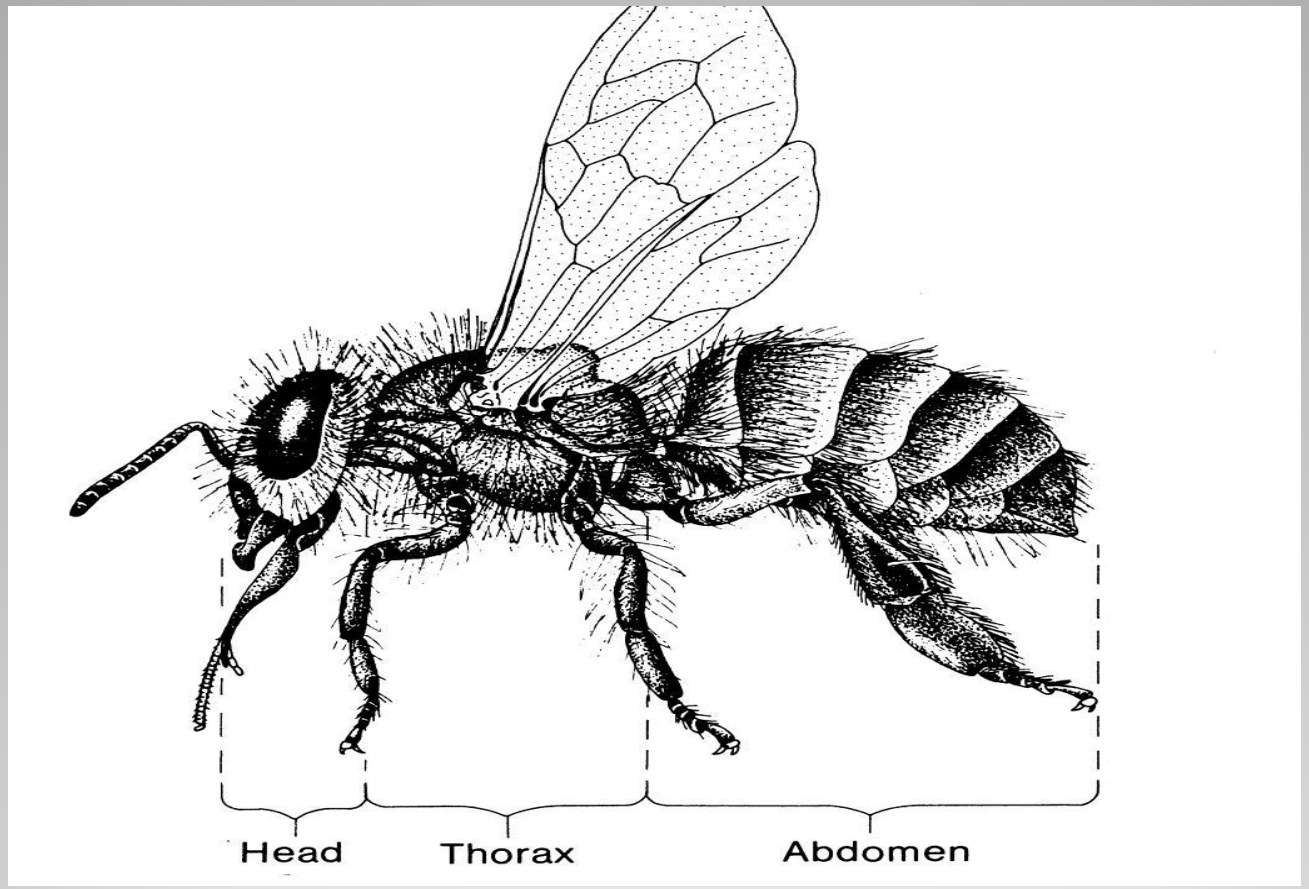
Anatomy and Physiology



Honey bees 3 segments

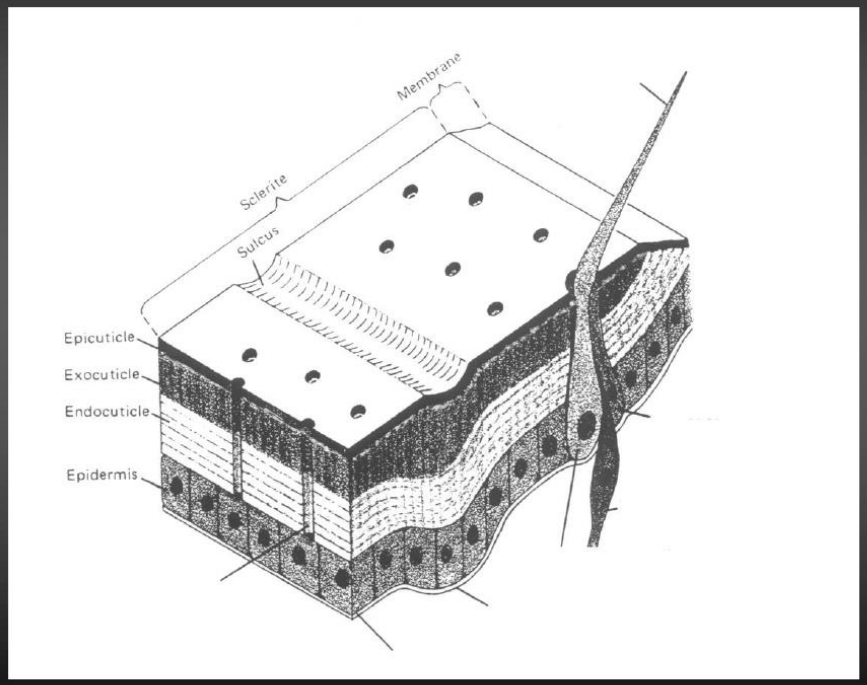
Exoskeleton

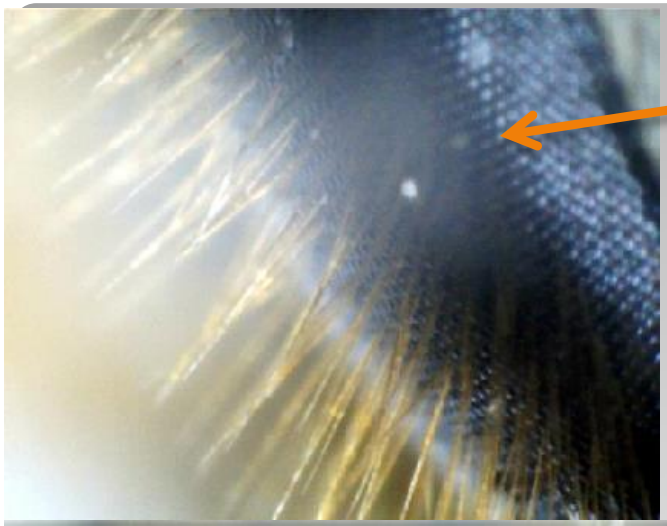
Bees have a hard outer covering call an exoskeleton The exoskeleton helps protect the delicate internal structures, conserves internal body fluids so the body does not desiccate, and also serves as a protective barrier to the entry of pathogens. The exo - skeleton is made of a material called Chitin The body of the bee is covered with setae or branched hair

•Bees are well covered by branched (plumose) body hairs.
• They also have thousands of unbranched hairs covering their body which are for sensory purposes.
The hairs extend from the body **exoskeleton** that gives shape and form to a bee.

Honeybee Anatomy

Exoskeleton



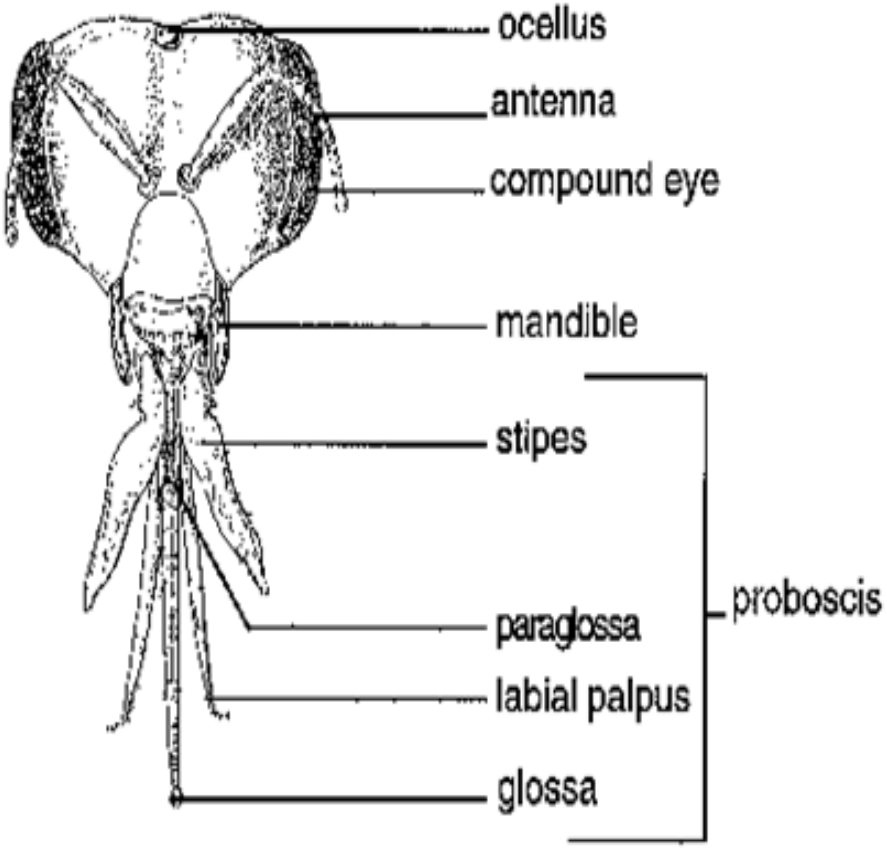


Eye

Tarsus

Head

Head external features



•There are three eyes, called ***ocelli*** , located at the top of the head between the bee's two larger compound eyes. The ocelli detect light but can't focus or arrange an image like the larger compound eyes Ocelli register intensity, wavelength, and duration of light. At dusk the ocelli estimate extent of approaching darkness, causing the bees to return to their hives.

