

How parasite communities changed in response to human-induced ecosystem perturbations in Lake Victoria

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LEIP
ZIG 

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Global change

Global change & populations

- Distribution shifts
- Population declines and extinctions
- Few invasions
- in plants
- in animals

free-living

(metazoan) parasites?

Expected to be affected, but direction of change has not been tested



Why bother about parasite destiny?

Individual with many parasites → unhealthy

Ecosystem with many parasites → healthy!

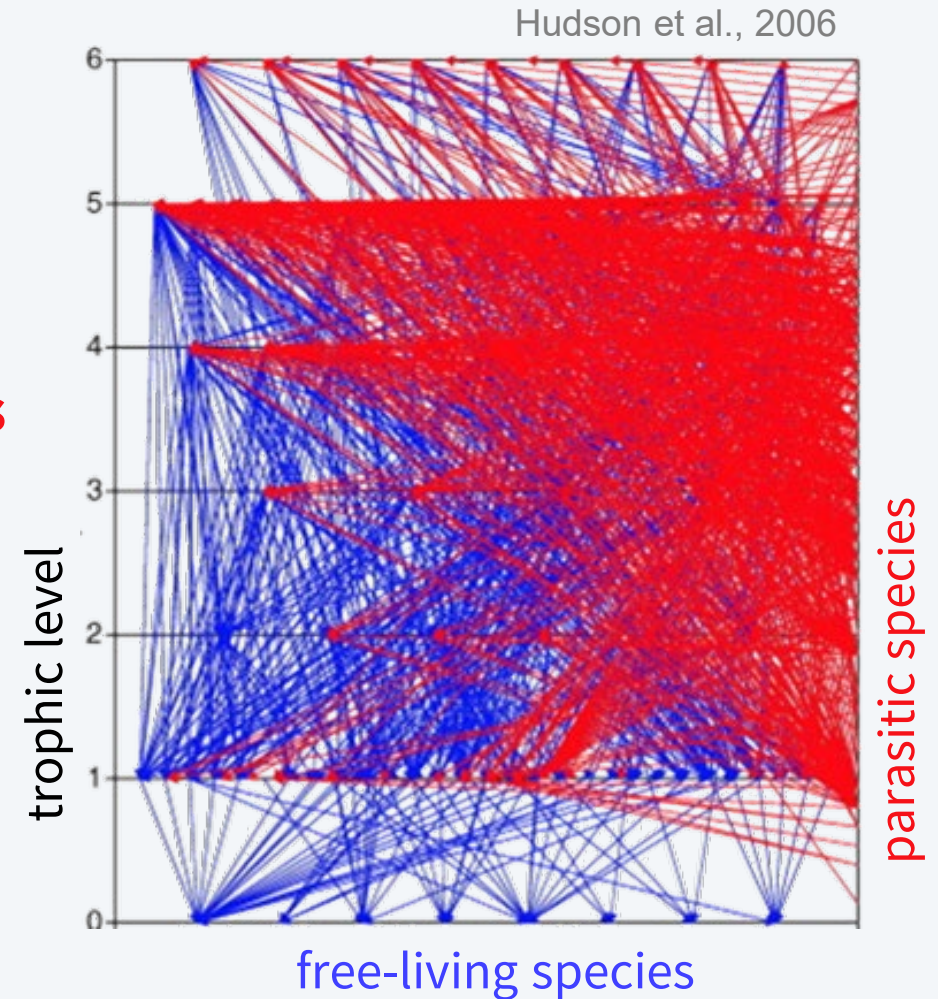
Health ecosystem ← contribution of parasites

Biodiversity (within ecosystem types)

Predictability

Resistance to perturbations

Resilience



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Health ecosystem ← contribution of parasites

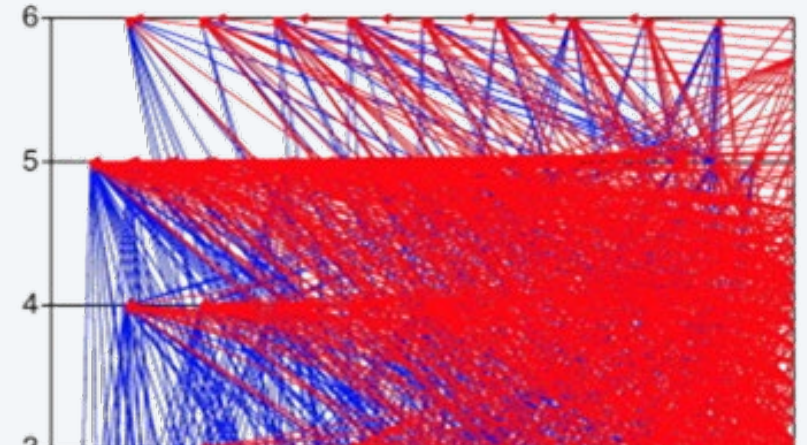
Biodiversity (within ecosystem types)

Predictability

Resistance to perturbations

Resilience

Hudson et al., 2006



Morton & Silliman, 2019

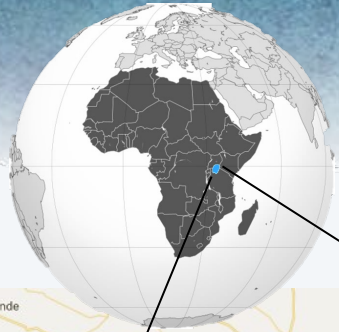
Global change

Anthropogenic changes

- Eutrophication
- Multiple invasions
- Overfishing
- Pollution



Lake Victoria



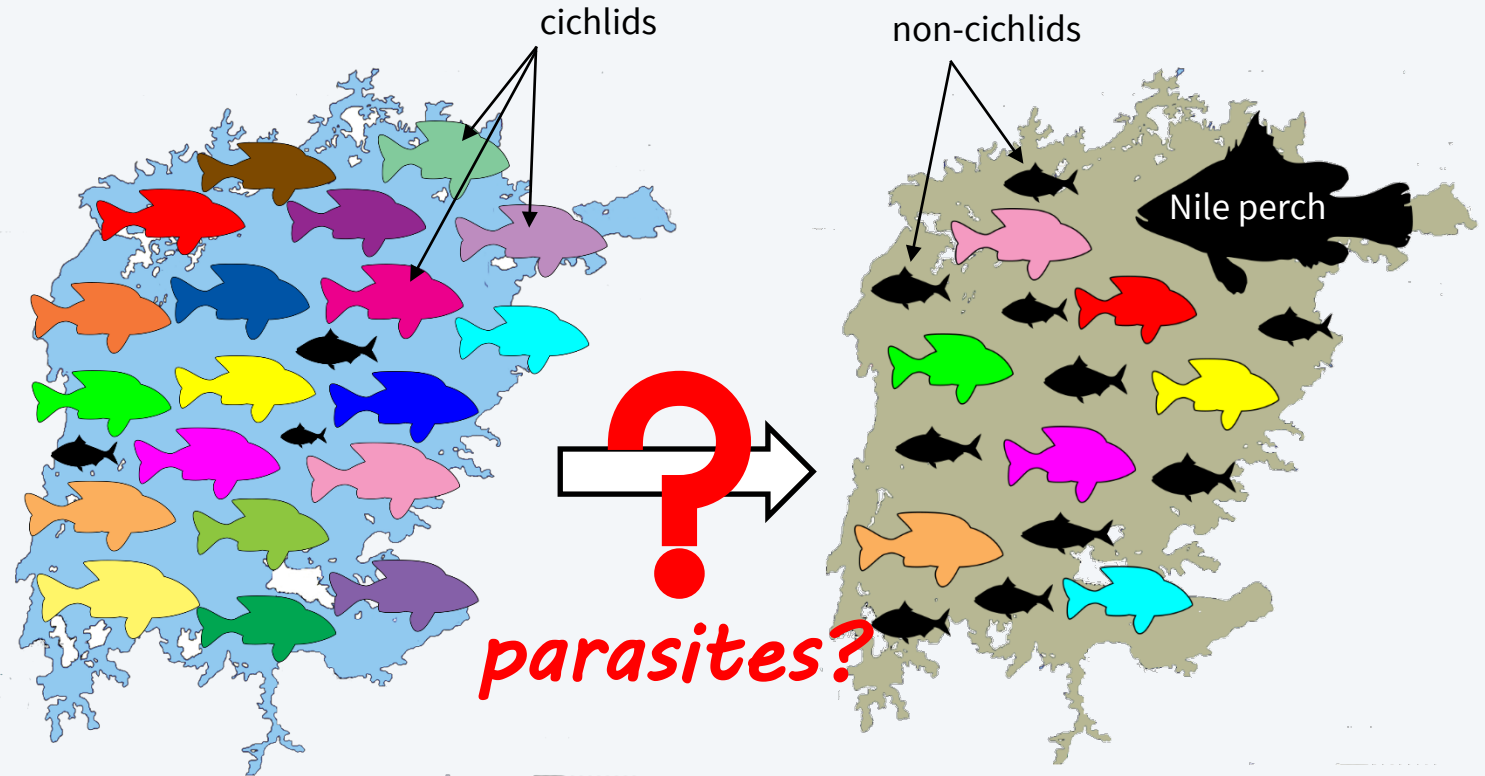
Lake Victoria

- Biodiversity hotspot (especially cichlid fish)
- Drastic anthropogenic changes since 1980s:
 - eutrophication
 - multiple invasions (incl. Nile perch)
 - overfishing
 - pollution

