

Scary Little Suckers - Predatory and Parasitic Invertebrates in Alberta's Streams and Sloughs



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Talk for North Saskatchewan Watershed Alliance
5 Oct 2022

A little about me



- Zoology 351 class in the North Saskatchewan in Sept 2022
(photo by Ilan Domnich)

Non-vertebrates vs invertebrates

- prokaryotes (e.g., bacteria) and many groups of eukaryotes live in freshwater habitats



- animals, plants, fungi and protists*

- many protists are almost the same size as small invertebrates like rotifers

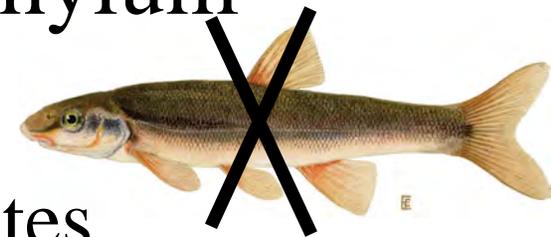
- some are larger than rotifers!

- includes photosynthetic (= algae) and heterotrophic species



- **invertebrates** are members of the phylum Animalia excluding the Vertebrata

- ~95% of animal species are invertebrates



*protists = eukaryotes other than members of the Plantae, Fungi and Metazoa (= Animalia)

Overview of freshwater invertebrate diversity

- fresh waters have every major terrestrial taxon found on land, plus a few that don't occur on land
 - e.g. bryozoans, sponges, cnidarians
- however, many phyla are restricted to marine habitats
 - e.g. ctenophores, echinoderms, chaetognaths, echiurans, hemichordates and a host of other wormy things



Origins of freshwater fauna

- several routes for colonization of inland waters
- directly from marine ancestors (e.g. crayfish)
 - trapped in a lagoon that was closed off from the sea and gradually became fresh
 - that moved up estuaries, or through groundwater
- from terrestrial ancestors that secondarily became aquatic
 - e.g. pulmonate snails, insects and most mites



Non-triploblastic animals

- only one family of **Porifera** in Alberta, Spongillidae
 - common but often overlooked because of amorphous structure
- only one free-living family of **Cnidaria** in Alberta, Hydridae
 - one species of freshwater ‘jellyfish’ found in eastern Canada
 - stay tuned for information on Alberta’s parasitic cnidarians



Triploblasts

- free-living **Platyhelminthes**
 - large and small
 - are also many parasitic flatworms in fresh water, but most of these are not discussed in the course
- **Nematoda**
- **Nematomorpha** (horsehair worms)
- **Gastrotricha**
- **Nemertea** – found by Zool 351 students in 2002!
- **Rotifera**
 - diverse and often beautiful



JH



H. Stormer

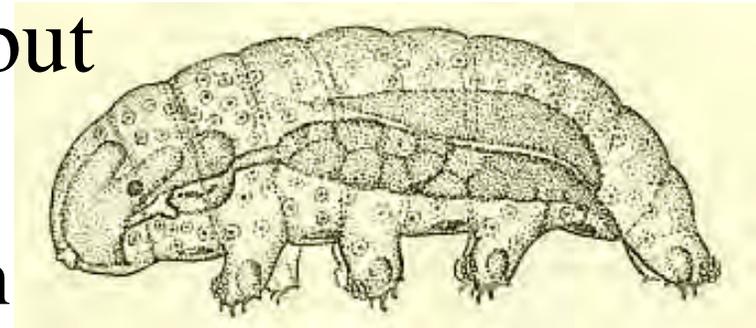
Triploblasts...

- four(?) species of **Bryozoa**
(= Ectoprocta) in Alberta
 - often overlooked, but statoblasts common
- **Annelida** represented by Clitellata
 - most freshwater **oligochaetes** small
 - Alberta blessed with high diversity of freshwater **leeches**, few of which bite humans
- no(?) polychaetes definitively known from Alberta
 - but reports of some from hyporheic waters near Kananaskis



Triploblasts...

- two classes of **Mollusca** in Alberta
- gastropods well-represented with 7 families and about 40 spp.
- bivalves (a.k.a. Pelycepoda) not as diverse with only 2 families
 - are the biggest freshwater invertebrates in AB by mass
- **Tardigrada** (water bears) tiny but tough!
 - diversity in Alberta poorly known



Triploblasts: Arthropoda

- dominant group in inland waters, numerically and by species richness, is the **Arthropoda**
- Class Insecta most diverse except in saline waters
- Alberta has ~ 95 families of insects with aquatic representatives
 - most are aquatic as larvae and aerial as adults



Arthropods...

- crustaceans are second highest in diversity
- Alberta has few large-bodied crustaceans compared to less glaciated areas
 - e.g. Alberta has 1 species of **crayfish**, Australia has ~100 species
 - amphipods (“**scuds**”) have high biomass and low diversity in AB
- **cladocerans** and **copepods** abundant and diverse
- **ostracods** poorly known but likely to be very diverse as well



Arthropods...

- arachnids represented by a few semi-aquatic **spiders** and many **mites**
- *Dolomedes* is a common genus of ‘fishing spider’
- water mites (**Hydrachnidia**) diverse and colourful
 - several other aquatic mite taxa

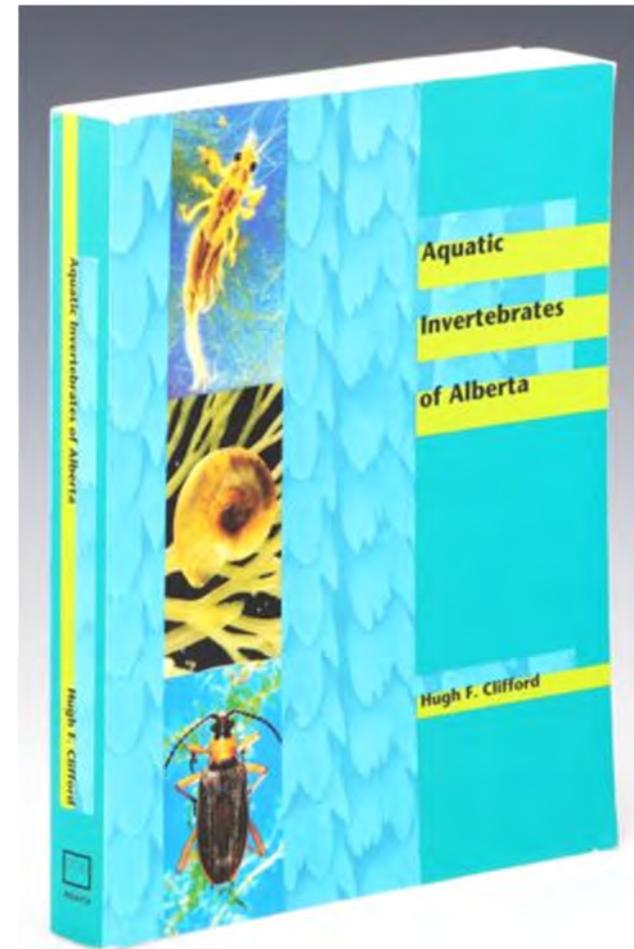


<https://www.pinejournal.com/sports/4306977-northland-nature-large-dock-spiders-can-be-seen-land-and-near-water>



How do we know what freshwater invertebrates are in Alberta?

