National Park Service
U. S. Department of the Interior

Fish Parasite Monitoring as an Index of Stream Health in San Francisco Bay Area, USA

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and

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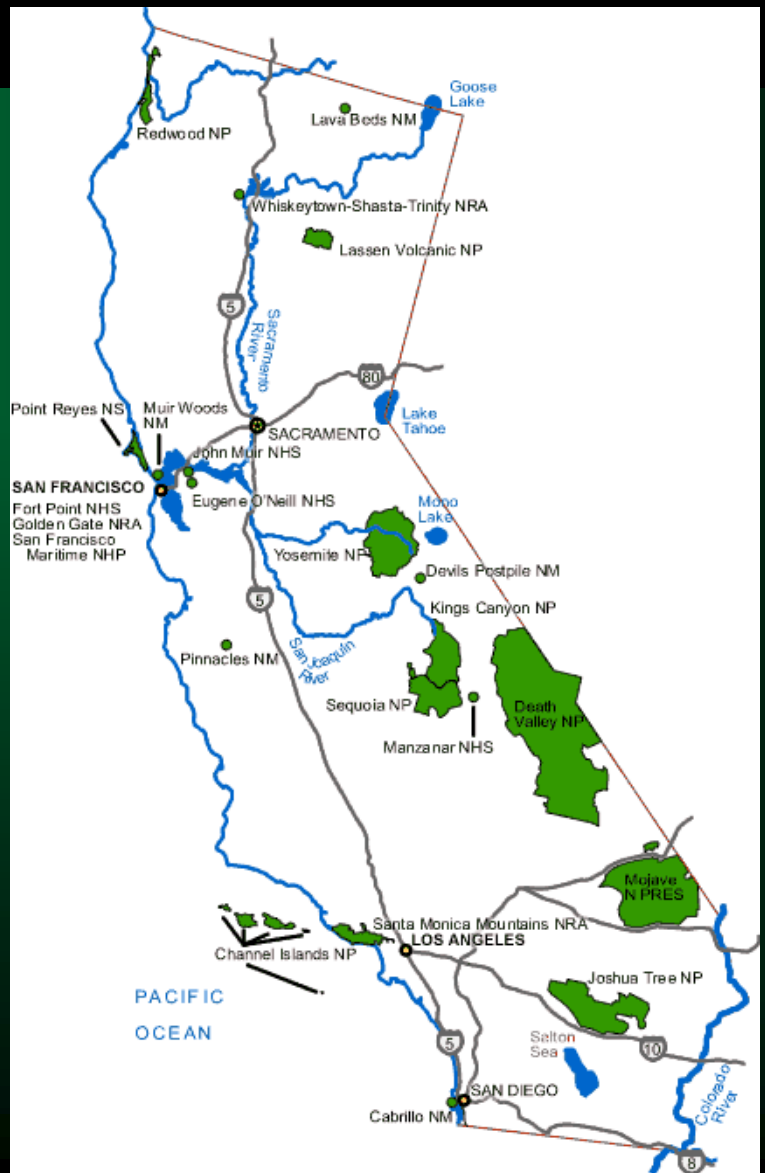
PRESENTATION OUTLINE

- **Determine feasibility and value of using fish parasite monitoring as a "Vital Sign" of stream health**
- **What fish parasites occur in California and how do they impact their host fish.**
- **How do fish parasites relate to other organisms in freshwater ecosystems (multiple hosts of different trophic levels involved, native and non-native invaders, etc.**
- **Conclusions and summary**

Location Map of San Francisco Bay Area in California

Most fish examined for parasites came from:
Point Reyes National Seashore
and
Golden Gate National Recreation Area



Streams and Lakes near, and often in, Protected Parks are Altered by Anthropogenic Activities

Examining fish from stream in Point Reyes National Seashore

- Impacts of human activities on composition of fish communities in California have been documented in many locations.

- However, distribution of exotic parasites in both native and non-native fishes remains largely unknown in California, due to a lack of systematic and comprehensive fish parasite surveys.

Undergraduate students can be trained to collect fish, conduct necropsies, and tentatively identify fish parasites

DU of C Student Parasite Pioneers:

Joyce Valencia
Rocky Chavez
Caitlin Sullivan
Marielle Discipulo

Training by Scott Bonar's, PhD, Asian-tapeworm, research team from University of Arizona, Tucson (Spring 2004)

Monitoring and Evaluating Eukaryotic Parasite diversity of native and non-native freshwater fishes

Collecting three-spine sticklebacks from Rodeo Lagoon in Golden Gate NRA (photos above)

We are examining species composition and diversity of fish parasites and assessing:

- for potential parasite pathogenicity
- as health indicators of streams and lakes

Native and Non-native Freshwater Fishes Examined for Parasites in this Study

Fishes Non-native to California:

- **Mosquitofish, *Gambusia affinis***
- **Black bullhead catfish, *Ameiurus melas***

Anindo Choudhury, PhD, (right) teaching research scholar, Jan Marie Cheng, (left) fish necropsy techniques (2006) for detecting fish parasites

