



What are these tiny critters swimming around in my larval sample bag?

Crustaceans (cladocerans, copepods, ostracods) and their effects on larval mosquito populations

Rachel Kempf
Environmental Health Specialist II
Division of Environmental Health
Fairfax, Virginia





FAIRFAX COUNTY HEALTH DEPARTMENT



Cladocerans



Copepods



Ostracods



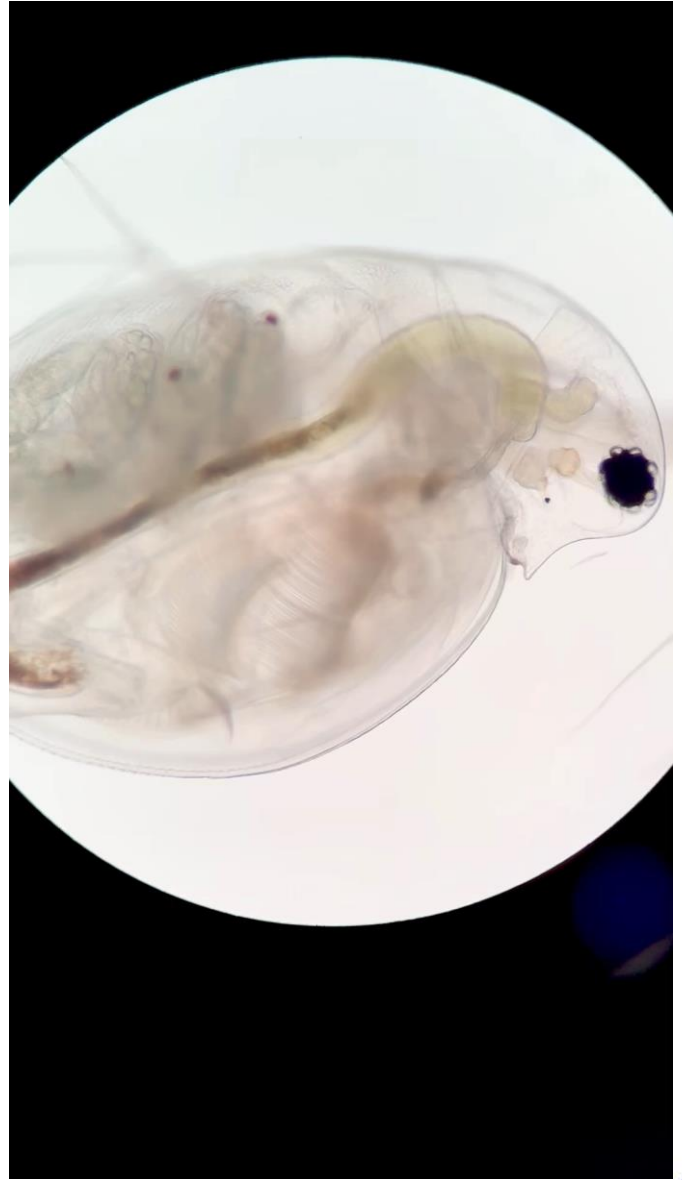
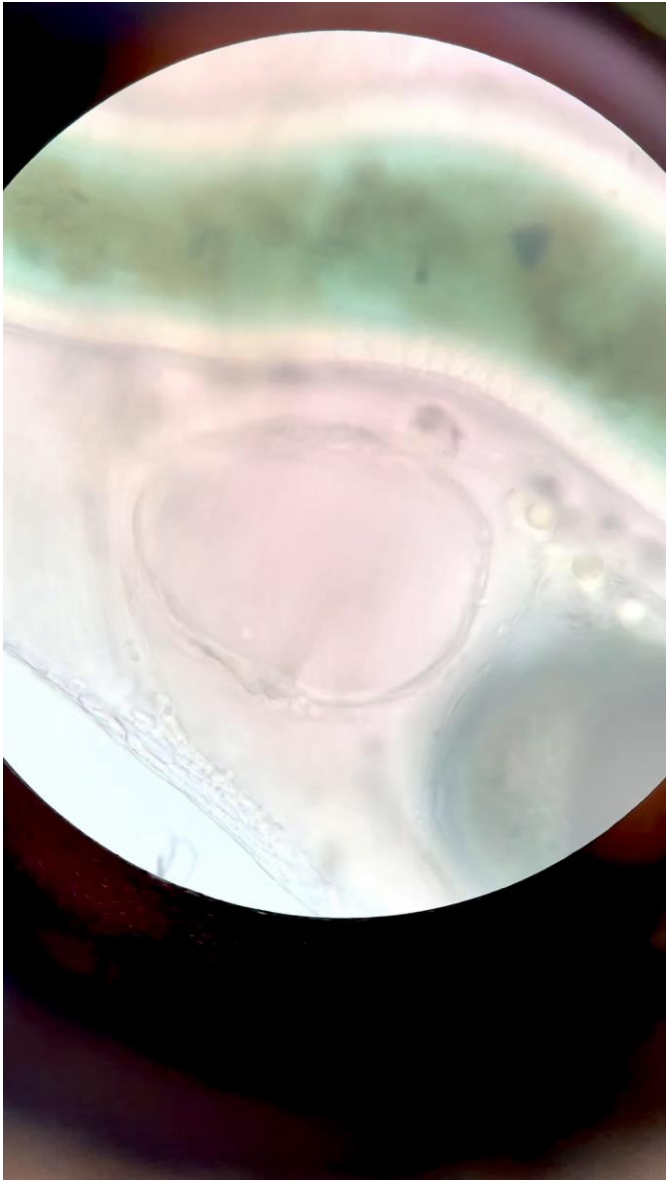
Cladocerans