- Dr. Hugh Clifford at the U of A studied FW inverts with a focus on mayflies
- he taught Invertebrate Zoology and other courses from 1965 to 1995
 - received the Science Award in 1990 for Excellence in Undergraduate Teaching in Science, and the Rutherford Award in 1993 for Excellence in Undergraduate Teaching
- a scanned version is freely available:
<https://archive.org/details/aquaticinvertebr00clif/mode/2up>



Clifford (1991) on eBay (\$199!),
and on Amazon for \$427!!
<https://www.ebay.com/itm/124979120332>;
<https://www.amazon.ca/Aquatic-Invertebrates-Alberta-Hugh-Clifford/dp/0888642334>

Freshwater invertebrates: why bother studying them?

- many reasons to be interested
- fisheries
 - fish ecology



stomach contents of a trout

(<https://westchesterfishing.com/forum/index.php?topic=5114.0>)



larval caddisfly

(Hydropsychidae: *Hydropsyche*)

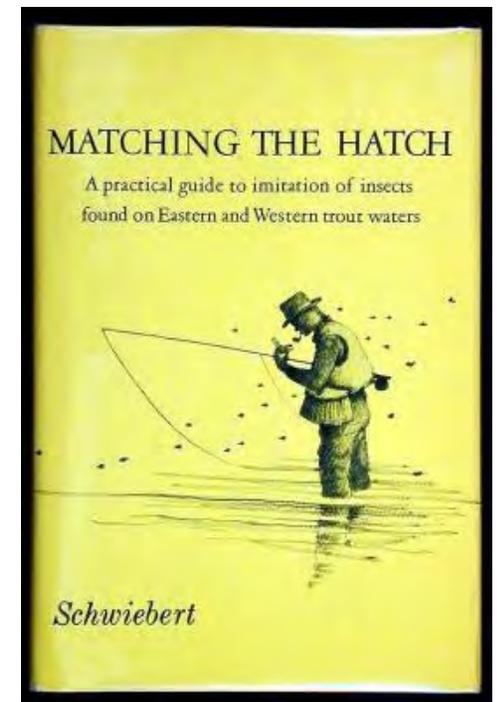
Wikimedia

Why bother...

- recreational fishing and fly-tying
 - “matching the hatch”



<https://www.amazon.com/Matching-Hatch-Earnerest-Jr-Schwiebert/dp/B004ZSZC7Y>;
https://www.flytierspage.com/lbentsen/oliver_edwards_hydropsyche_larva.htm;
<https://www.urbanangler.com/fly-tyer-magazine-fly-tyer-magazine.html>



Why bother...

- ecological assessment, biomonitoring
 - e.g. ABMI has goal of monitoring ecological change over time based on distribution of terrestrial and freshwater species
- presence and absence of particular invertebrate taxa often reflects ‘health’ of habitat
- ‘healthy’ water has high diversity and many taxa sensitive to disturbance and/or pollution



**high
oxygen**



low oxygen

Biomonitoring programs using freshwater invertebrates

- U.S. Environmental Protection Agency (EPA)
 - <https://www.epa.gov/national-aquatic-resource-surveys/indicators-benthic-macroinvertebrates>
- United Kingdom and the EU: RICT, RIvPACS
 - <https://www.ceh.ac.uk/services/rivpacs-reference-database>
 - Australia: AusRIvAS
 - <http://ausrivas.ewater.org.au/>
- Canada: CABiN
 - <https://www.canada.ca/en/environment-climate-change/services/canadian-aquatic-biomonitoring-network.html>
 - Alberta Biodiversity Monitoring Institute (ABMI)
 - <https://www.abmi.ca/home/publications/351-400/396>

Why bother...

- ecotoxicology
 - some invertebrates accumulate toxins or metals
- conservation
 - areas of high invertebrate endemism
 - springs
- assessment of rehabilitation success
 - e.g. ponds in coal-mining landscape
- vectors of disease
 - biting flies (e.g. mosquitoes and West Nile), snails as intermediate trematode hosts



East Pit Lake, Alberta

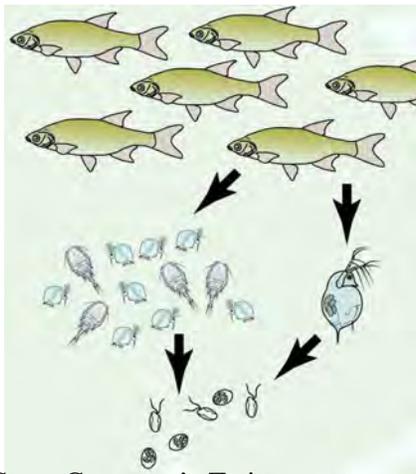


Why bother...

- paleolimnology
 - uses cores from lake beds to assess past climate
- testing general ecological theory
 - food webs, trophic cascades, effects of invasive species
- culture, aesthetics, wonderment



https://serc.carleton.edu/NZFires/predict_future.html

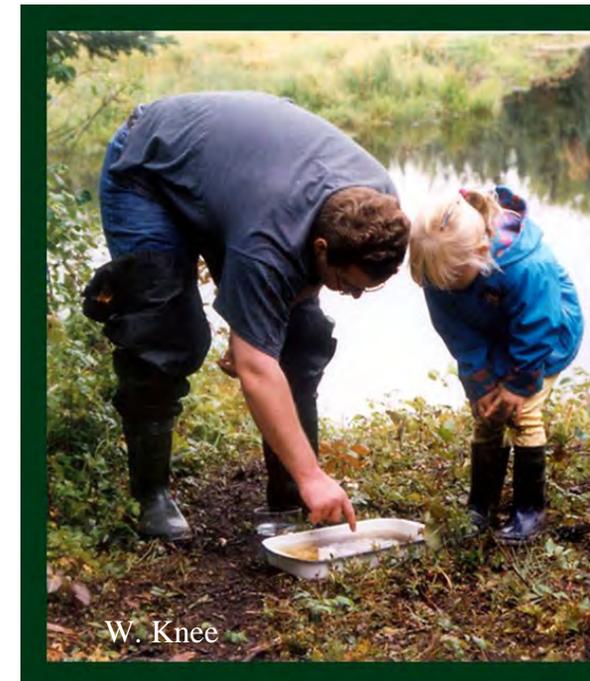


Steve Carpenter's Twitter acct



Charles Krebs on

<https://www.photomacrography.net/>



W. Knee

Four featured fiends

- stealthy stabbers
- lethal liquefiers
- body snatchers
- nasty cnidarians



Stealthy stabbers I: Hemiptera - Belostomatidae

- giant water bugs
 - camouflaged ambush hunters with beak-like mouthparts, powerful digestive enzymes
 - *Lethocerus americanus* is in AB



