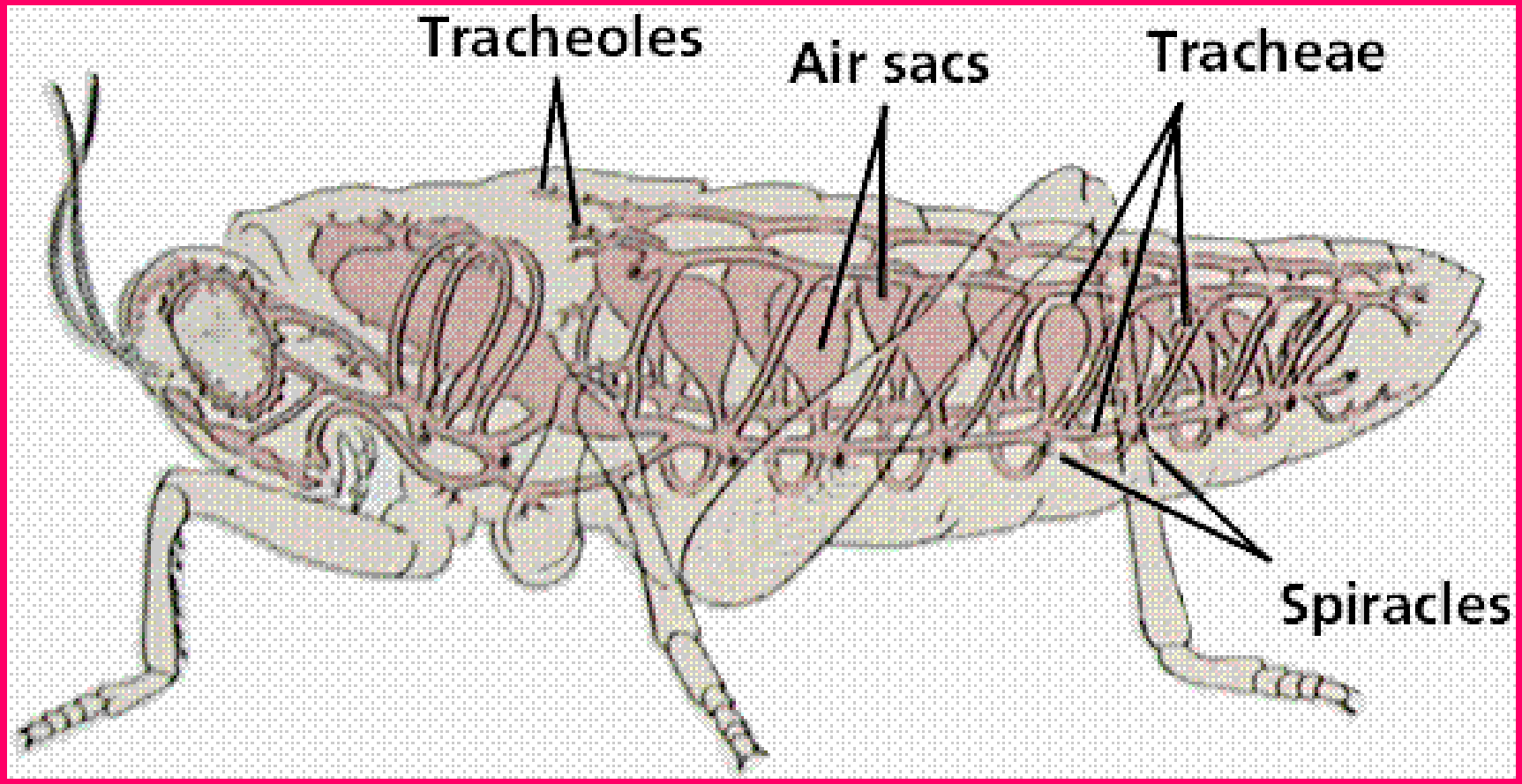
Transparency, Honesty and Accountability Defined