- “Water fleas”
 - Swimming resembles flea movement
- Superorder Cladocera (Diplostraca)
- Mostly freshwater (some marine)
- 1000+ described species
- Use antennae for locomotion
- Filter feeders
- Mostly transparent
- Switch between parthenogenesis (asexual) and sexual reproduction



Movement





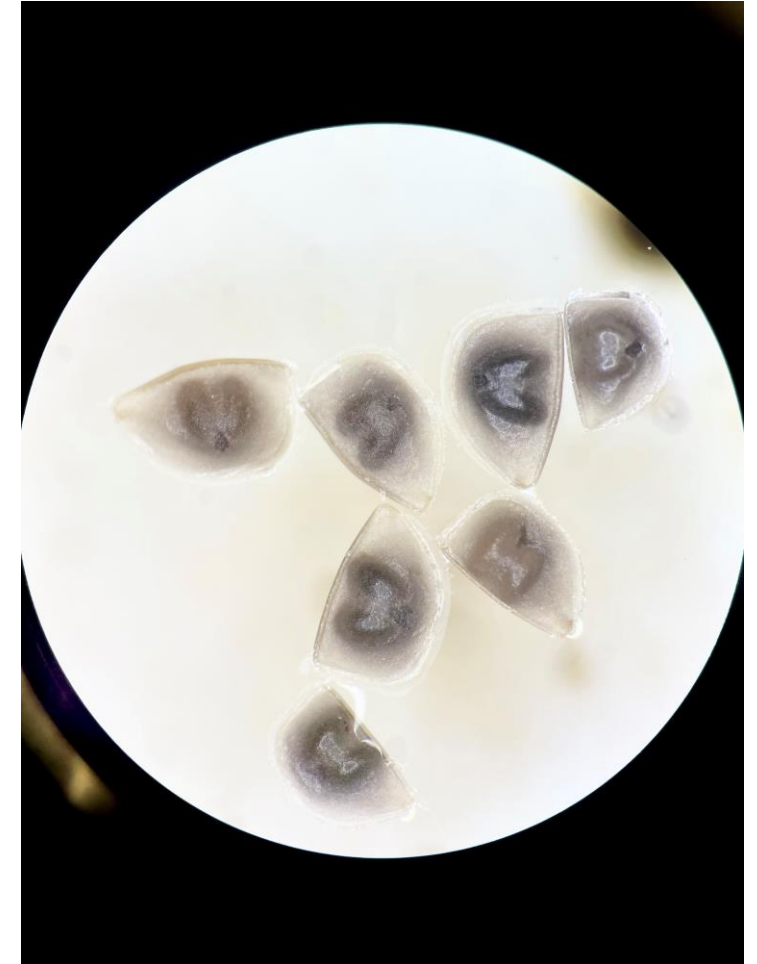
FAIRFAX COUNTY HEALTH DEPARTMENT



Parthenogenetic (asexual) broods



Resting Eggs (sexual reproduction)



Cladoceran Coloration

What can the color of your cladocerans tell you about the environment?

- Use hemoglobin (Hb) to support O₂ transport
 - Low dissolved O₂ = up to 20fold increase in Hb
 - Hb bound to O₂ is red
 - Gives the animal a reddish-pinkish tinge
- Food source can also affect color:
 - Transparent or yellow/green = green algae
 - White/salmon pink = bacteria