Changes in Lake Victoria

Simultaneous
anthropogenic changes

- rapid loss of biodiversity
- loss of complexity
- less stable ecosystem



BEFORE

>500 cichlids
dominated by cichlids
low predation
low water turbidity

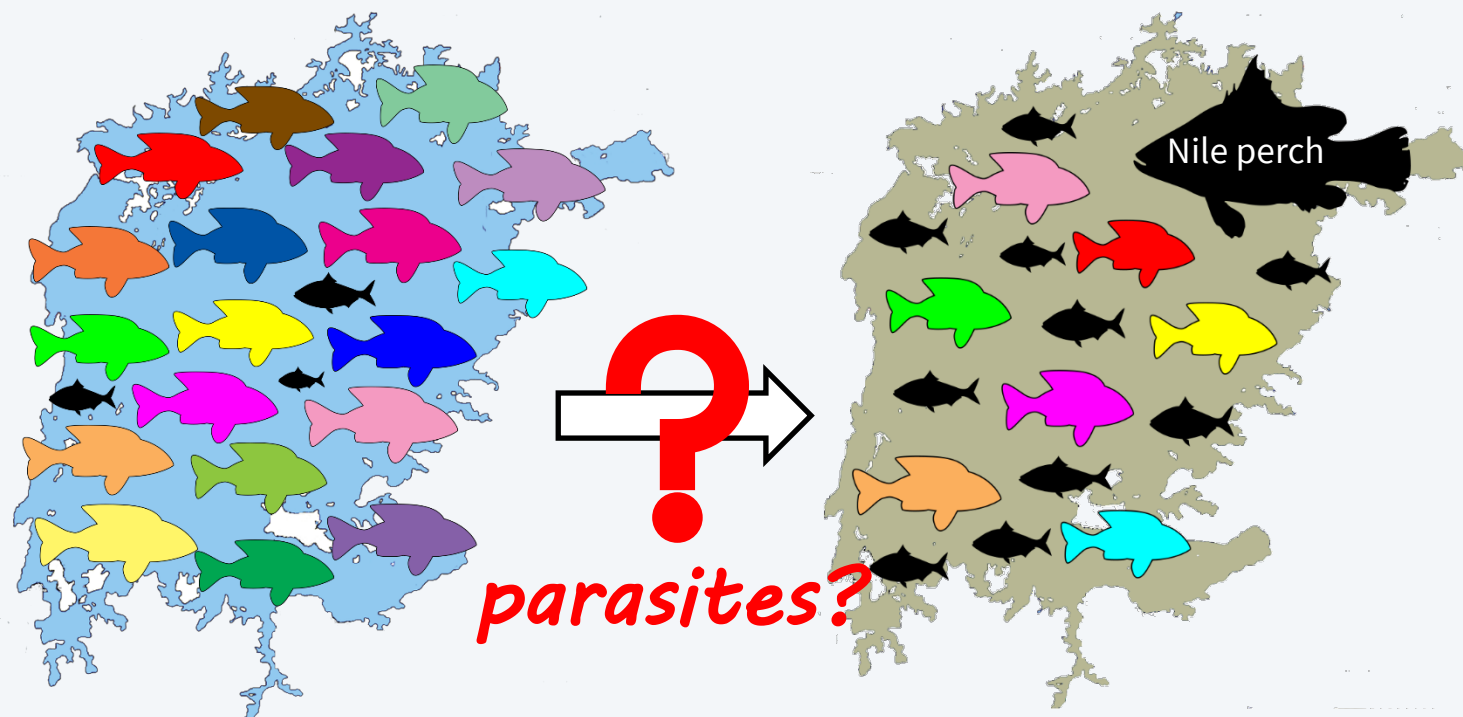
AFTER

250 cichlids
dominated by non-cichlids
high predation (Nile perch)
high water turbidity

Research questions

How parasite communities changed in response to ecosystem perturbations in Lake Victoria?

- parasite abundance
- parasite prevalence
- parasite species richness
- host range of parasites
- host-parasite combinations