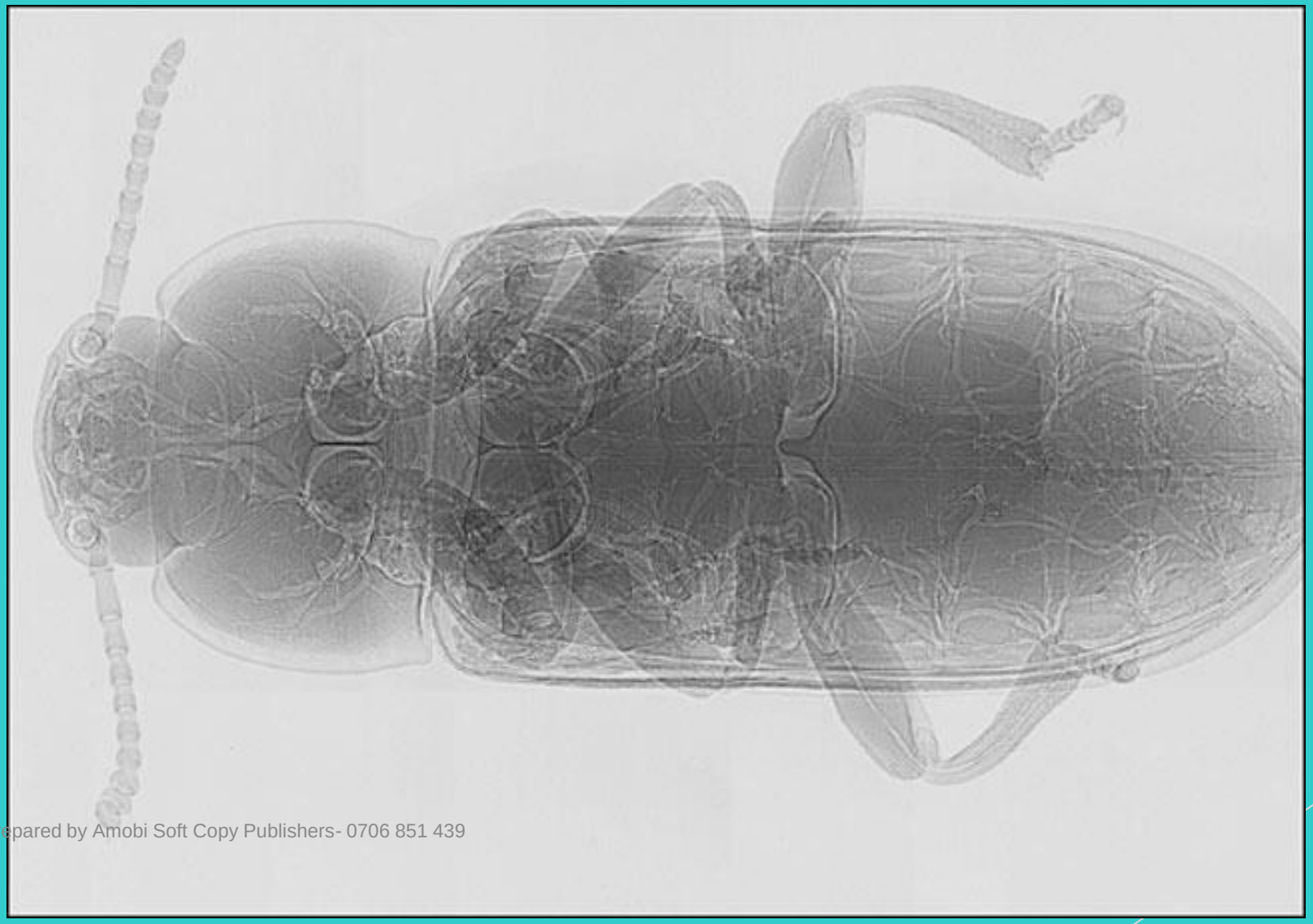
By Sir Obiero Amos Resources

0706 851 439

The Insect Gas Exchange System

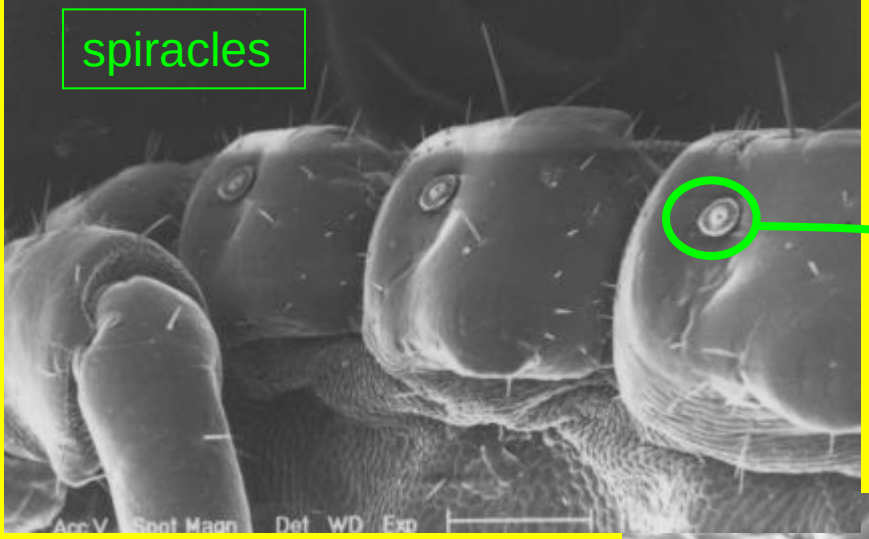


An X-ray of the yellow mealworm beetle - revealing the system of white tubes or tracheae running through its body

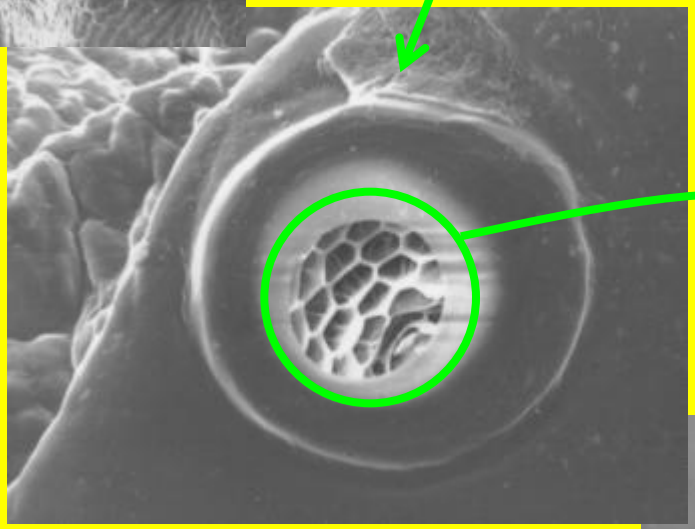


The Insect Gas Exchange System

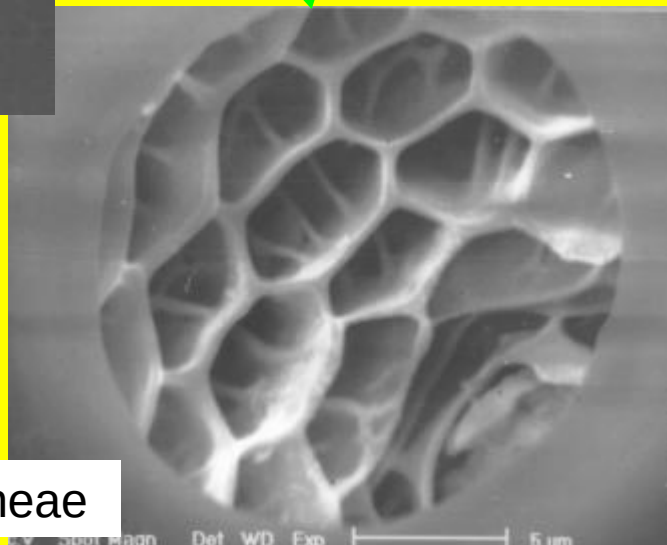
- An insect has spiracles (openings) lined with chitin on the sides of its body.
- The chitin give shape to the openings.
- The spiracles can open and close by small muscles.
- These muscles contract to shut flap like valves and relax to open the valves – allows control of the flow of air as well as slow down the loss of water.