<https://www.nationalgeographic.co.uk/2019/04/giant-water-bugs-eat-turtles-ducklings-and-even-snakes>

<https://www.youtube.com/watch?v=rpWZBf7GIyg>

Stealthy stabbers II: Hemiptera - Nepidae

- water scorpions
 - same hunting method as belostomatids
 - broad-bodied and slender-bodied genera



Nepa (left) and *Ranatra* (right) (both JH)

Stealthy stabbers II: Hemiptera - Nepidae...

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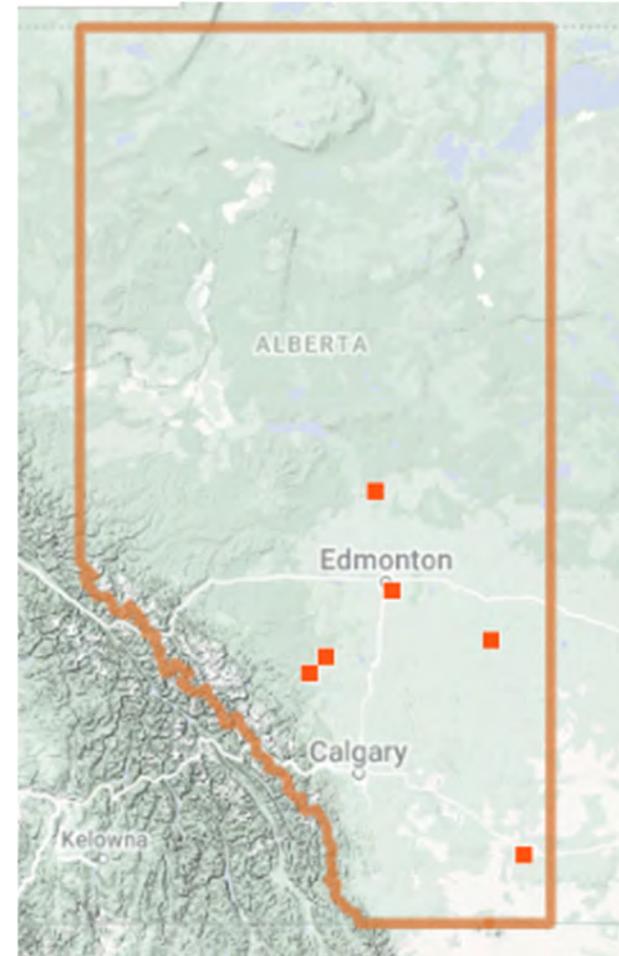
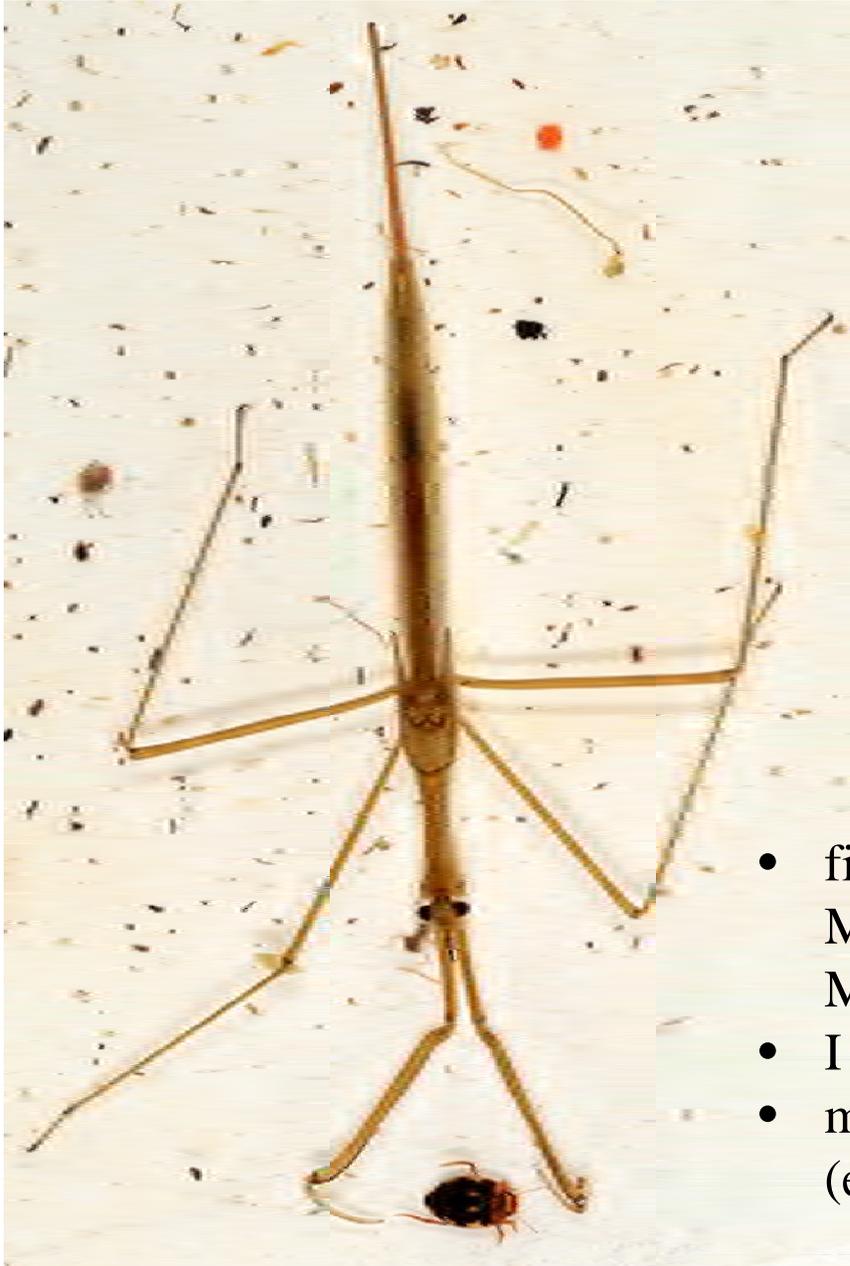
Some Taxa Not Reported From Alberta

Perhaps, eventually, representatives of some of the seven North American families that have not been reported from Alberta will be collected in the province. These are the Hydrometridae (marsh treaders), **Nepidae** (water scorpions), Naucoridae (creeping water bugs), Pleidae (pigmy back swimmers), Gelastocoridae (toad bugs), Macroveliidae (no common name), and Ochteridae (no common name).