•Honey Bees use their **antennae** to learn about their environment: Tiny sensory hairs on each antenna allow them to smell, taste, feel air movements and to communicate with one another

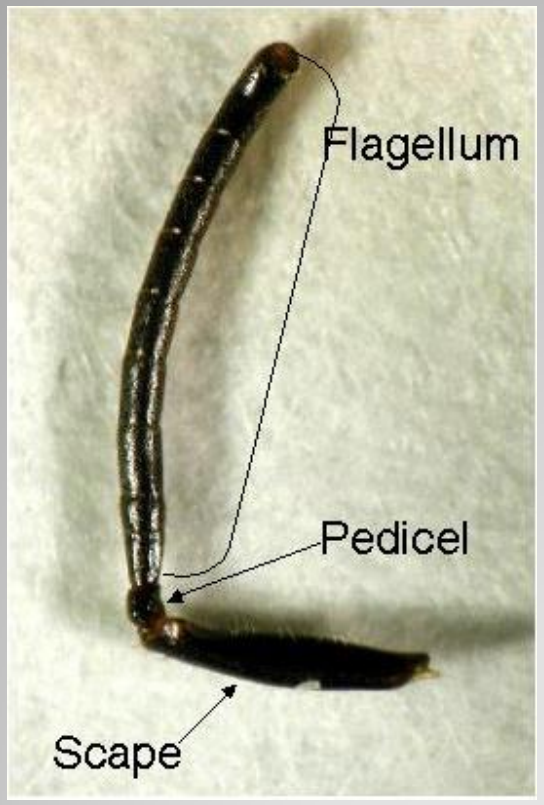
•The ***compound eyes*** each have almost 7,000 hexagonal facets. Each facet is like a mini-eye, containing its own lens and sensory cells

•A bee's curved, spoon-shaped jaws, called the **mandible**, are built for many uses: They can be used to ingest food, manipulate wax to build the hive cells, feed the young or queen, and even fight

•The long ***proboscis*** at the front of the bee's head is used to ingest liquids such as nectar, honey or water. The proboscis is tipped with a spoon-shaped **glossa**

Mandibles

Tongue



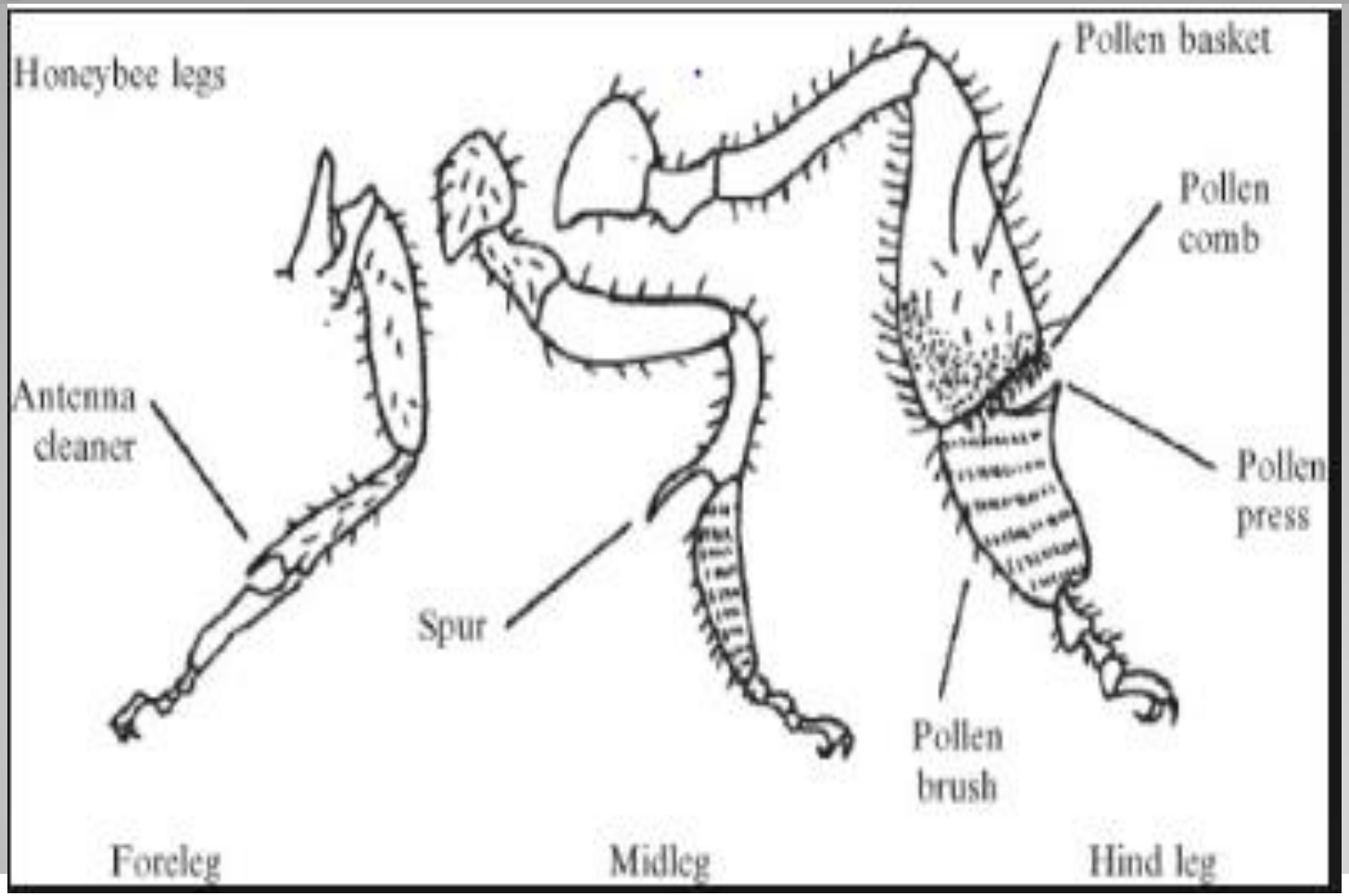
Antennae receive and analyze highly volatile substances that are responsible for odor and taste. Antennae also perceive vibrations and movement of air (, sounds, temperature and humidity . Aide in communication

Johnston's organ is a collection of sensory cells found in the pedicel (the second segment) of the antennae i.[1] Johnston's organ detects motion in the flagellum (third and final antennal segment). Johnston's organ can also sense wind. It consists of over 200 scolopidia arrayed in a bowl shape, each of which contains a mechanosensory neuron

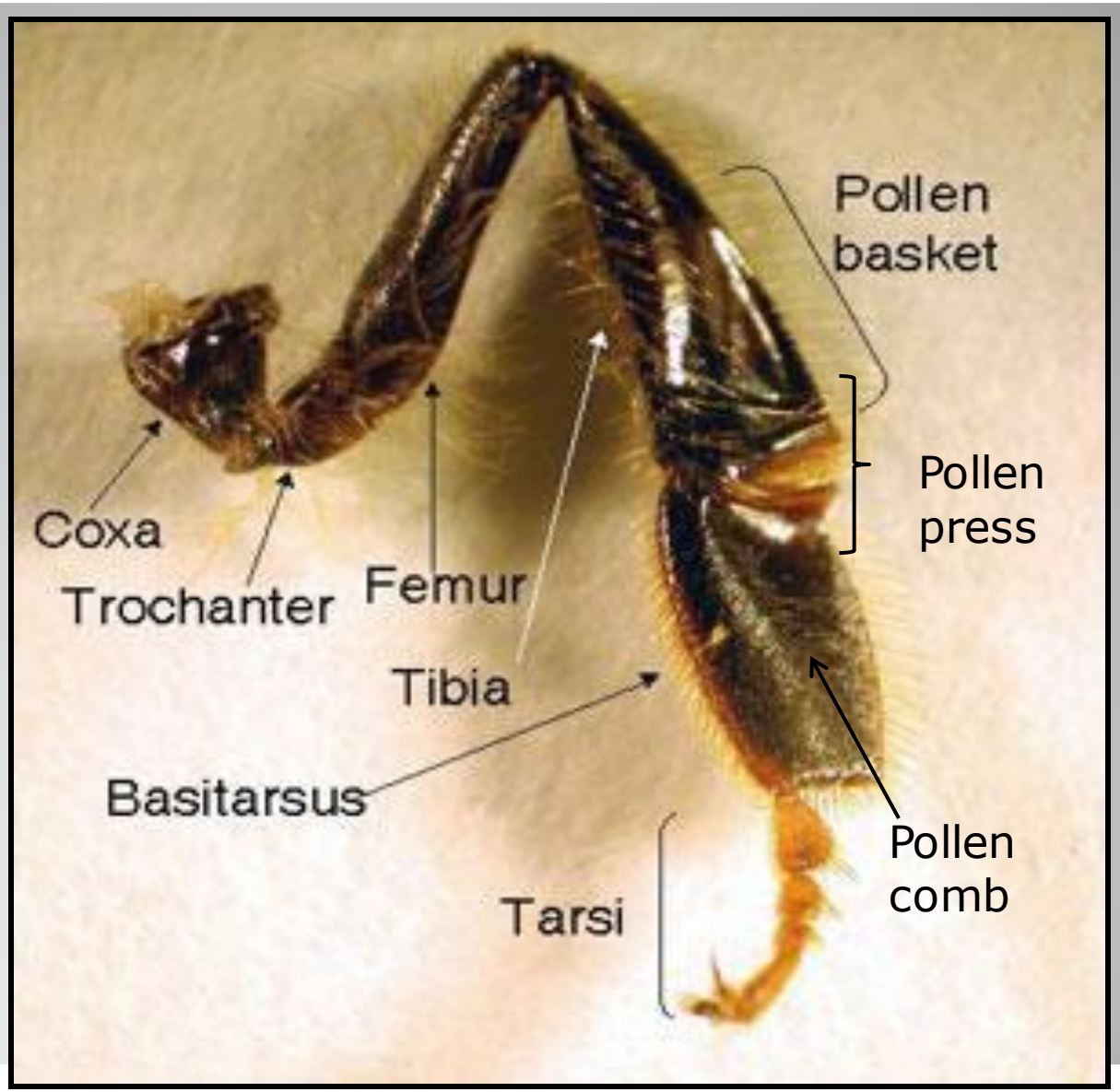
The scrape of the drone is shorter than in the workers but the flagellum is longer with 12 rings compared to 11 in worker and queen