Zoom

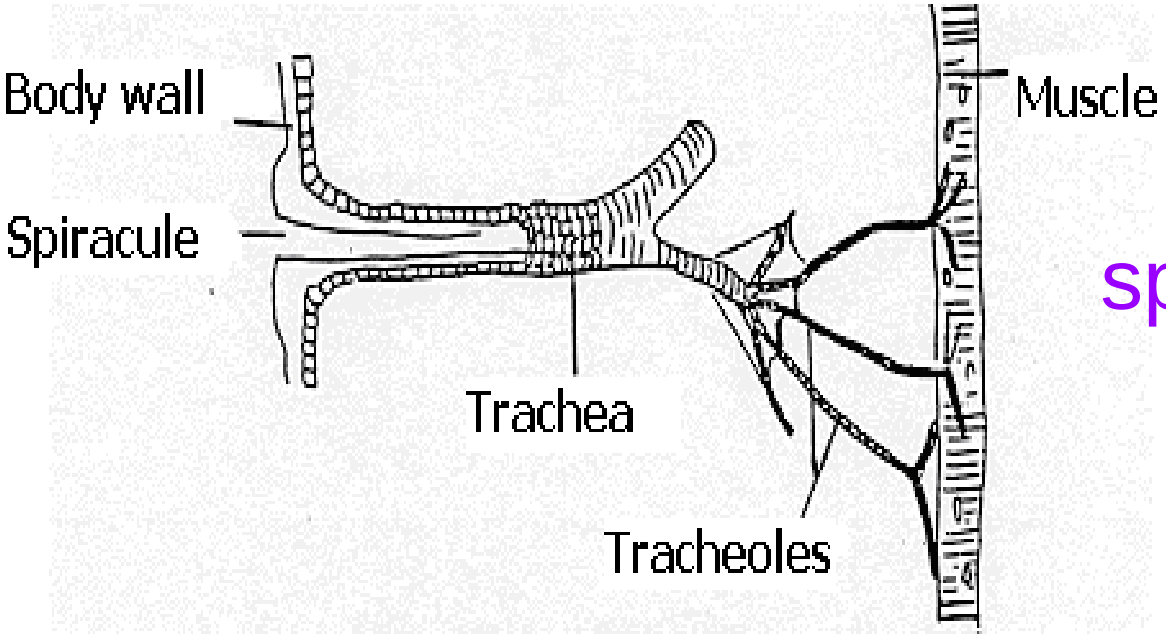


Zoom



The spiracles open into a system of tubes called tracheae

Tracheal System



Outside air

↓

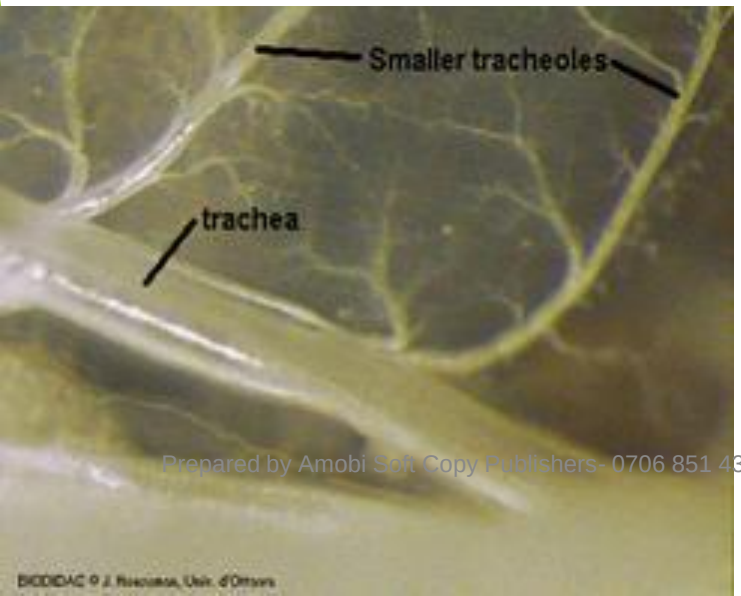
spiracles (openings)