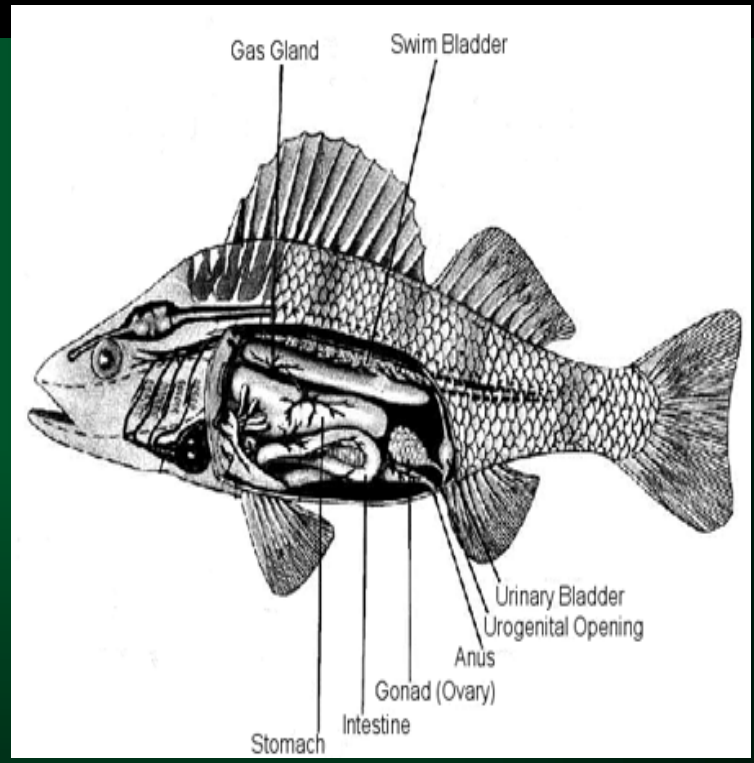
Native California Fishes:

- **Prickly sculpin, *Cottus asper***
- **Three-spine stickleback, *Gasterosteus aculeatus***
- **California roach, H*esperoleucus symmetricus***

Fish Necropsy and Data Base Protocols developed by A. Choudhury, PhD

Examine exterior of fish and remove organs for detailed examination:

- Blood smear
- Gastrointestinal system
- Bladder
- Gills
- Eye sockets
- Coelomic cavity
- Liver



Record information on standard data sheets:

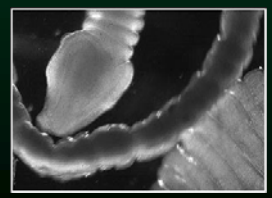
- Fish weight and length, location collected, habitat, date, time, water salinity, etc.
- Location and number of parasites, parasite photos, names, sample preservation, etc.

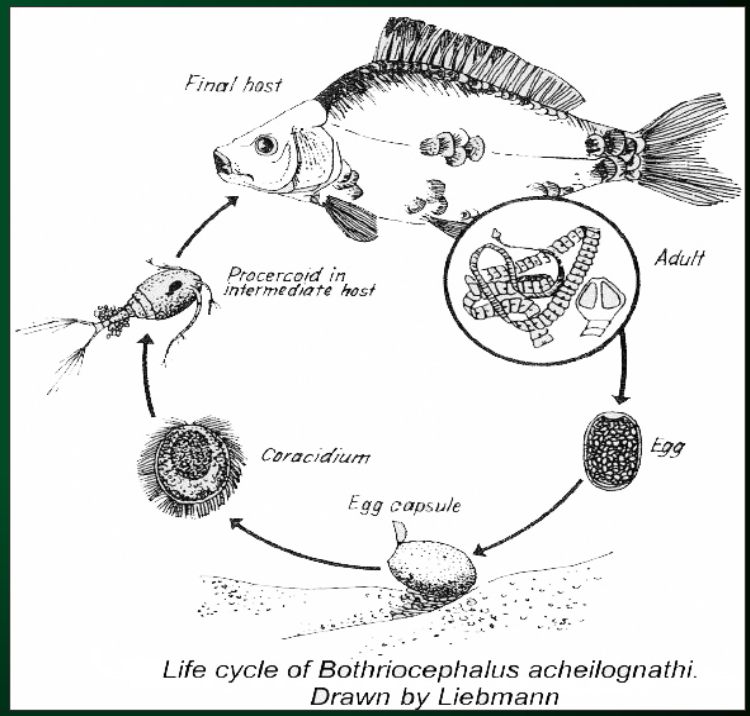
Many parasites have complex life cycles often involving multiple hosts: snails, crustaceans, frogs, birds, etc.

- Fish parasites can provide broader understanding of aquatic and adjacent riparian ecosystems

- Example: Asian tapeworm has already infected a variety of freshwater fish species (mostly Cyprinids) of all sizes in U.S.A.
  - -Origin: Eurasian baitfish
  - -Inhibits growth with potential death to fish; parasitizes small intestine

