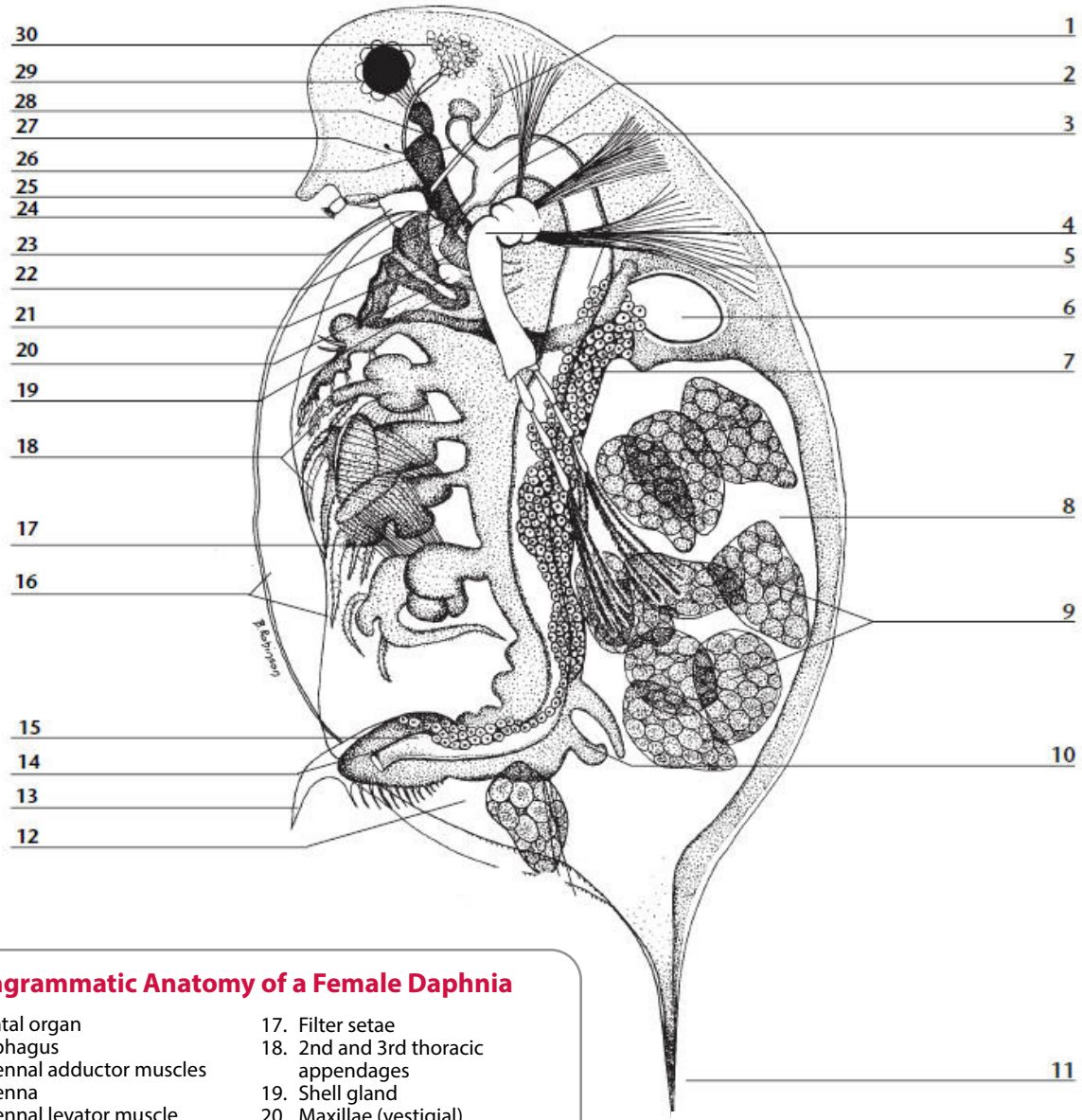
Working with Daphnia

Daphnia

Form and Structure



Diagrammatic Anatomy of a Female Daphnia

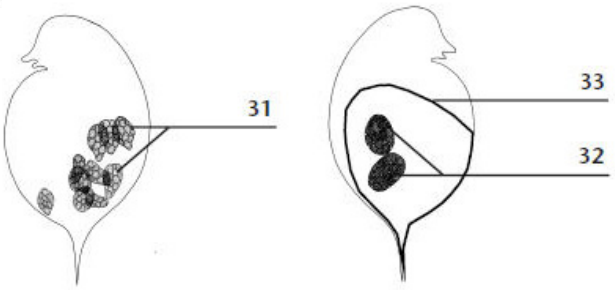
1. Frontal organ
2. Esophagus
3. Antennal adductor muscles
4. Antenna
5. Antennal levator muscle
6. Heart
7. Ovary
8. Blood Chamber
9. Thin-shelled "summer eggs"*
10. Abdominal process
11. Apical spine
12. Post abdomen
13. Post abdominal claw (paired)
14. Anus
15. Rectum
16. Carapace
17. Filter setae
18. 2nd and 3rd thoracic appendages
19. Shell gland
20. Maxillae (vestigial)
21. Mandible
22. Mouth
23. Labrum
24. Antennule
25. Rostrum
26. Hepatic cecae
27. Ocellus or nauplius eye
28. Optic ganglion
29. Compound eye with optic nerve
30. Nuchal or neck organ

Diagrammatic Representation of Position of "Summer Eggs"

31. "Summer eggs"

Diagrammatic Representation of Ephippium and Position of "Winter Eggs"

32. "Winter eggs"
33. Ephippium



*See illustrations of "summer eggs," which develop parthenogenically, and "winter eggs," which develop after being fertilized. Winter eggs have a thick shell and are produced in smaller numbers; the brood chamber is molted to form a protective ephippium.