Diversity



Genus *Daphnia*



Genus *Scapholeberis*



Family *Chydoridae*



Diversity



Family *Sididae*



Genus *Ceriodaphnia*



Genus *Daphnia*

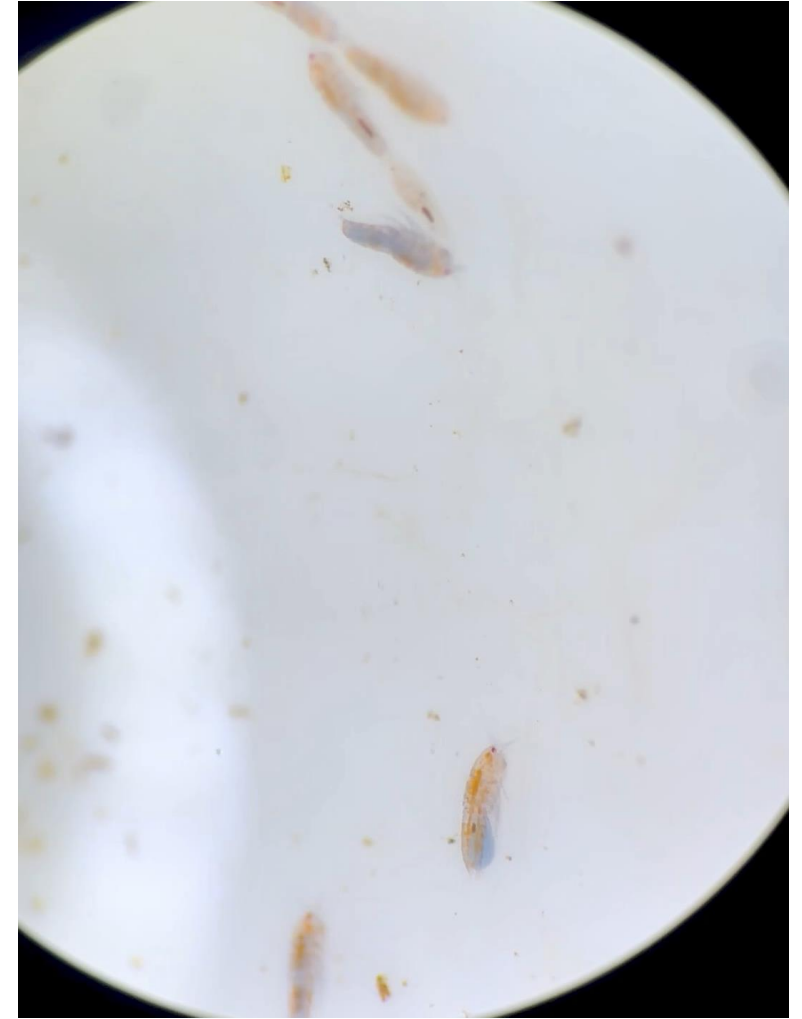


Copepods

- Class Copepoda
- “Oar feet”
- Dominate zooplankton group in most freshwater and saltwater habitats
- Diverse life histories
- 14,000+ described species
 - ~7000 have parasitic phase
- Move rapidly in “stop-start” motion
 - Sophisticated myelination



Copepod Movement



Order Harpacticoida



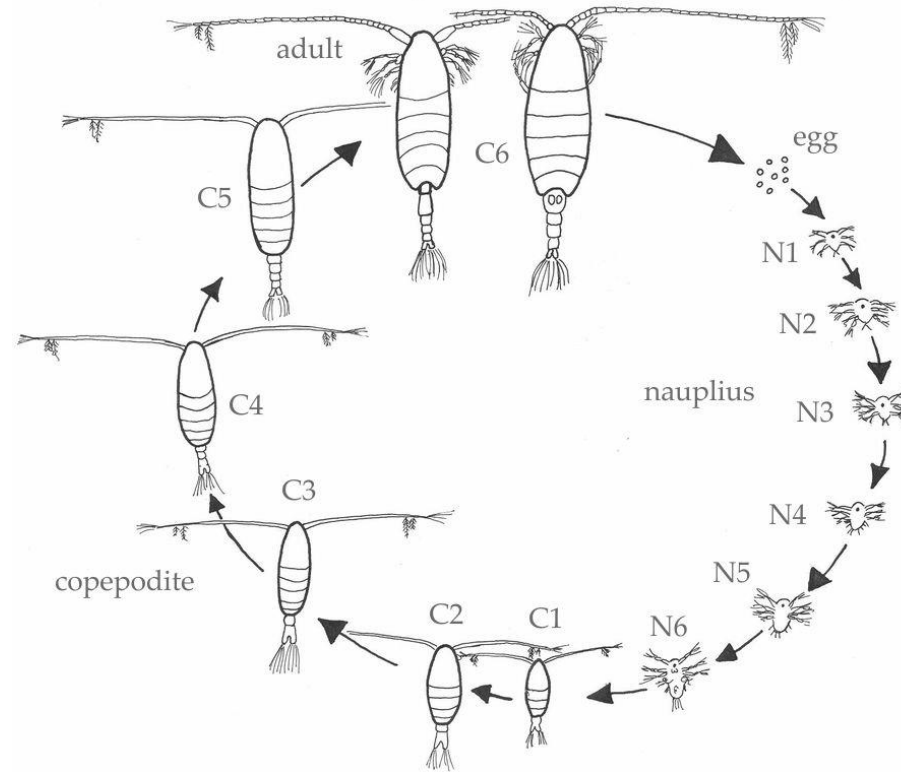
Reproduction

- Primarily sexual
- Free-spawning or clutch-bearing
- Clutch-bearing embryos develop in gonadal sacs
- Eggs and juveniles diapause in unfavorable conditions