Clifford (1991) p. 278

Stealthy stabbers II: Hemiptera - Nepidae...

- *Ranatra* is now in Alberta!



- first record in AB to my knowledge was 2006 by Doug Macaulay in the Pinhorn Provincial Grazing Reserve, Milk River
- I first saw it at Long Lake SE of Athabasca in Aug 2016
- map of iNaturalist observations of *Ranatra* in AB (earliest are also in 2016)

Lethal (and non-lethal) liquefiers: Hydrachnidia



<https://twitter.com/saab95adventure/status/783867738997403648>



<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0254598>

- water mites are parasitic as larvae and predatory as nymphs and adults
- 28 families and ~200(?) spp. of water mites in AB

Life-history of water mites

calyptostase: a pupa-like (or rather, puparium like) stage in which an individual moults, stays inside the cast skin, and moults again



parasitic larvae

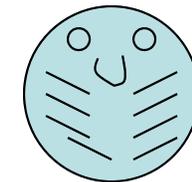


calyptostatic protonymphs

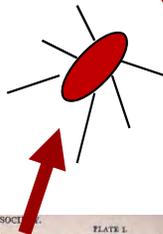
active, predatory deutonymphs



predatory, sexual adults



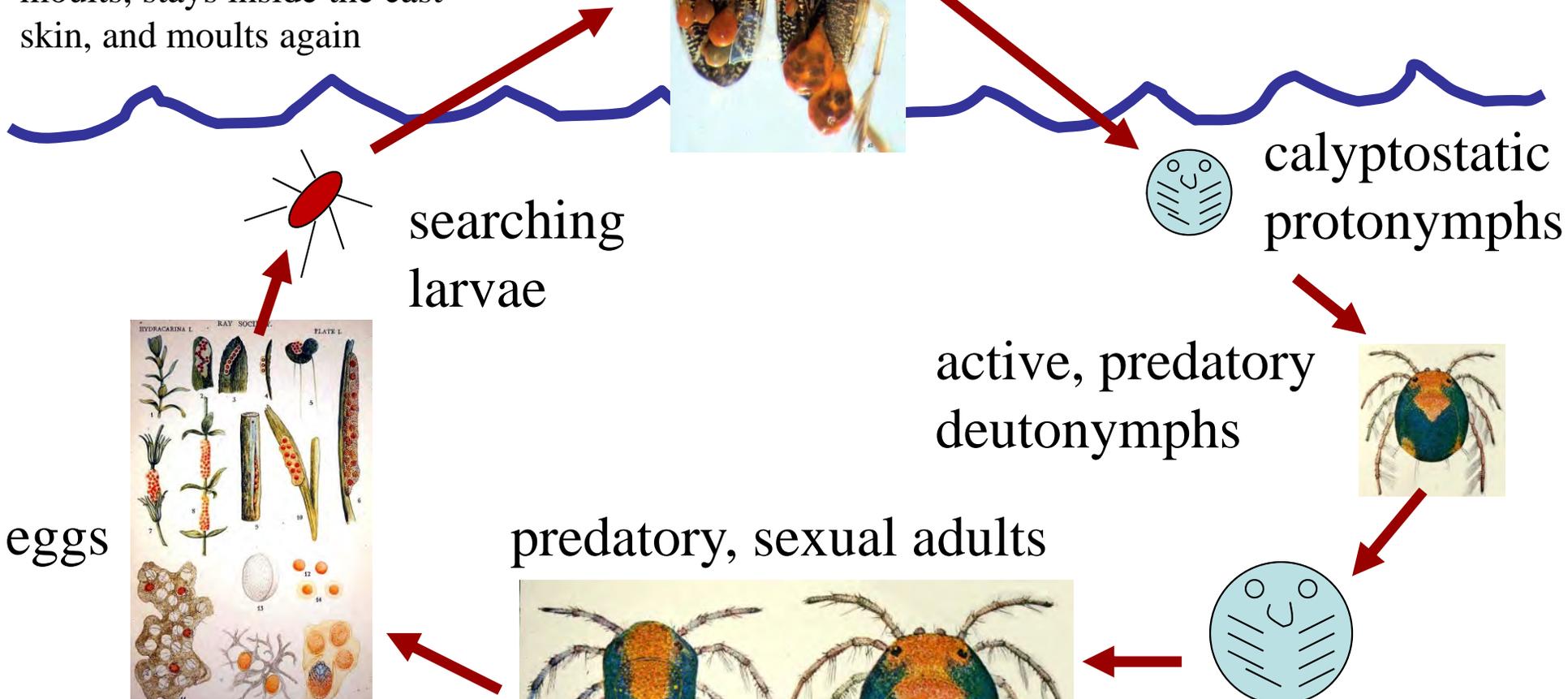
calyptostatic tritonymphs



searching larvae



eggs



Ecology of water mites

- active postlarval stages (deutonymphs and adults) **prey on**:
 - insect larvae, eggs and pupae
 - small crustaceans
 - other water mites
- can be very **fierce**, attacking animals much larger than themselves
 - subdue prey with powerful digestive saliva; **drink liquefied tissues**
- as **larvae**, **parasitize** almost all families of **aquatic insects**
 - Chironomidae (non-biting midges) are particularly popular hosts



water mite attacking a dytiscid beetle larva (JH)



<https://bugguide.net/node/view/126584>



<https://ibol.org/barcodebulletin/research/hunting-for-a-water-mite-neotype-in-southern-norway/>

Ecology...

- larvae *Thermacarus* feed on amphibians
 - or maybe *Thermacarus* larvae feed on snails? Liard Hot Spring observations →
- although parasitism mostly limited to larvae, **deutonymphs and adults** of some taxa feed **parasitically** on tissues of **mussels and snails...**
- ...and some parasitize **newts**
- **rarely eaten by fish**
 - red species are especially distasteful to vertebrates
- are **sometimes eaten by insects** and soft-bodied water mites are often eaten by **other water mites**

Nymphal *Ranatra* (Hemiptera: Nepidae) from Narrow Lk. eating a water mite of the genus *Hydrachna* (Hydrachnidae)



Thermacarus larva on *Physella wrightii* (Physidae) from Liard Hot Springs, BC (photos by E. Helmond, 2019)



Hygrobates forcipifer nymphs and adults in mouth of a newt (<https://doi.org/10.1016/j.limno.2021.125872>)



Meta



- *Ranatra* eating a water boatman while being eaten by water mite larvae (*Hydrachna* sp.)