Working with Daphnia

Daphnia magna and other cladocerans are of great importance in the aquatic food chain. They are a food staple for young and adult fish; stomach contents of a variety of fish can contain up to 95% cladocerans. Hydra and both immature and mature insects also eat Daphnia.

Due to its varied habitats and its complex yet easily studied anatomy, the water flea is an ideal organism for study. Although the complex muscular system obscures some of Daphnia's smaller anatomical features, the essential parts of most organ systems can be easily distinguished. The most visible feature is the long, bent, dark-colored intestine. The simple football-shaped heart is readily visible behind the head on the dorsal side of the animal. Daphnia possesses no actual blood vessels, its colorless blood plasma being guided throughout the animal by a series of minute mesenteries. Its heart rate varies with water temperature, making it easy to alter the Daphnia's heart rate and observe the changes.

Environment

Cladocerans are common in almost all aquatic environments, with the exception of fast-moving streams and brooks, and heavily polluted waters. The two most common inhabitants of ponds, permanent pools, and temporary pools are *D. magna* (usually supplied) and *D. pulex*. Daphnia move through the water in a series of "hops" produced by rapid strokes of its feathery paired antennae.

Reproduction and Growth

In cladocerans, reproduction is parthenogenic, which means that eggs develop without fertilization in the brood chamber and hatch there as fully developed young. They develop during the year, in most habitats, and only females are produced. The number of eggs per clutch (group of eggs) varies among species; *D. magna* carries ten to fifteen. When the young hatch, the adult releases them by moving its post abdomen downward. Normally one clutch is released during each adult instar, or molt.

Daphnia populations peak in spring and autumn, beginning when the water temperature rises to approximately 12°C. During these times, special "sexual" males and females may be produced, usually in response to a variety of environmental circumstances such as excessive crowding of females, a decrease in the food supply, impending harmful change in environmental conditions such as a pond drying up, or an increase in water temperature. Under these conditions, males copulate with specialized females who produce haploid eggs.

These haploid eggs are housed in the brood chamber, the walls of which thicken and darken to form an ephippium. The brood chamber, which houses one or two "winter eggs", separates from the rest of the carapace during the next molt. When released, ephippia either sink to the bottom of the body of water or float on the surface, depending on the currents, wind, and even other animals to distribute them. Ephippia and their eggs are capable of withstanding the rigors of winter and summer droughts, and can survive in temporary ponds that dry up in the summer and fill up again in the fall. Ephippia eggs hatch parthenogenic females.

The length of Daphnia's life cycle ranges from 10–40 days, depending on water temperature. The number of instars for *D. magna* is between six and 22, their duration lasting from one day to several weeks, depending on environmental conditions.

Most cladocerans grow to a length of 0.2 mm to 3 mm; mature *D. magna* are usually 3 mm long.

Culturing

The most critical environmental factor when culturing Daphnia is temperature, which should remain as close to 20°C (68°F) as possible. Higher temperatures could prove fatal to the organisms, while lower temperatures slow reproduction rates.

Daphnia flourish best in a large container with a 10- to 100-gallon capacity, although containers with a one-to five-gallon capacity will suffice if the population is monitored closely and subculturing is done frequently. Use pond or spring water; allow the water to sit undisturbed for several days before adding the Daphnia to ensure that all air bubbles have escaped from the water. Any air bubbles in the water may become trapped beneath the Daphnia's' carapaces, lifting the animals to the surface, where they will die. If this happens, sometimes gently pushing the Daphnia back below the surface will release any trapped air. You may also prepare a container for Daphnia by covering the bottom with a thin layer of peat humus and filling the container with hot tap water. Allow the water to sit undisturbed for 48 hours.

Introduce a relatively large "seed" culture to the water by immersing the jar, upright, in the water. Empty the jar underwater to keep any air from entering the water. Then stir the surface of the water to break up any film that forms; the film will block oxygen exchange between the water and the air.

Care and Feeding

Daphnia feed on smaller protists. Add approximately five drops of a Daphnia growth medium per gallon three times a week, or add Euglena to the culture twice a week. Keep feeding schedules consistent. Avoid over-feeding, as extra food will foul the water.

Some populations prefer sunlight, providing the temperature of the water does not rise, while others do just as well without sunlight. *D. magna* flourish in diffused or indirect light.

Perform a partial water change (about half the amount) once a month. Subculture at least every two weeks to prevent overcrowding, production of males, and development of ephippial eggs. Harvest populations regularly using a net with a mesh large enough to remove most of the adults, yet leave behind the developing Daphnia.

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