- This tapeworm impacts six Federally listed fish species

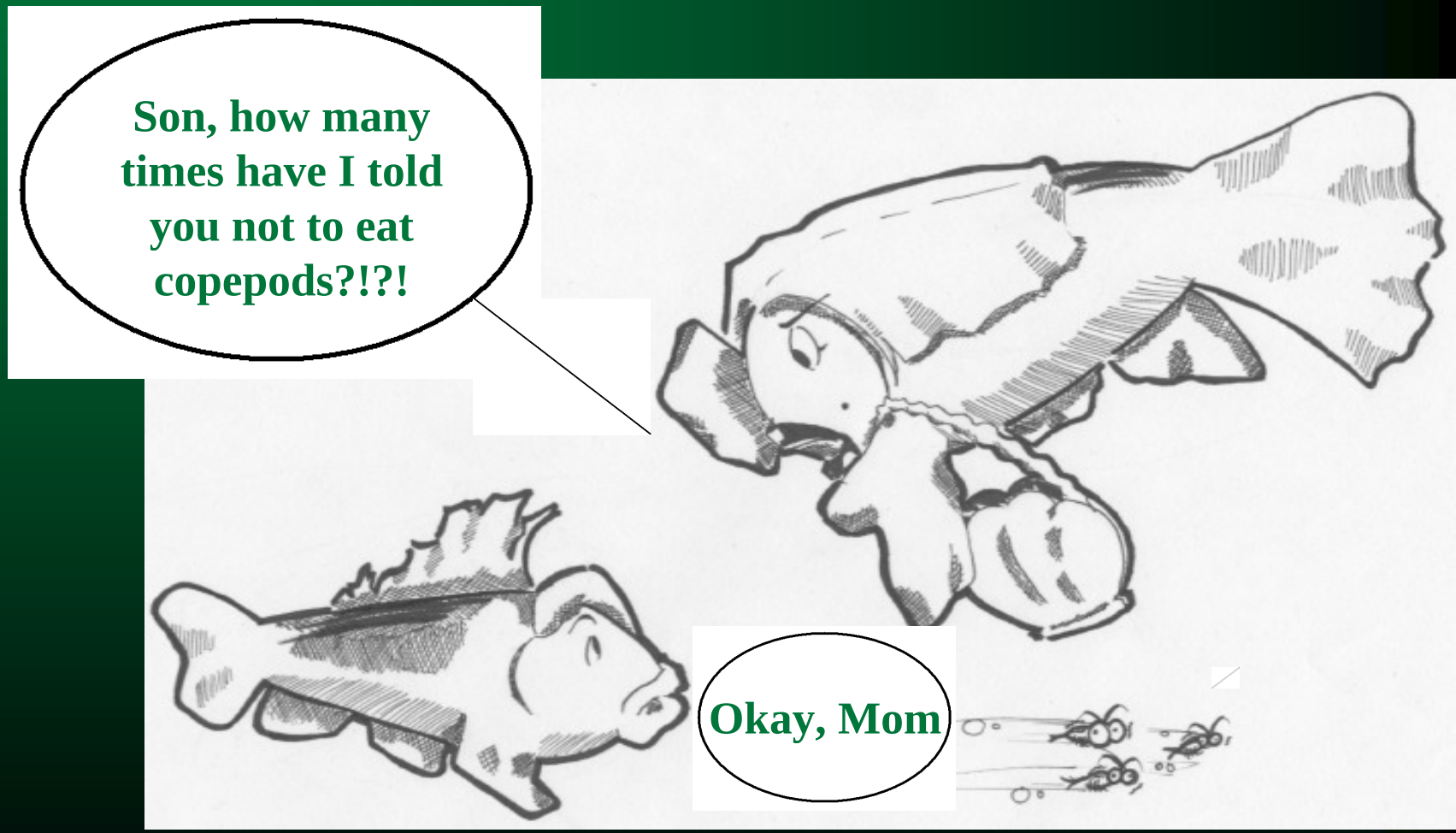




Life cycle of Bothriocephalus acheilognathi. Drawn by Liebmann

Several different copepod species serve as intermediate hosts for Asian tapeworm (Phylum Platyhelminthes)

Asian tapeworms infest mosquitofish in endangered Mojave tui chub in Mojave NP and in other fish species in streams near San Diego, California



Cartoon by Joyce Valencia, DU of C student

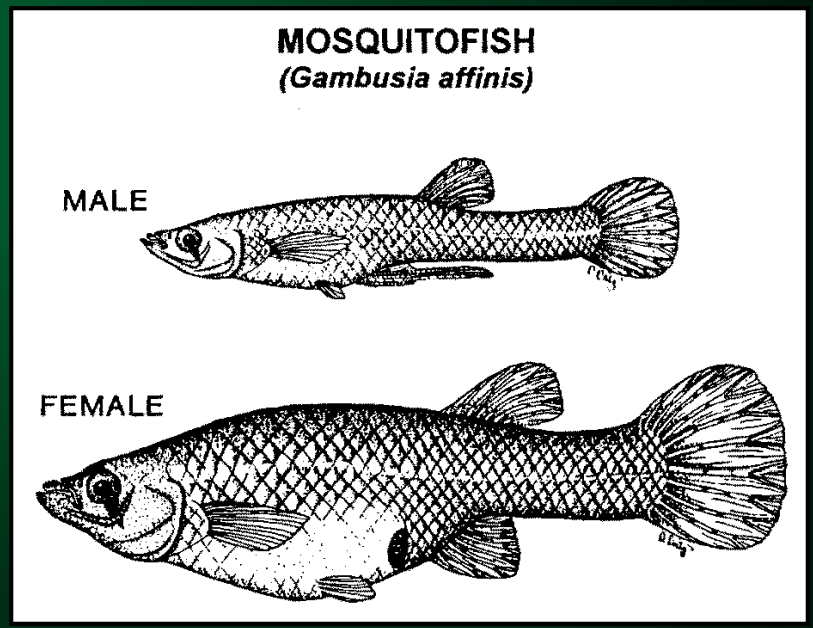
Parasites found in mosquitofish in San Francisco Bay Area

***Non-native fishes when introduced into a new area can also bring along their non-native parasites**

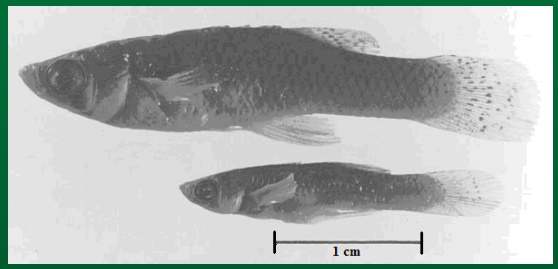
***Mosquitofish in SFO Bay Area host two parasites:**

one possibly native (a yellow grub),

the other non-native (a spiny-headed worm)