Development

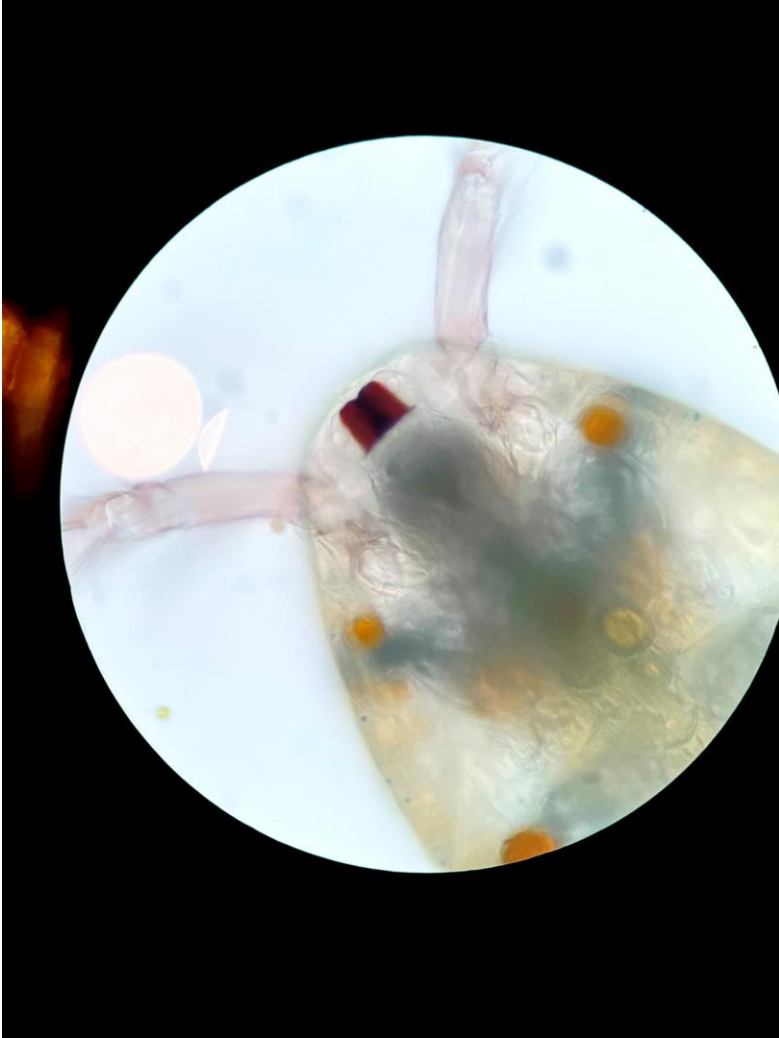
- Hatch into **nauplii**
 - Mite-like larvae
 - 6-10 legs
 - Red eye present
- After 5-6 molts, metamorphosize to **copepodites**
 - Resemble adults
 - 5-6 more molts
- **10-12 molts to reach sexual maturity**