↓

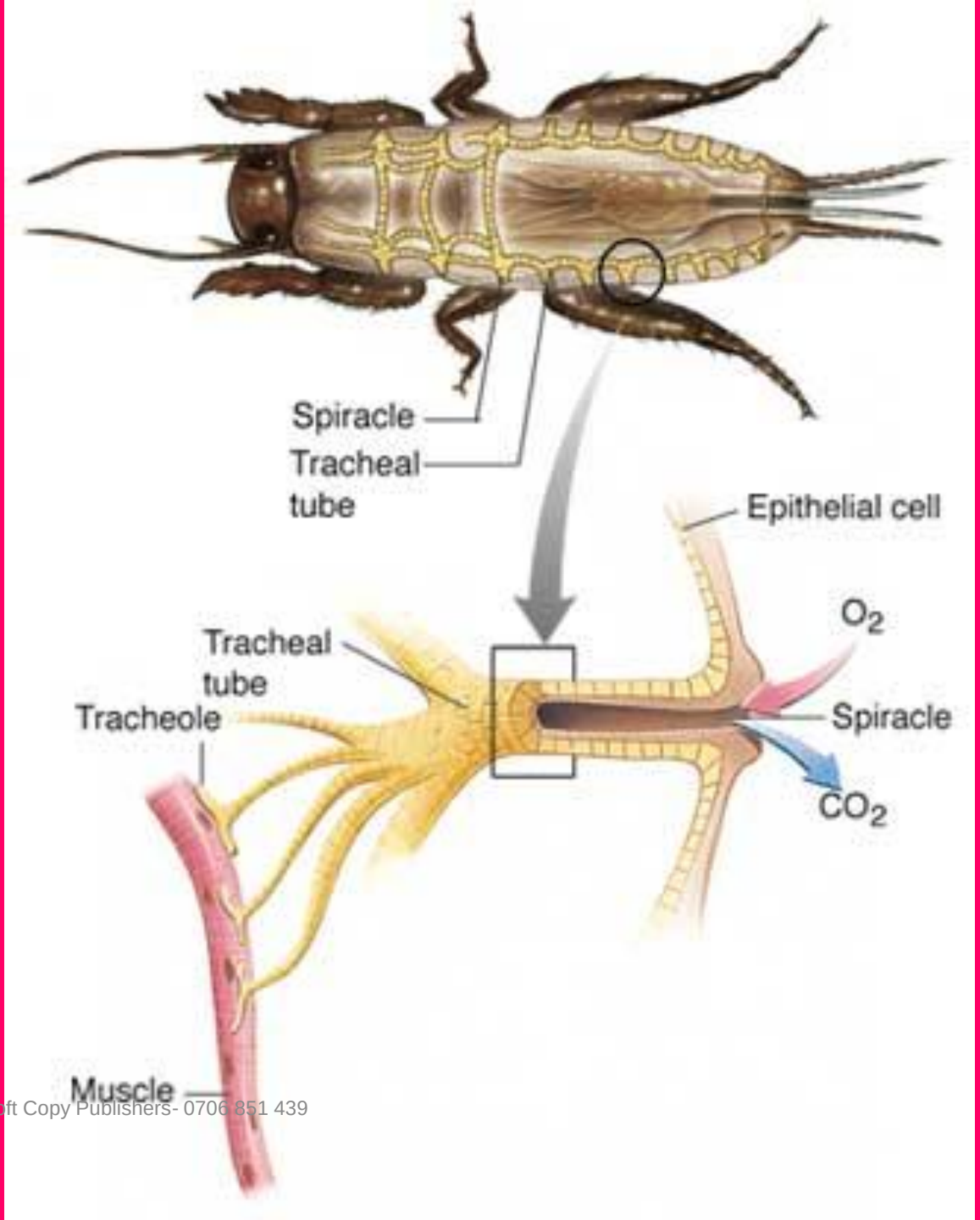
Tracheae

↓

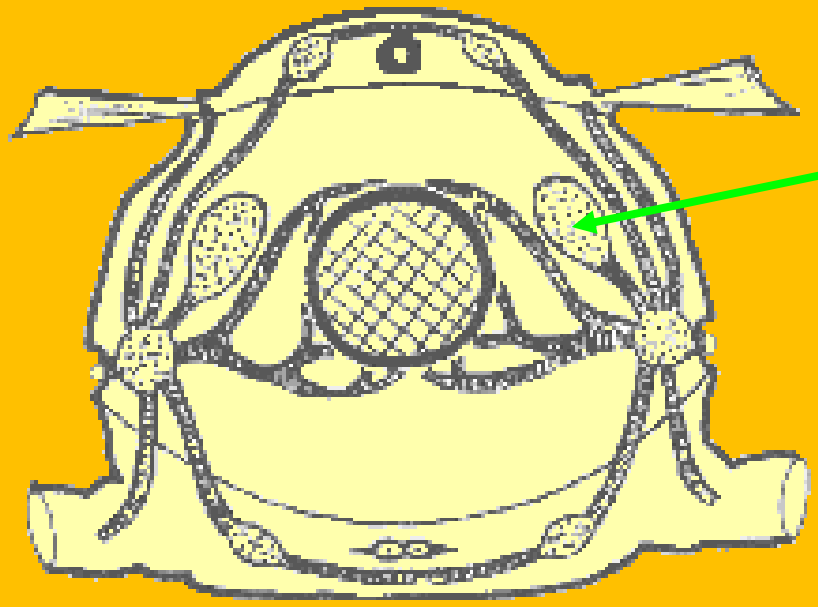
Tracheoles



Trachea walls are reinforced with **Taenidiae** (thickening of the chitin) – allows insects to flex and stretch without developing kinks that might restrict air flow.