Study design

Before-after impact study
using historical and recent collections

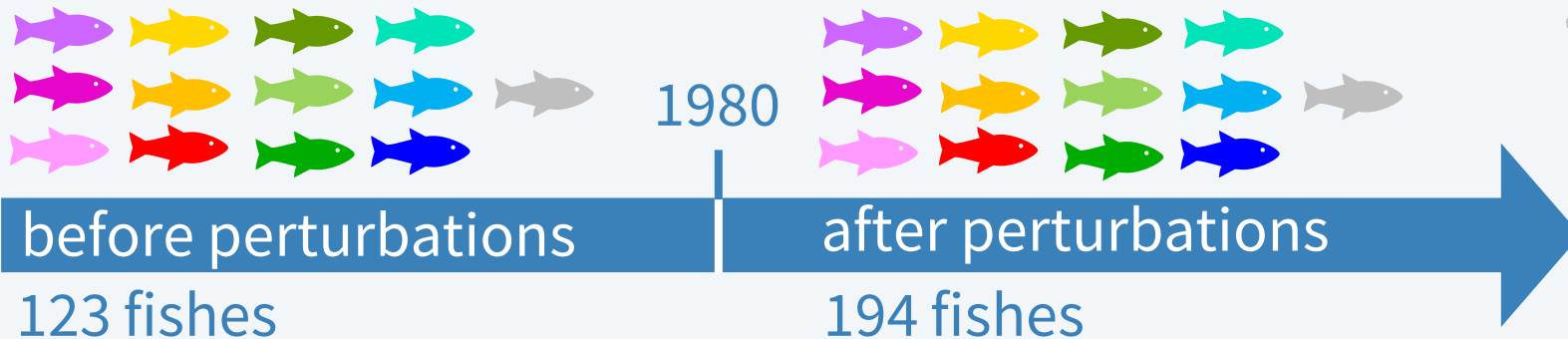


Study design

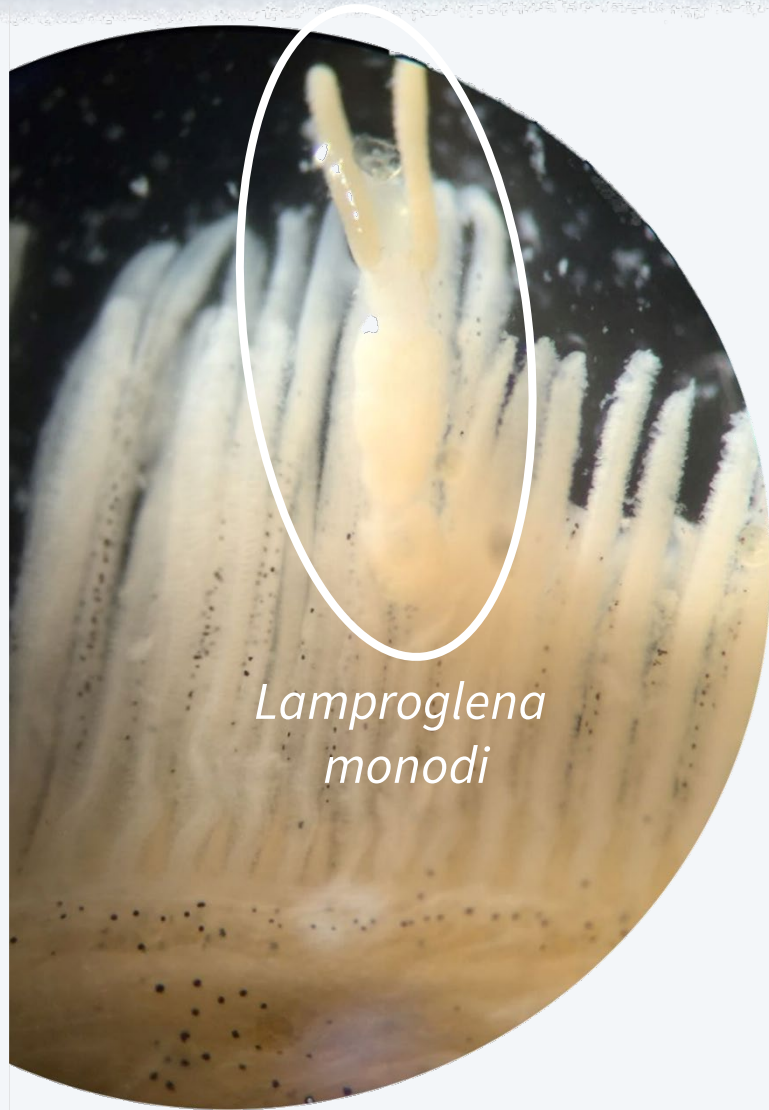
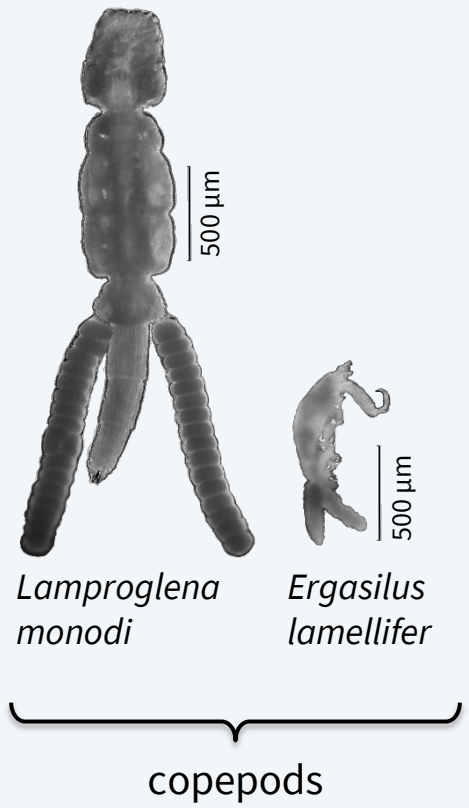
Before-after impact study
using historical and recent collections

13 cichlid species
7 eco-morphological groups
sampled 1973 – 2014

screened for metazoan gill parasites



Gill parasites

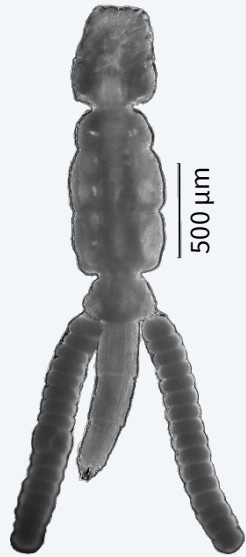


Lamproglena monodi

Gill parasites



6 *Cichlidogyrus* spp.



Lamproglena monodi

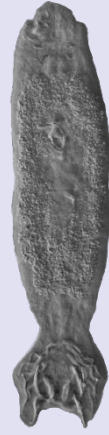


Ergasilus lamellifer

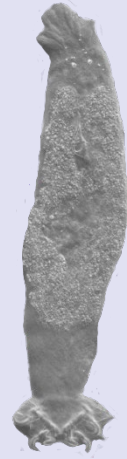
copepods



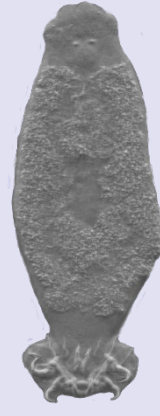
C. nyanza



C. pseudodossoui



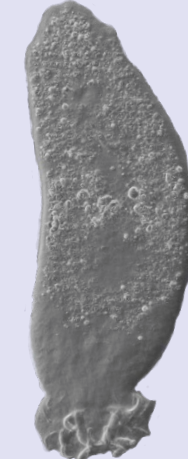
C. furu



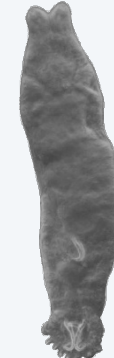
C. vetusmolendarius



C. longipenis



C. bifurcatus



Gyrodactylus sturmbaueri

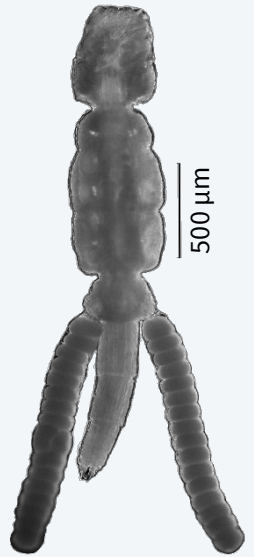
monogeneans (flatworms)



Gill parasites



6 *Cichlidogyrus* spp.
4 species new to science! (Gobbin et al. in prep.)



Lamproglena monodi



Ergasilus lamellifer

copepods



C. nyanza



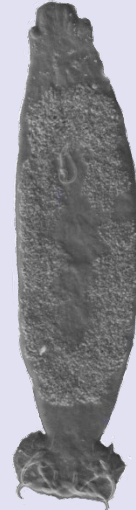
C. pseudodossoui



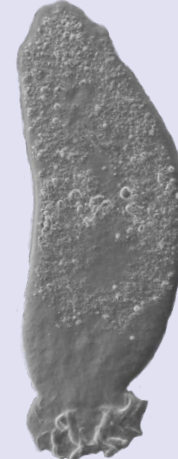
C. furu



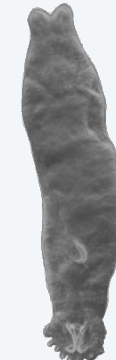
C. vetusmolendarius



C. longipenis



C. bifurcatus

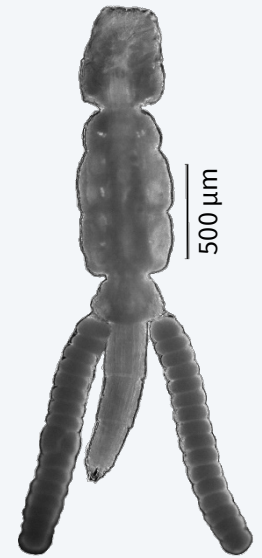


Gyrodactylus sturmbaueri

monogeneans (flatworms)



Gill parasites



Lamproglana monodi



Ergasilus lamellifer

copepods

6 *Cichlidogyrus* spp.



C. nyanza



C. pseudodossoui



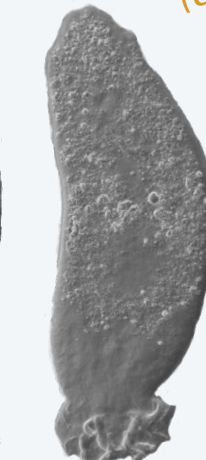
C. furu



C. vetusmolendarius



C. longipenis



C. bifurcatus

monogeneans (flatworms)

1 individual only
(after perturbations)



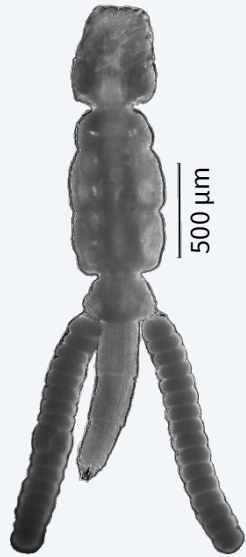
Gyrodactylus sturmbaueri



Gill parasites



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Lamproglena monodi



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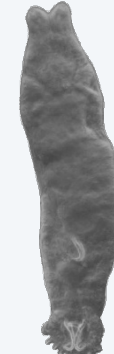
C. vetusmolendarius



