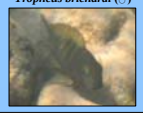
Responses of Herbivorous Cichlid Fishes to Anthropogenic Sedimentation in Lake Tanganyika

Tropheus brichardi (♂)



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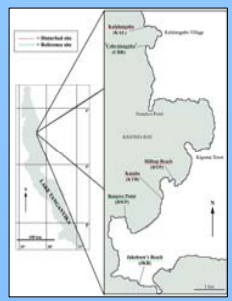
Petrochromis polyodon (♂)

ABSTRACT

Anthropogenic sedimentation poses a serious threat to littoral communities in the East African rift lakes. Herbivorous fishes may be particularly susceptible due to reduced accessibility and quality of food resources. We studied the effects of sedimentation on two algivorous cichlids, *Tropheus brichardi* and *Petrochromis polyodon*, at sediment-disturbed and reference sites along the northeastern shore of Lake Tanganyika. *T. brichardi* uses fused oral combs to graze filamentous algae, whereas *P. polyodon* gleans unicellular algae using mobile pads of brush-like teeth. Our results show that sedimented sites have a higher proportion of inorganic matter and less total algae than reference sites, confirming that food quantity and quality are decreased. *T. brichardi* are more aggressive at sedimented sites, suggesting that decreased food quality increases the importance of defending feeding territories. The territoriality of *P. polyodon* does not appear to be influenced by sedimentation, though their grazing frequency is significantly reduced. The added bulk of inorganic sediments at disturbed sites may have a saiting effect. In contrast to these behavioral shifts, population densities, gut length, and body condition of *T. brichardi* and *P. polyodon* are similar at disturbed and reference sites. This suggests that behavioral plasticity alleviates the effects of sedimentation on these algivorous fishes.



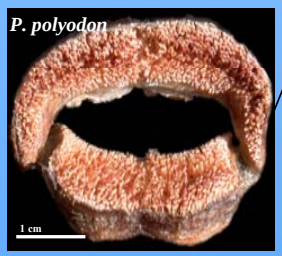
OBJECTIVES

At each of three sedimented and three reference sites, we examined:

- inorganic sediment load
- the amount of filamentous and unicellular algae
- population density of *T. brichardi* and *P. polyodon*
- grazing frequency of *T. brichardi* and *P. polyodon*
- antagonistic behavior of *T. brichardi* and *P. polyodon*
- average gut length of *T. brichardi* and *P. polyodon*

← Reference site: Bangwe Point

Sedimented site: Katabe Bay →



METHODS

Quantification of Sediment Load and Algae Biomass at Each Site

- Attached and non-attached material collected from rocks at 2m depth.
- Algae biomass determined from measurement of chlorophyll a.
- Organic and inorganic matter in non-attached and attached material measured by ash-free dry mass.
- Algae separated into filamentous and unicellular sections by centrifugation in 80% colloidal silica; individual sections analyzed for organic matter by ash-free dry mass.

Population Density Counts of *T. brichardi* and *P. polyodon*

- 25m x 2m belt transects established at 2m depth; 32 counts per species per site made over 2 days.

Grazing Frequency and Territorial Behavior of *T. brichardi* and *P. polyodon*

- A focal fish was selected and observed for ten minutes.
  - In the first five-minute segment, grazing frequency was recorded.
  - In the second five-minute segment, the fish's territorial interactions were noted.
    - These included aggressions and victimizations towards/by conspecifics, the other subject species: *P. polyodon*/*T. brichardi*, and other fish species.
- Sixteen *T. brichardi* and sixteen *P. polyodon* were observed at each site

Average Standardized Gut Length of *T. brichardi* and *P. polyodon* Populations

- Eight *T. brichardi* and eight *P. polyodon* collected from each site by hand.
- Stomach contents were preserved for further analysis.
- Gut length measured from stomach to rectum, standardized by standard length.

BACKGROUND

Most of the Tanganyikan shoreline is relatively pristine, but recent development and agriculture have led to sediment pollution in littoral zones near human populations. Anthropogenic sedimentation poses a significant threat to benthic ecosystems, reducing species diversity and eliminating habitats for rock-dwelling organisms. The piscine response to sedimentation is examined in this case study of two algal-grazing cichlids, *Petrochromis polyodon* and *Tropheus brichardi*.

Competition plays an important role in the ecology of rock-grazing cichlids. A decrease in available habitat and food quality may intensify competition for food resources, requiring shifts in behavioral strategies. The herbivorous genera *Petrochromis* and *Tropheus* present an interesting case of opposing feeding strategies: *Petrochromis* spp. use mobile, brush-like premaxillary pads of tricuspid teeth to consume epilithic and epiphytic unicellular algae, whereas *Tropheus* spp. have premaxillary combs of fused bicuspid teeth to graze on filamentous algae. The species *P. polyodon* and *T. brichardi* were selected for this study because of their abundance and ease of identification. The study was conducted near Kigoma, Tanzania, during June-August 2003.

