

Introduction

- Recent developments in acoustic recording technologies have revealed that **fish produce sounds** like marine mammals.
 - However, most existing research has been limited to descriptive accounts, and baseline data remain scarce.
 - It is unclear whether fish are simply producing sounds (by-product) or actively using them for communication.**



To explore whether fish use sounds as a communication signal ...

We focused on cichlid inhabit in Lake Tanganyika

- Tanganyikan cichlids have **highly developed social relationship**.^[1,2]
 - Intra (e.g., courtship) and interspecific **communication** (e.g., attacks) have important roles in maintaining stable social relationships.^[3]
 - We predict that these cichlids, which have highly developed relationships, are likely to **use sound**, a low-cost signal, for communication.

Aims

We focused on the LT cichlid to:

- Describe the acoustic characteristics of the sounds
- Determine whether these sounds function as communication signals
- Clarify how they are used in social and ecological contexts

Methods

Study site & period



- Southern part of Lake Tanganyika, Zambia (Central Africa)
- Aug.~Dec. 2023, Oct.~Dec. 2024, Apr. ~May. 2025

Observations

- We set up hydrophones and cameras in the cichlid nests to observe their behaviors and the associated sounds



Sound Analysis

- Analyzed sound 50 hours data using Raven Pro, and R studio.
 - Sounds that clearly synchronized with behaviors were used in the analysis.

Results & Discussions

1. Sounds and behaviors

- We found **31 cichlid species produce sounds**
 - All species generated as **byproducts** of certain behaviors
 - Five species produced sounds **spontaneously** during specific behaviors in social contexts

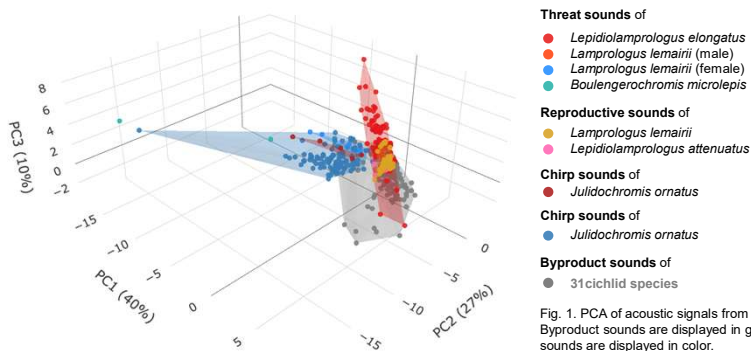
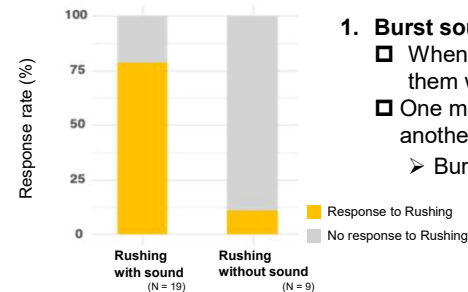


Fig. 1. PCA of acoustic signals from 31 cichlid species. Byproduct sounds are displayed in gray, whereas spontaneous sounds are displayed in color.

- The acoustic structure of the recordings allowed us to distinguish spontaneous sounds from byproduct sounds, as confirmed by PERMANOVA ($R^2 = 0.071$, $F = 68.70$, $p = 0.001$)
- An analysis of within-group dispersion indicated that spontaneous sounds showed significantly higher variability than byproduct sounds (PERMDISP: $F = 8.81$, $p = 0.002$)
 - Spontaneous sounds flexibly vary across contexts, while byproduct sounds are simply incidental acoustic effects of actions**

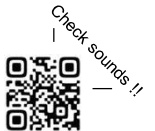
2. Context - dependent use of vocalizations

- We focused on ***Boulengerochromis microlepis***, which showed particularly diverse use of sounds among LT cichlids, and examined the potential functional roles of its acoustic signals.
- B. microlepis* produced two types of sounds in different contexts**



1. Burst sound

- When intruders approached the nest, parents rushed toward them with "Burst"
- One member of the pair rushed with "Burst sound", another member **response** or **support** rushing
 - Burst sounds play a role as a **trigger for partners action**



2. Knock sound

- The guarding parents produced "Knock" sounds, No specific behavior was associated with the sounds
- Call rate differed depending on habitat**
 - Large number of sounds were detected in the rocky habitat (Fisher's exact test, $P < 0.01$)
 - Nests in rocky habitats are surrounded by more intruders than in other habitats, parents produce "Knock" as **warning signals** directed toward approaching threats