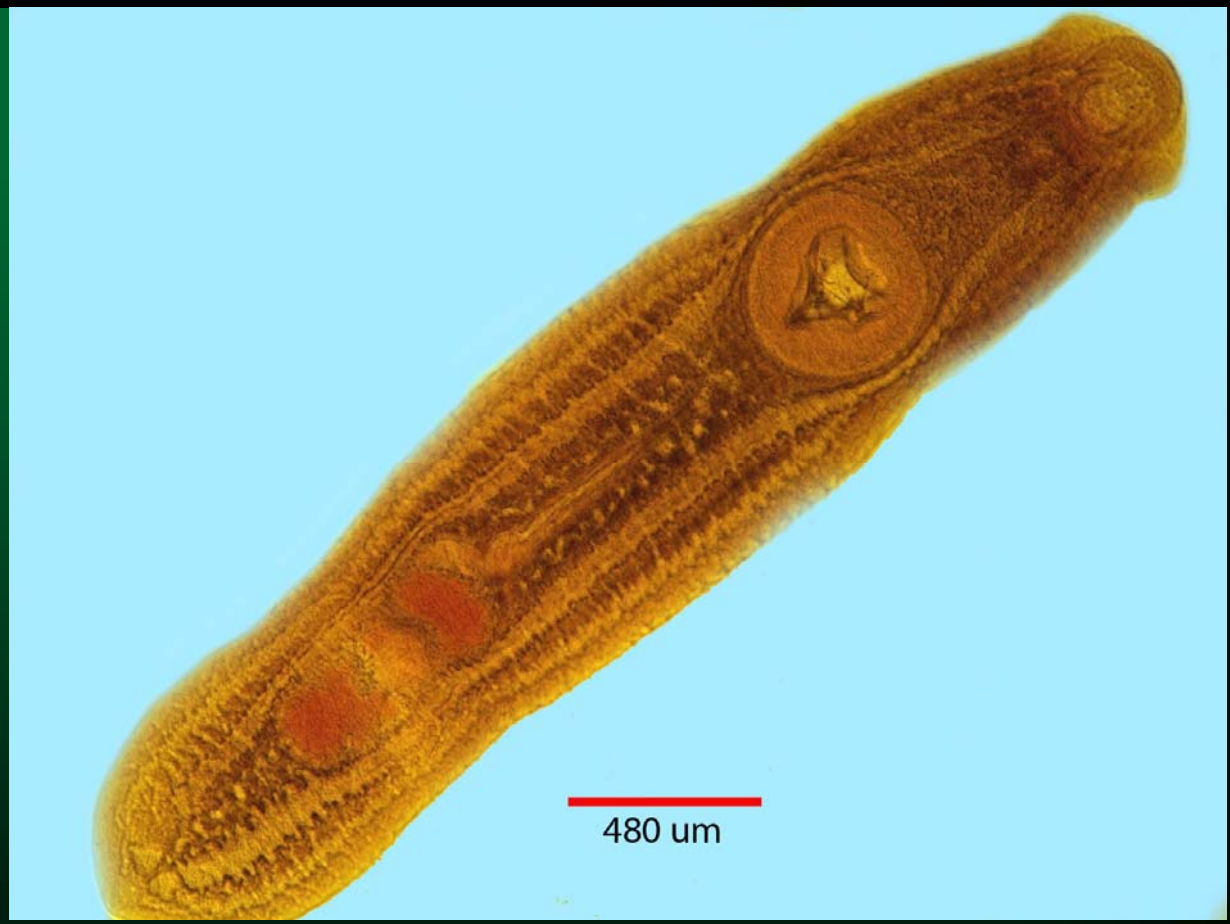


Clinostomum complanatum, yellow grub, (Platyhelminthes, trematode (fluke), in SFO Bay Area is probably native



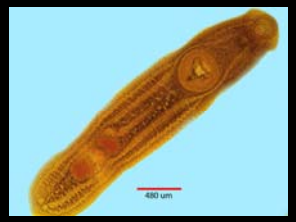
Mosquitofish are small. In adults (above), females (top) are considerably larger than males

Of 310 mosquitofish examined from 12 bodies of water, only 5 fish (>2%) had yellow grubs