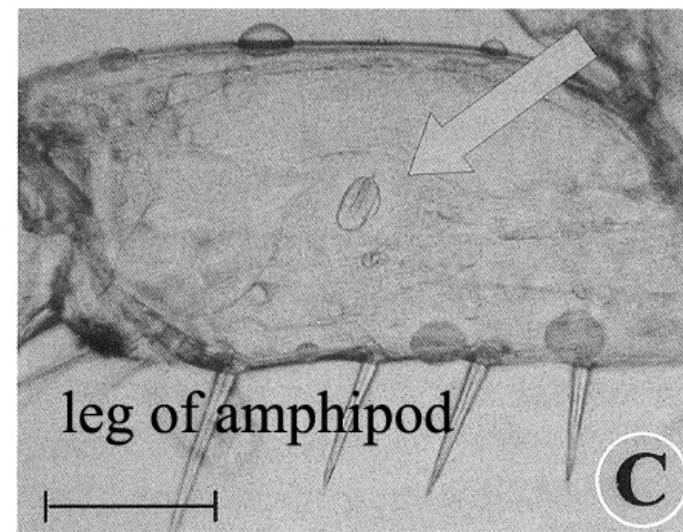
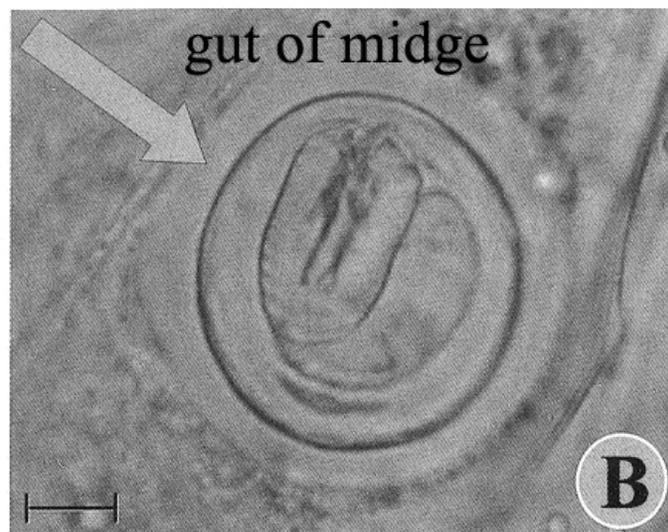
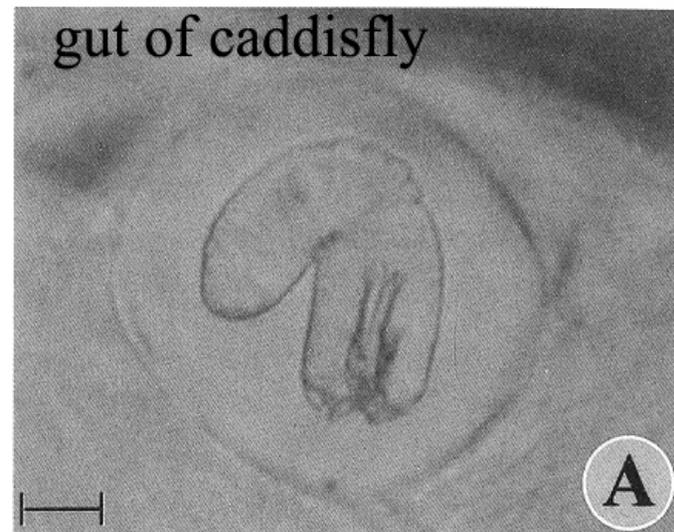
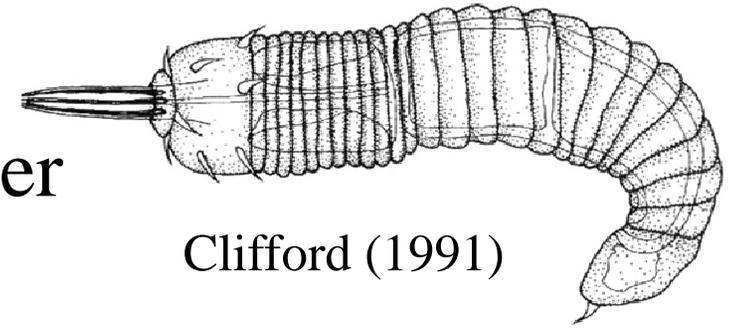
Body snatchers: Nematomorpha

- common name **Gordian worms**...
 - from the ancient Greek story of the Gordian knot (adult worms often form mating tangles)
- ...or **horsehair worms**
 - thought to arise from horse hairs that fell into water
- almost entirely freshwater
 - 326 FW, 5 marine
- adults can get up to 1 m long!
- members of two families known from AB (not clear how many spp.)



Nematomorph life cycle

- adults **do not feed** (have no gut)
- lay eggs in standing or running water
- eggs hatch into parasitic larvae
- larvae sometimes directly eaten by **final host**, but in most cases they burrow into a transport host (**'paratenic'** host = host in which no feeding occurs)



Life cycle...

- paratenic host eaten by final host
 - which is usually a terrestrial insect
- when worm mature it breaks out of host and re-enters water to mate and lay eggs
 - famous ‘cricket throwing itself into a swimming pool’ video:
https://www.youtube.com/watch?v=Df_iGe_JSzI
 - perhaps the worm makes terrestrial hosts thirsty first?

