The Effect of Water Temperature and Water Hardness on Reproductive Indicators *Hemichromis lifalili*

Ján Kopecký*

Slovak University of Agriculture, Faculty of Agrobiology and Food Resources, Department of Poultry Science and Small Animal Husbandry, 949 76-Nitra, Tr. A. Hlinku, 2, Slovakia

Abstract
In this work we investigated the effect of temperature and water hardness on reproductive indicators *Hemichromis lifalili* in aquarium conditions. From bred individuals we have compiled three breeding pairs, which we placed in aquariums with different temperature and water hardness. In experimental pairs, we evaluated these reproductive variables: number of spawning eggs, the number of hatched, dead and bred individuals. Experiments showed that 28°C, and 8°N carbonate water hardness increased the reproductive activity of fish and the quantity of fish hatched. Decreasing temperature in the tanks was proportionally increased the number of unhatched individuals, and the mortality. The mortality was 88 pieces per spawn at 25°C. Water at 28°C and 8°N carbonate hardness was reached spawn to 1200 eggs pieces.

Keywords: *Hemichromis lifalili*, reproduction, water hardness, water temperature

1. Introduction

Because of their spectacular diversity, the cichlid fish of East Africa have figured prominently in debates about the mechanisms of speciation. Independent radiations have produced morphologically and behaviorally diverse flocks of several hundred species in each of the major rift lakes [1]. The extraordinary radiation of haplochromine cichlids in lakes Malawi and Victoria has occurred in the last million years [2-5]. These species flocks provide a rare opportunity to study speciation occurring in nearly historical time [3].
Reproductive skew in animal societies is expected to depend on within-group relatedness, inbreeding avoidance, ecological constraints on independent breeding and the ability of dominants to control subordinate reproduction [6].

* Corresponding author: Ján Kopecký
E-mail: jan.kopecky@uniag.sk

Comprehending the population-level consequences of stressful events requires understanding the effects of stress on an individual; such understanding is critical for conservation biology, stewardship of wild populations, and aquaculture. From an ecological as well as a management perspective, factors affecting brood fish quality can be reflected in the number and quality of their progeny. Stressful situations can overwhelm the homeostatic mechanisms of a fish, thereby placing a load on the body in an attempt to compensate and achieve another level of stasis.
When stressed, fish can assume a different mode of operating, *allostasis* [7, 8] that is adaptive in terms of keeping the animal alive in the face of the stressor but can be maladaptive in terms of performing other necessary life functions or of reproductive fitness [9].
Environmental stressors and particularly nutrition can also affect realized fecundity and gamete quality. In general, larger females produce larger eggs, which give rise to progeny that are believed to have an ecological advantage over those from

smaller eggs. Therefore, a stressor that affects growth may lead to the production of progeny that are already at a disadvantage because of their smaller size. The number of ripe eggs a female produces is also based on environmental quality. A female produces oogonia during early developmental stages and then during the process of oogenesis establishes the actual number of these that will start to mature and that will be ovulated, with the remainder being reabsorbed through atresia. Fish must balance the production of eggs against the requirements to maintain at least some minimal level of quality (size and content). How fish weigh the trade-off between these variables is unknown. Literature in this area includes discussions on reproductive tactics relative to egg size, fecundity and age at maturity [10] the relation of hatching success to female condition [11]. Water for reproduction *Hemichromis lifalili* should be slightly soft and acidic with a pH of around 6.5-7.0 and a temperature of 24-28°C [12].

2. Materials and methods

Fish, feed and rearing conditions

Trial was undertaken with *Hemichromis lifalili* in 15 months age. As much as 6 pair (3 male and 3 female) fish were distributed in 2 tanks. The fish were fed standard flake feed. Composition of flake feed is shown in Table 1. In both groups, fish were fed by hand *ad libitum* three times a day (6 am, 2 pm and 10 pm).

Table 1. Composition of flake feed

Crude protein	48%
Crude fat	6%
Ash	8%

Table 2. Water conditions of first tank (Tr1)

Temperature	25°C
Carbonate hardness	16.5°N
Total hardness	29°N
pH	6.7-7.3
Co_2	35 $mg.l^{-1}$

The water conditions of first tank (Tr1) are shown in Table 2 and second tank (Tr2) is shown in Table 3.

