

short communication / kratko priopćenje

## NON-VISUAL LOCALISATION OF

A CONSPECIFIC MALE BY SURFACE- AND CAVE-DWELLING ATLANTIC MOLLY FEMALES (*POECILIA MEXICANA*, POECILIIDAE, TELEOSTEI)

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We investigated the ability of surface- and cave-dwelling *P. mexicana* females to localise conspecific males in light and darkness. Females of both populations showed a predilection for the male in both experiments. Non-visual association behaviour in darkness in the surface form can be viewed as a pre-adaptation to cave life in this species.

Key words: Cave fish, non-visual communication, association behaviour, sensory capabilities

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Istraživali smo sposobnost površinskih i špiljskih ženki vrste *P. mexicana* za pronalaženje mužjaka iste vrste pri svjetlu i u tami. Ženke obju populacija pokazale su predispoziciju za pronalaženje mužjaka u oba pokusa. Nevizualno socijalno ponašanje u tami kod površinskog tipa ove vrste ribe može se promatrati kao preadaptacija na špiljski način života.

Ključne riječi: špiljske ribe, nevizualna komunikacija, društveno ponašanje, osjetilne sposobnosti

## INTRODUCTION

Cave animals offer a unique opportunity to study the evolution of behaviour and sensory systems in the absence of visual communication. The cave form of the Atlantic molly (*Poecilia mexicana* Steindachner 1863) is one of the most thoroughly studied cave fishes (Parzefall, 2001). While many cave fishes are completely eyeless, the cave molly has slightly reduced but still functional eyes (Peters et al., 1973). Previous studies have shown that cave molly females exhibit non-visual mating preferences. For example, they discriminate between males that differ in size or males that differ in their nutritional state in the absence of visible light (Plath et al., 2004, 2005). In contrast, females from a surface population exhibited mating preferences (i.e., they preferred the specific traits of one out of two simultaneously offered males) only in visible light (Plath et al., 2004). In the present study, we asked why surface-dwelling females do not show mating preferences in the dark. We tested the hypothesis that surface females generally cannot detect males in darkness. Alternatively, surface females might have the sensory capability to detect and localise conspecific males in darkness, but might not be (sexually) motivated to associate with a male in darkness. In both cases, the straightforward explanation for the absence of non-visual female choice in the surface form would be that surface-dwelling females do not associate with males once visual communication is impossible. On the other hand, if surface females do associate with a male even in darkness, the presence of non-visual mating preferences only in cave-dwelling females would suggest more subtle differences between surface- and cave-dwelling females: In this scenario, association behaviour would be triggered by non-visual cues in both populations, but only cave females would use non-visual cues to determine specific male traits like size differences (Plath et al., 2004) or differences in male nutritional state (Plath et al., 2005).

## METHODS

Test fish came from randomly outbred large aquarium stocks, maintained at the Biozentrum Grindel in Hamburg in several 100–200 l aquaria at 25–30°C under a 16:8 h light-dark cycle. Cave stocks were derived from animals caught in the rearmost cave chamber of the Cueva del Azufre in Tabasco, Mexico (Gordon & Rosen, 1962). The surface fish were caught in the nearby Rio Oxolotan. Fish were fed twice daily ad libitum with flake food and *Artemia-nauplii*.

Prior to the tests, females (standard length, mean $\pm$ SD, light: 40.1 $\pm$ 4.7 mm, darkness: 42.3 $\pm$ 3.3 mm) were isolated from males in all-female aquaria for four days to standardise motivations. We experimentally gave single females the opportunity to associate with a male (standard length, mean $\pm$ SD, light: 34.1 $\pm$ 4.0 mm, darkness: 33.8 $\pm$ 5.7 mm). The experimental design resembled a binary choice test. However, we offered a stimulus (a male) versus no stimulus, thus testing for the capability to recognise and localise the stimulus. Two wire-mesh cylinders (12 cm diameter, 5 mm mesh-width, 1 mm wire-diameter) were placed in the two outer compartments (»preference zones«; each one third of the tank) of a standard test tank (100 35 35 cm), filled up to two thirds with aged tap-water of 28–30°C. A male matching the test female's population was randomly chosen from a stock tank and was introduced into one of the cylinders, while the other cylinder remained empty. When the male was swimming calmly, a focal female was gently introduced into the central neutral zone. We measured the time the focal female spent in either preference zone for ten minutes. Then, the two cylinders were interchanged and the measurement was repeated. We summed up the times near the male and in the empty compartment during both parts of the trial. We decided a priori to exclude trials in which the females spent less than 50 % of their time in the preference zones due to low response and those trials in which the females spent more than 80 % of their choice time during both parts of the trial in only one compartment due to side-bias. However, throughout the response indices were never below 50 % and only one female (a cave molly under light conditions) showed a side-bias.