From the NOAA COPEPOD Project



Anatomical Details



Single red compound eye



Mouthparts

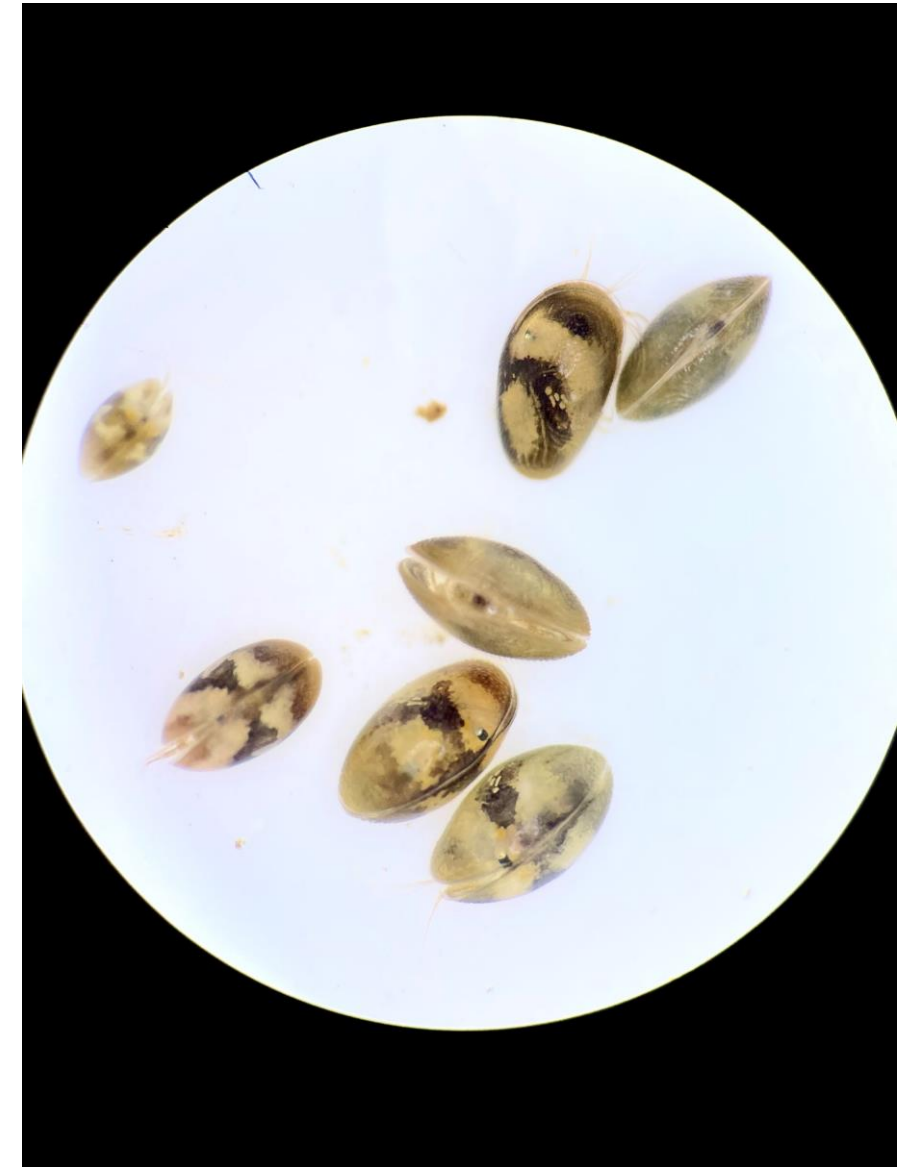


Thoracic limbs

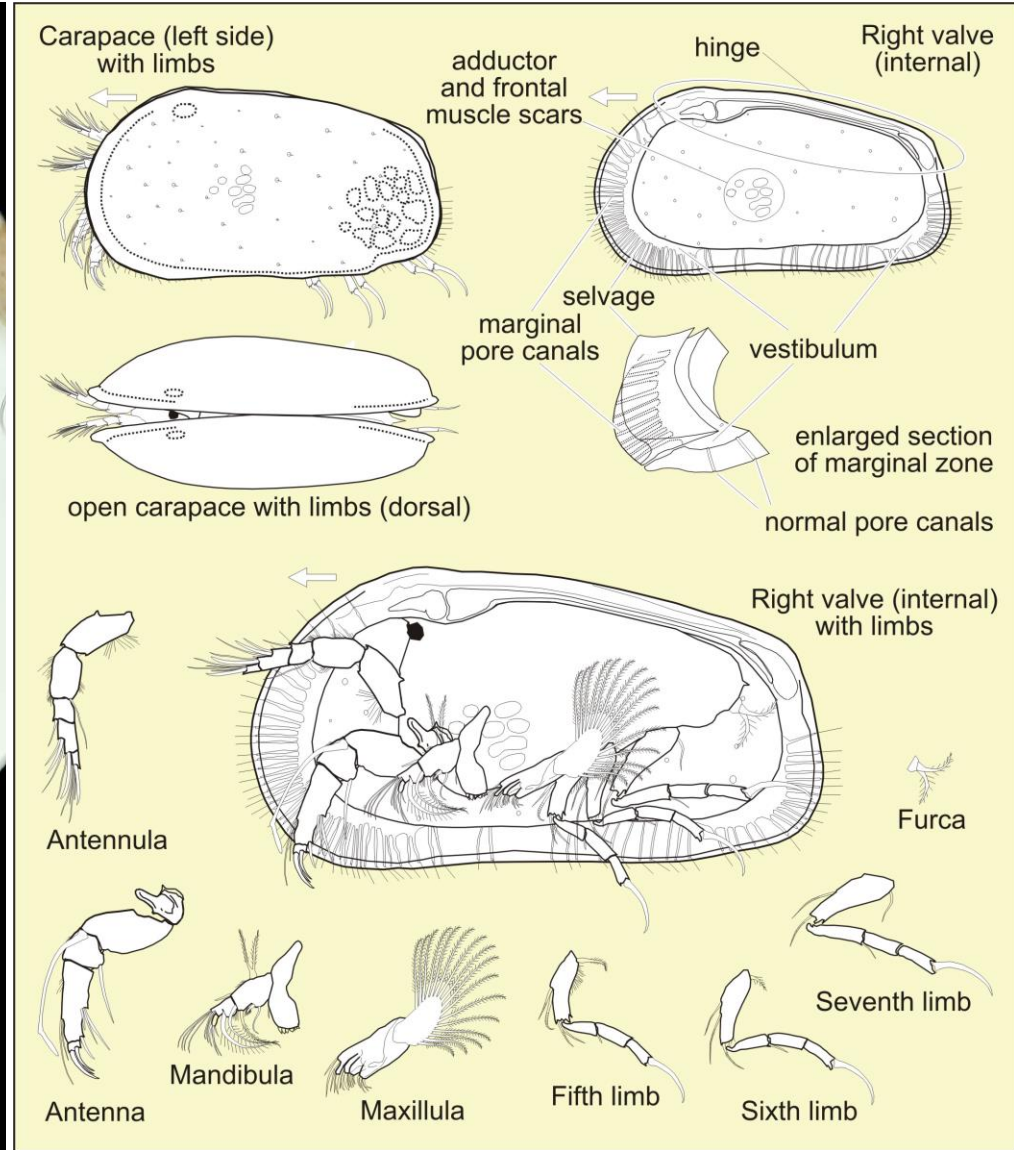


Ostracods

- “Seed shrimp”
- Class Ostracoda
- 13,000+ extant species
- Huge variation in physiology and life history
 - Carnivores
 - Filter feeders
 - Detritivores
 - Scavengers
 - Deposit feeders
- Switch between sexual reproduction and parthenogenesis
- Molt up to nine times before adulthood



- Body not clearly segmented
- Bivalve-like carapace
- All have “ventilatory appendages”