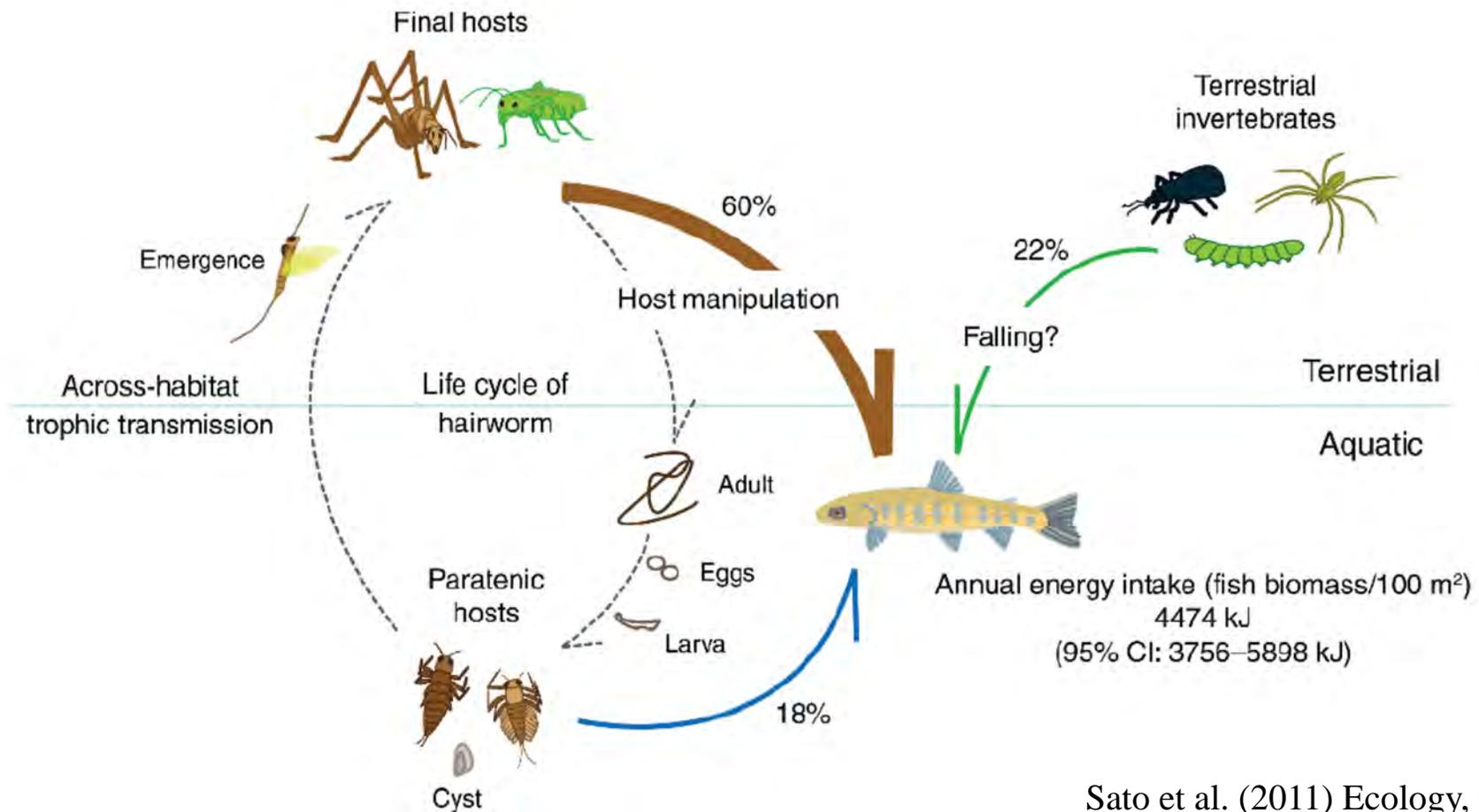


Gordian worm exiting a katydid

<https://bunyipco.blogspot.com/2020/02/horse-hair-worms.html>

Life cycle...

- camel crickets and grasshoppers with Gordian worms 20x more likely to jump in water than uninfected ones
- these parasitized orthopterans make up 60% of Japanese trout diet during ‘nematomorph season’ (Aug – Nov)



Escape from predators of hosts

- Ponton et al. (2006) showed that adult Gordian worms could crawl uninjured out of mouth/gills/nose of predators that had eaten their final hosts

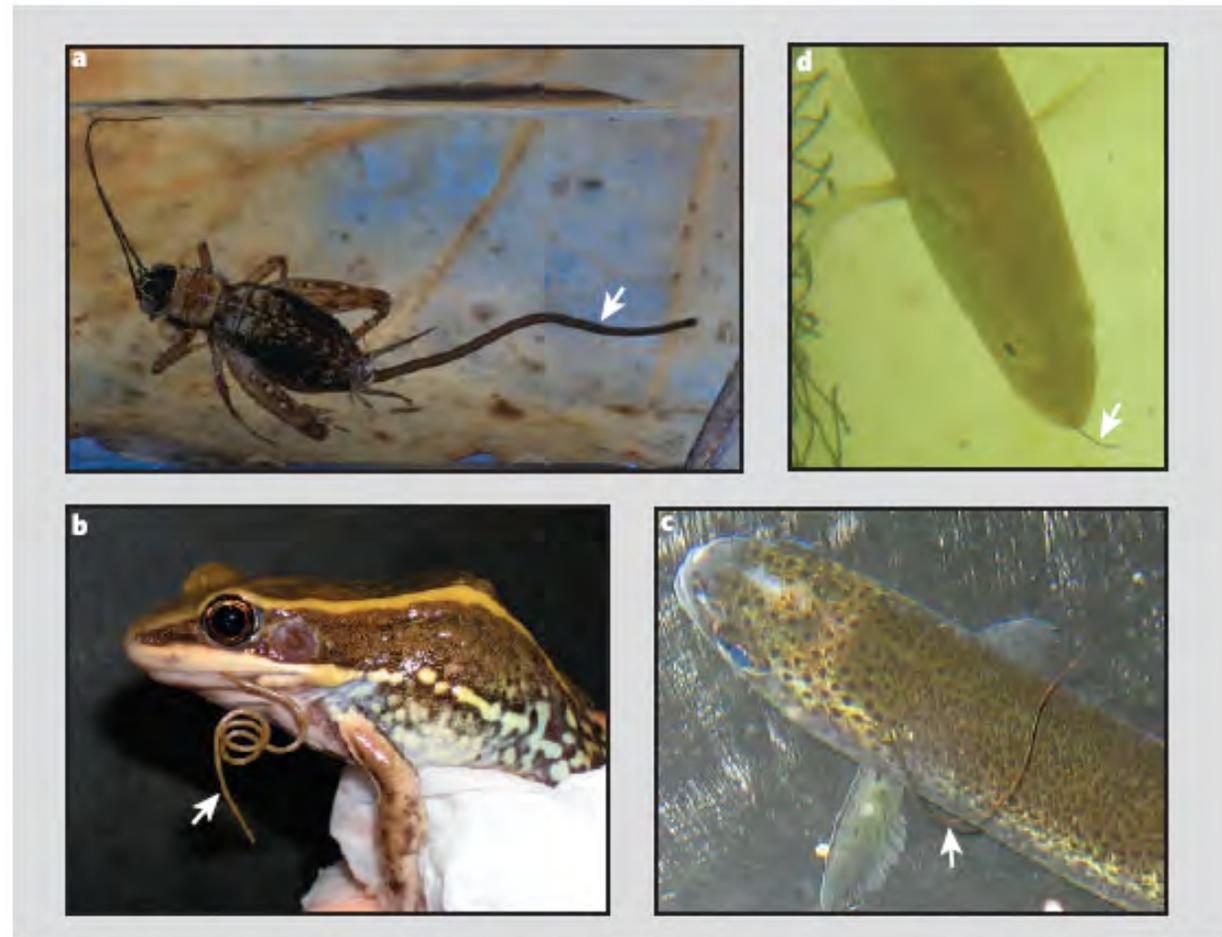
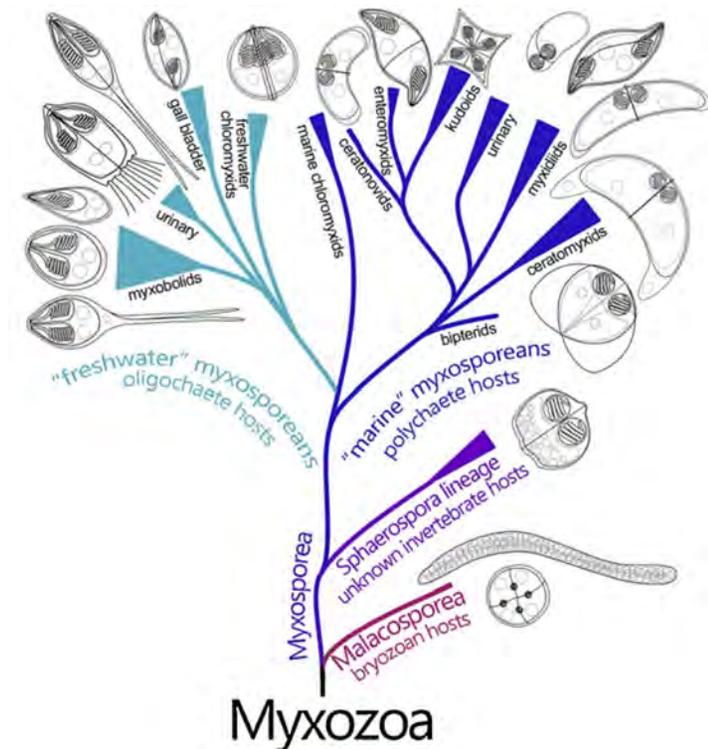