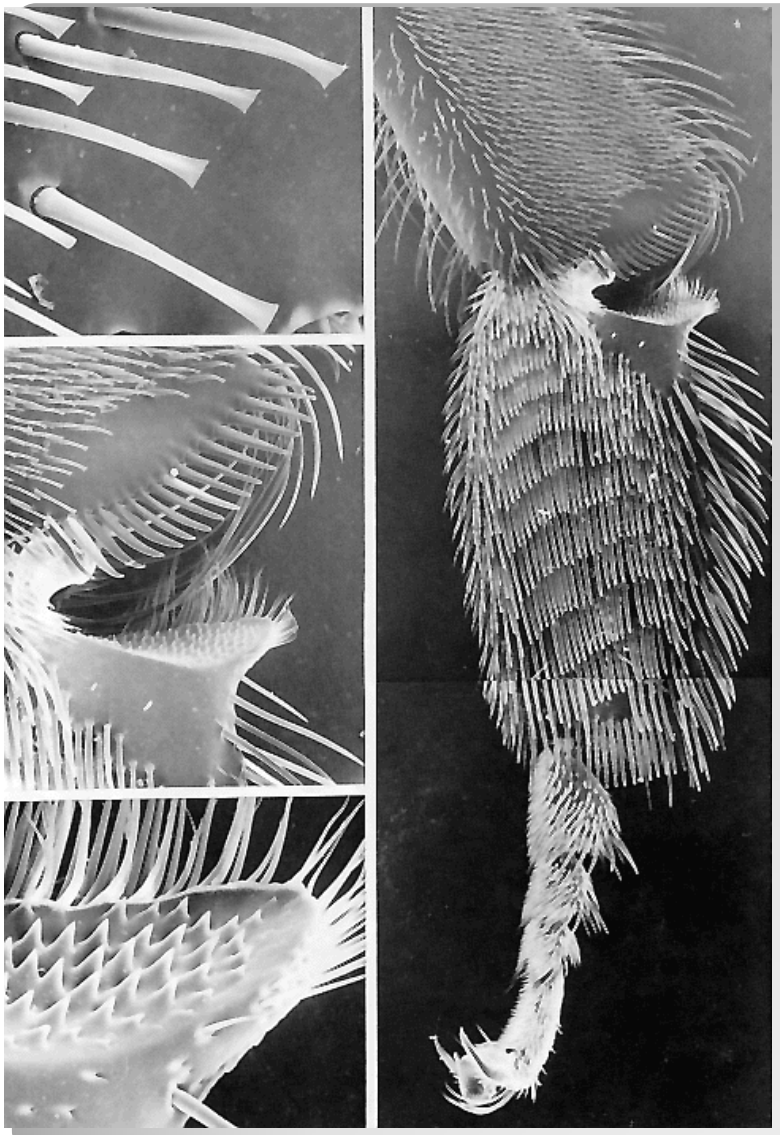
Thorax

Honey bees six legs and specialized structures

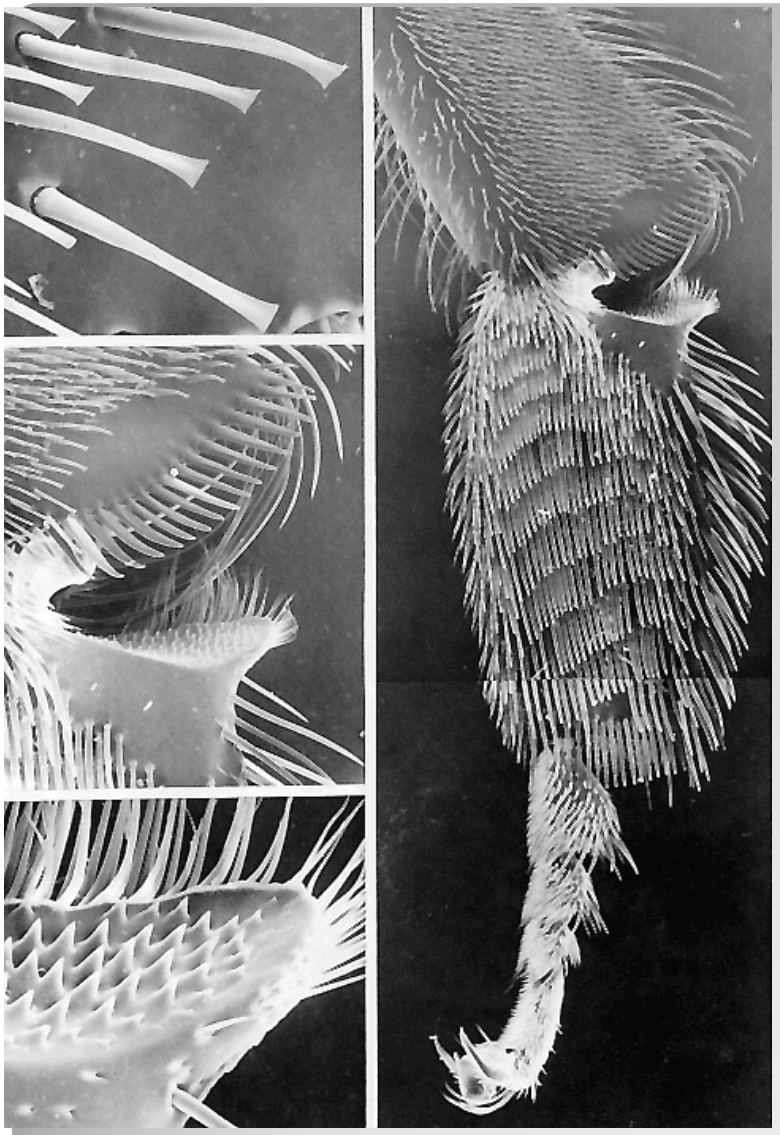


Hind leg


Pollen basket
Pollen press
Coxa
Trochanter
Femur
Tibia
Basitarsus
Tarsi
Pollen comb

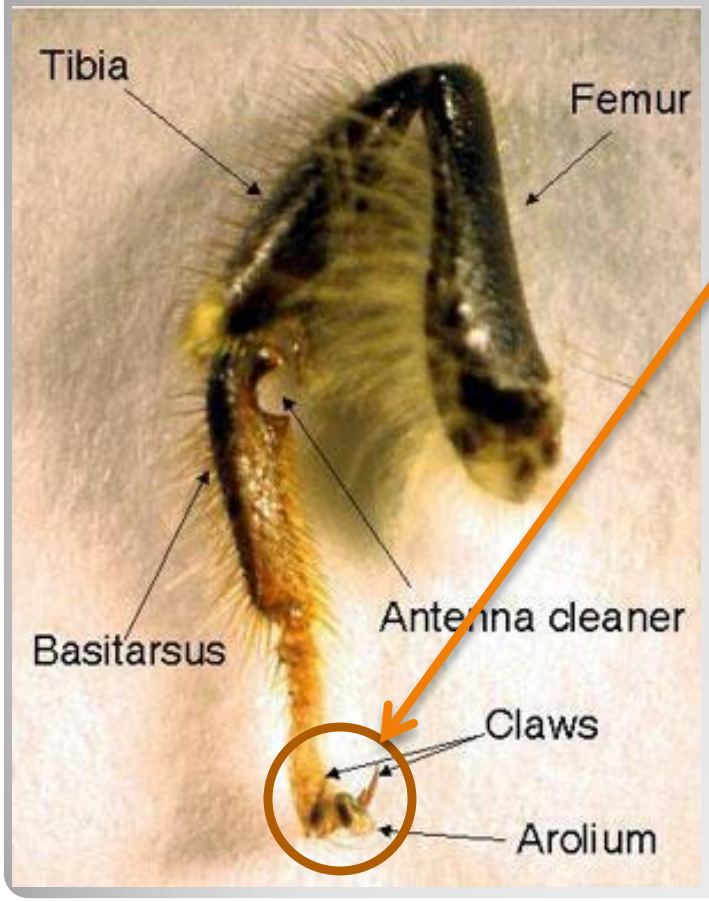


- RIGHT (hind) leg and
- its medial surface. From top to bottom are the tibia,
- basitarsus, and four short tarsal segments. Between the
- tibia and basitarsus is the flattened, notched pollen press.
- The ranks of hairs act as combs for grooming and pollen
- gathering. When the basitarsal combs are loaded to
- capacity with pollen, the rastellum (rake) is used to unload
- the comb by scraping it into the press where the pollen is
- compressed and transferred to the tibial baskets on the
- outside surface above the pollen press. Hence, pollen
- groomed from the right side of the body is combed from
- the inner surfaces of the middle and forelegs by the left
- hind leg, from which it is removed by the right rastelhun
- for deposition in the pollen basket of the same leg. The



MIDDLE LEFT Mediolateral view, of the pollen press.
The floor of the press is edged with fine hairs, and its
surface is covered with denticlelike cuticular spines or
scales. Long, curved hairs from the tibia bend down and
lie over the press and a picket of shorter, stiff spines
(rastellum) lines the dorsomedial margin of the press.
Small mechanoreceptor hairs are visible at the leading edge of the spatulate hairs (upper left). (x 100)
TOP LEFT Hairs on the medial surface of the tibia. The flattened-tip spatulate character of these hairs
contrasts markedly with the basitarsal hairs, which have serrated edges and a fairly sharp tip. The
specialized hairs of the tibia may have an important function in the process of gathering and packing

Front leg



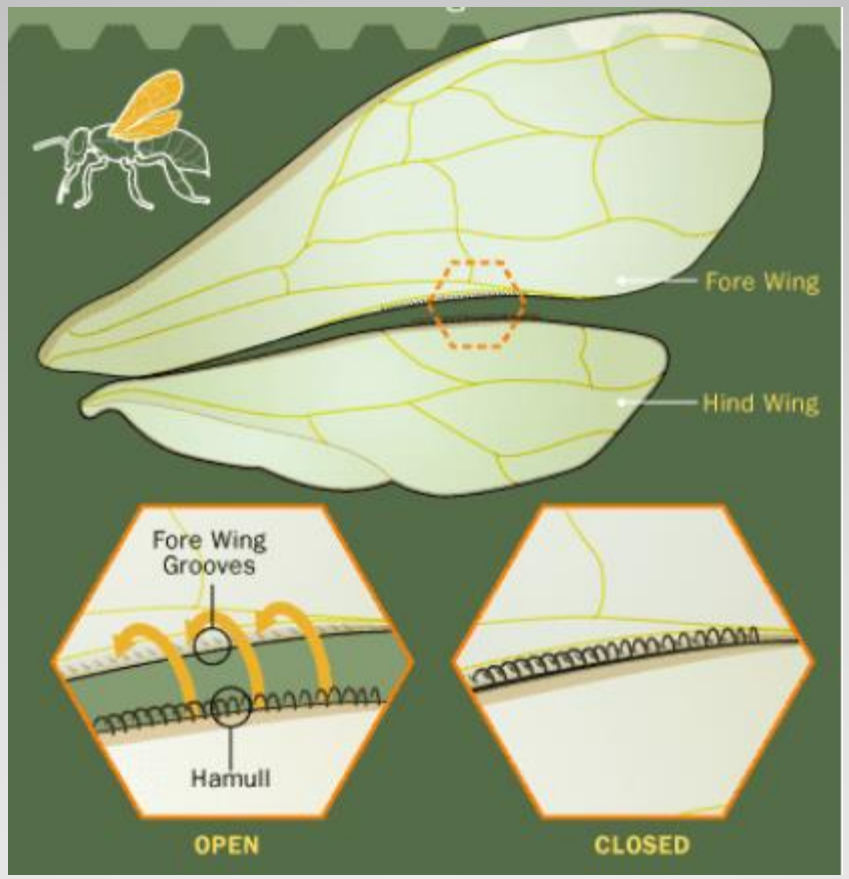
Pretarsus – foot – very important part of the bee is the part the allows the bee to cling to surfaces smooth or rough