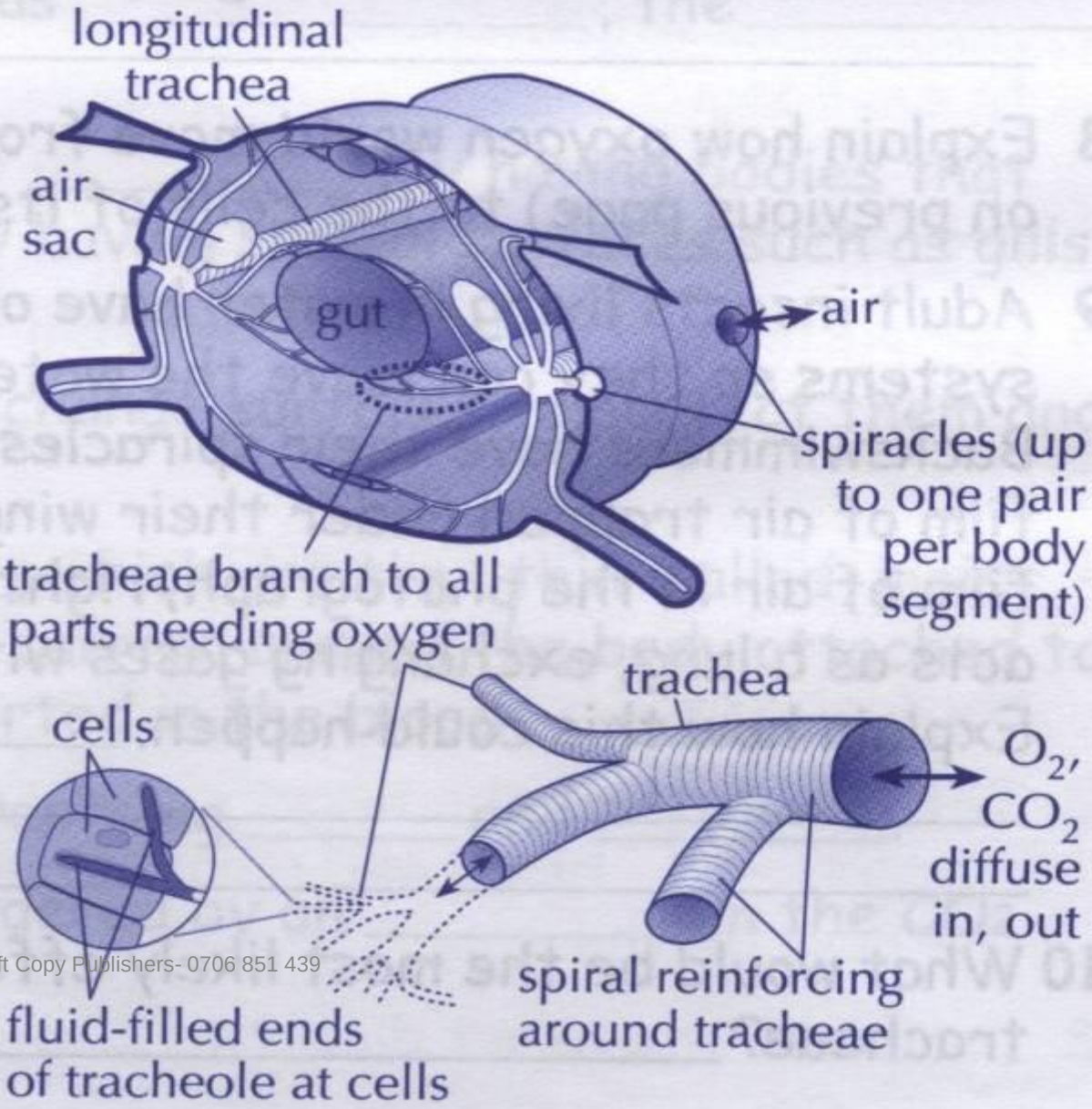


Storage of Air - adaptation for dry habitat



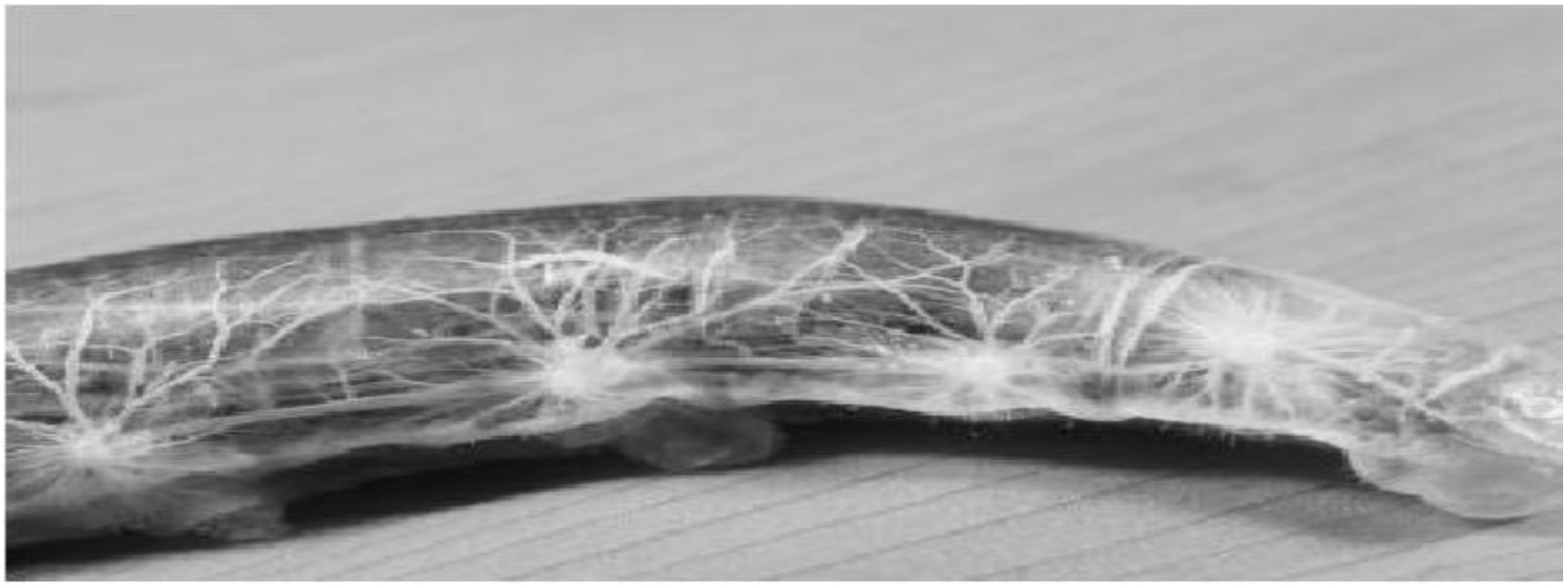
- Collapsible air sacs present in areas without taenidiae
- In dry terrestrial environments, this temporary air supply allows insects to conserve water by closing it spiracles during very dry periods use the stored air in the sacs.

A diagram showing the general arrangement of tracheae and spiracles in open tracheal systems