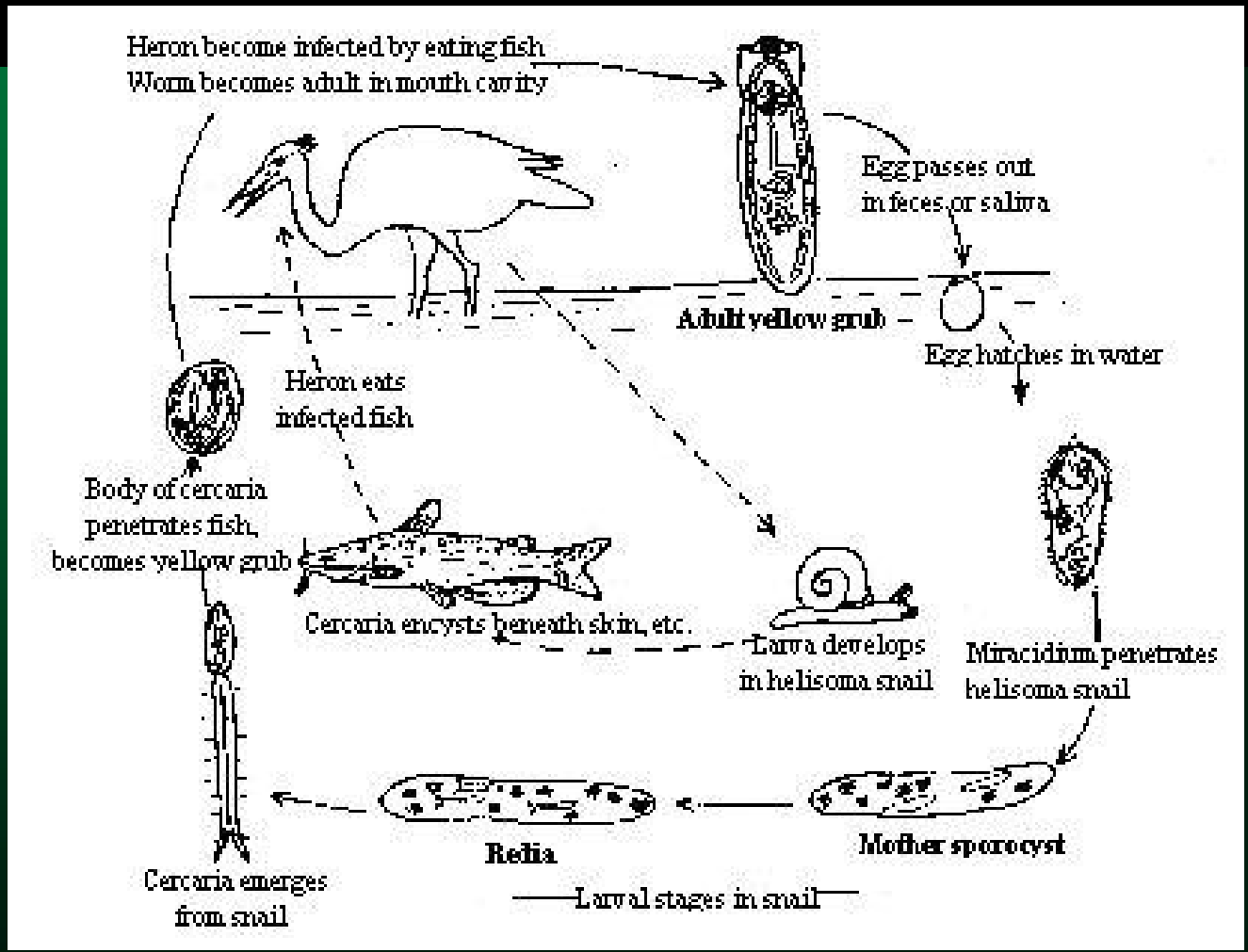
C. complanatum metacercaria (10x)

Identification and photo by A. Choudhury



C. complanatum metacercaria

Yellow grub life cycle

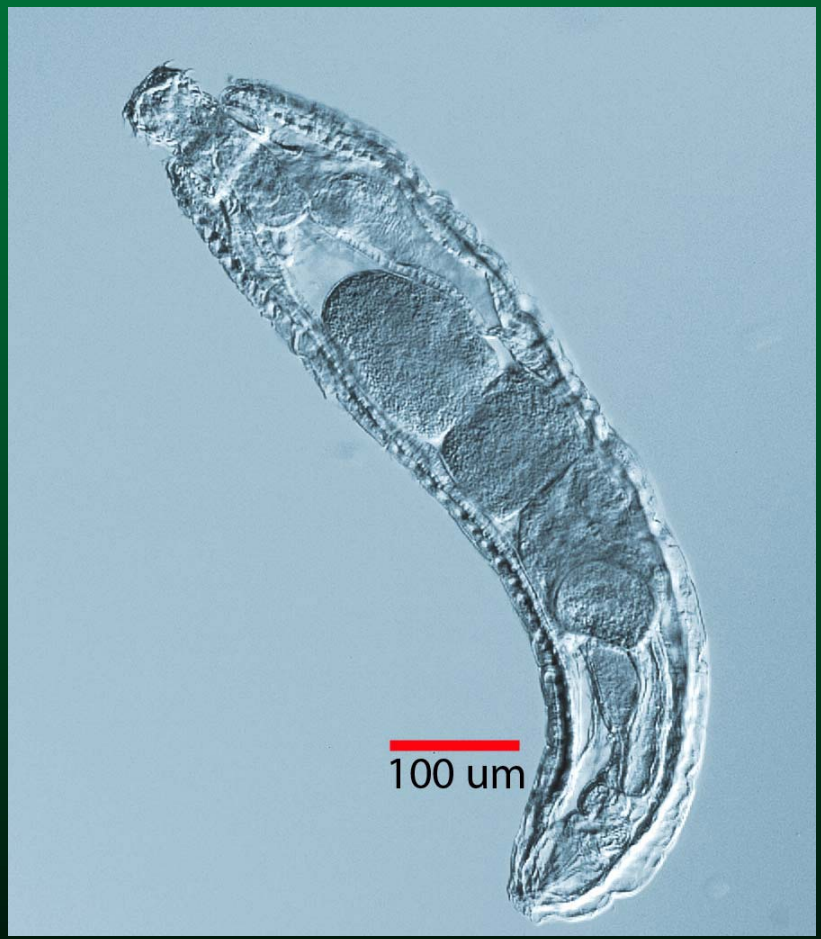


C. Complanatum **has life stages in which it invades snails, various fish species, and finally birds**

Mosquitofish are native east of the Continental Divide

Mosquitofish, non-native to California, feed on native aquatic organisms, such as other fishes, larval amphibians, and larval insects