The claws aid in clinging to rough surfaces

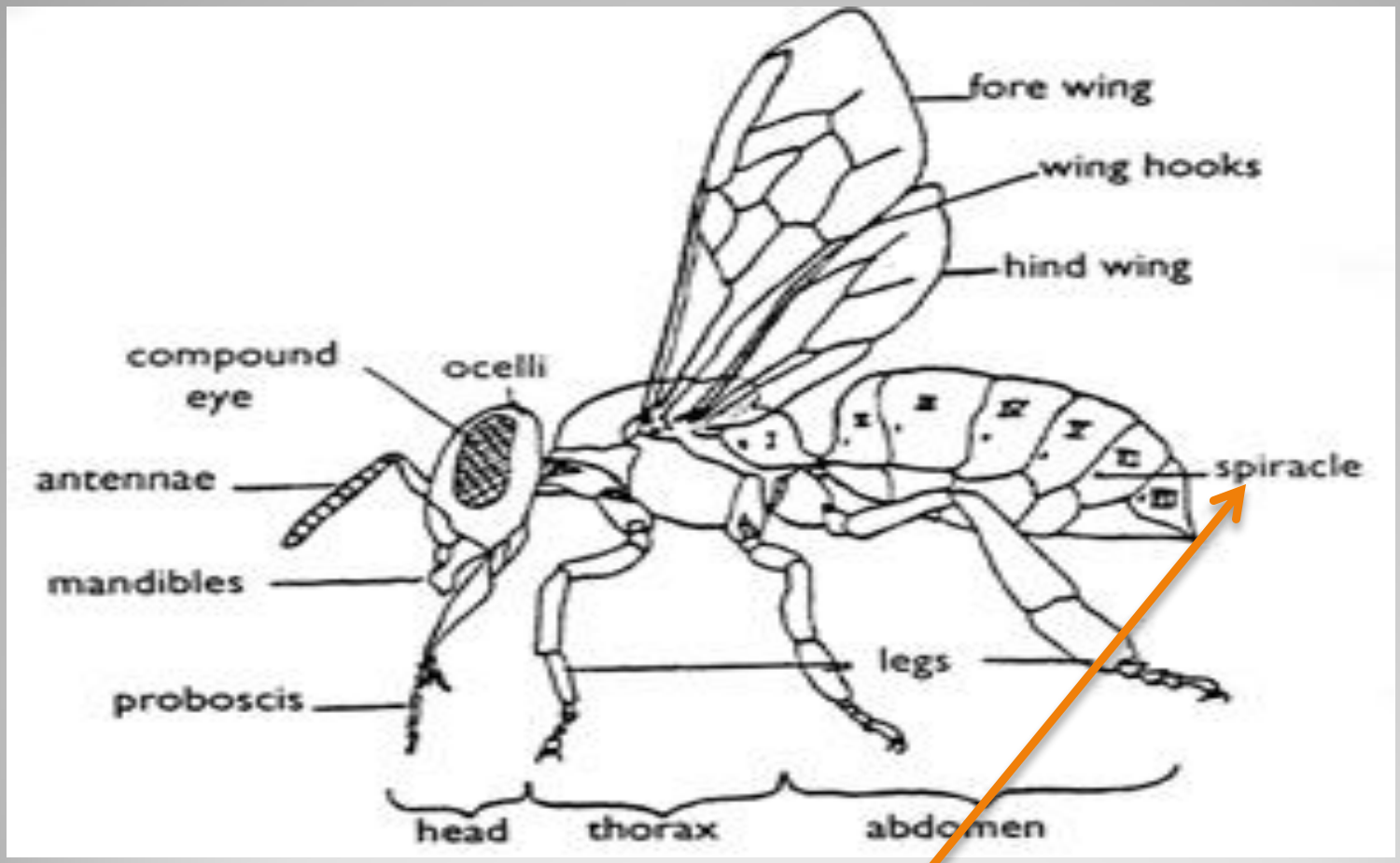
The arolium aids in clinging to smooth surfaces .

The ***Antenna cleaner***

Wings



Abdomen of honey bee external



Spiracle use for breathing

Four basic functions of Glands in Honeybees

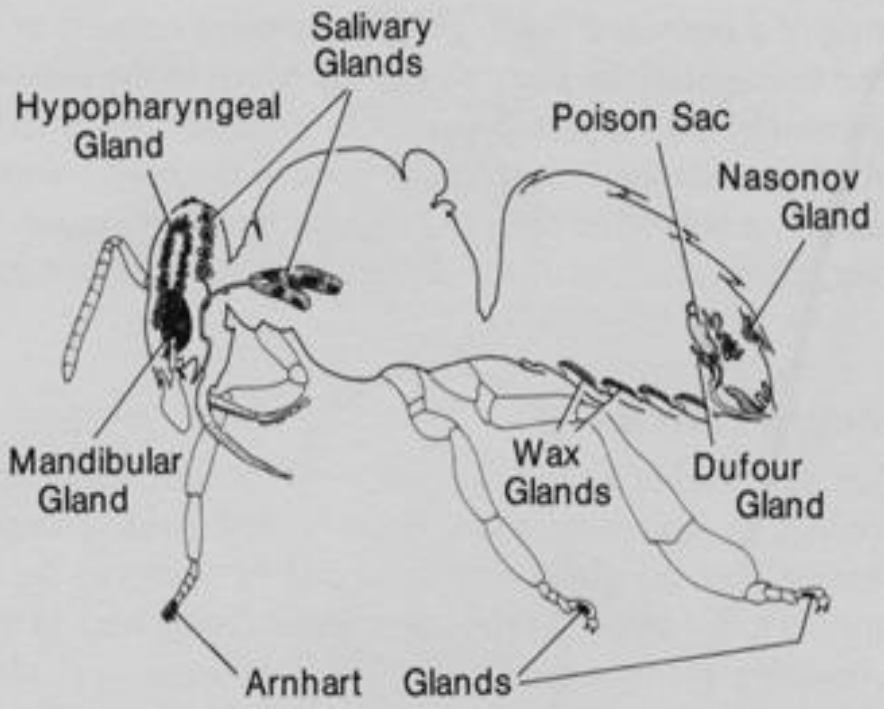


Fig. 3.19

The worker glandular system. (Redrawn from Michener, 1974.)

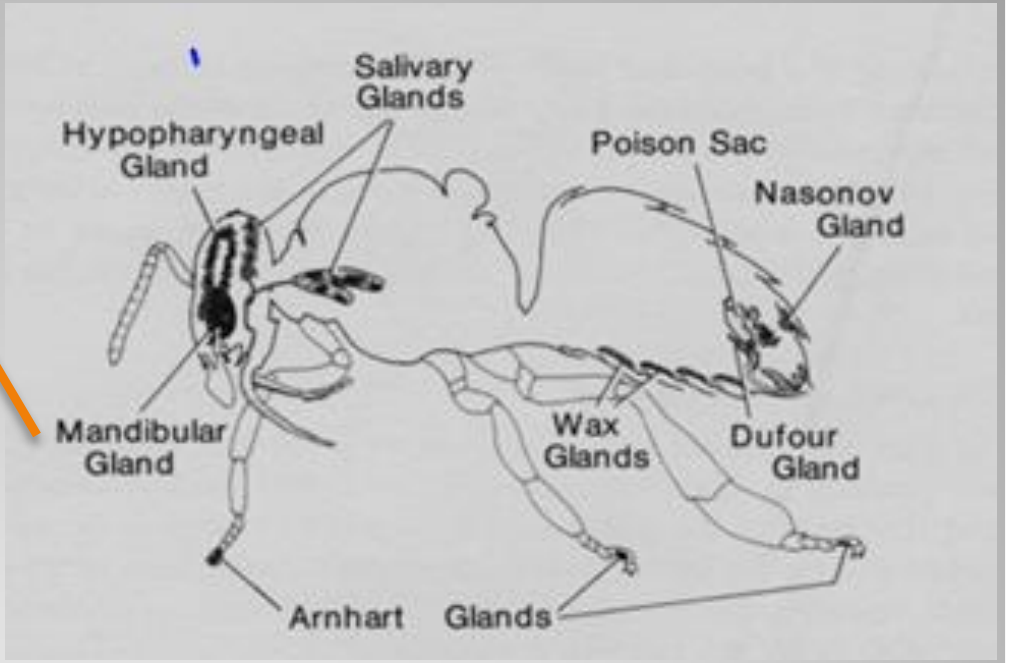
- Wax production
- Communication
- Defense
- Food processing

Honey bee glands

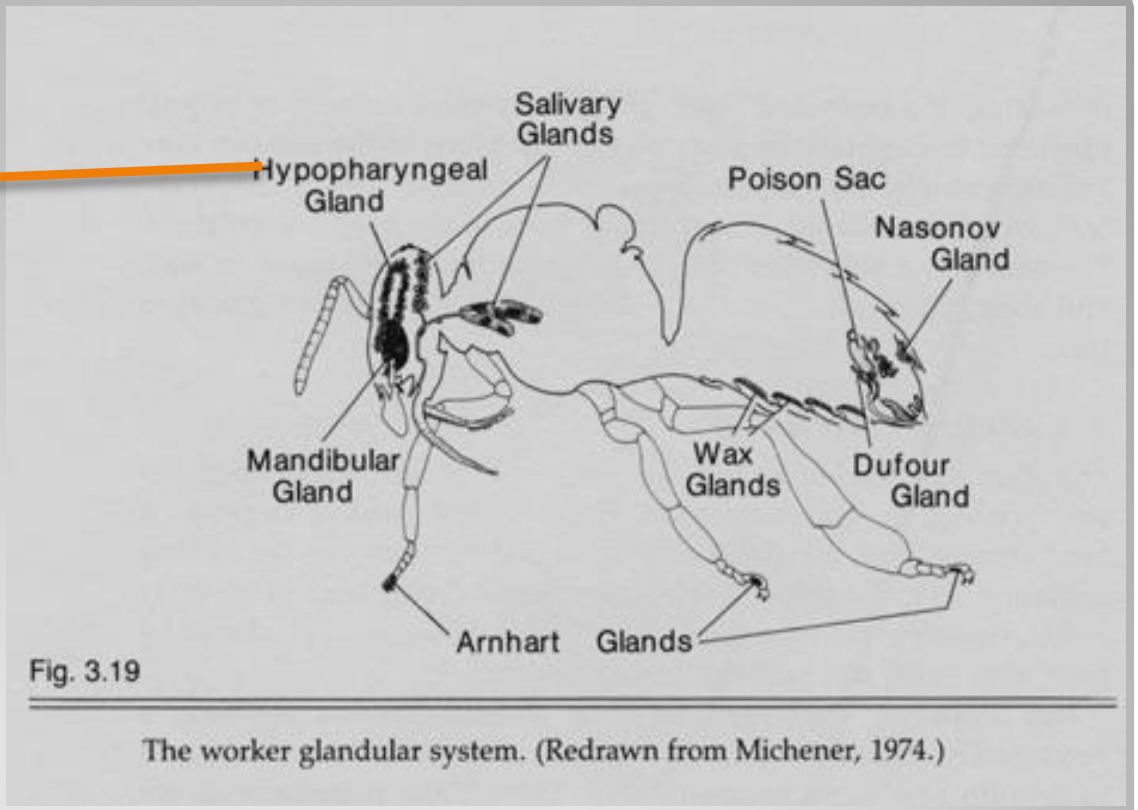
wax gland	produce wax in segments of abdomen
nasonov gland	orient swarm/hive entrance/flower attraction. produced in the last abdomen segment. dispersed by wing buzzing
mandibular gland	makes lipids for larval food/alarm pheromone '2-heptanone'/ and queen substance. produced in the head
sting pheromone gland	makes the alarm 'isopental'. produced in the stinger
arnhart gland	leaves the 'scented footprint' on flowers and hive. produced in the tarsal segment of legs
salivary gland	secretes invertase. produced in the mouth
hypopharyngeal gland	produces royal jelly, produced in the head
Dufour gland	secretions are utilized in defense by workers or reproduction In queens.

MANDIBULAR GLANDS

- Reduced or well developed in the young worker depending on colony condition; produces "royal jelly" components.



- HYPOPHARYNGEAL GLANDS
- ☐ Most developed in worker nurse bees to produce “brood food”.
- ☐ Rudimentary in the queens but may produce some communication chemicals with these glands (under investigation).
- ☐ Absent or vestigial in the drone (debated question).



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The worker glandular system. (Redrawn from Michener, 1974.)