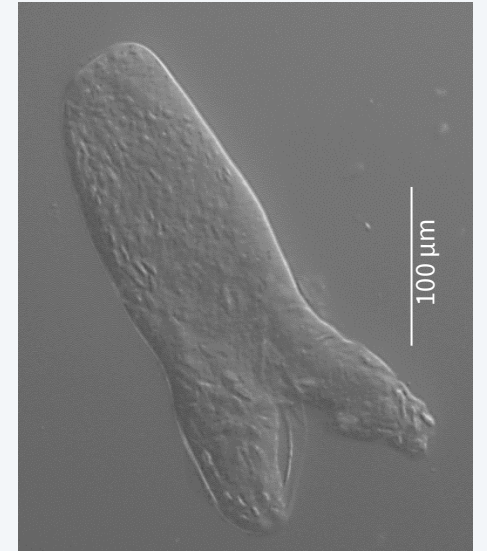
C. longipenis



C. bifurcatus



Gyrodactylus sturmbaueri

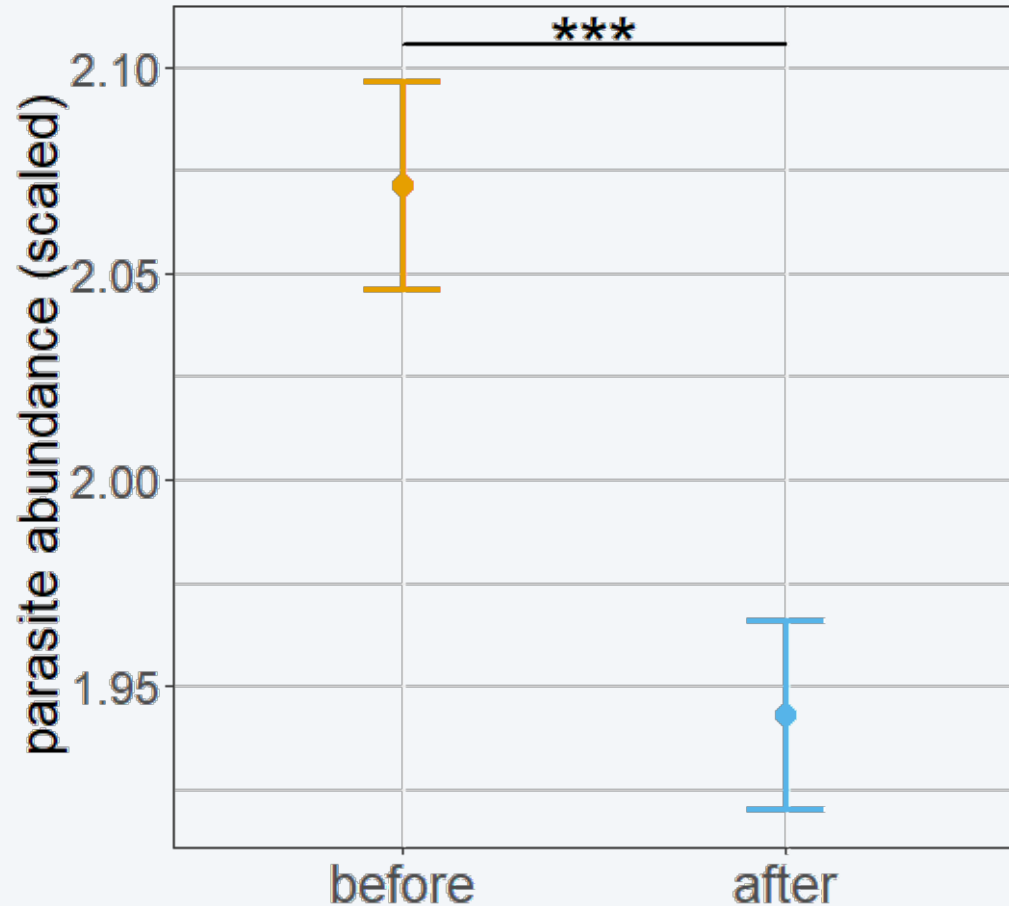


Unidentified parasite taxon
(before perturbations)
→ taxon 1

copepods

monogeneans (flatworms)