Two air pumps and one sponge filter were used in the aquariums for filtration and airflow. The aquariums were placed side by side in two lines. Natural photoperiod was used during the experiment.

The number of spawning eggs, the number of hatched, dead and bred individuals were counting and recorded.

Table 3. Water conditions of second tank (Tr2)

Temperature	28°C
Carbonate hardness	8°N
Total hardness	29°N
pH	6.7-7.3
Co_2	35 $mg.l^{-1}$

3. Results and discussion

The water temperature of 25°C and the carbonate water hardness of 16.5°N was recorded eight spawns. The highest number of eggs was observed in the second breeding pairs (220 pcs.). From 220 eggs was 175 pieces hatched. The highest number of individuals from Tr1 was raised for the first breeding pair, when from 180 eggs were hatched 135 pieces and reared 43 individuals. The highest mortality was 139 pieces per spawn from 175 hatched (Table 4).

The water temperature of 28°C and the carbonate hardness of 8°N was recorded eleven spawns. The highest number of eggs (1200 pcs.) was observed in the second breeding pairs in first spawns.

Eight hundred hatched pieces was observed in first breeding pair from 1000 pieces of eggs and from second breeding pair, when were 800 pieces hatched from 1200 eggs.

The highest number of individuals from Tr2 was raised for the first breeding pair, when the 1000 eggs were hatched 800 pieces and reared 700 individuals and also in second breeding pair, when from 1200 eggs were hatched 800 pieces and reared 700 individuals (Table 5).

The highest mortality was 100 pieces per spawn from 800 hatched in first breeding pair and also 100 pieces from 800 hatched in second breeding pair.

Table 4. The number and percentage of spawning eggs, hatched, dead and bred individuals, Tr1

Breeding pair	Spawn	Eggs (pcs.)	Hatched (pcs.)	Hatched (%)	Dead (pcs.)	Dead (%)	Bred (pcs.)	Bred (%)
1	1	140	100	71.43	100	100	0	0
	2	200	150	75	110	73.33	40	26.66
	3	180	135	75	92	68.15	43	31.85
	x	173.3	128.3	74.03	100.67	78.46	27.66	21.56
2	1	150	93	62	81	87.1	12	12.9
	2	220	175	79.55	139	79.43	36	20.57
	3	110	80	72.73	38	47.5	42	52.5
	x	160	116	71.43	86	74.14	30	25.86
3	1	140	95	67.86	68	71,58	27	28.42
	2	185	115	62.16	77	66.96	38	33.04
	x	162.5	105	65.01	74.29	70.72	32.5	30.95

pcs.-pieces, %-percentage, x–average

Table 5. The number and percentage of spawning eggs, hatched, dead and bred individuals, Tr2

Breeding pair	Spawn	Eggs (pcs.)	Hatched (pcs.)	Hatched (%)	Dead (pcs.)	Dead (%)	Bred (pcs.)	Bred (%)
1	1	1000	800	80	100	12.5	700	87.5
	2	230	180	78.26	40	22.22	140	77.78
	3	200	150	75	64	42.67	86	57.33
	x	476.67	376.67	77.75	68	25.79	308.7	74.20
2	1	1200	800	66.67	100	12.5	700	87.5
	2	250	200	80	20	10	180	90
	3	350	300	85.71	30	10	270	90
	4	700	450	64.29	100	22.22	300	66.67
	x	625	437,5	74.17	62.5	13.68	362.5	83.54
3	1	183	150	81.97	72	48	78	52
	2	240	200	83.33	80	40	120	60
	3	350	300	85.71	50	16.67	250	83.33
	4	250	220	88	20	9.09	200	90.91
	x	255.8	217.5	84.75	55.5	28.44	162	71.56

pcs.-pieces, %-percentage, x–average

4. Conclusions

Experiments showed that 28°C, and 8°N carbonate hardness increased the reproductive activity of fish and the quantity of fish hatched. Decreasing temperature and increasing carbonate hardness in the tanks proportionally increased the number of unhatched individuals, and the mortality. The mortality was 88 pieces per spawn at 25°C. Water at 28°C and 8°N carbonate hardness was reached spawn to 1200 eggs pieces

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