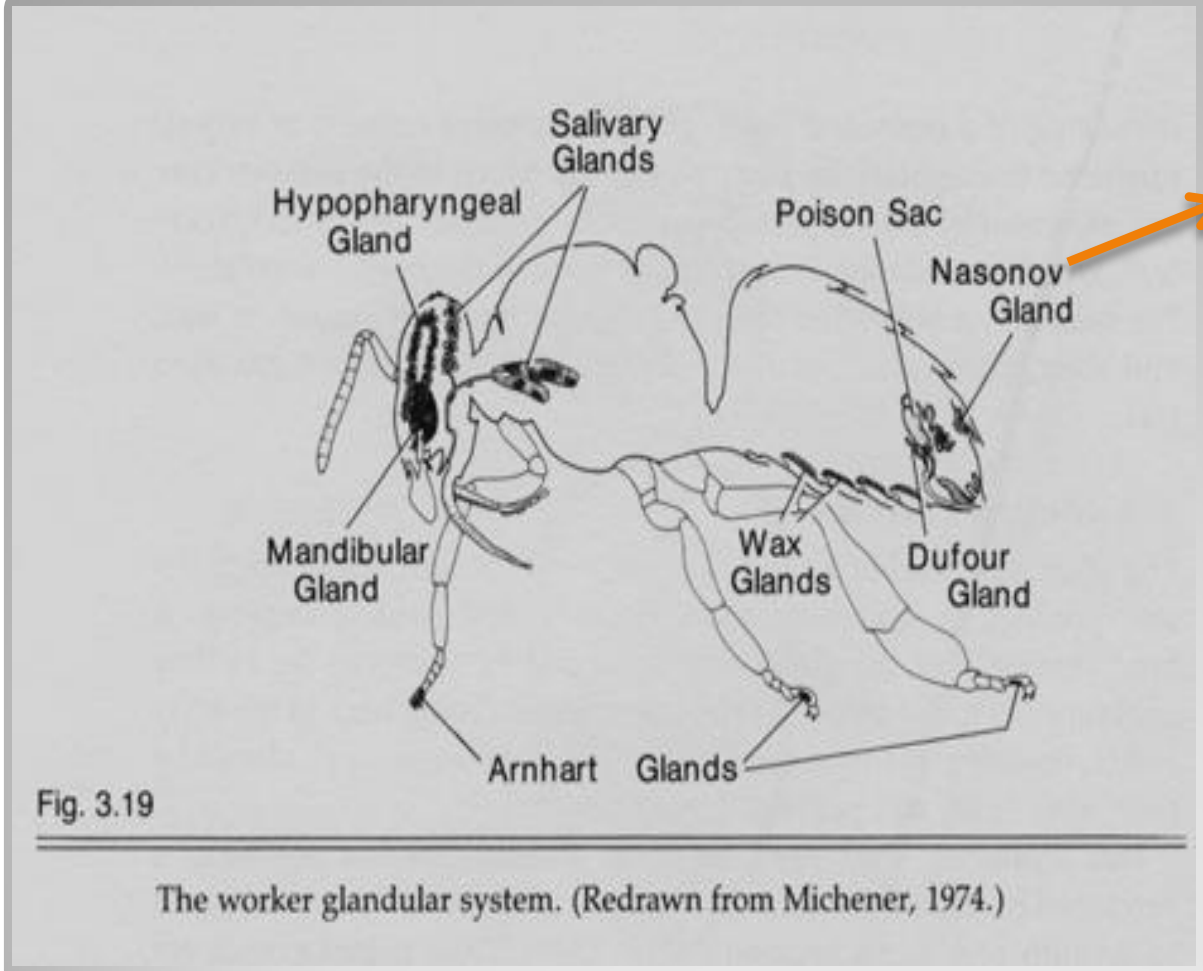


Fig. 3.19

The worker glandular system. (Redrawn from Michener, 1974.)

orient swarm/hive entrance/flower attraction. produced in the last abdomen segment. dispersed by wing buzzing

secretes invertase. Used in converting sugars

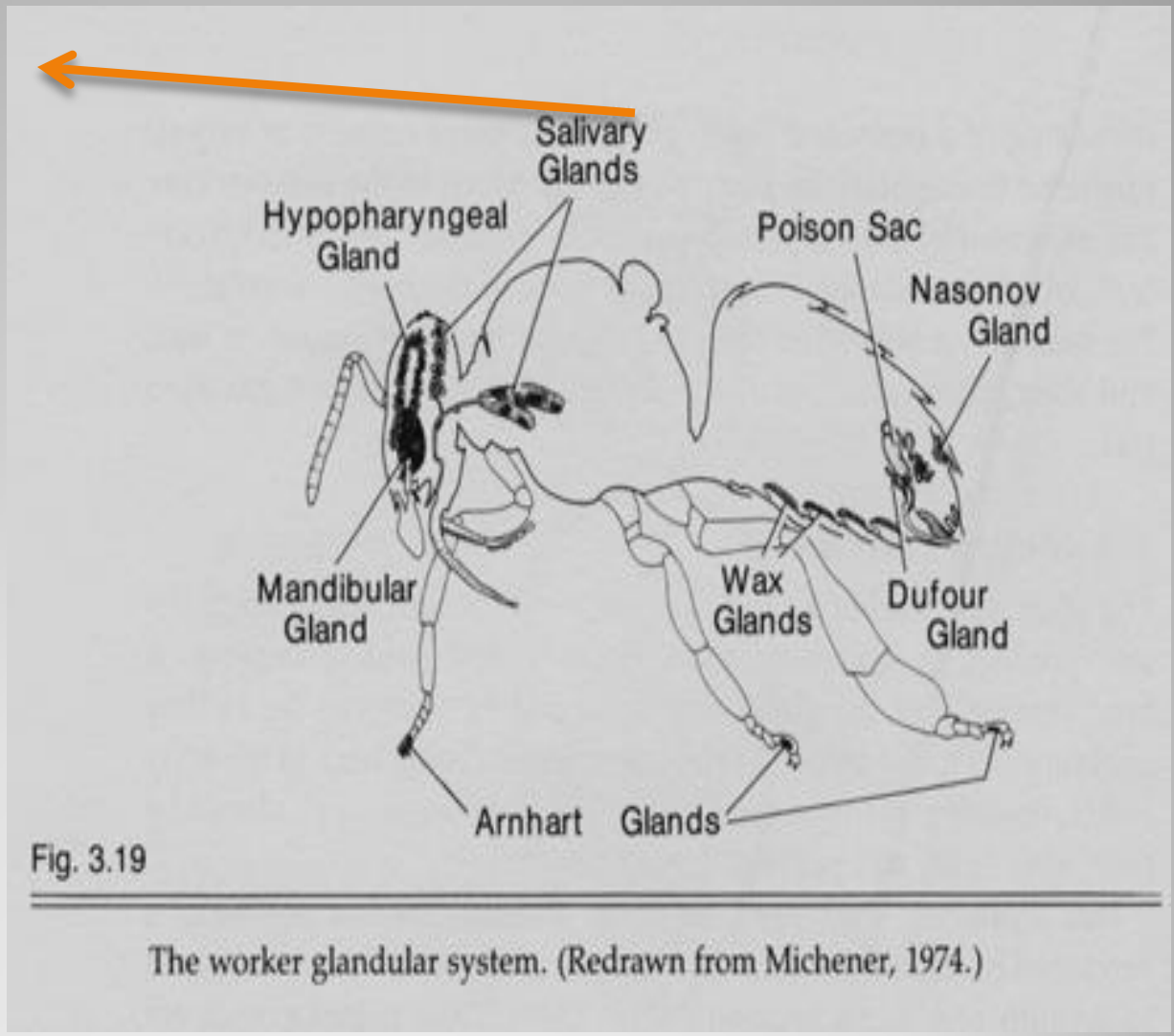
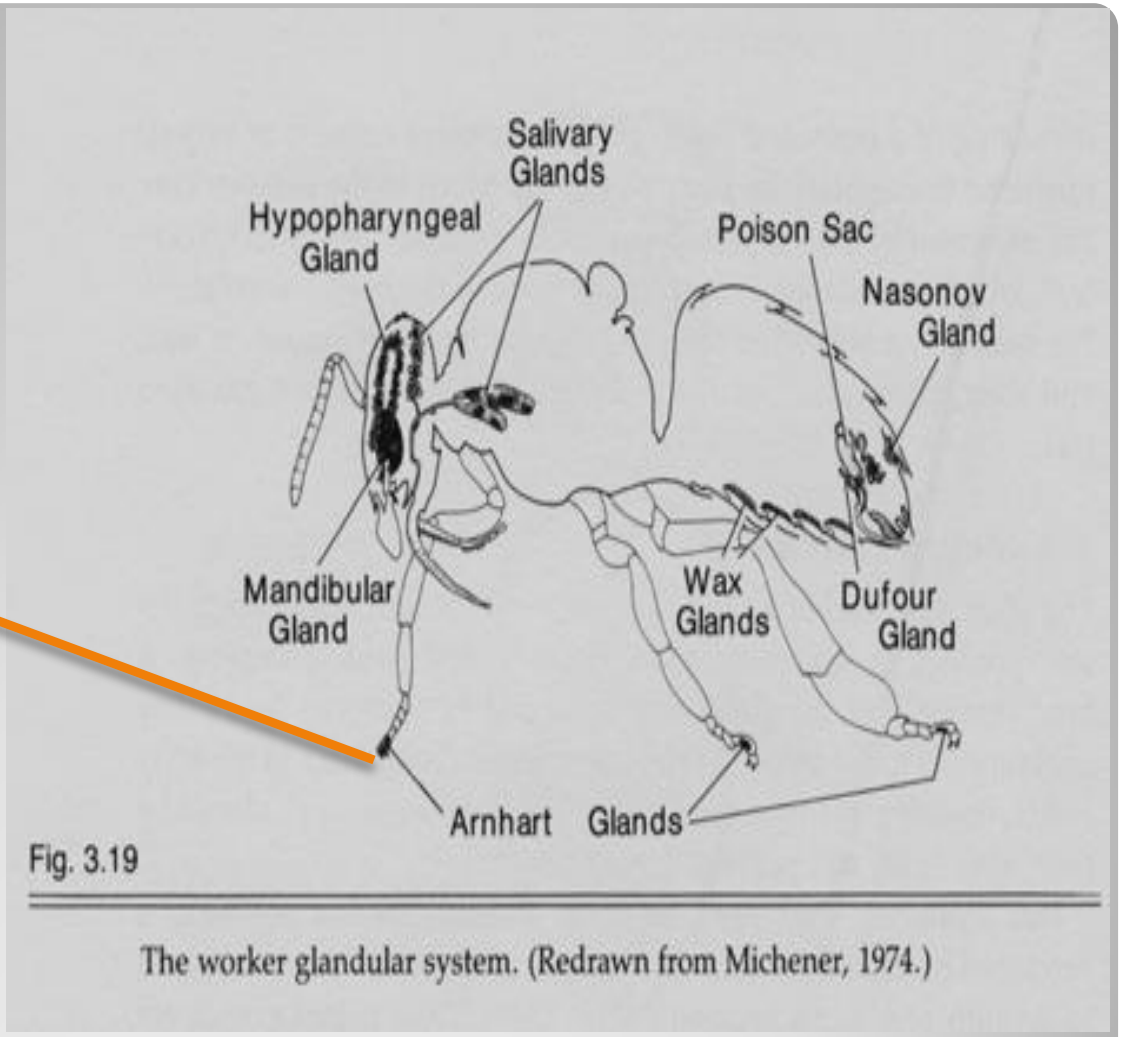


Fig. 3.19

The worker glandular system. (Redrawn from Michener, 1974.)

leaves the 'scented footprint' on flowers and hive. produced in the tarsal segment of legs



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The worker glandular system. (Redrawn from Michener, 1974.)