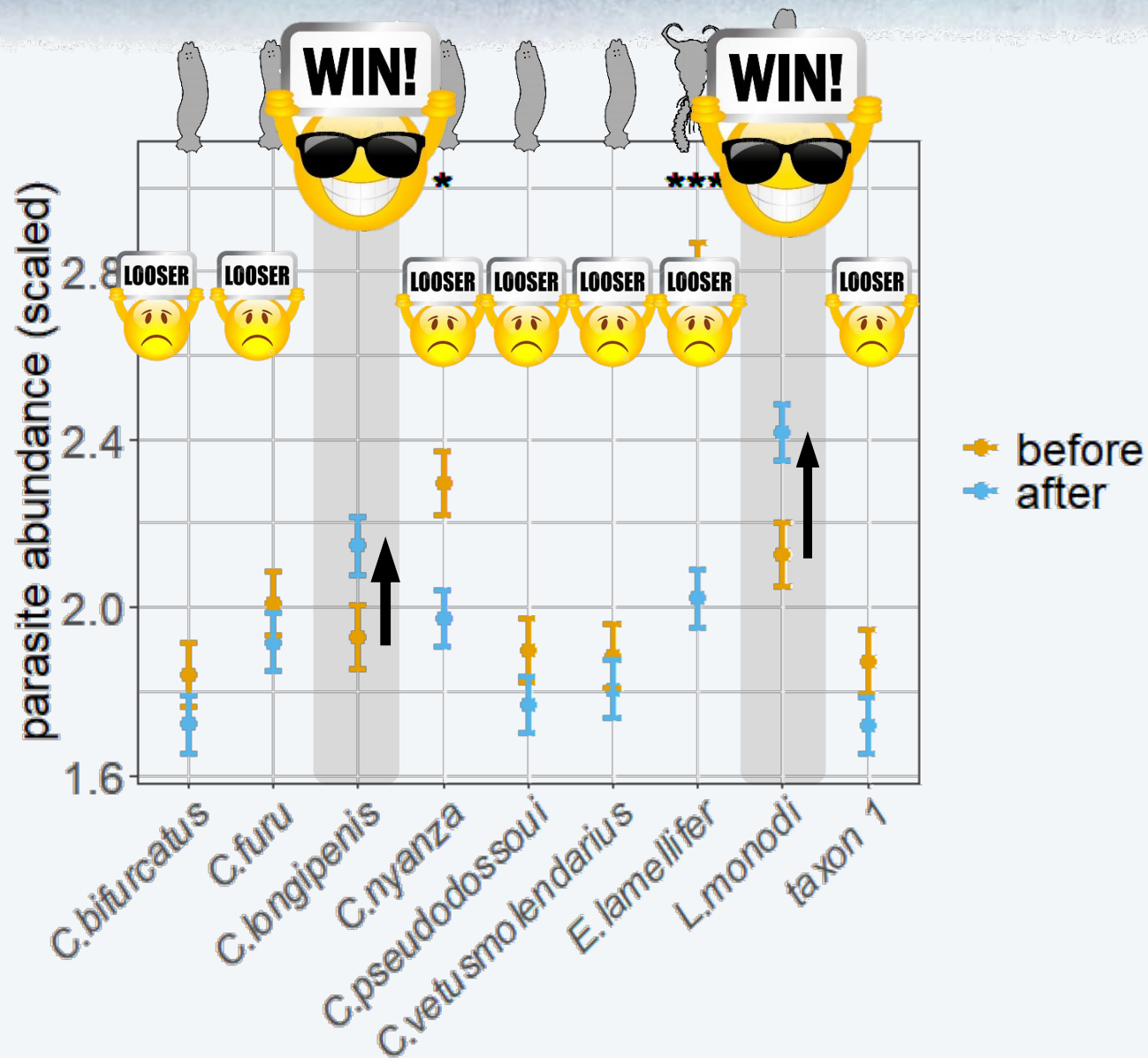
Changes in parasite abundance



Overall, parasite **abundance decreased** after perturbations in Lake Victoria

GLM, controlled for fish size

Changes in parasite abundance



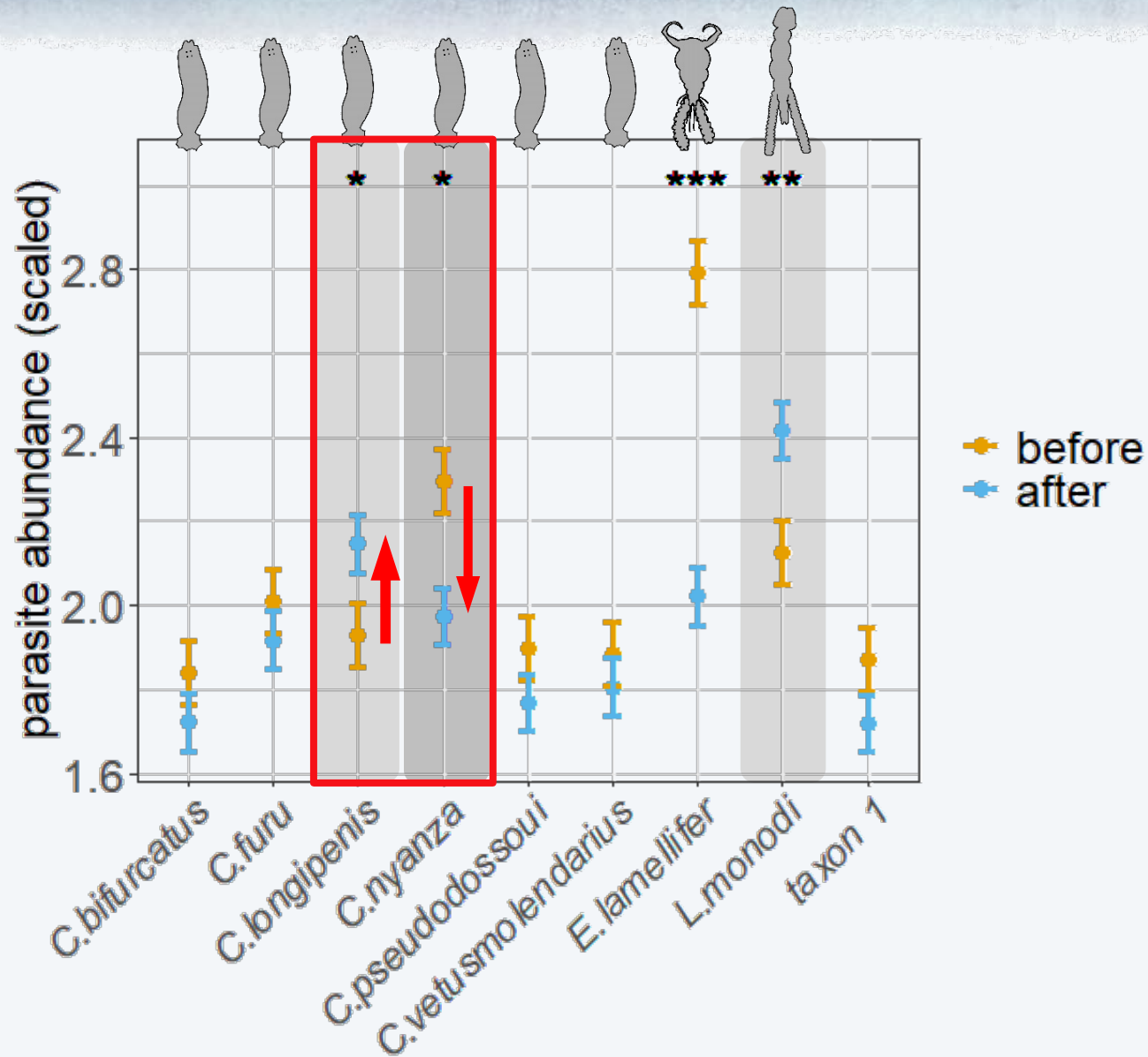
This trend holds for most parasite species

Two parasite species increased in abundance

GLM, controlled for fish size & Tukey posthoc test

Few winners, many losers

Changes in parasite abundance

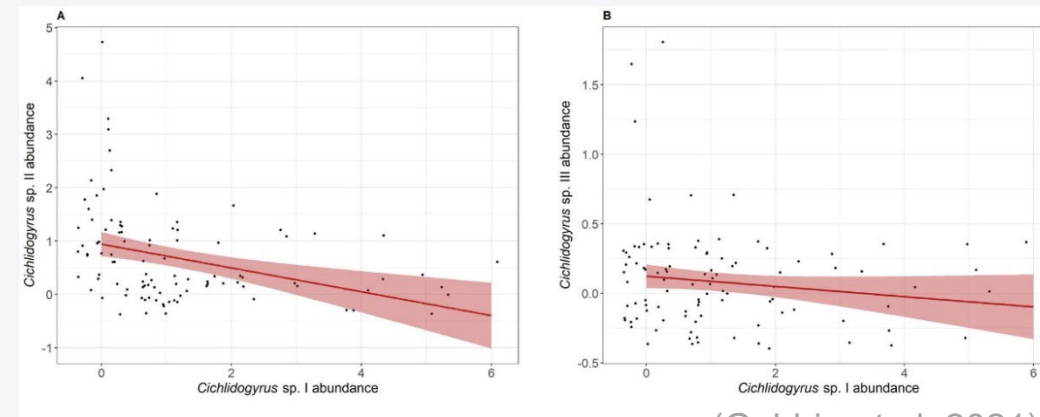


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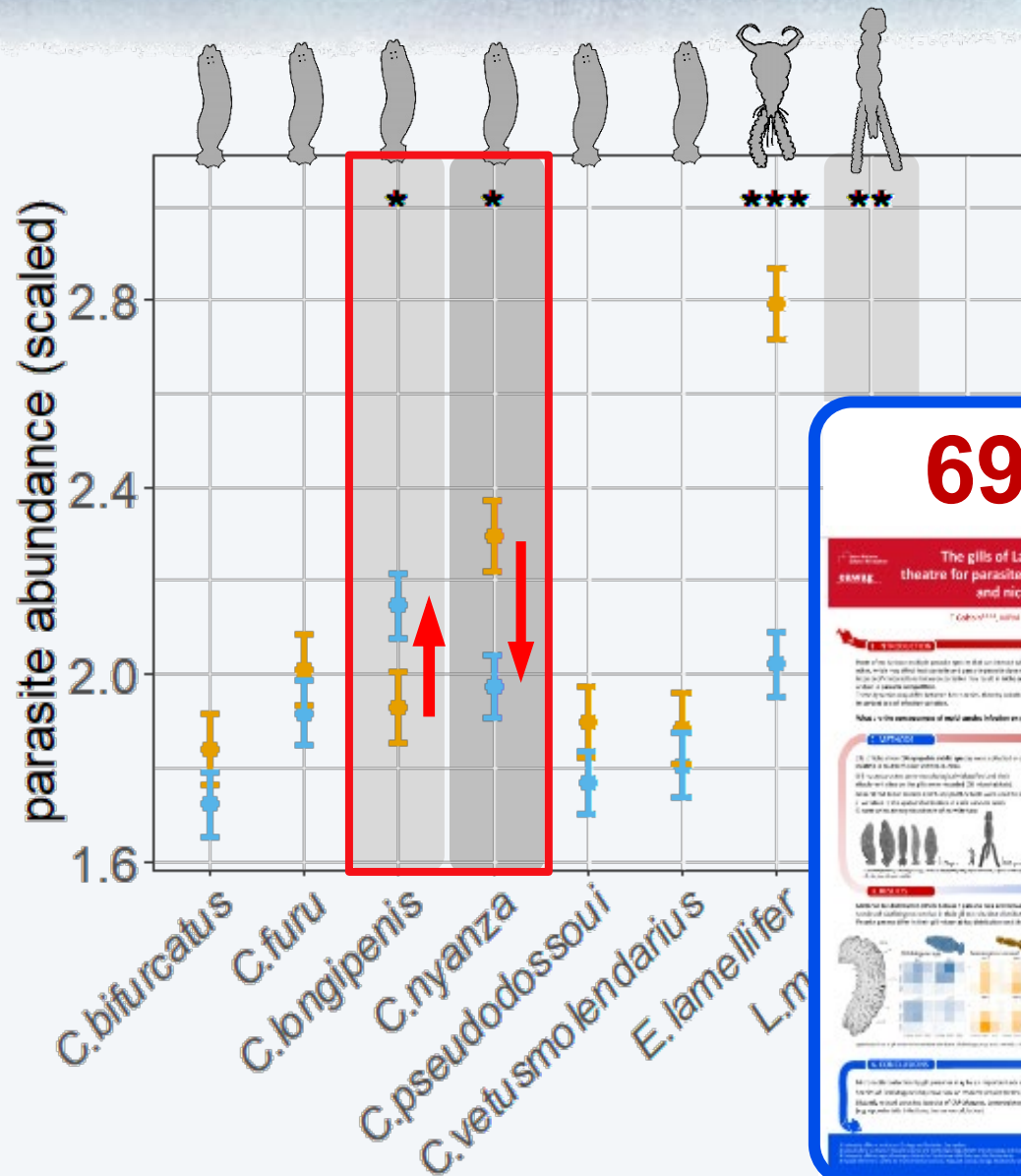
GLM, controlled for fish size & Tukey posthoc test