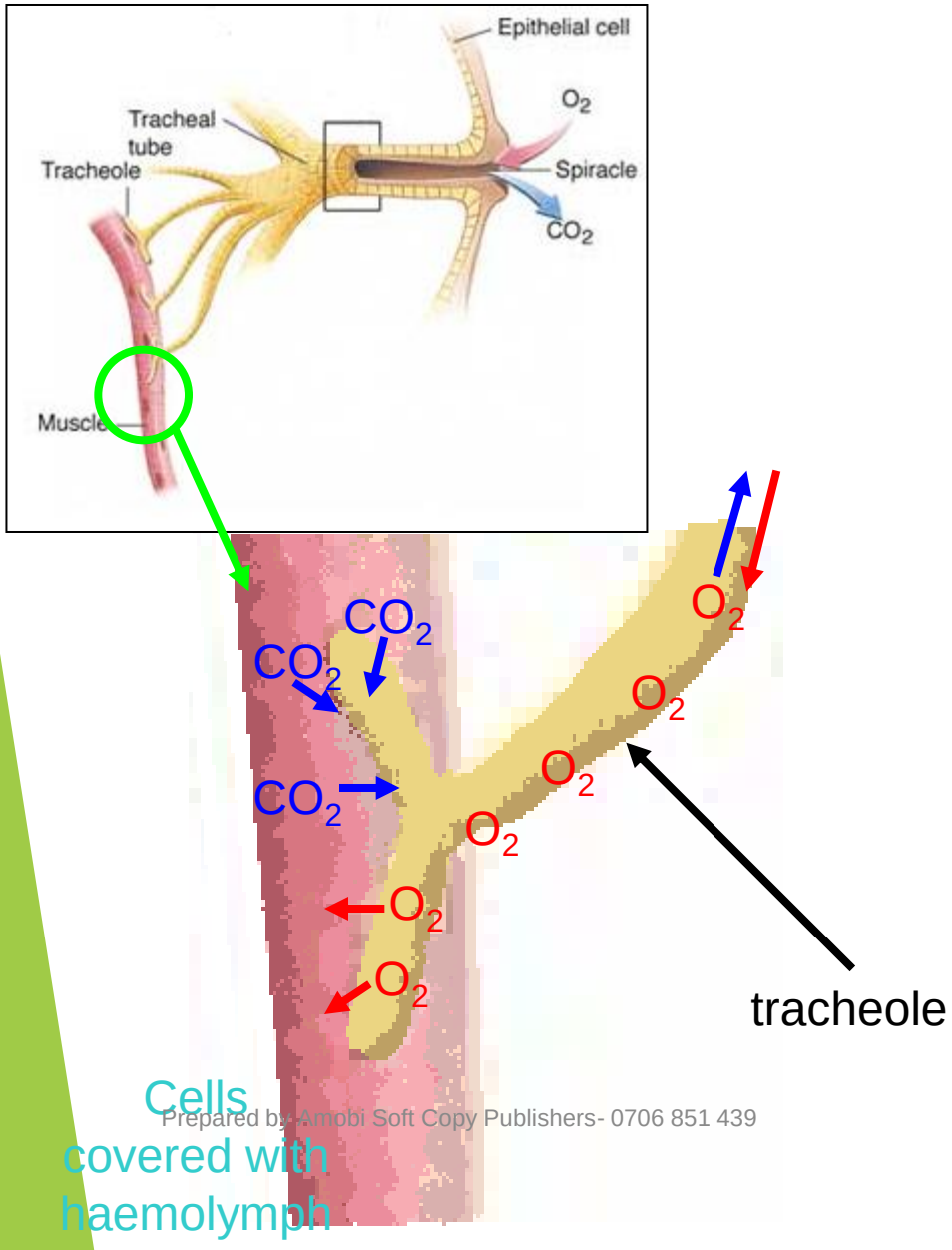
Respiratory tubes in a mayfly larva

Tracheoles



- Trachea lead to smaller tracheoles.
- The ends of each tracheole finishes in a group of body cells.
- The ends are lined with a thin moist surface (membranes) where the exchange of gases can take place.
- The thin membranes are surrounded by watery **haemolymph**.
- The body cells are bathed in the haemolymph.

Passive Diffusion of Gases



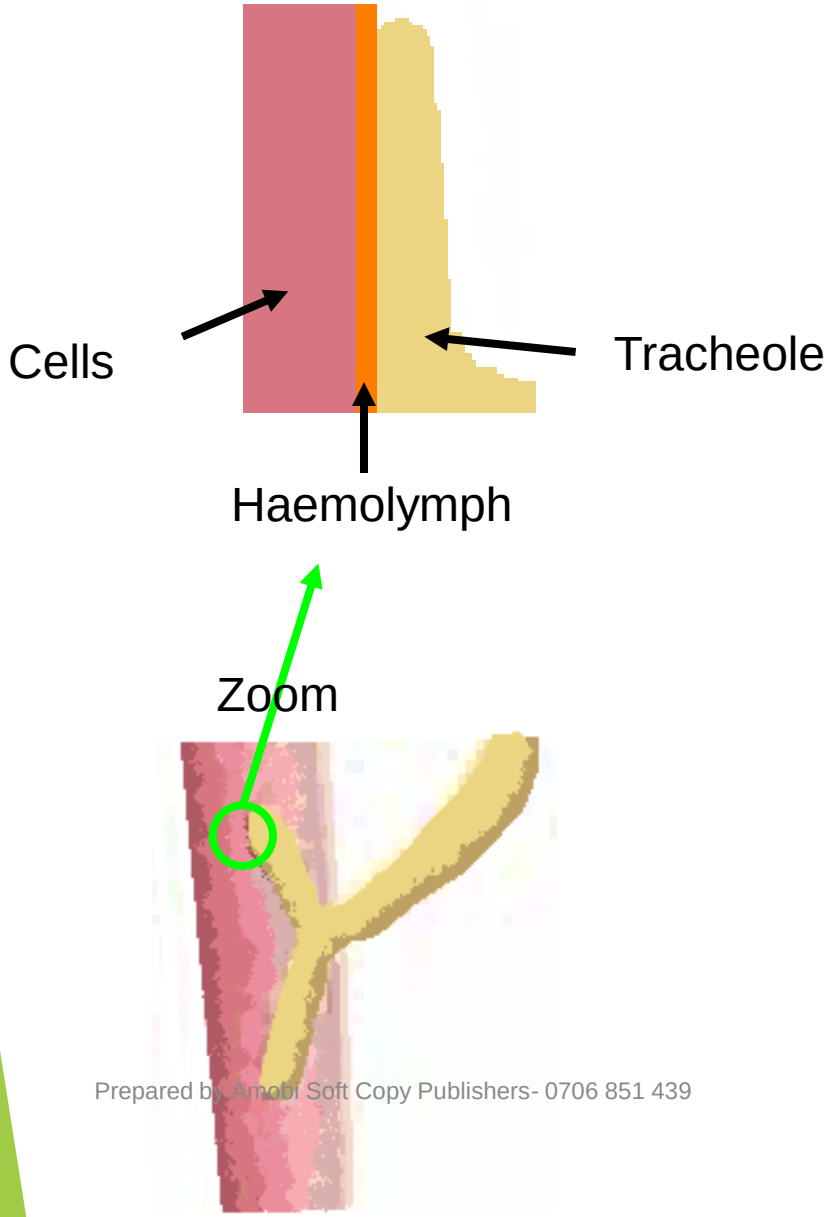
- Oxygen from the air in the tracheoles dissolves into the haemolymph fluid on the thin moist membrane surface and diffuses into the cells.
- O_2 diffuse from tracheoles into haemolymph from a high concentration of O_2 to a lower concentration of O_2.
- CO_2 produced by cell respiration can diffuse from the cells into haemolymph into tracheoles from a high concentration of CO_2 to a lower concentration of CO_2.