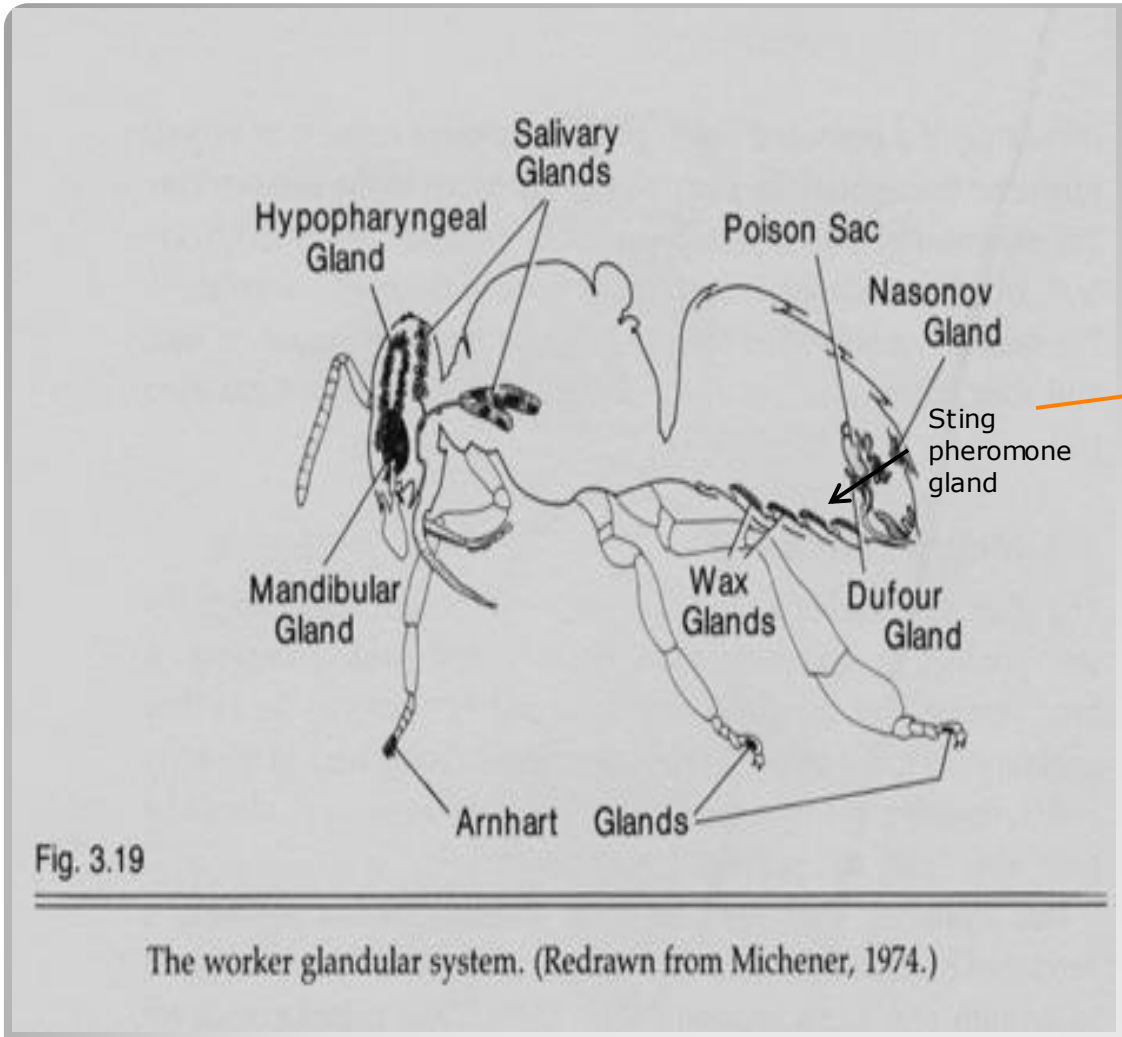


Fig. 3.19

The worker glandular system. (Redrawn from Michener, 1974.)

makes the alarm 'isopental'.

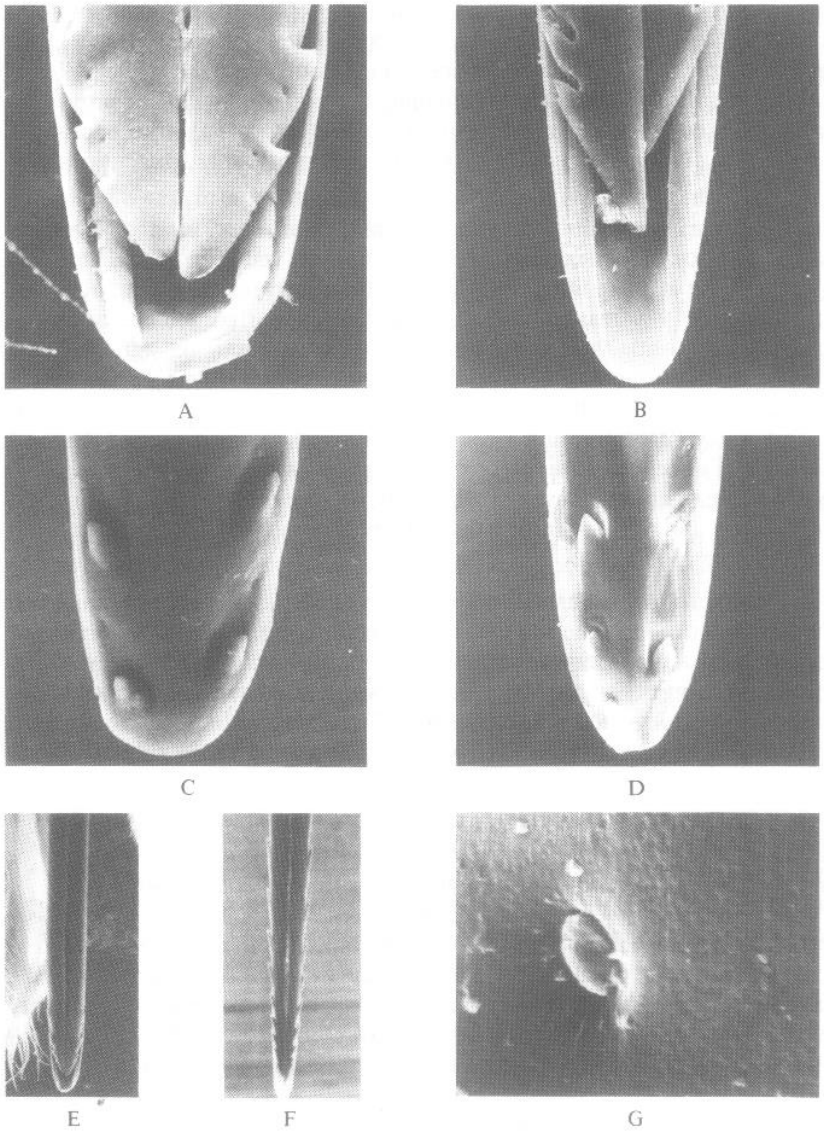


PLATE 21. Comparison of the stings of the queen and worker. A. Tips of the queen lancets (X 270). B. Tips of the worker lancets (X 270). C. Tip of the queen stylet (X 270). D. Tip of the worker stylet (X 270). E. Shaft of the queen sting (X 110). F. Shaft of the worker sting (X 110). G. Close-up of a sensillum for detecting pressure (X 7,615). Note that one of these sensors is associated with each barb on both the stylet and lancets.