 - Beat rhythmically to create a water current
- Movement is smooth and “bumbly”



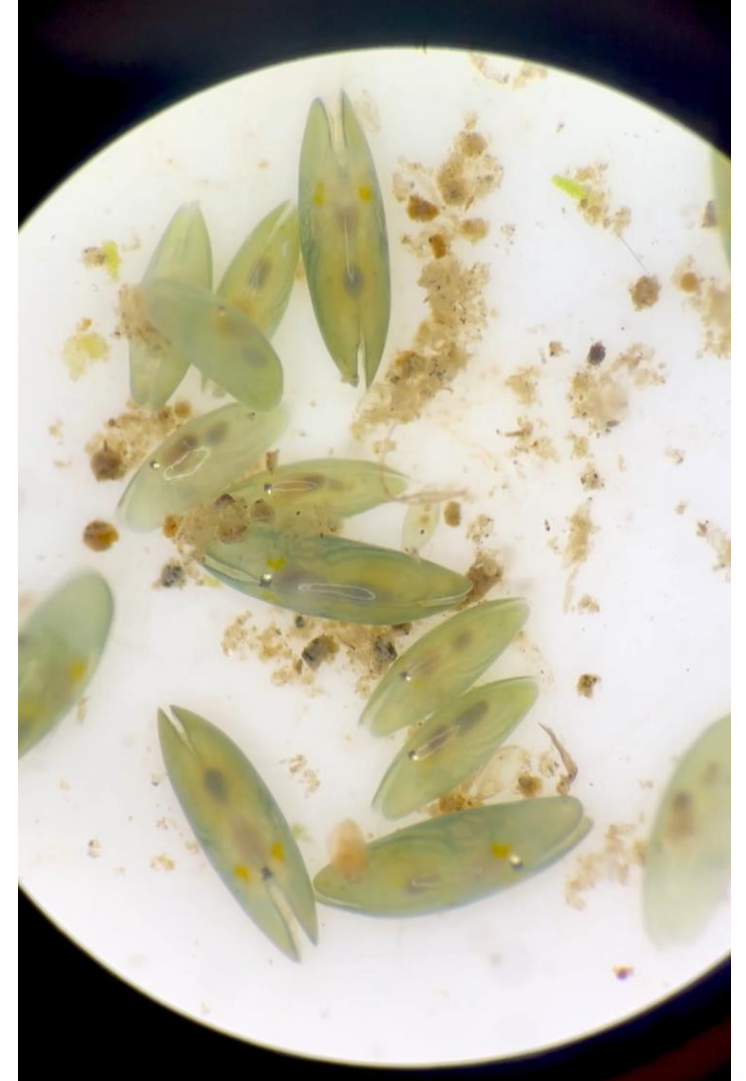
Author: David Horne



FAIRFAX COUNTY HEALTH DEPARTMENT



Ostracod Movement





Crustacean/Mosquito Interactions

Direct Predation

Interspecific Competition



Direct Predation

- Primarily in copepod order *Cyclopoida* (cyclopoids)
- Predatory species large (>1mm)
- Generalists/opportunists
 - Do not specialize in mosquito larvae
- Prey on 1st instars (occasionally 2nd)
- Attack from side or behind
 - Damage abdomen or siphon
 - Can be compulsive killers