Competition within species of *Cichlidogyrus* may play a role



(Gobbin et al. 2021)

Changes in parasite abundance

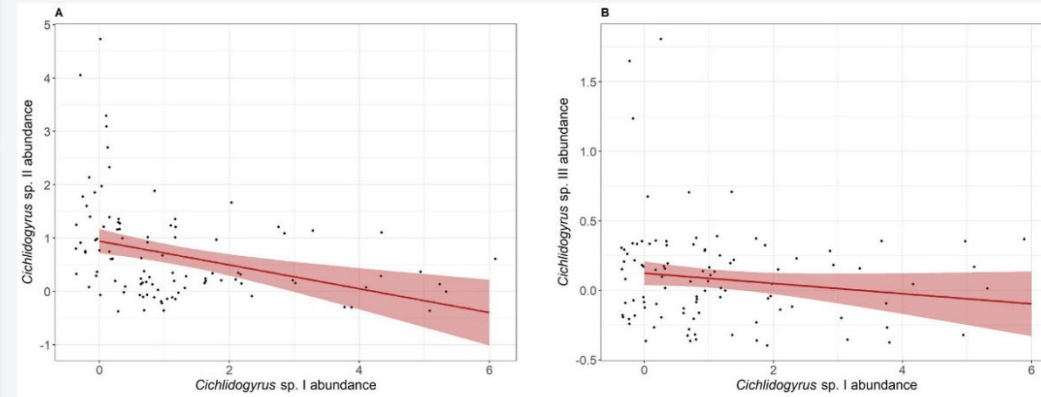


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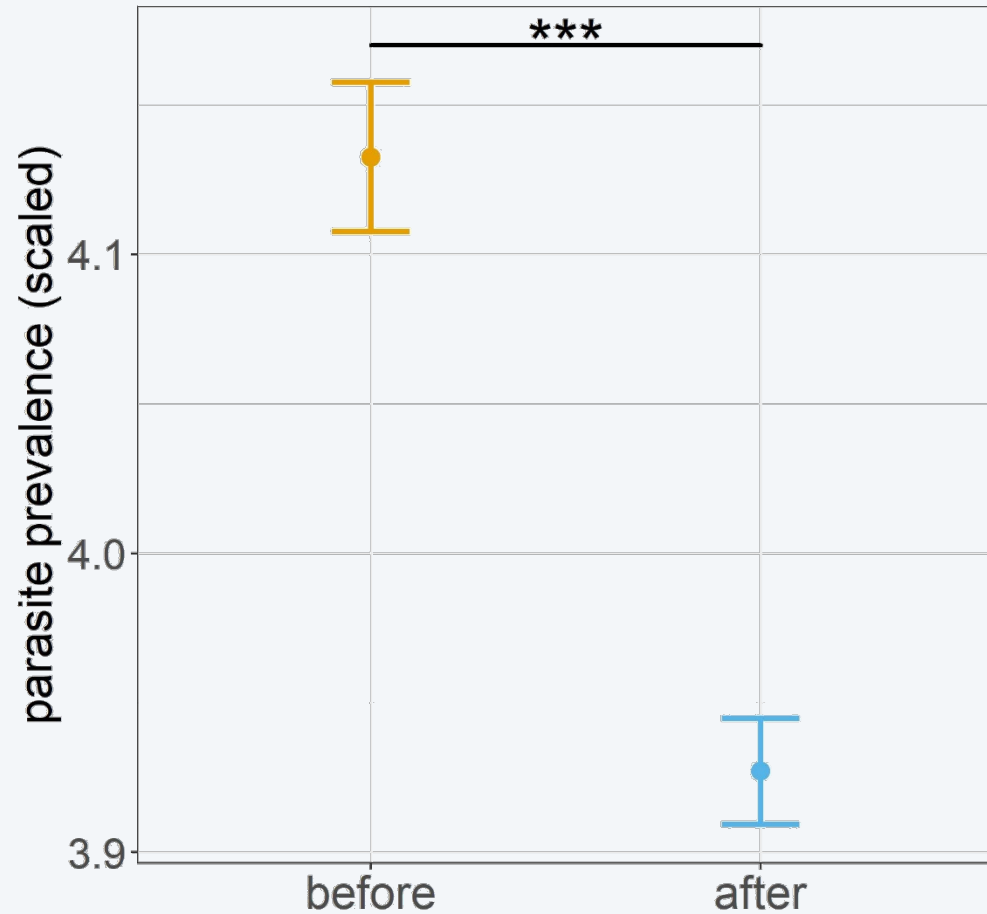
GLM, controlled for fish size & Tukey posthoc test

Competition within species of *Cichlidogyrus* may play a role



(Gobin et al. 2021)