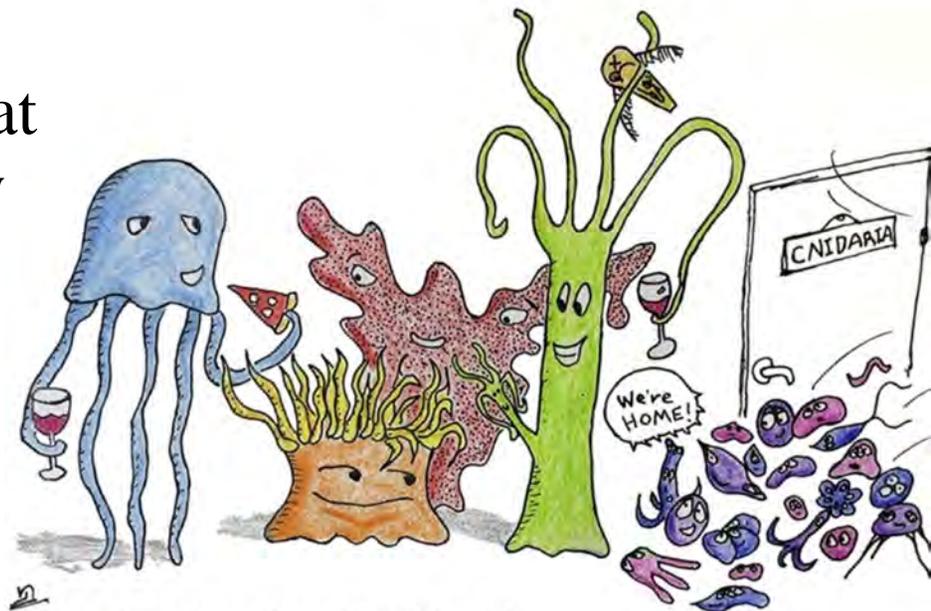
Figure 1 | Escape of parasitic gordian worms from their insect host and from the host's predators. a, Gordian worm (arrow) emerging from a host cricket; b-d, gordian worms (arrows) emerging from a frog (b), a trout (c) and a bass (d) after ingestion of the host insect by these predators. For movies, see supplementary information.

Nasty cnidarians: Myxozoa

- members of the Myxozoa are very small, protist-like organisms
- identified as animals belonging to the Phylum **Cnidaria** via molecular methods around a decade ago
- include > 2000 species, all of which are parasites of animals
 - best known species are those that cause problems in economically important **fish**



