uously breeding species. Two mechanisms of generation overlap may exist; the first one involves individuals of a given age-class but of different generations that eclose synchronously (generation overlap within an age-class, which is necessarily between cohorts); and the second one involves newly eclosed females of the youngest age-class and males of the older age-classes from other generations (generation overlap between age-classes regardless of the cohort). The relative importance of these two mechanisms depends on both the proportions of the different generations and the duration of adult eclosions within each of them.

Numerous authors have described male mating success as an age-dependent phenomenon. It increases to a plateau value in the first days of life (6–8 days) and decreases a few days after the plateau has been reached[5, 10, 11].

If the results obtained on age-related mating success and productivity are important for understanding mate 'choice', the relevance of the findings for natural populations is that older males have a mating advantage during the short period when newly eclosed females are sexually mature and no newly eclosed males are 'available'. This situation is likely to occur in populations living in temperate places especially when they 'start up' each spring.

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Responses of the cavefish *Astyanax mexicanus (Anoptichthys antrobius)* to the odor of known or unknown conspecifics

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Summary. Juvenile individuals of the cave characid *Astyanax mexicanus* recognize to a significant extent, in a choice-apparatus, the odor of known conspecifics as compared to that of unknown ones during the first 2 min of a 10-min experiment. After this initial oriented response, exploration becomes random.
Key words. Cavefish; blindfish; specific odor; chemical sense; chemoreception; locomotory response; choice reaction.

Several studies[1] have stressed the biological significance of chemoreception in the behavior of cavefishes, and its dominant role in the detection at a distance of the odor of food and of conspecifics. Concerning the detection of the latter, Berti et al.[2, 3] were able to show that samples of water drawn from home-tanks occupied during a given length of time (2–10 months) by adult individuals of the cavefish *Caecobarbus geertsi* (9 individuals) or *Phreatichthys andruzzii* (13 and 14 individuals) were characterized by the presence of chemical traces, able to attract systematically a test-fish of the same species in an appropriate choice-apparatus. Results show, moreover, that the test-fish tends to orient itself preferentially in the direction of these traces, be they those of known or unknown conspecifics. In a more recent study, de Fraipont[4] showed that juvenile individuals (total length: 40 mm) of the blind characid *Astyanax mexicanus* (formerly *Anoptichthys antrobius*) displayed the same preferential locomotry response to the odor of conspecifics and that the fish, whatever its home-group was, was always more attracted by the chemical traces of the larger group. Since home-groups with different numbers of individuals were always kept in the same volume of water, the intensity of the response is a function of the concentration of chemical traces left behind by the home-individuals in the water. In the above-quoted experiments of Berti et al., the test-fish had to make a choice between a sample of water drawn from a home-aquarium containing conspecifics, and distilled water. In the present experiments, a further problem was tackled. Given the fact that a test-fish reacts positively to the odor of conspecifics as opposed to pure water, an investigation was made of whether it would discriminate between the odor of a home-group to which it belonged itself and the odor of unknown conspecifics.

A total of 120 juvenile *Astyanax mexicanus (A. antrobius)* total length: 47 mm) of the same hatching were used. Eight days after hatching, they were distributed in 4 × 2 groups of 4 (4A–4B), 8 (8A–8B), 16 (16A–16B) and 32 (32A–32B) individuals. All groups were kept in the same volume of water (48 l) during 8 months. Two groups (A and B) were necessary for each density in order to have an equal number of known and unknown conspecifics available in each case. The experimental trough was

Table 1. Example of experimental design for a test-fish belonging to the 32A home-group. This design was applied in all groups

Home group of test-fishes (6 sessions per group)	Origin of water sample at right end of trough (3 sessions each)	Origin of water sample at left end of trough
32 A	32 A or B	32 A or B
32 B	32 A or B	32 A or B
16 A	16 A or B	16 A or B
16 B	16 A or B	16 A or B
8 A	8 A or B	8 A or B
8 B	8 A or B	8 A or B
4 A	4 A or B	4 A or B
4 B	4 A or B	4 A or B

Table 2. Statistical analysis (χ^2) of results obtained during the two first min of registering of test-fish positions

Groups tested	Class frequencies Positive	Neutral	Negative	χ^2	p
32 known → 32 unkw.	9	1	2	4.45	$0.05 < p < 0.02$
16 known → 16 unkw.	10	0	2	5.3	$0.05 < p < 0.02$
8 known → 8 unkw.	10	0	2	5.3	$0.05 < p < 0.02$
4 known → 4 unkw.	11	0	1	8.33	$0.001 < p < 0.01$

Table 3. Statistical analysis (χ^2) of results obtained on 10-min registering of test-fish positions

Groups tested	Class frequencies Positive	Neutral	Negative	χ^2	p
32 known → 32 unkw.	9	0	3	3	$0.1 < p < 0.05$
16 known → 16 unkw.	8	0	4	1.33	NS
8 known → 8 unkw.	7	0	6	0	NS
4 known → 4 unkw.	6	0	5	1.33	NS