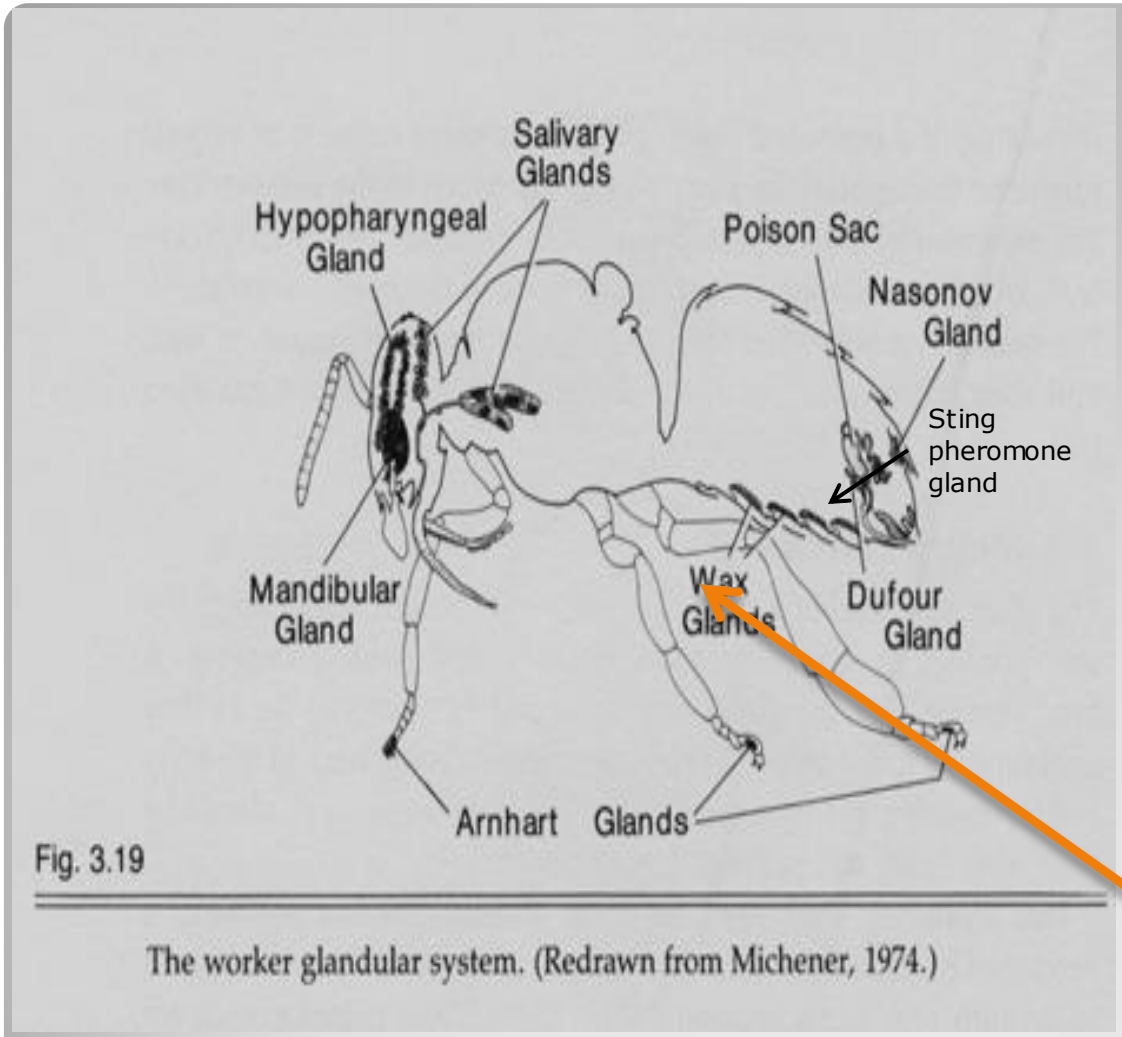
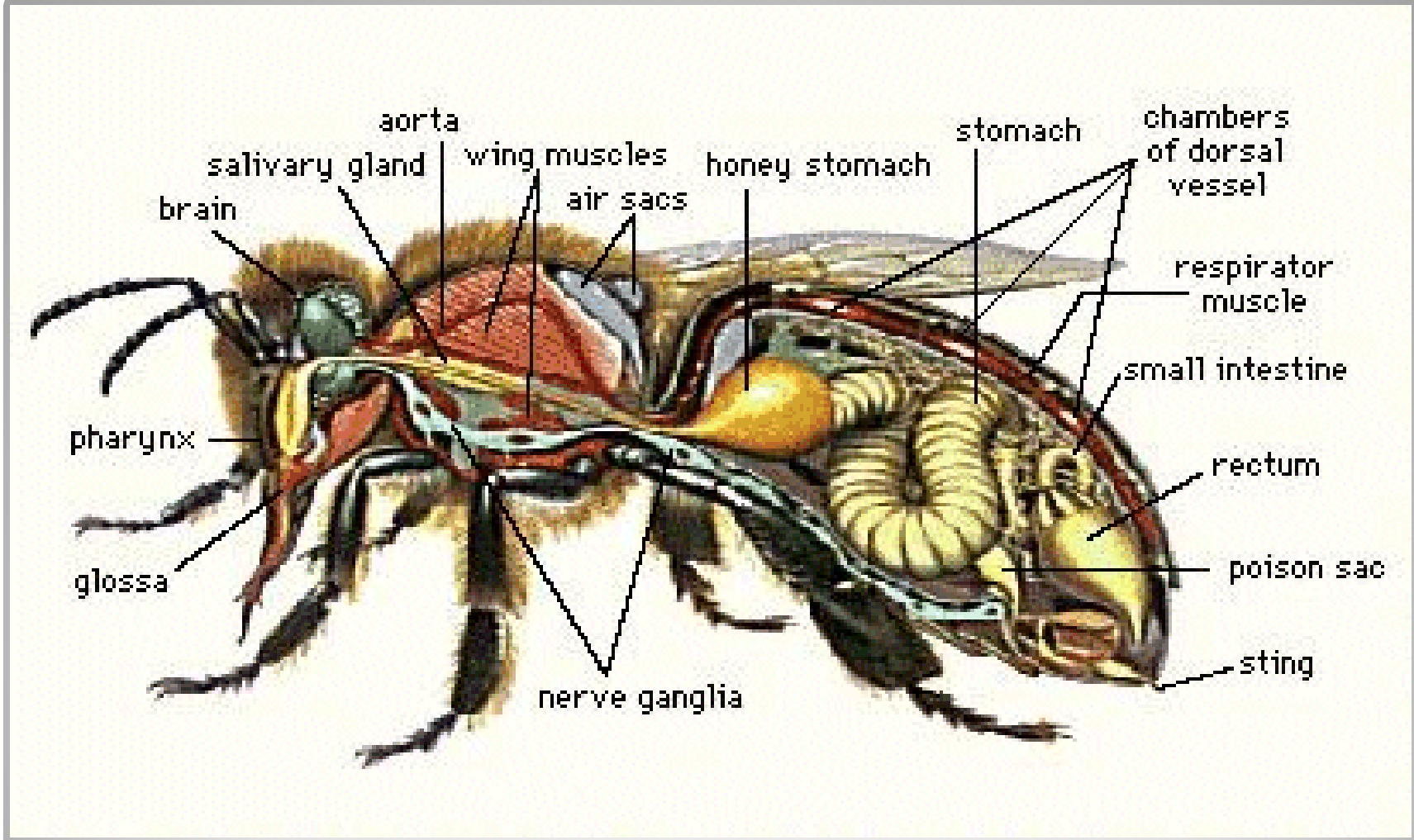


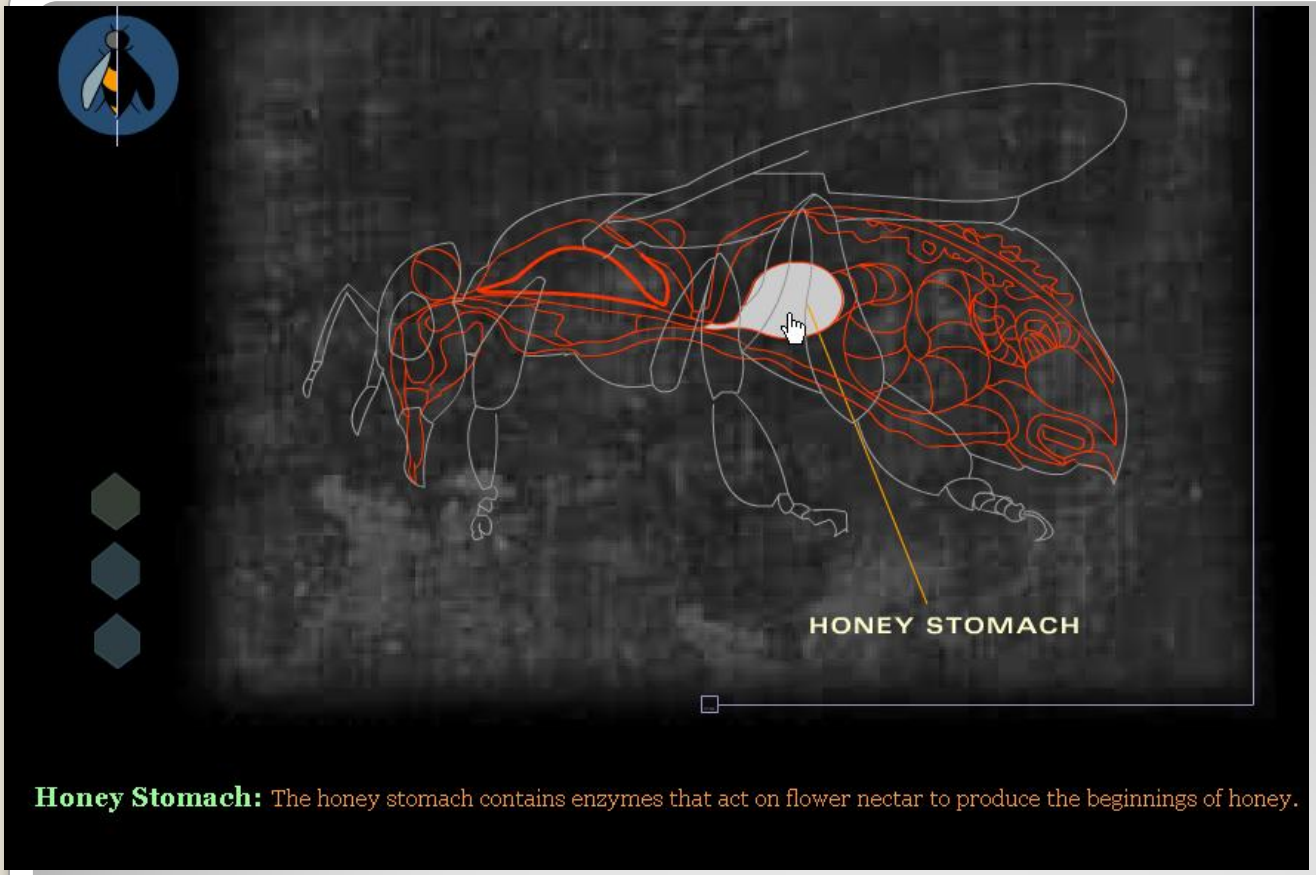
Fig. 3.19

The worker glandular system. (Redrawn from Michener, 1974.)

produce wax in segments of abdomen worker only segments 4,5,6 and 7



Digestive system



Honey bees have reversible movement of foods from mouthparts to/from a honey stomach. The ***proventriculus***, honey stopper prevent nectar form entering The honey stomach is a crop or storage area to hold freshly collected nectar or water for transport to/from the nest.

Digestion of foods occurs in the mid-gut. The hind-gut reclaims water and nutrients and passes small amounts of indigestible wastes to the rectum for storage until excretion.

In the spring you will find how much waste can be stored when the girls make their cleansing flights over your nice new, clean bee suit or jacket.

(You might want to get the kind with a detachable veil)

Circulatory system

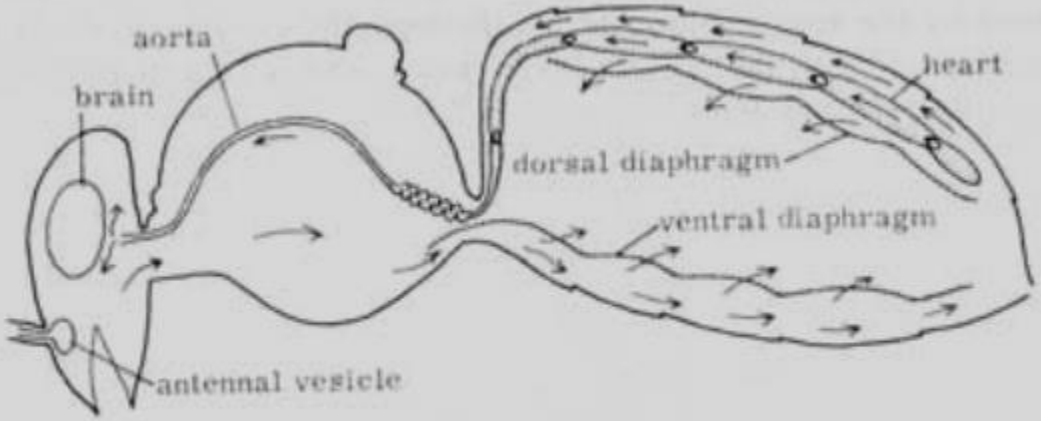


Fig. 20. Diagram illustrating the action of the heart and diaphragms.

Unlike mammals the circulatory and respiratory systems are mostly separated .

- The circulatory system is “open”, consisting of a dorsal heart and aorta to assist in blood circulation. .
- The main functions of the circulatory system are to transport food from the midgut to body cells, transport gases, hormones, defensive proteins, waste materials from cells to excretory organs.
- ***Blood (hemolymph) has only a minor role in gas transpor***t.

Fig. 22. The principal tracheal sacs and trunks of the adult bee.

1. Insects have no lungs or centralized respiratory system.
2. System of ***trachea*** which carry oxygen to and CO2 away from cells.
3. Trachea are connected to the outside by a series of 10 holes in the exoskeleton called ***spiracles***.
4. At rest respiration occurs passively by diffusion.
5. Under stress, such as during flight, bees pump their abdomens to increase gas exchange and expand air sacs of the trachea like bellows, facilitating greater gas exchange.
6. Though the blood contains no hemoglobin, muscles indirectly connected to the wings contain cytochrome, a molecule which enhances gas exchange.

