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## Animal behaviour

# Monkey business in the aquarium

Rory Howlett

Occasionally, long-lost works come to light to the delight of scholars and laypersons alike — a sketch by Rembrandt, a Shakespeare sonnet or an early recording by the Beatles. So it is with the publication in *Evolution and Cognition* of a paper based on a manuscript drafted in February 1979 by Konrad Lorenz. The paper (K. Lorenz, K. Okawa & K. Kotschal *Evol. Cogn.* **4**, 108–135; 1998) has been completed by translator Kurt Kotschal and Keiko Okawa, a former student of Lorenz who has also provided additional results.

Along with Karl von Frisch and Nikolaas Tinbergen, Lorenz was a co-recipient of the 1973 Nobel Prize in Physiology or Medicine for their discoveries concerning “organization and elicitation of individual and social behaviour patterns”. At the time of his death in 1989, Lorenz had plans to write a book about “the biology, notably ethology of perciform fish”, on the basis of long-term observations of coral-reef fish. Observations on the competitive interactions within reef fish species had featured large in Lorenz’s classic text *On Aggression* (Harcourt Brace, 1963).

Many marine fish, including those that inhabit coral reefs, have larvae that are essentially planktonic, living at the mercy of ocean currents. A crucial stage is when they come out of the planktonic phase and settle on the reef. This recruitment phase is characterized by profound changes in morphology, behaviour and colouring. Lorenz was most struck by the vivid coloration of reef fish, and proposed that these colour patterns act as signalling ‘posters’ in the acquisition and defence of a territory. Others argued that the patterns might be involved in species recognition and mate choice, or defence against predators, either by way of camouflage or as warning signals.

Perhaps more than any other ethologist of his time, Lorenz recognized that to distinguish between these competing hypotheses, and to understand fully the social development of reef fish, detailed behavioural observation as well as experiment was required. In 1967, he spent some time in Hawaii making further notes on the behaviour of reef fish,

but evidently realized that what was needed was a large marine aquarium where the fish could be observed at leisure, and in which interactions between the fish could be experimentally manipulated.

The opportunity came in the mid-1970s, when Lorenz used money from his Nobel prize to construct a large reef tank at his home in Altenberg, Austria. This was no typical living-room tropical aquarium, but a giant 4 × 4 × 2-metre observation tank containing 32,000 litres of circulating sea water. The tank was stocked with the young of the Indo-Pacific coral-reef fish *Zanclus cornutus*, shown in the picture here, known as the Moorish idol or the *kihikihi* in Hawaiian. The first batch of fish did not prosper, but a second attempt to stock the tank was successful and between April 1976 and July 1978 Lorenz spent at least 1,000 hours observing the fish.

In the wild, newly recruited Moorish idols are territorial, defending their patch of reef. Later, individual territoriality breaks down and schools of more mature fish will often roam a common territory. Similar changes in behaviour occurred in the aquarium. When first introduced to the tank, the fish partitioned the available space into individual territories at the bottom and walls of the tank. During the following months, neighbouring fish fused their territories and defended them against outsiders, and with time further fusing of territories occurred. By 1978, two cohort groups, composed of fish aged five and six years respectively, roamed the entire tank keeping out of each other’s way. Subsequent introductions were attacked, often fatally, but sometimes they managed to integrate into a new group; such interlopers

occasionally sparked aggressive interactions between existing group members. Under natural conditions, such mechanisms might modulate group size to provide an optimal balance between warding off predators and competition for food, mates and so on.

The initial breakdown of individual territoriality fascinated Lorenz. During this period individuals seem to change the way in which they respond to ‘poster colour’ stimuli, depending on the ecological context and the motivational state of the fish. In the aquarium, at least, the character of the ‘dyadic’ relationships between pairs of fish provided evidence of individual recognition. Initially the interactions between fiercely territorial fish were aggressive. During the transition from strict territoriality to sociality, however, the dyadic relationships were characterized by a suite of ritualized behaviours apparently aimed at appeasement. These included parallel ‘side-by-side’ grazing along territorial borders, pseudospawning at the bottom of the tank, and eel-like swimming.

Complex appeasement behaviours are usually associated with highly social animals with well-developed cognitive abilities, such as primates. Lorenz’s findings demonstrated the potential for complex sociality in the Moorish idol, and similar behaviours are now known to occur in other coral fish, butterfly fish, for instance. In their commentary, Kotschal and Okawa liken the dynamic social structure of the Moorish idol to the ‘fission–fusion’ social behaviour of chimpanzees, which is characterized by dominance hierarchies and shifting coalitions of individuals. But whether the Moorish idols similarly ape primate social organization in the wild remains to be established. □

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