Spiny-headed worm (Phylum Acanthocephala) from mosquitofish, *G. affinis*: Both parasite and fish are non-native to California



Octospiniferoides chandleri

Identification and photo by A. Choudhury

- **We examined 310 mosquitofish from 12 bodies of water in SFO Bay Area**
- **Only 4 fish (approx. 1%) from only one location were infected by this Acanthocephalan**

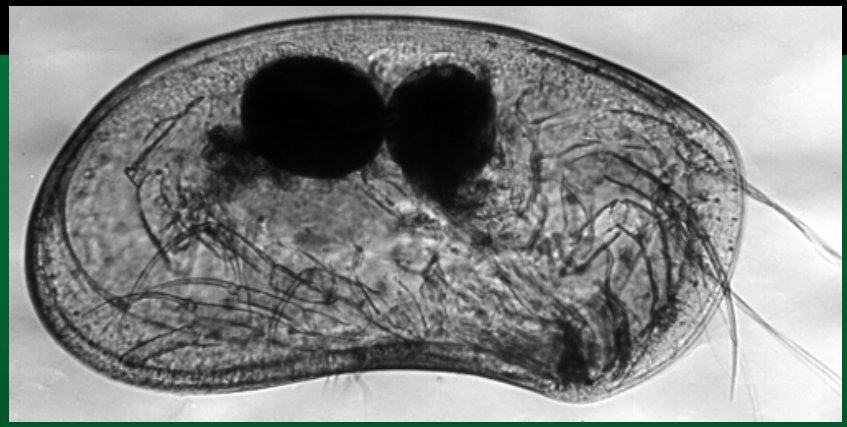
Octospiniferoides chandleri life cycle

Ostracodes *are primary hosts for Octospiniferoides chandleri. Smaller fishes, such as mosquitofish, become hosts of this parasite. Larger fish feeding on a mosquitofish have potential to become terminal hosts*

Drawing of adult Octospiniferoides chandleri

Head of *O. chandleri*

Non-marine ostracodes are reported in the literature as potential biomonitors of water quality



Tiny ostracodes (crustaceans) with their calcite shells are amazingly similar in external appearance to bivalve molluscs

OSTRACODES AS HYDROLOGIC INDICATORS IN SPRINGS, STREAMS AND WETLANDS: A TOOL FOR ENVIRONMENTAL AND PALEOENVIRONMENTAL ASSESSMENT

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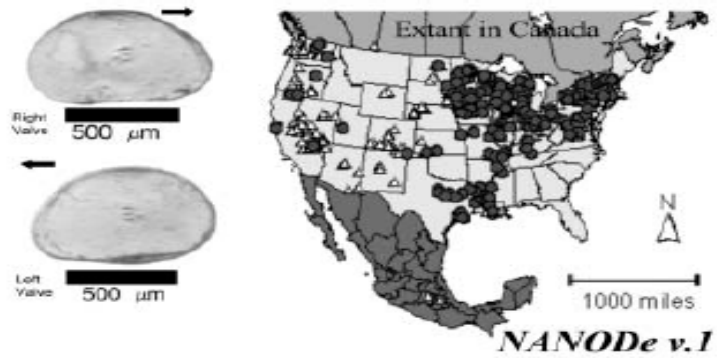
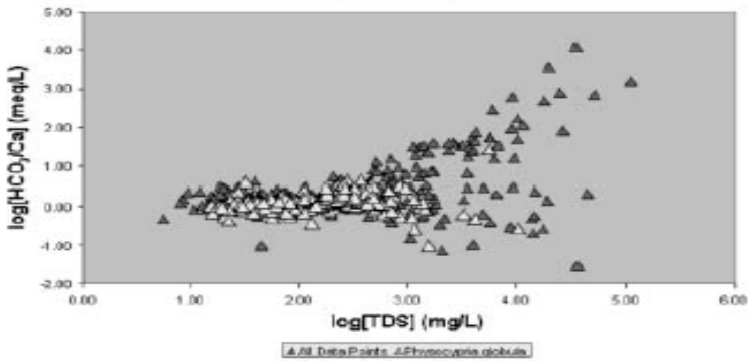
ABSTRACT—*Although the majority of publications on extant non-marine ostracode species in North America are concerned with lacustrine settings, many species that are potentially valuable as indicators of water quality changes live in non-lacustrine settings. Ostracode distributions in 157 springs, wetlands and streams in the United States are examined here in order to assess 1) species richness, 2) association with physical and chemical parameters of their habitats and 3) the presence of potentially useful biomonitors and environmental sentinels.*



Physocypria globula



RE 10—*Physocypria globula* left and right valves (10a), distribution in NANODe showing all DDe sites as white triangles, and those sites with P. globula as dark circles (10b), and chemical range in NANODe showing all NANODe sites as dark symbols, and those sites with P. la as light symbols (10c).

Parasites found in native three-spine stickleback, *Gaserosteus aculeatus*

- Indigenous threespine stickleback fish of PORE and GOGA are infected mainly with adult parasites that are specific or typical of this fish species.