In one experiment, the test tank was illuminated with visible light provided by a 40 W neon tube 28 cm above the tank. The second experiment was carried out under infrared illumination (500 W), while observations were done with the help of an infrared-sensitive camera. All fish were used only once per experiment. However, some fish may have been used both in the light- and in the dark-experiment. We tested for differences between the time spent near the male and the time in the empty compartment in each experiment. Since data were not normally distributed, non-parametric two-tailed Wilcoxon signed-rank tests were employed.

## RESULTS

Females from the surface population spent significantly more time near the stimulus male both under light conditions (59.1 %;  $P = 0.016$ ,  $n = 12$ ; Fig. 1) and in darkness (55.0 %;  $P = 0.034$ ,  $n = 12$ ; Fig. 1). Cave molly females also spent significantly more time near the stimulus male under visible light (68.8 %;  $P < 0.01$ ,  $n = 10$ ; Fig. 1) as well as in the dark (57.5 %;  $P < 0.01$ ,  $n = 12$ ; Fig. 1).

## DISCUSSION

We gave female Atlantic mollies from a surface- and a cave-dwelling population an opportunity to associate with a conspecific male in light and darkness. In both populations and in both experiments, females preferred to associate with the male. Apparently, non-visual cues are sufficient to release association behaviour in females of both populations. We suggest that surface females have a sensory pre-adaptation to cave life in that they are able to detect and localise conspecific males even in the absence of vision. The role of mechanosensory »lateral-line cues« for localising school members even in surface fish is well known (Partidge & Pitcher, 1980). Furthermore, several poeciliids have been shown to respond to pheromones by conspecifics (e.g. guppies: Shohet & Watt, 2003). However, preliminary data suggest no role for chemical communication in *P. mexicana* (Wenzel et al., unpublished data).

Plath et al. (2004) could demonstrate that unlike cave females, surface-dwelling *P. mexicana* females do not exhibit mating preferences for large males in darkness, but rather showed no preference at all. This study shows that the lack of non-visual mating preferences in surface females is not caused by the absence of association behaviour in the dark. We propose that the higher processing of mating preferences responds to non-visual cues from males only in the cave form (Plath et al., 2004); this is likely to be an adaptation to life in permanent darkness.

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## REFERENCES

- Gordon, M. S. & D. E. Rosen, 1962: A cavernicolous form of the Poeciliid fish *Poecilia sphenops* from Tabasco, Mexico. *Copeia* 1962, 360–368.
- Partidge, B. L. & T. J. PITCHER, 1980: The sensory basis for fish schools: relative roles of lateral line and vision. *J. Comp. Physiol. A* 162, 543–550.
- Parzefall, J., 2001: A review on morphological and behavioural changes in the cave molly *Poecilia mexicana* from Tabasco, Mexico. *Environ. Biol. Fish.* 50, 263–275.
- PETERS, N., G. PETERS, J. PARZEFALL & H. WILKENS, 1973: Über degenerative und konstruktive Merkmale bei einer phylogenetisch jungen Höhlenform von *Poecilia sphenops* (Pisces, Poeciliidae). *Int. Rev. ges. Hydrobiol.* 58, 417–436.
- PLATH, M., J. PARZEFALL, K. E. KÖRNER & I. SCHLUPP, 2004: Sexual selection in darkness? Female mating preferences in surface- and cave-dwelling Atlantic mollies, *Poecilia mexicana* (Poeciliidae, Teleostei). *Behav. Ecol. Sociobiol.* 55, 596–601.
- PLATH, M., K. U. HEUBEL, F. J. GARCIA DE LEON & I. SCHLUPP, 2005: Cave molly females (*Poecilia mexicana*, Poeciliidae, Teleostei) like well fed males. *Behav. Ecol. Sociobiol.* in press.
- SHOHET, A. J. & P. J. WATT, 2003: Female association preferences based on olfactory cues in the guppy, *Poecilia reticulata*. *Behav. Ecol. Sociobiol.* 55, 363–369.