Direct Predation

- ~50 species tested for biocontrol potential
- Reduce container breeding mosquitoes by 99-100% in laboratory assays
 - Can kill up to 50 larvae/day per copepod
- Limitations:
 - Appropriate species must be introduced
 - Sensitive to desiccation
 - Lasting control depends on long-term establishment



Interspecific Competition

- **Interspecific** = competition between individuals of different species
- Crustaceans occupy same trophic level as mosquito larvae
- All consume algae, bacteria, detritus
 - Competition for limited resources
 - Can reduce fitness of adult populations
 - Can reduce survival and colonization of larvae



Impacts on growth and adult fitness

Study 1:

“The effect of a cladoceran, *Daphnia magna*, on the growth and pupation of *Aedes aegypti* mosquito larvae”

Ankita Thakur & Devinder Kaur Kocher

The Journal of Basic and Applied Zoology, Volume 83,
Article 36 (2022)



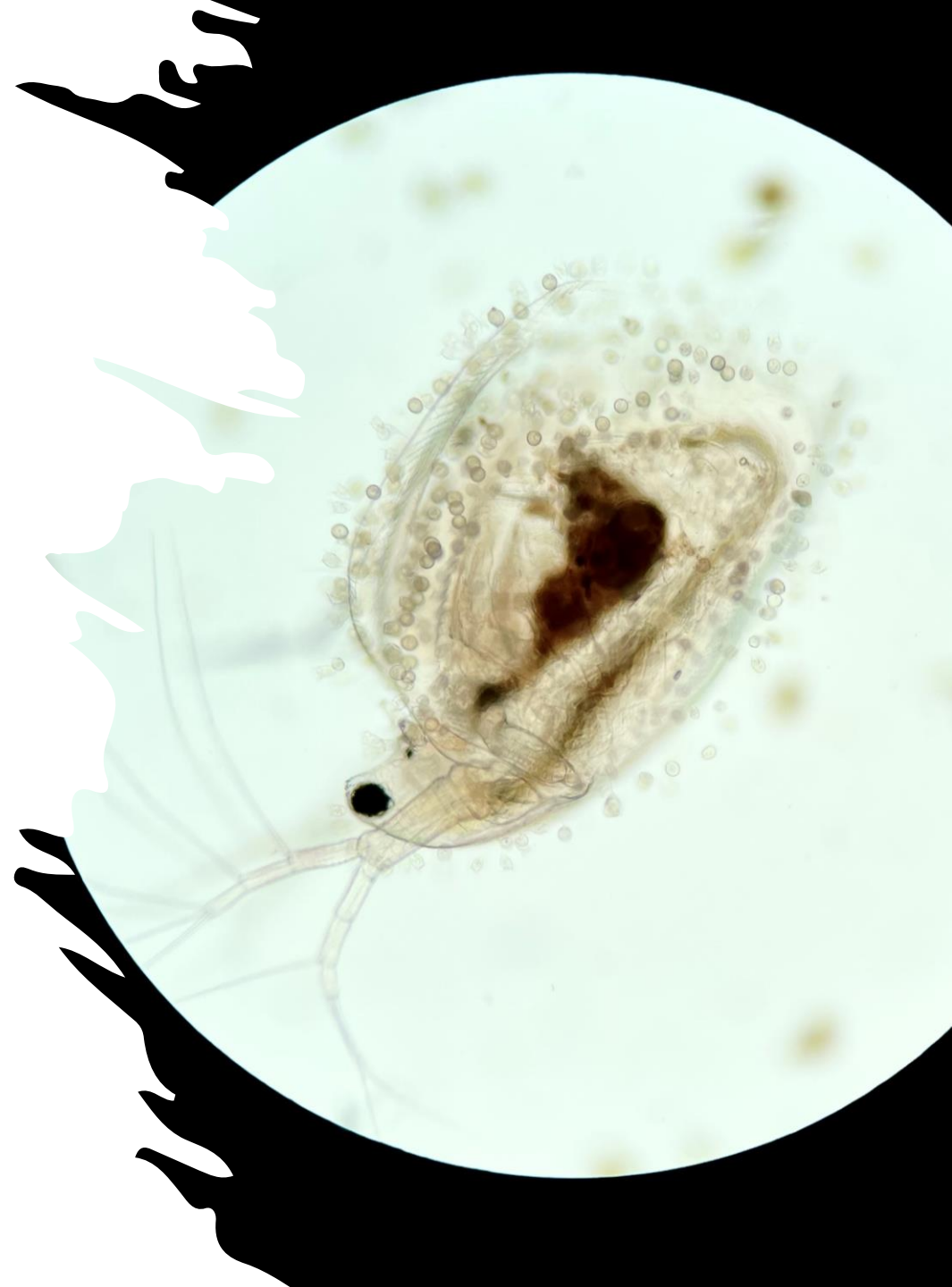
Aedes aegypti reared in beakers with varying ratios of *Daphnia magna*