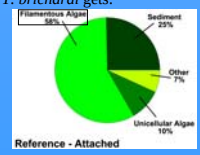
We hypothesized that sediment presents a more significant obstacle to feeding for the immobile tooth combs of *Tropheus* than for the tooth pads of *Petrochromis*. Such effects on foraging could influence fish behavior, gut morphology, and population dynamics. To test whether sedimentation affects *T. brichardi* more strongly than *P. polyodon*, we surveyed food availability, population density, feeding and territorial behaviors, stomach contents, and gut length of *Tropheus brichardi* and *Petrochromis polyodon* at three sediment-disturbed and three reference (non-sedimented) sites.

➢ *T. brichardi* consumes filamentous, attached algae.

➢ *P. polyodon* consumes unicellular, non-attached algae.

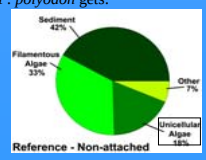
What does a fish get when it grazes?

At reference sites, *T. brichardi* gets:

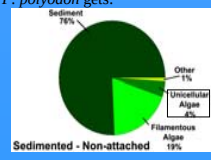


At sedimented sites, *T. brichardi* gets:

At reference sites, *P. polyodon* gets:



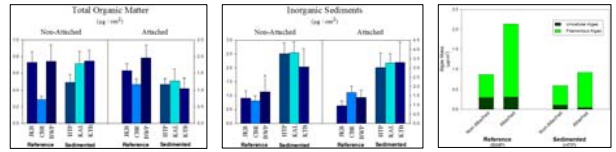
At sedimented sites, *P. polyodon* gets:



▪ **At sedimented sites, *T. brichardi* and *P. polyodon* are consuming about 75% inorganic sediment. At reference sites, inorganic sediments make up only 25 - 40% of food ingested.**

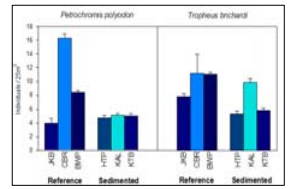
RESULTS

- Sedimented sites have significantly more inorganic sediment in both non-attached ($p < 0.05$) and attached material ($p < 0.02$), whereas there is no difference in total organic matter.



- Algae biomass was examined at one reference site and one disturbed site. The disturbed site has relatively lower levels of both filamentous and unicellular algae in both non-attached and attached material.

- Population density of *T. brichardi* does not differ significantly between reference and disturbed sites, nor does population density of *P. polyodon*.

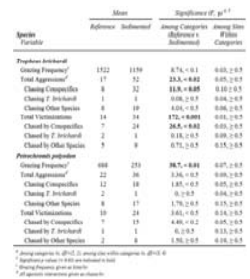


Average values of standardized gut length (n = 8/species/site)

Category / Site	*T. brichardi*	*P. polyodon*
Reference		
JKB	4.9	8.8
CBR	4.2	7.9
BWP	4.4	9.1
Sedimented		
HTP	4.5	7.9
KAL	4.2	8.4
KTB	4.1	7.6

- Gut length does not differ significantly for either species between disturbed/reference sites.

- Grazing frequency and territorial behavior:
  - *P. polyodon* grazes less frequently at sedimented sites ($p < 0.01$).
  - *T. brichardi* is more aggressive at sedimented sites ($p < 0.02$).
  - There is little interaction between *T. brichardi* and *P. polyodon*.
  - There are no significant differences among sites within the sedimented and reference categories.



CONCLUSIONS

- Sedimented sites have significantly more inorganic sediment in both attached and non-attached material. They also have less filamentous and unicellular algae. Thus, food quantity and quality are decreased for both *T. brichardi* and *P. polyodon* at sedimented sites.

- Sedimentation is not associated with changes in population density or gut length of *T. brichardi* or *P. polyodon*. This suggests that these fishes compensate for decreased food quantity and quality by behavioral shifts.

- *T. brichardi* are significantly more aggressive at sedimented sites and *P. polyodon* is somewhat more aggressive. This suggests that feeding territory becomes more valuable as food quantity and quality decrease. The weaker response of *P. polyodon* may reflect greater feeding flexibility associated with mobile oral dentition.

- *P. polyodon* graze significantly less frequently at sedimented sites, yet the mass of their gut contents is higher. This behavioral change may reflect a satiating effect of consuming large amounts of sediment.

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