

Electronic Appendix A

Mothers determine offspring size in response to own juvenile growth conditions

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Study species

In *Simochromis pleurospilus* Nelissen (Subfamily: Tropheini), a mouthbrooding cichlid endemic to Lake Tanganyika, females produce clutches year-round and care for the young alone. Brood care consists of two phases; two weeks of continuous incubation when young only use yolk reserves are followed by another one to two weeks when young are periodically released from the mouth for feeding on the surrounding substrate. Afterwards, young are independent.

Experimental fish and housing

The experimental fish were recruited from 14 broods, bred from closely related parents (siblings and half-siblings) to minimize genetic variability. I raised 120 young *S. pleurospilus*, each in a separate 20-litre tank. Each 20-litre tank contained an internal biological filter and a clay flower pot half (10 cm diameter), both used as shelters by the fish, and a layer of river sand. Water temperature was kept at 27°C by controlled heating of the room temperature. The light:dark regime was set to 13h:11h including 10 min periods of dimmed light in the mornings and evenings to simulate natural light conditions at Lake Tanganyika. The sexes of the experimental fish could only be determined from an age of 5 to 6 month, when there were 55 females in the experimental population. Of these, 46 females (23 high-food and 23 low-food females) produced clutches of eggs during the experiment. These females were used in both the juvenile and the adult treatment phases. Of the 46 females, 23 females produced 'successful broods', i.e. they incubated and raised their young. The probability of successful incubation was not influenced by the food treatment (Taborsky 2005), and it is unknown why the remaining females always abandoned or swallowed their eggs.

Transition between juvenile and adult treatment

I switched the females from the juvenile to the adult treatment after their first breeding attempt. Most first-spawning females (37 of 46) interrupted incubation after 3.1 days (mean \pm 0.29 SE) and swallowed the eggs, a phenomenon generally observed in mouthbrooding cichlids. Only 9 females raised their first clutch. I wanted to ensure that all females were in the same developmental stage at the switch. Therefore, the day *after* the first breeding attempt was chosen as starting point for the adult treatment as first spawning is the first

unequivocal sign of maturity in these fish. Hence, the juvenile treatment period covered the entire phase of 'early development' (the time from birth to developmental maturity, Lindström 1999). Additionally it included a short period of ovary maturation before first spawning (2-3 weeks in Tropheini, Yanagisawa & Nishida 1991, B. Taborsky unpub. data, i.e., 6-7% of the juvenile treatment period), and in 9 females also incubation.

Of the 9 females that did raise the first clutch, six were switched to the opposite food level after incubation, according to the experimental protocol. As the first young of these 6 females were produced still under the previous (juvenile) food conditions, data of these clutches were analysed together with data of the respective non-switched groups whenever all four treatment groups were compared.

The majority (83%) of the 54 successful broods (produced by 23 females, mean: 1.9 broods \pm 0.18 SE per female, range 1-4), were produced during the adult treatment. Therefore, the timing of the treatment switch closely matched the divide between juvenile and adult stages of the experimental females.

Food source for young during adult treatment

Overall, clutch size increased with female size, while the latter was influenced by the food treatment (Taborsky 2005). In principle, it would be possible that the differences of growth rates during the second incubation phase have been caused by differential levels of density-dependent competition for the food rations provided daily. However, this possibility is unlikely because (i) larvae fed mainly on detritus and algae, which were plentiful in all tanks, and were thereby largely independent of the daily food rations and (ii) growth rates did not correlate with clutch size within treatments (except for the LH group, $r=-0.55$, $P=0.034$, $n=15$ individual broods).

Field survey

Data were collected along a 150m stretch of coastline in Mbete Bay at the southern tip of Lake Tanganyika about 1 km west of Mpulungu, Zambia. Data include counts of four study periods (25 Dec 96 to 26 Jan 97, 28 Jan to 2 Mar 98, 1 Mar to 10 Mar 2002, 1 Mar to 20 Mar 2003).

Before starting with the actual data collection each observer did several training trials allow for a direct comparison of count data collected by different observers. During these training trials, the observer first estimated the size of a randomly chosen focal individual, then he caught it and measured its total length to verify his estimate. At least 5 successive estimates had to be done correctly before an observer started to collect the data. This condition was usually fulfilled after very few training trials.

When conducting a transect count, the observer swam in parallel to the shoreline in constant water depth either by snorkelling or by SCUBA diving. Transects were conducted at each half depth meter between 0.5 and 6 m depth (12 transects per study period). Every 10 m along a transect the observer stopped, remained motionless for 2 min, counted all *S. pleurospilus* by once scanning the substrate and the water

column in a half-circle with a radius of 2 m. He then noted the size of each individual, which was estimated to the nearest 1.0 cm resulting size classes from 2.5-3.4 cm to 10.5-11.4 cm for females and juveniles. Male counts are not presented in this paper, as only the habitat use of females and juveniles is relevant for the focus of this study. Adult males were easily distinguished from juveniles and females by their bright colour pattern.

For further analysis the counts of all 15 positions of a transect were summed. Whenever a transect was repeated (all transects of 2002 and some transects in 1998), the counts of the repeated transects were averaged by taking the arithmetic mean.

The total numbers of juvenile fish detected during the transect counts was relatively low compared to the number of adults. This is because a large number of juveniles occurred above 0.5 m of depth, where the counting method described above is not feasible. To account for this problem, two additional counts were done in 2002 by walking on land along 100 m of shoreline in front of the study site (shore transects). For these transects fish were counted every 5 m on an area of a half-circle with 1 m radius. An additional size class (1.5-2.4 cm) was found during these counts. The numbers of fish in count 1 and 2, respectively, were 27 and 22 in size class 1.5 to 2.4 cm, 16 and 25 in class 2.5-3.4 cm and 7 and 9 in class 3.5-4.4 cm. No *S. pleurospilus* larger than 4.4 cm were found during these shore transects. As the counting method used in the shore transects is not directly comparable with the transects done by swimming, the results of these two additional transects were not included in the data presented in the 'Results' section.

References

- Lindström, J. (1999). Early development and fitness in birds and mammals. *Trends Ecol. Evol.* **14**, 343-348.
- Taborsky, B. (2005). The influence of juvenile and adult environments on life history trajectories. *Proc. Royal. Soc. Lond B*, doi: 10.1098/rspb.2005.3347
- Yanagisawa, Y. & Nishida, M. (1991). The social and mating system of the maternal mouthbrooder *Tropheus moorii* (Cichlidae) in Lake Tanganyika. *Jap. J. Ichthyol.* **38**, 271-282.