- Larvae: *Daphnia*
- 1:1, 1:2, 1:3

Results:

- Adult mosquito emergence significantly reduced
 - Control: 100% emergence
 - 1:1 43.33%
 - 1:2 25%
 - 1:3 16.66%
- 1:3 treatment delayed emergence by 3-4 days
- Body size of males and females reduced
- Longevity of adults reduced
- Wing length reduced

Larval survival and adult fitness can be significantly affected by crustacean populations



Effects on larval control & establishment

Study 2:

“Sustainable control of mosquito larvae in the field by the combined actions of the biological insecticide Bti and natural competitors”

Iris Kroeger, Matthias Liess, Frank Dziock, Sabine Duquesne
The Society for Vector Ecology, 2013



Field experiments exposed ponds with established *Culex pipiens* larvae to:

- A) Bti treatment
- B) Introduction of a crustacean community
- C) Bti treatment followed by crustacean introduction

Results:

- A) Bti significantly reduced populations only in the short term (3-10 days)
- B) Crustacean introduction alone had no impact
- C) Combined treatment kept mosquito populations low for 28 days

When larval populations were reduced by Bti, crustacean populations became better established and prevented larval recolonization



UNH Center for Freshwater Biology: An Image-Based Key to the Zooplankton of North America

Home Instructions Use the Key Groups Species Anatomy

Click on the image which your specimen most closely resembles.

Families: Bosminidae and Chydoridae

Families: Holopedidae and Sididae

Families: Daphniidae, Ilyocryptidae, Macrothricidae, Moinidae

Taxonomy

Phylum	Arthropoda
Subphylum	Crustacea
Class	Branchiopoda
Suborder	Cladocera

Home Instructions Use the Key Groups Species Anatomy

Click on the image which your specimen most closely resembles.

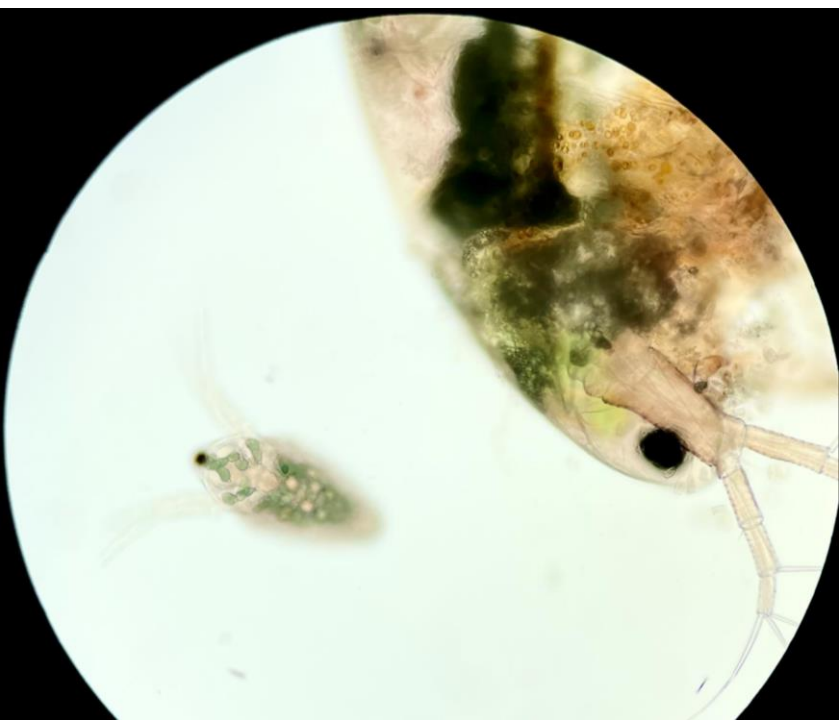
First antennae (ant) long relative to body, with 23 to 25 segments

First antennae (ant) short relative to body, with 18 or less segments

Taxonomy

Phylum	Arthropoda
Subphylum	Crustacea
Class	Maxillopoda
Subclass	Copepoda





Thank you!