- We documented nine, external and internal, native parasitic taxa in threespine sticklebacks

- This fish with a rich parasite fauna has potential to serve as a model for monitoring stream health

Three-spine stickleback parasites from British Columbia (Campbell Creek) and from California: Giacomini Creek (PORE), Lobos Creek (GOGA, Presidio), and Rodeo Lagoon (GOGA)

	Campbell Cr. (131)	Giacomini Cr. (FW) (29)	Giacomini Cr. (BW) (35)	Lobos Cr. (29)	Rodeo Lag. (47)
Cyathocephalus sp.	•				
Proteocephalus sp.	•	•			
Schistocephalus sp.	•	•			
Bunodera mediovitellata	•	• ?			
Plagioporus undescribed sp.				•	
Clinostomum sp.		•			
Neoechinorhynchus sp.	•				
"Black spot" Cryptocotyle sp	•			•	
Eustrongylides sp.	•			•	
Spiruridan: Genus? sp.?				•	
Ergasilus turgidus			•		•

Table legend: BW=Brackish water, FW=Freshwater
Numbers in rackets indicate how many fish were examined from that location.
Campbell Creek data from British Columbia cited from a previous study by Anindo Choudhury

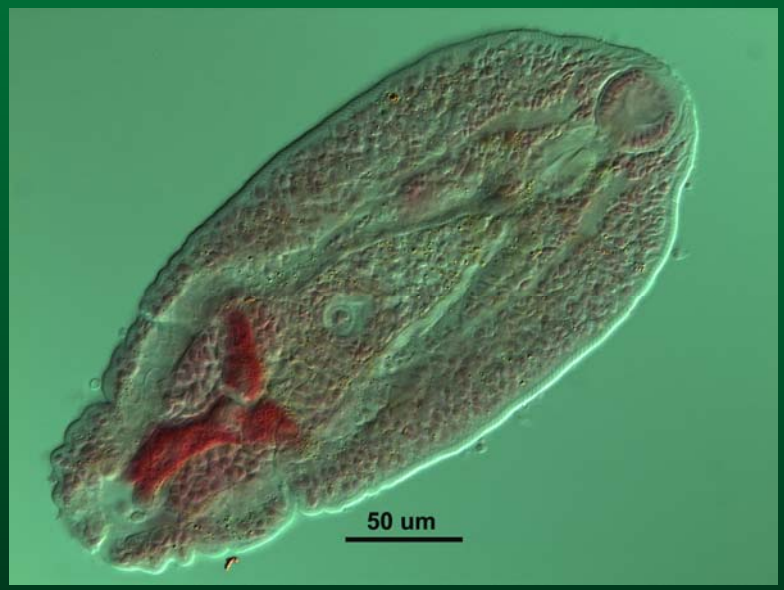
Three-spine stickleback (cont'd.)

- Infection rates of the nine parasite taxa we collected from *G. aculeatus* in PORE and GOGA varied tremendously: from a single parasite specimen in one fish to 100% infection in one stream location for another parasite species

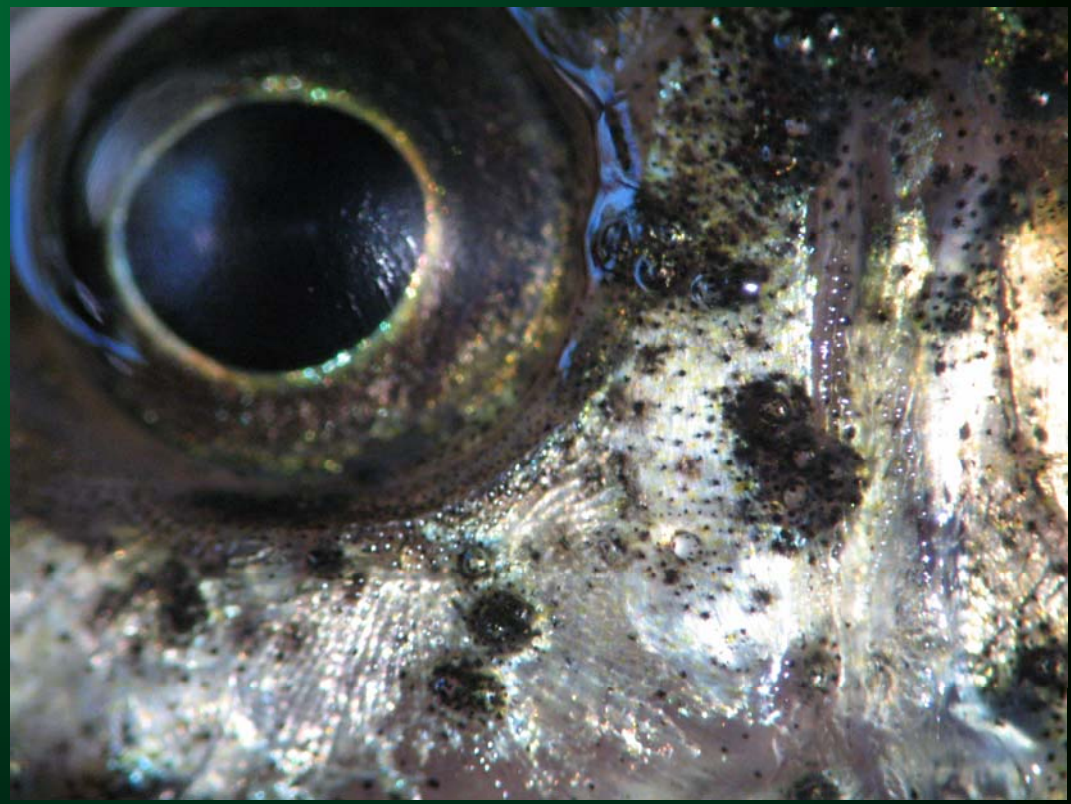
Three-spine stickleback at PORE and GOGA. This species bears 9 different parasite taxa, all new records in California

Intestinal helminth fauna of threespine sticklebacks from British Columbia (Campbell Creek) is identical to what has been reported from that host in that area (Lester, 1975) more than two decades before sticklebacks were sampled again (1998), indicating stable and predictable host-parasite associations.