Increased Surface Area for Gas Exchange

Extensive network of trachea and tracheoles ↑'s surface area exposed for diffusion of:

- O_2 into haemolymph and further to the body cells.
- CO_2 out of cells into haemolymph into tracheoles.

Thin Surface for Gas Exchange



Thin surface to endings of tracheoles ↓'s the barrier to diffusion of:

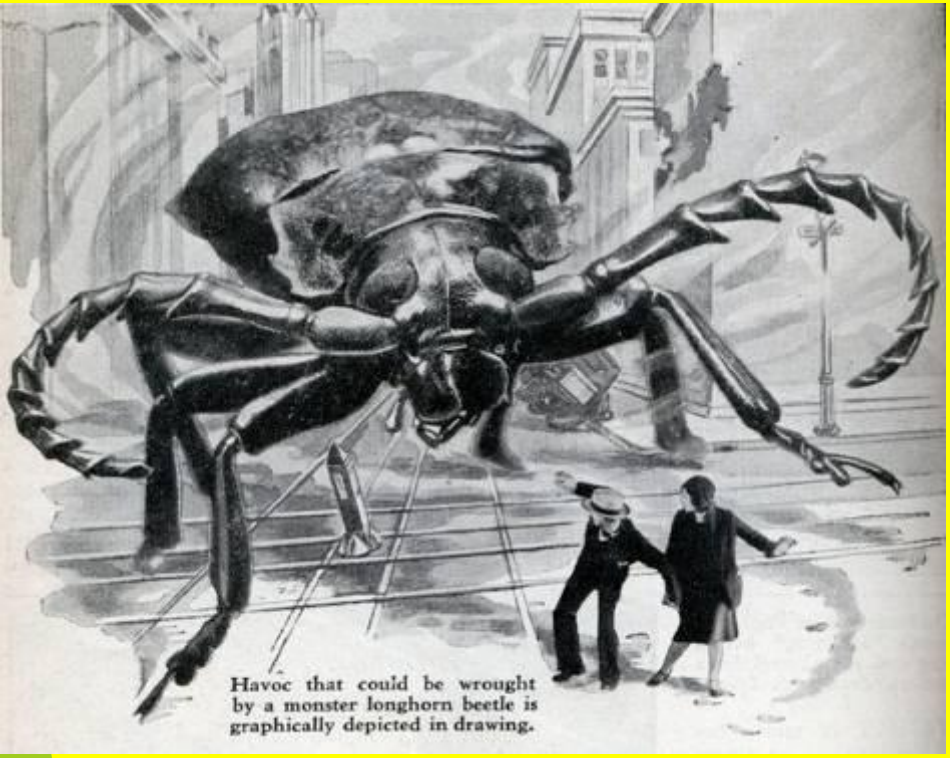
- O_2 into haemolymph and further to the body cells.
- CO_2 out of cells into the haemolymph into the tracheoles.

Moist Surface for Gas Exchange

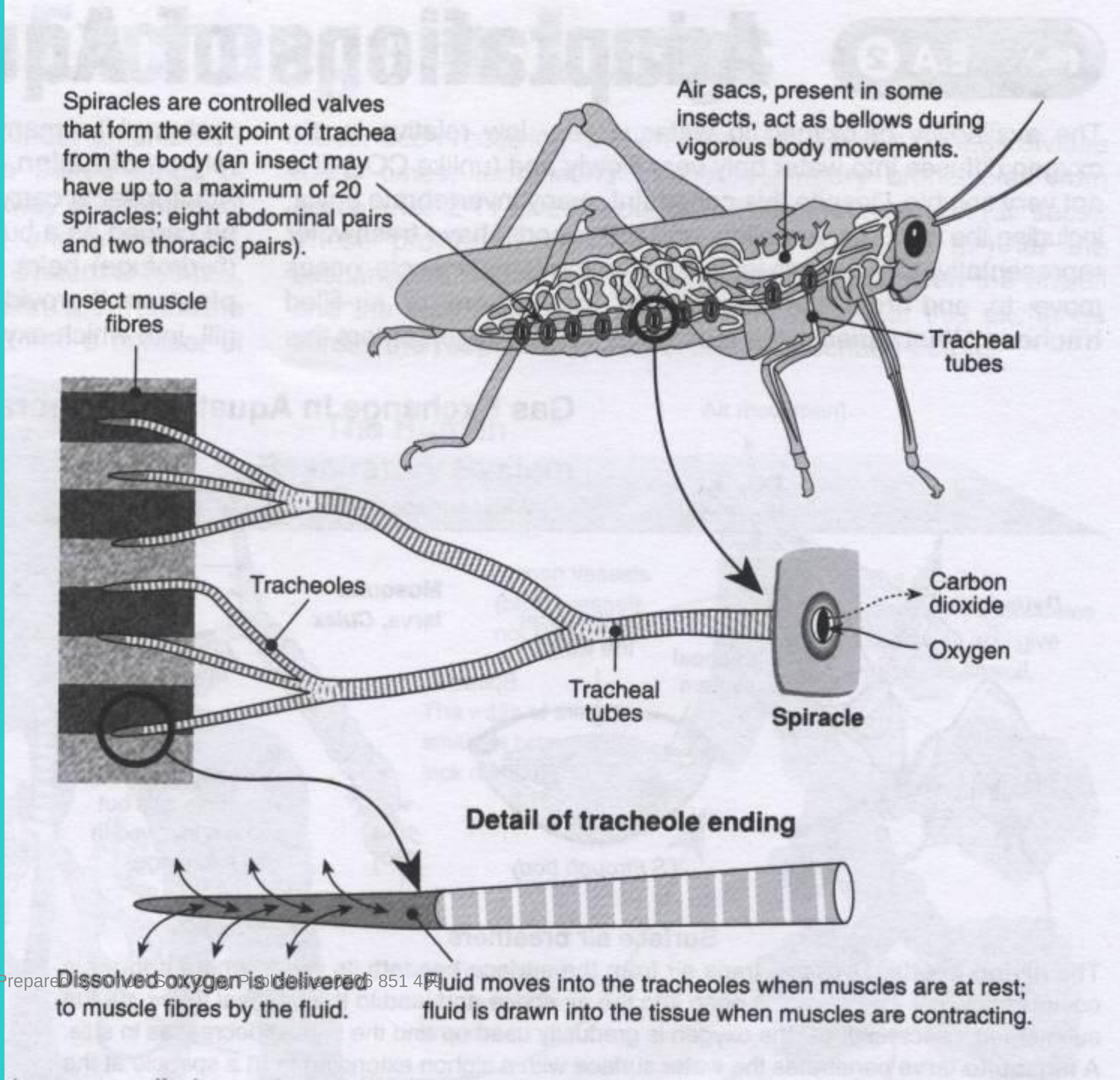
Moist surface at end of the tracheoles is important for:

- O_2 to dissolve into the watery substance for diffusion into the haemolymph.
- CO_2 to dissolve into the water substance for diffusion out of the haemolymph into the tracheoles

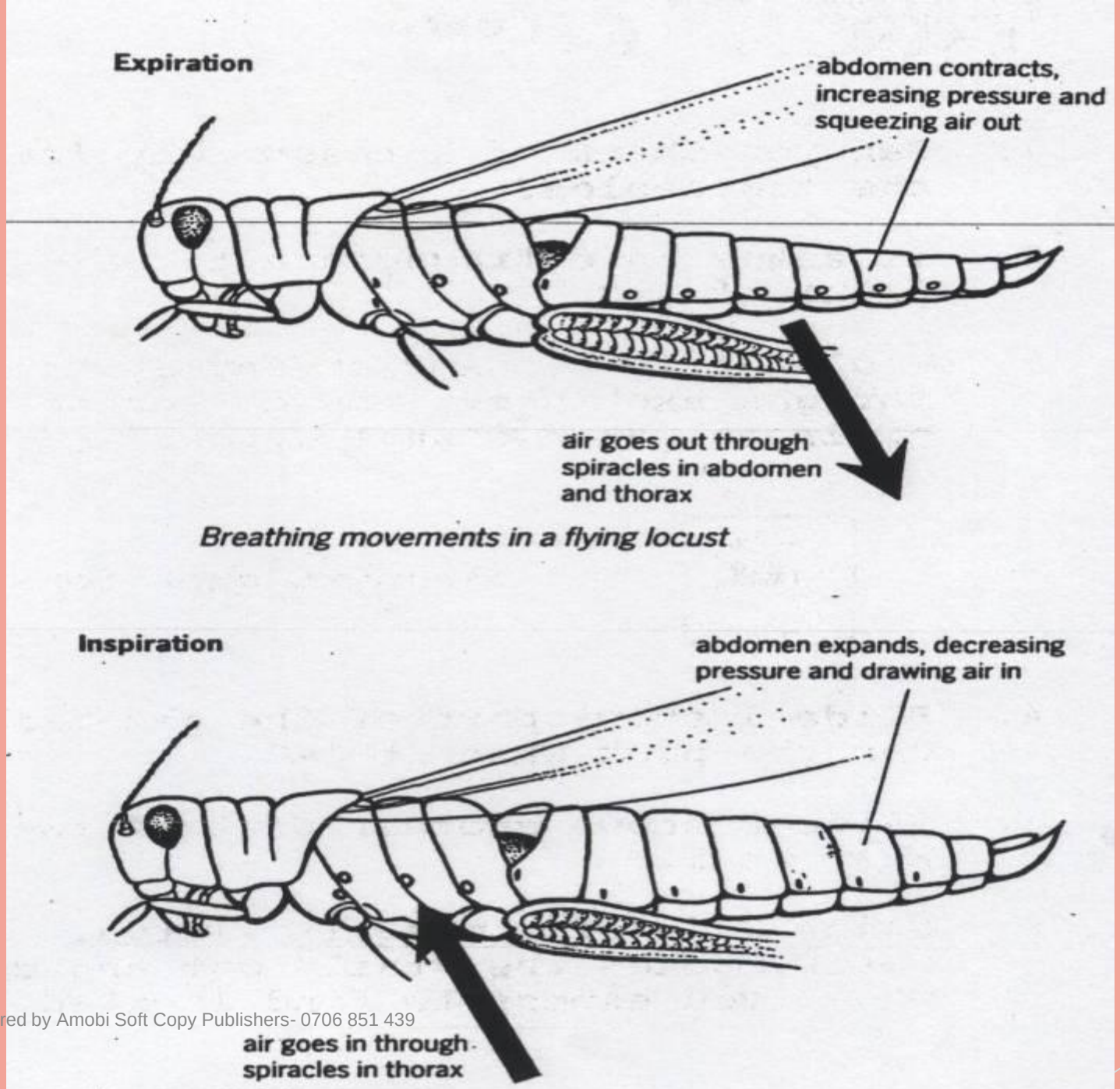
What Prevents Insects from being the Size we see in the Horror Movies?



- Insects rely upon passive diffusion and physical activity for the movement of gases within the tracheal system.
- Diffusion of O_2 and CO_2 through the air in the tracheal tubes is fast enough only for distances less than 1cm for the body surface. This limits the size/radius of the insect's body.
- Larger organisms use a blood circulatory system (blood vessels) to over come this limitation.



Spiracles are controlled valves that form the exit point of trachea from the body (an insect may have up to a maximum of 20 spiracles; eight abdominal pairs and two thoracic pairs).
Air sacs, present in some insects, act as bellows during vigorous body movements.
Insect muscle fibres
Tracheal tubes
Tracheoles
Tracheal tubes
Carbon dioxide
Oxygen
Spiracle
Detail of tracheole ending
Dissolved oxygen is delivered to muscle fibres by the fluid.
Fluid moves into the tracheoles when muscles are at rest; fluid is drawn into the tissue when muscles are contracting.



Breathing movements in a flying locust