Changes in parasite prevalence

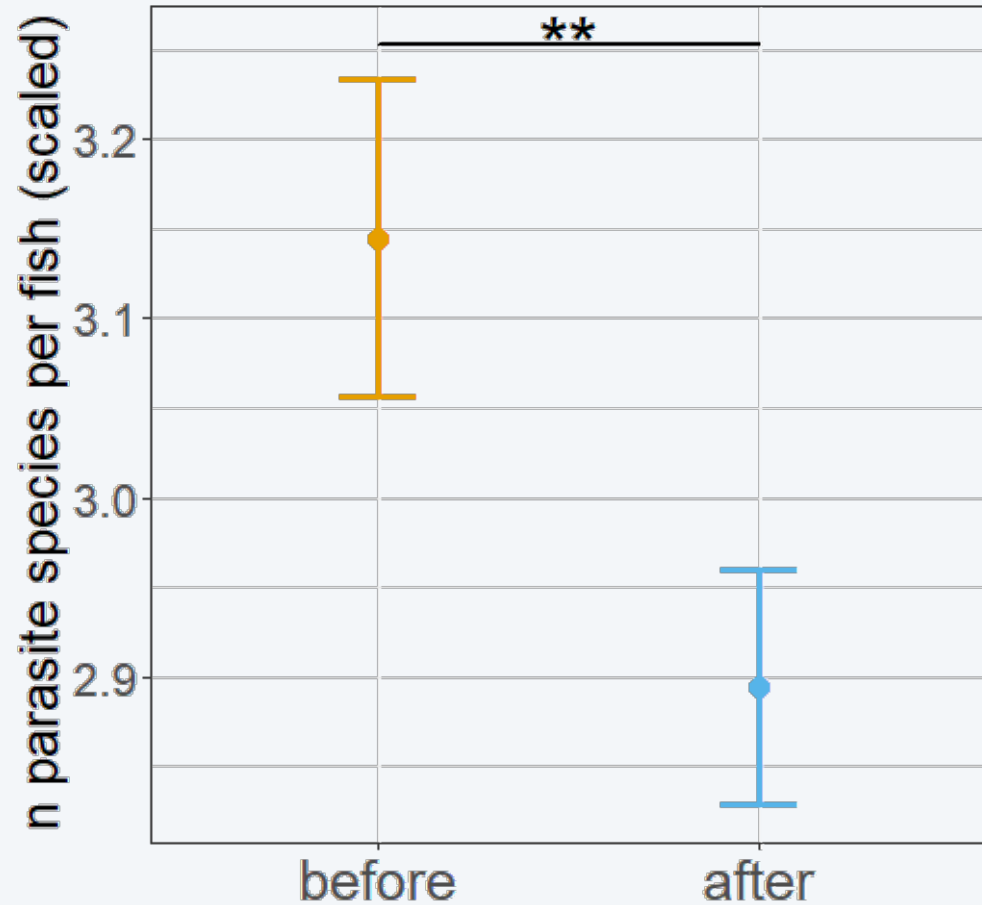


Overall, parasite **prevalence decreased** after perturbations in Lake Victoria

prevalence = proportion of infected host individuals

GLM, controlled for fish size

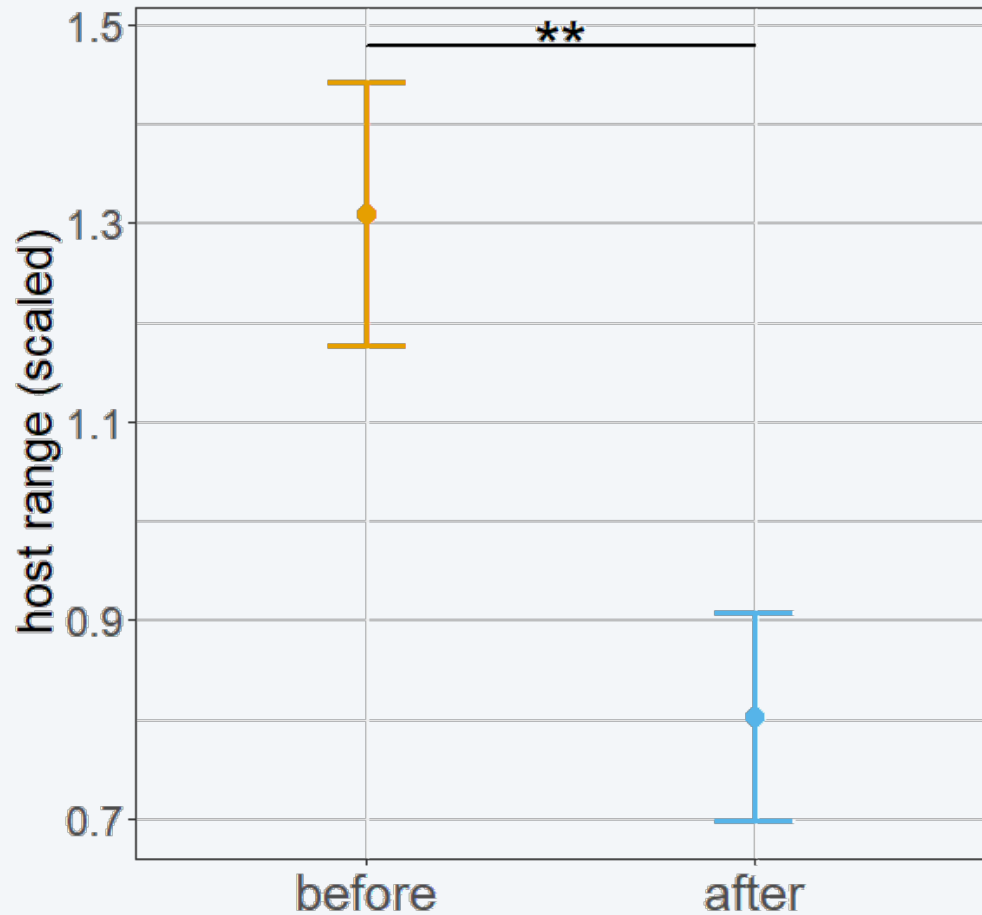
Changes in parasite species richness



After perturbations in Lake Victoria, host individuals are infected by fewer **parasite** species.

GLM, controlled for fish size

Changes in host range

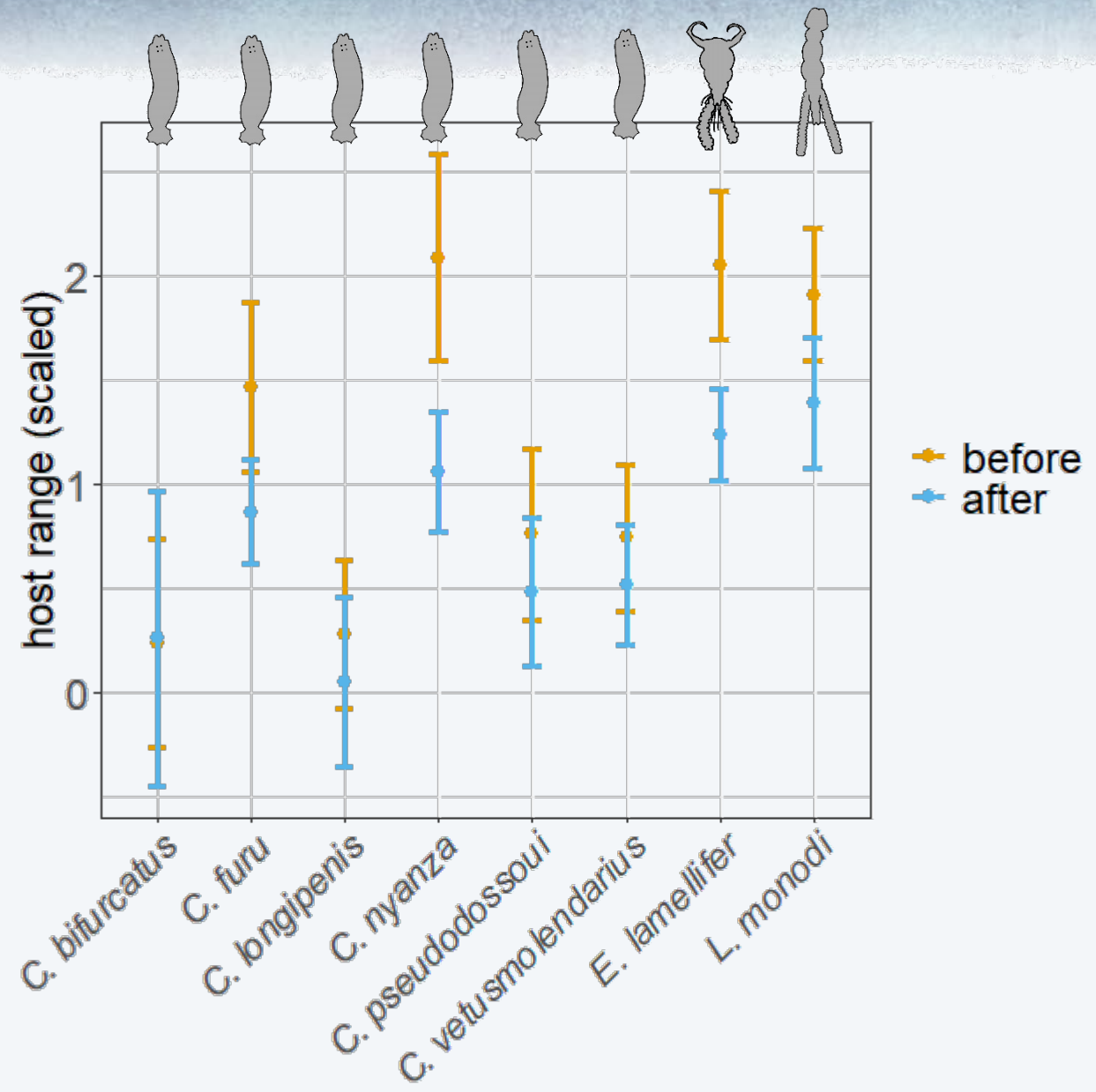


After perturbations in Lake Victoria, parasite species infected fewer **host** species.

host range = number of host species infected by a given parasite species

GLM, controlled for fish sampling effort

Changes in host range



After perturbations in Lake Victoria, parasite species infected fewer **host** species.

This trend holds for most parasite species.