Three-spine stickleback, *Gasterosteus aculeatus*, afflicted with “black spot “



Cryptocotyle sp. (metacercaria)
causative agent of black spot



Note abundant black spots embedded on skin surface and invading eye tissue of this stickleback

Ergasilus turgidus, a parasitic crustacean

Found in abundance (typically hundreds) in gills of three-spine sticklebacks at GOGA and PORE

Three-spine stickleback is also afflicted with a new species of *Plagioporus*

This species is new to science, being described, and will be published in a parasitology journal.

I appreciate the kindness of
Anindo Choudhury
in naming this species:

Plagioporus kolipinskii

Roundworm, Eustrongylides sp., in three-spine sticklebacks of GOGA/Presidio and Campbell Creek in British Columbia

***Eustrongylides sp.* in**
Phylum Nemahelminthes

Brain parasites (trematode) in fathead minnow, *Pimephales promelas, from a pond in Sebastopol, California*

- Prickly sculpin and CA roach discussed below also had a brain trematode….. not yet identified taxonomically

- Trematodes have complex life cycles with multiple hosts

Infected brain may lead to erratic swimming behavior …easier prey for birds, other fish species, etc.

Family : Cottidae

Prickly sculpin, *Cottus asper*

Prickly sculpin;

We found that 100% of 12 prickly sculpins examined had at least one type of parasite. Taxonomic work on parasites is underway:

*trematodes (flukes)

*a trichuroid nematode, undescribed species (Phylum Nemahelminthes) of genus, *Capillaria*.

Prickly sculpin:

Prickly Sculpin:

-7 fish had infections of various parasites in the brain, eyes, and intestine, totalling 284 parasites

-Trematodes infected the brain at an average of 52 per fish

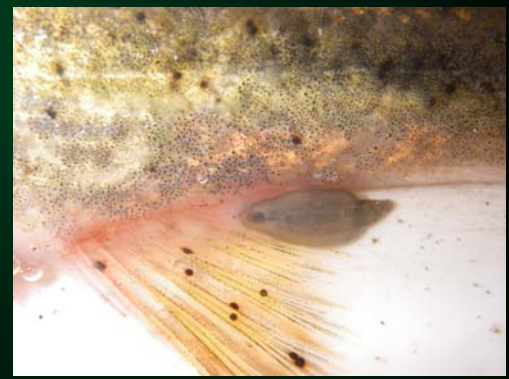
-2 other sculpin had trematode parasites in or around the eyes

California roach, *Hesperoleucus symmetricus*
Results of 18 necropsies, collected from PORE

California roach collected from Olema Creek In Point Reyes NS:

- 8 (44%) of 18 California roach studied had a total of 40 parasites (average 5 per fish)
- Taxonomic work underway
- California roaches hosted parasites in gills, viscera, stomach, intestine, brain, and externally
- Parasites include:
  Class Monogenea, Platyhelminthes, in the gills; stomach trematodes; intestinal trematodes, and brain trematodes; and a leech

Fish Family: Cyprinidae



Fin of California roach with attached leech

CONCLUSIONS AND SUMMARY

- **Only one or possibly two non-native parasites found so far, all others are likely native to California**
- **We found new host records, range extensions and also discovered two parasite species new to science.**
- **Fish parasites may be important to monitor for they have potential to serve as a vital sign of the health of aquatic ecosystems. A parasite with multiple hosts provides an indication of a broader picture of what is happening in an aquatic system at different trophic levels.**

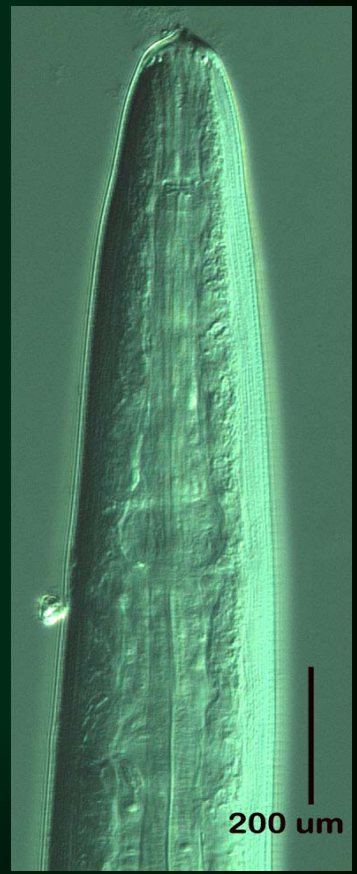
CONCLUSIONS AND SUMMARY CONTINUED

- **Undergraduate students or technicians can be trained to conduct parasitological monitoring at relatively low cost (comparable with training technicians in basic water quality work, basic stream invertebrate identifications, etc.)**

- **Populations of fish parasites vary from fish to fish and from one water body to another. Multiple factors are involved.**

CONCLUSIONS AND SUMMARY CONTINUED

- **We are striving to better understand fish parasite ecology in the SFOBA, so that it can be used as a tool for providing recommendations for management of aquatic resources.**
- **Managers need such information to make decisions related to control or elimination of non-native fishes and other aquatic organisms and in attempting to restore natural ecological processes.**



Thanks to many who participated in this ongoing project

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