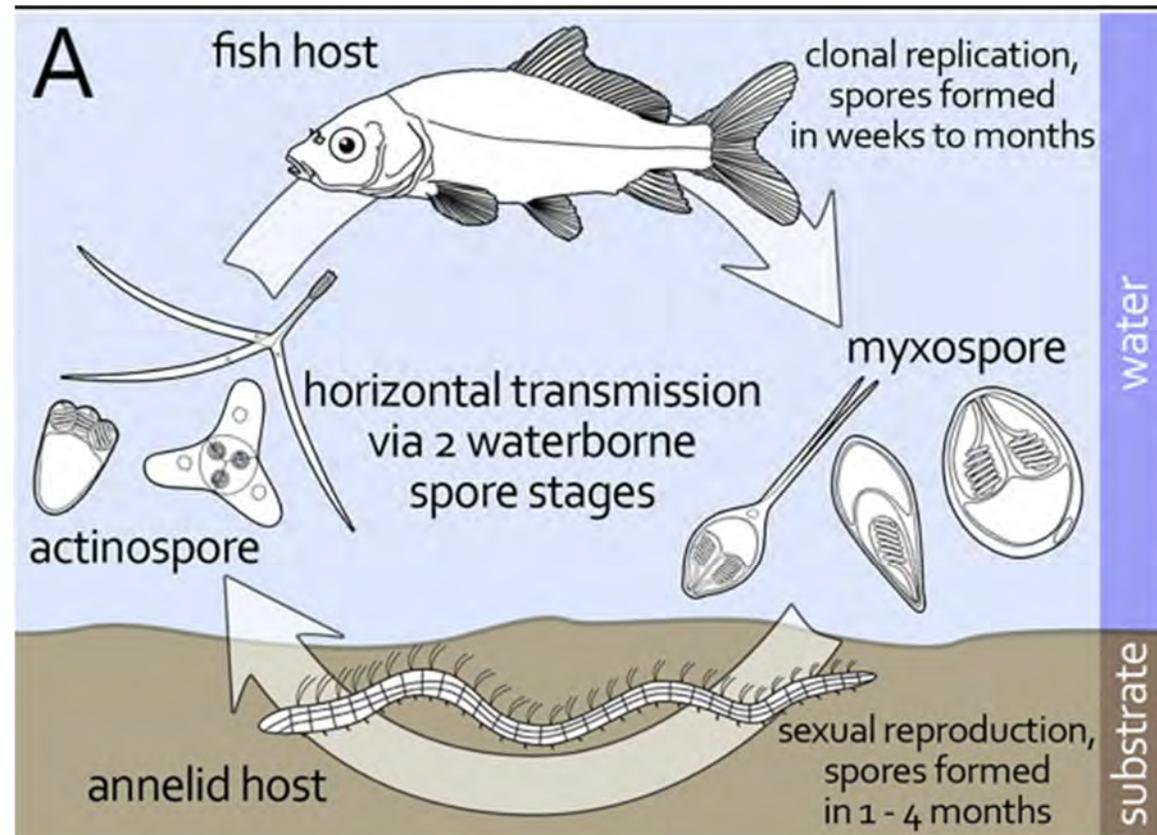
Welcome home Myxozoa



Drawn by: Jonathan Ben-David

Nasty cnidarians: Myxozoa...

- *Myxobolus cerebralis*, a myxozoan parasite of salmonid fish and of oligochaete worms
- causes very serious ‘whirling disease’ in which cartilage and nerves of fish host are damaged



<https://doi.org/10.1016/j.zool.2018.06.005>

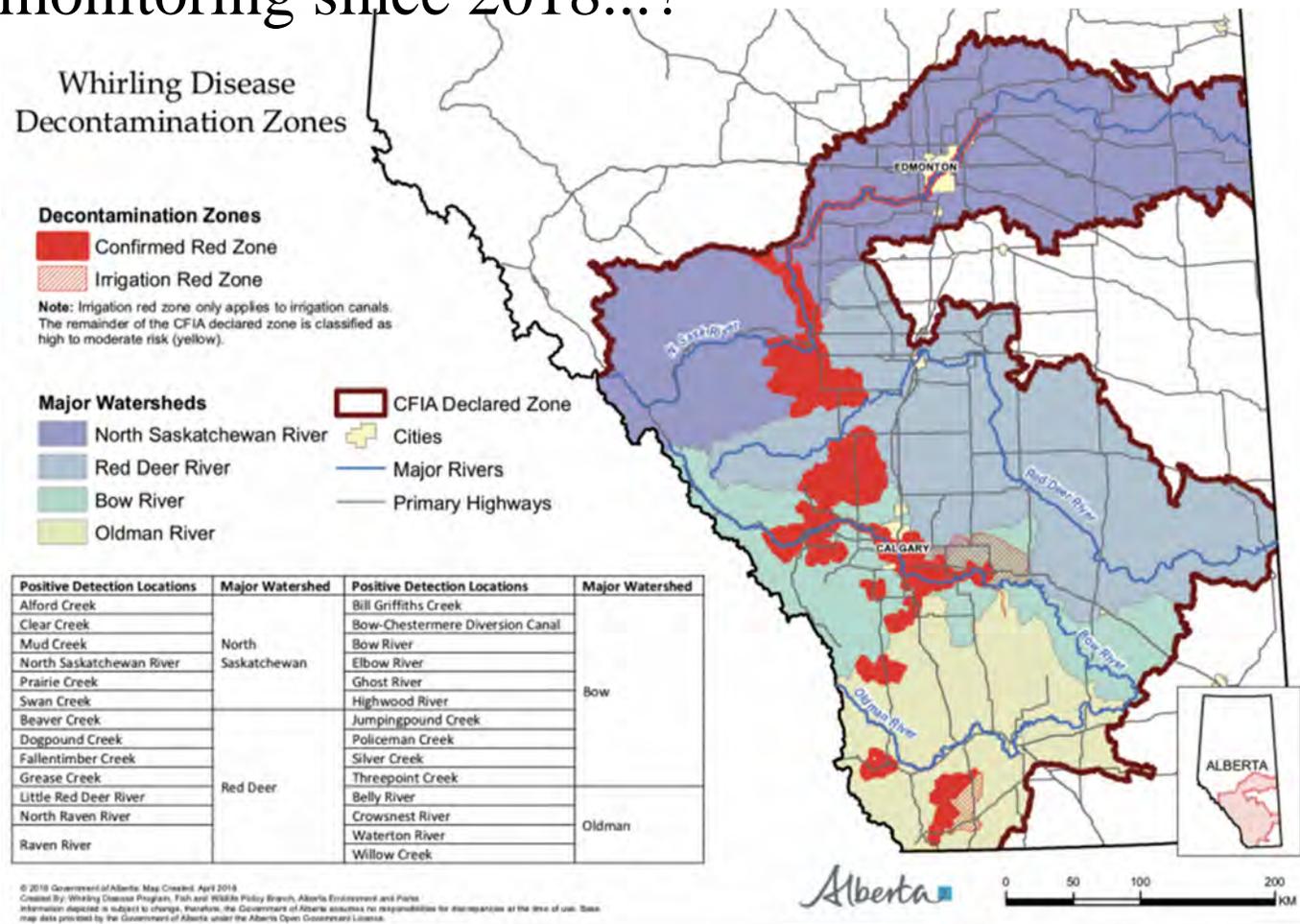
<https://www.tn.gov/twra/fishing/twra-fish-species/whirling-disease.html>



Brown Trout with black, deformed tail.

Whirling disease – first reported in AB in Aug 2016

- Johnson Lake, Banff
- has been detected in many places since then
- DNA-based monitoring: <https://stream-dna.com/2020/06/09/dna-metabarcoding-whirling-disease/>
 - no monitoring since 2018...?



Nasty cnidarians: Polypodiozoa

- endoparasitic polyp
 - *Polypodium* (not known from AB)*
 - early stages parasitic inside eggs of **sturgeon!**
 - somehow *Polypodium* eggs invade developing sturgeon eggs in gonad
 - develop as a branching form inside egg, containing several polyps
 - when fish eggs laid, polyps break free
 - predatory polyps walk upside down on substrate



<https://www.nps.gov/miss/learn/nature/lake-sturgeon.htm>



Wikimedia

*but is in lake sturgeon in Manitoba and Saskatchewan

(https://www.jstor.org/stable/3283140?origin=crossref#metadata_info_tab_contents)

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not a treat if infected
with *Polypodium!*

*but is in lake sturgeon in Manitoba and Saskatchewan

(https://www.jstor.org/stable/3283140?origin=crossref#metadata_info_tab_contents)



Dragonfly larvae always wear masks!



Thanks for
your attention!