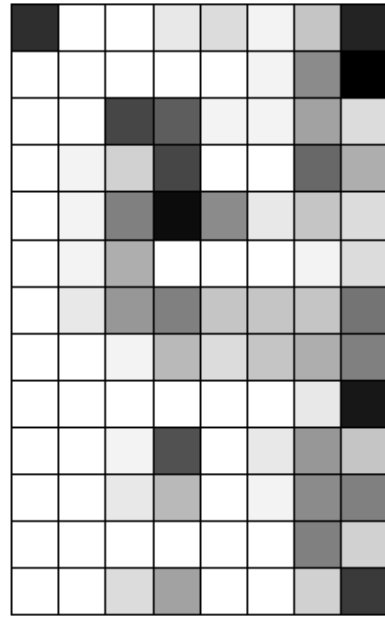
Changes in host-parasite combinations

before
ecosystem changes after

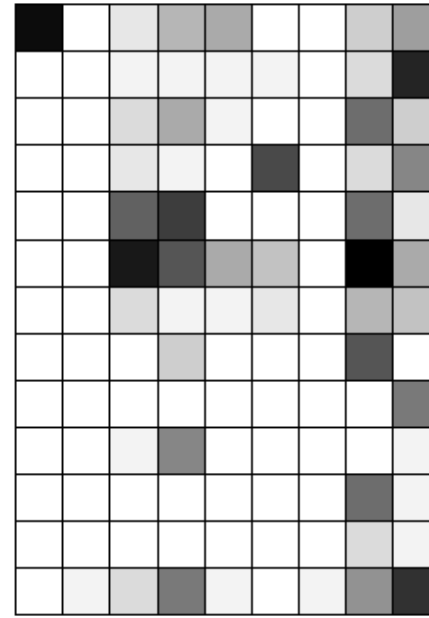
hosts



- A. alluaudi*
- H. antleter*
- Pa. chilotes*
- H. ishmaeli*
- M. mbipi*
- P. nyererei*
- H. obliquidens*
- Li. yellow chin pseudonigricans*
- Ha. pyrrocephalus*
- H. riponianus*
- Pa. rockribensis*
- H. spekii*
- Pt. xenognathus*



- C. longipenis*
- C. bifurcatus*
- C. furu*
- C. nyanza*
- C. pseudodossoui*
- C. vetusmolendarius*
- L. monodi*
- E. lamellifer*

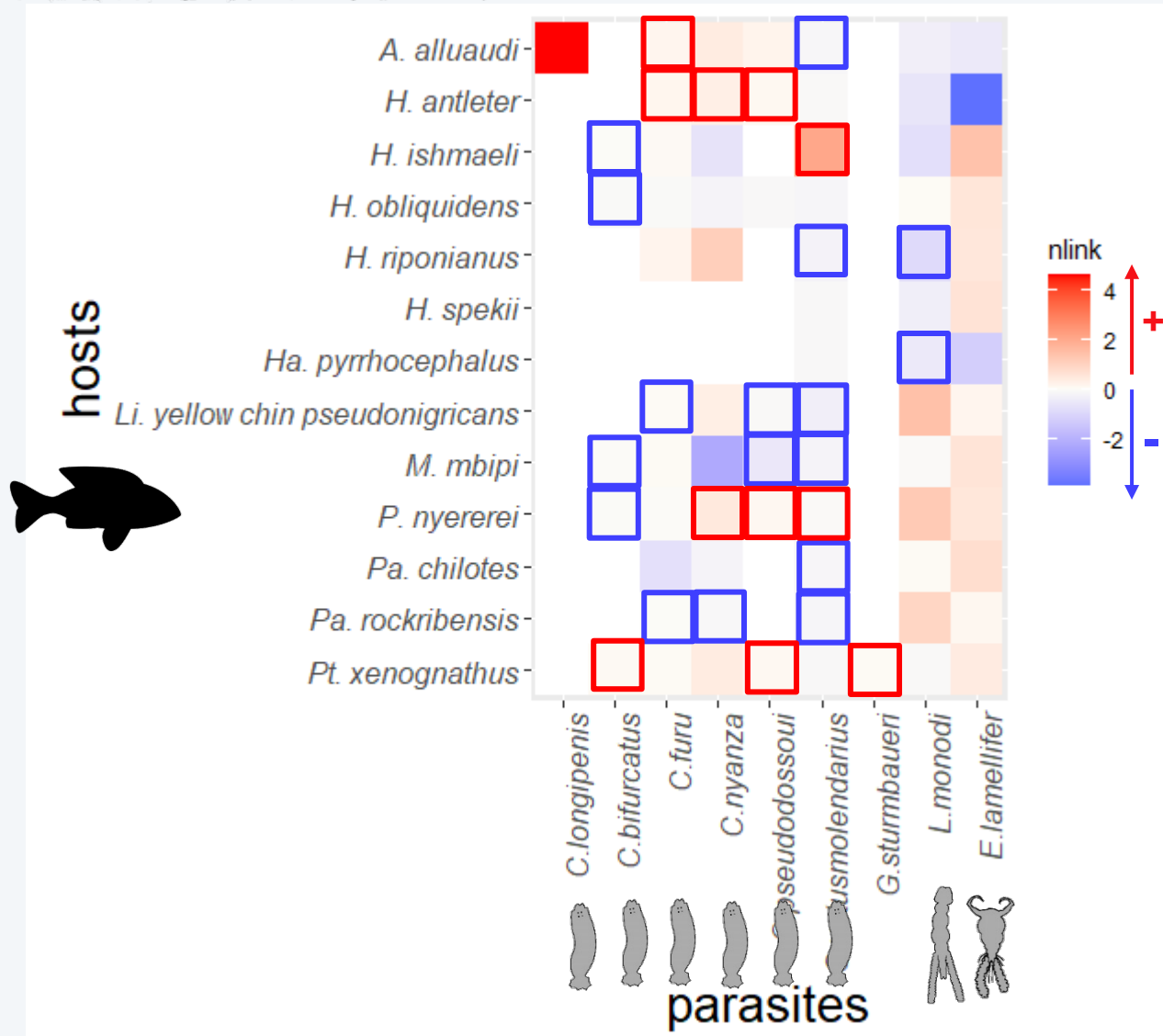


- C. longipenis*
- C. bifurcatus*
- C. furu*
- C. nyanza*
- C. pseudodossoui*
- C. vetusmolendarius*
- G. sturmbaueri*
- L. monodi*
- E. lamellifer*



Number of host-parasite links

Changes in host-parasite combinations



- some parasites disappeared from some host species, and
- colonized few new host species that they did not infect before.

Perturbations may favor host switching
 → network rearrangement

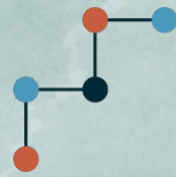
Conclusions

After perturbations in Lake Victoria:

- parasites decreased in abundance and prevalence
only two parasite species became more abundant: few winners, many losers
- fewer parasite species infected host individuals
- parasites infected fewer and different host species
→ ecosystem perturbations may favor host switching

Parasites as sentinels for ecosystem health





**Swiss National
Science Foundation**



Thank you

Ichthyo-parasitological team @ Hasselt University (B)

Royal Museum for Central Africa (B)

Royal Belgian Institute of Natural Sciences (B)

Naturalis Biodiversity Center (NL)

EAWAG, Swiss Federal Institute of Aquatic Science and Technology (CH)

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- ✦ **TP Gobbin**, MPM Vanhove, O Seehausen, ME Maan, and A Pariselle (*subm.*), **Four new species of *Cichlidogyrus* (Platyhelminthes, Monogenea, Dactylogyridae) from Lake Victoria haplochromine cichlid fishes, with the redescription of *C. bifurcatus* and *C. longipenis***. Submitted to *Parasite*. Preprint available on bioRxiv doi: 10.1101/2021.01.29.428376.
- ✦ **TP Gobbin**, MPM Vanhove, R Veenstra, ME Maan, and O Seehausen (2023). **Variation in parasite infection between replicates of speciation in Lake Victoria cichlid fish**. *Evolution* 77(7), 1682-1690. doi:10.1093/evolut/qpad080
- ✦ **TP Gobbin**, MPM Vanhove, A Pariselle, ME Maan, and O Seehausen (2020). **Temporally consistent species differences in parasite infection but no evidence for rapid parasite-mediated speciation in Lake Victoria cichlid fish**. *Journal of Evolutionary Biology* 33(5): 556. doi:10.1111/jeb.13615
- ✦ **TP Gobbin**, MPM Vanhove, O Seehausen, and ME Maan (2020). **Microhabitat distributions and species interactions of ectoparasites on the gills of cichlid fish in Lake Victoria, Tanzania**. *International Journal for Parasitology* 51(2-3), 201-204. doi:10.1016/j.ijpara.2020.09.001
- ✦ **TP Gobbin**, R Tiemersma, G Leone, O Seehausen, and ME Maan (2020), **Patterns of ectoparasite infection in wild-caught and laboratory-bred cichlid fish, and their hybrids, implicate extrinsic rather than intrinsic causes of species differences in infection**, *Hydrobiologia* 848(16), 3817-3831. doi:10.1007/s10750-020-04423-7.