Respiratory system

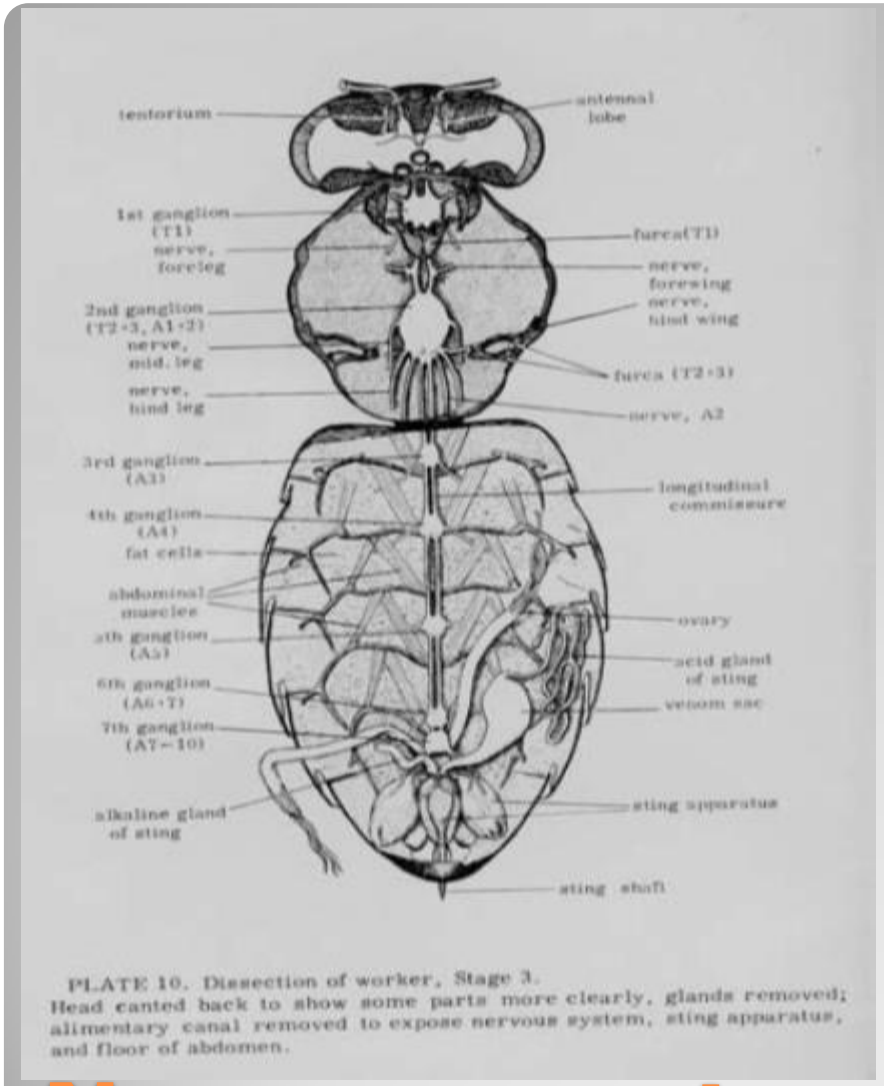


PLATE 10. Dissection of worker, Stage 3. Head canted back to show some parts more clearly, glands removed; alimentary canal removed to expose nervous system, sting apparatus, and floor of abdomen.

Nervous system

- Consists of the brain and **7 ganglia** at various junctions throughout the body.
- Most locomotion is controlled by the ganglia not the brain.
- A beheaded insect can move it's legs and wings vigorously.
- A decapitated bee can walk and sting but flying is not possible because it is out of balance without the head.
- The bee brain consists of a small bundle of cells with all the automatic functions transferred to the ganglia (~spinal cord).
- The ganglia are reduced to barely visible proportions.
- Bees are able to learn and have "short-term" memory.

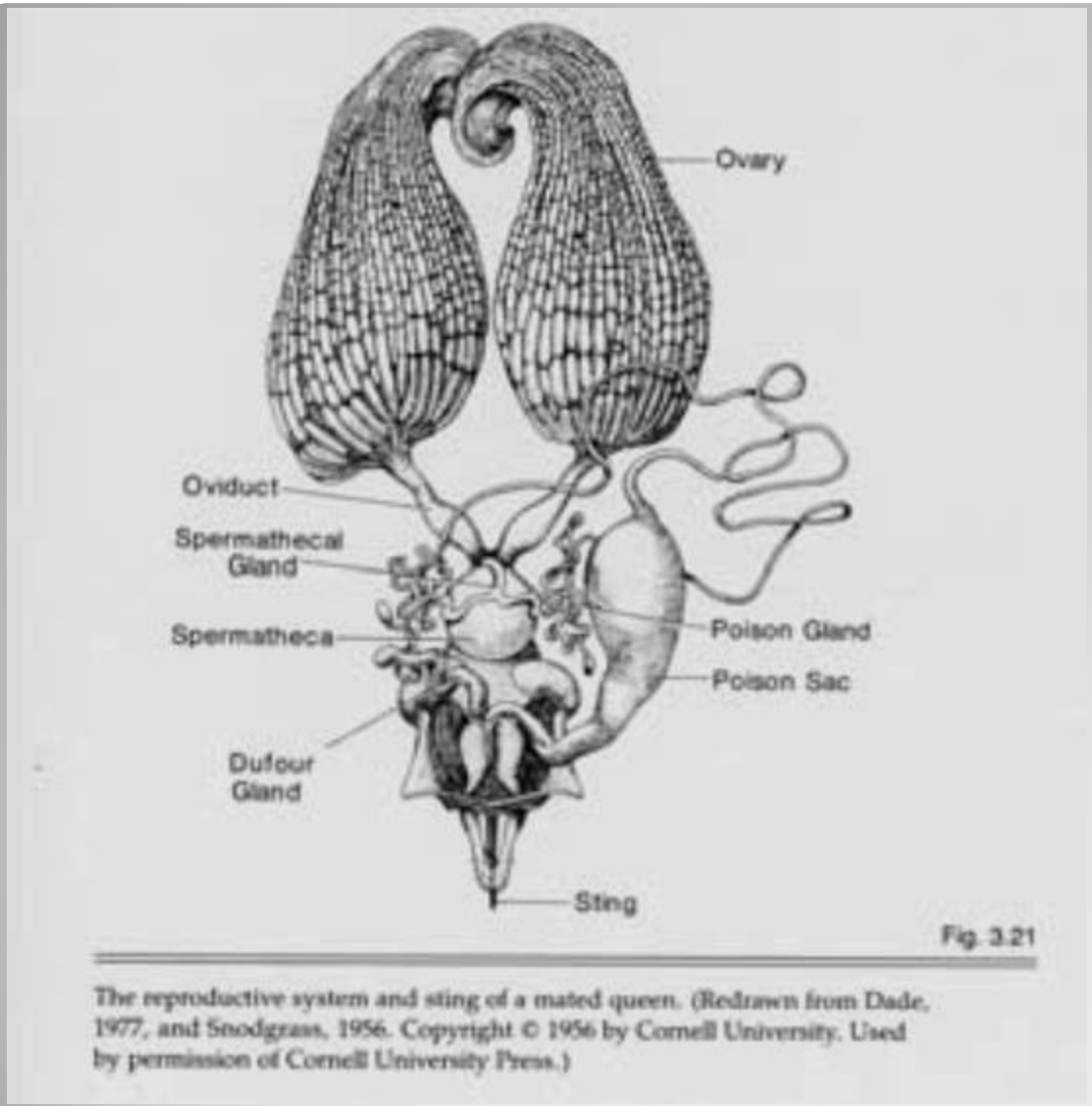
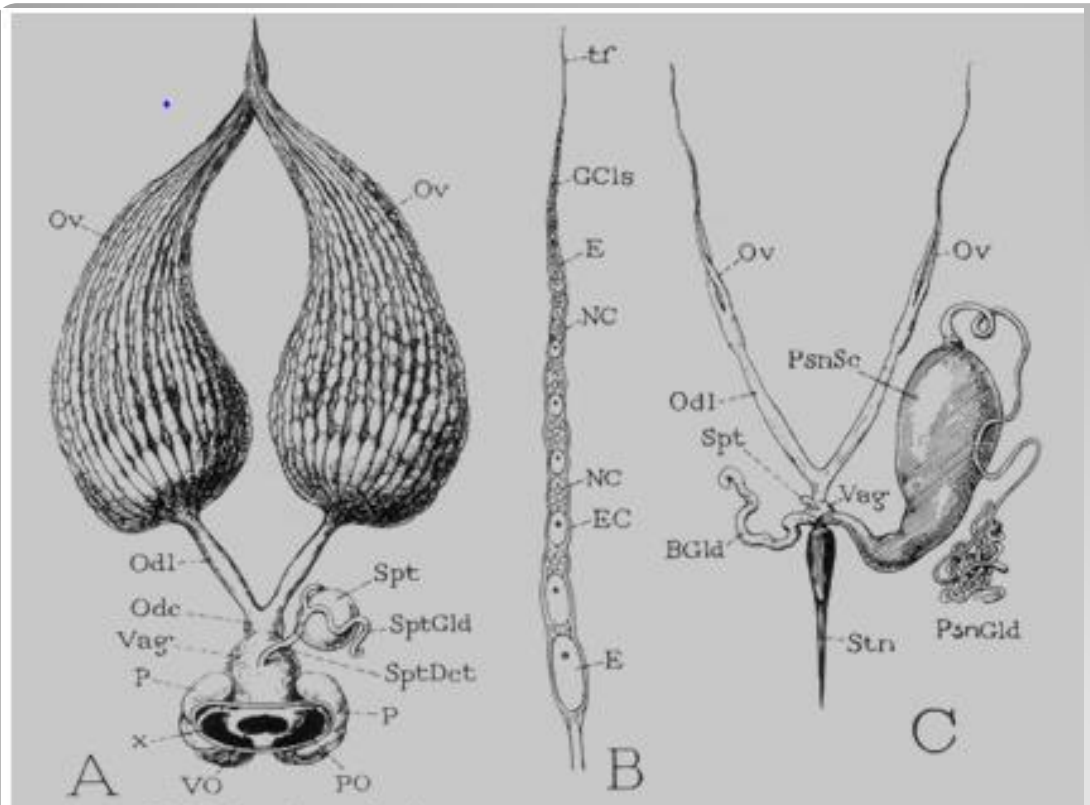


Fig. 3.21

The reproductive system and sting of a mated queen. (Redrawn from Dade, 1977, and Snodgrass, 1956. Copyright © 1956 by Cornell University. Used by permission of Cornell University Press.)

- ☐ Enormous ovaries compared to workers.
- ☐ Mated queen is an egg-laying machine; up to 2,000 eggs per day.
- ☐ Queens mate in the 2nd week of adult life with 5-20 males in 1-3 mating flights and will never mate again.
- ☐ Sperm is stored in the **spermatheca**; enough to last a life span of 2-8 years.

Queen reproductive system



A, ovaries, genital ducts and genital pouches of the queen. B, single ovariole, diagrammatic, showing succession of egg cells and nurse cells. C, reproductive organs of a worker, together with shaft of sting, sting glands, and poison sac.

BGld, "alkaline" gland of sting; *E*, egg; *EC*, egg chamber; *GCls*, undifferentiated germ cells; *NC*, nurse chamber; *Odc*, common oviduct; *Odl*, lateral (paired) oviduct; *Ov*, ovary; *P*, lateral genital pouch; *PO*, opening of lateral pouch; *PsnGld*, poison gland of sting; *PsnSc*, poison sac; *Spt*, spermatheca; *SptDct*, spermathecal duct; *SptGld*, spermathecal gland; *Stn*, shaft of sting; *tf*, terminal filament; *Vag*, vagina; *VO*, opening of vagina; *x*, cut edge of body wall around genital openings.

- The Drone