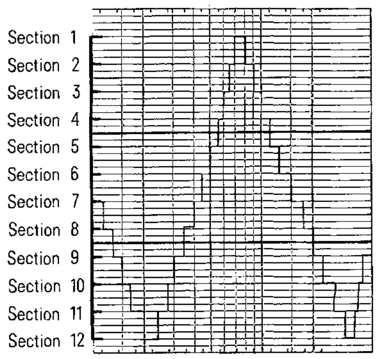

Figure 1. Example of test-fish position recording during 80 s. Abscissa: time-scale (1 mm = 1 s). Ordinate: sections of experimental trough relative to observer (section 1: extreme right; section 12: extreme left). The thick horizontal bars correspond to the position of sliding doors. In this example, the test-fish has moved from section 7 (middle of trough) to section 12 (extreme left) and from there to section 1 (extreme right).

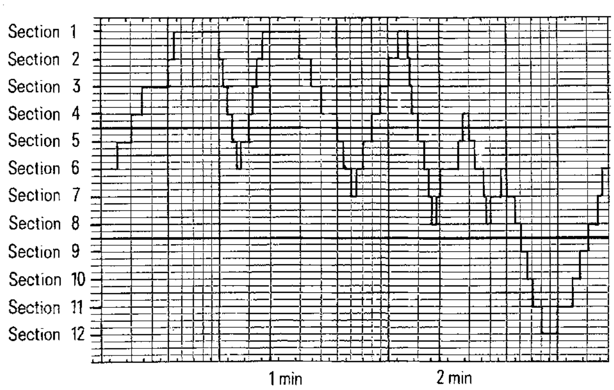

Figure 2. Example of graph (test fish No. 2 from group 8A) showing the 3 first minutes of recording. Ordinate: sections of experimental trough relative to observer (section 1: extreme right, where a water sample of group 8B was introduced; section 12: extreme left, where a water sample from group 8A, known to the test-fish, was introduced). Abscissa: time-scale (1 mm = 1.5 s). The thick horizontal bars correspond to the position of sliding doors. In this example, the test-fish moved mostly during the first 2 min, from section 6 to section 1 (which contained water from the known group); during the last min, the movements spread to all sections and became random.

a long parallelepiped (180 × 20 × 8 cm) divided into three 60-cm sections by sliding doors. The three sections were marked every 15 cm by black bars in order to facilitate localization. An electronic recorder made it possible to follow the test-fish continuously in its displacement along the 12 zones (180:15 cm) of the trough. The graphs thus obtained (figs 1 and 2) express the relative positions of the fish in the various zones and the corresponding time intervals it spent in each.

The experiments were performed in a room dimly and homogeneously illuminated by 36 W tubes, the water temperature being kept at 25.5 °C in accordance with natural conditions[5]. The fishes were not fed during the 24 h prior to the experiment. The experiments were conducted as follows: the test-fish was placed in the central section of the aquarium, where it remained for 2 min with all the sliding doors shut. During this time interval, two water samples (500 ml each) drawn from home aquariums were delivered at either end of the trough with the help of baxter bottles, using a table of random numbers in such a fashion that each individual bottle was placed an equal number of times at either end. The doors were then lifted and the displacements of the fish were registered during 10 min. Four series of 12 experiments were carried out under these conditions.

The overall results show that juvenile cavernicolous *A. mexicanus* discriminate significantly between two samples of water containing chemical traces from known or unknown conspecifics, kept in separate home-tanks at equal densities (table 1). They display a significant locomotory response ($p < 0.01$) towards the traces of the known group during the first 2 min of the experiment (table 2). After this time-interval, exploration becomes random (table 3). A similar phenomenon was previously noted by Berti et al.[3] with adult *Phreatichthys andruzzii*, which swim directly in the direction of traces of known conspecifics, but only after 9 min towards those of unknown ones, in both cases compared with a neutral stimulus (distilled water). It appears therefore that *A. mexicanus* recognizes the odor of conspecifics, and shows moreover a tendency to orient itself preferentially towards known ones during a short time, but the fairly quick fading of the response in these conditions of choice has still to be explained. An accurate determination of the chemical traces actually at work is needed to devise further experiments able to throw light on the specific factors determining the preferential response observed.

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Risk-sensitive foraging by a migratory bird *(Dendroica coronata)*[1]

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Summary. Because migration is a period of exceptional energy demand, individuals in migratory disposition should be particularly sensitive to variability in food availability, i.e. show risk-sensitivity in their foraging behavior. When given the opportunity to feed at either a constant or a variable reward station, birds in migratory disposition (experimentals) chose the variable reward (risk-acceptance) more often than the constant reward during the premigratory fattening period as they gained weight and accumulated an energy reserve, while control birds not in migratory disposition consistently preferred the constant reward (risk-aversion). Once birds in migratory disposition attained maximum body weight and began to show nocturnal restlessness, their behavior changed and they, too, behaved in a risk-averse manner.

Key words. Bird migration; foraging behavior; risk-sensitivity.