

## Not just a pretty face

They learn quickly, use tools, have sophisticated social structures and impressive long-term memories. So why does everyone think fish are plain stupid, asks **Culum Brown**

**M**OST people dismiss fish as dim-witted pea-brains that spend all day swimming around doing...well, nothing. Worse still, others believe that, like Dory in the film *Finding Nemo*, fish have a 3-second memory span and are doomed to perpetually rediscover the joys of their fish tank or goldfish bowl. And as for culture or social engagement – forget it.

Yet this is a great fallacy. Fish are more intelligent than they appear. In many areas, such as memory, their cognitive powers match or exceed those of “higher” vertebrates, including non-human primates. Best of all, given the central place memory plays in intelligence and social structures, fish not only recognise individuals but can also keep track of complex social relationships.

The widespread notion of fish as stupid is partially grounded in a traditional reading of evolution. According to this, fish are the most primitive vertebrates and evolution has progressed by gradual linear gradients, from fish through amphibians, reptiles, birds, mammals and primates to humans. The “higher” the species, the more complex its brain structure, intelligence and behaviour. Because the more primitive vertebrates have relatively simple neural circuits their behaviour is primarily automated or

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innate. At the other end of the scale, humans have sophisticated neural circuits and are capable of performing complex cognitive tasks.

But perhaps there is another, deeper reason for our prejudice against fish. Humans have lived side-by-side with many terrestrial creatures for millennia. We have shared their environment and bonded with them as we domesticated them. We think we understand what dogs, cats and horses see, feel and think, and that positive emotional response has developed into empathy. Fish, on the other hand, are cold and slimy. They live in a world biologists have only started to understand. Scuba gear was not widely available until the 1960s, and even today few people have experienced life underwater. How can we hope to relate to fish if we haven't the faintest idea what their world is like?

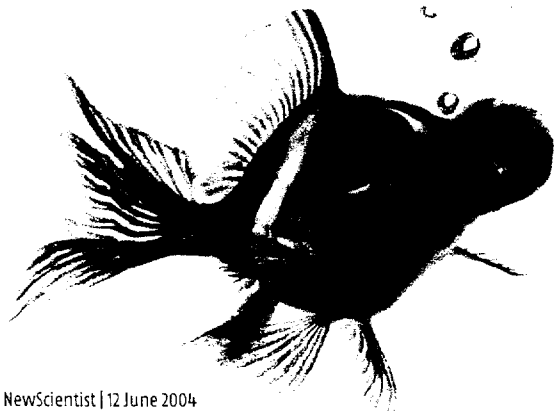
Having spent over a decade studying fish, I feel I must champion their cause. Here are the facts. Fish have existed for more than 400 million years, they inhabit every imaginable aquatic niche, and show a diversity unparalleled in any other vertebrate group. There are 28,500 known fish species, more species than all other vertebrates combined. There has been ample time for fish to evolve complex and diverse behaviours as befits their multiplicity of lifestyles – plus the cognitive hardware to go with them.

Rather than viewing evolution as a linear progression of increasing complexity, modern evolutionary theory views the various vertebrate lineages as highly diverse groups in all their forms and specialisations. All groups occupy more or less parallel lines of evolution, radiating from a common ancestor hundreds of millions of years ago. Rather than highlighting differences, comparative psychologists, behavioural ecologists and

neuroscientists are increasingly uncovering a huge degree of similarity between the groups.

Over the past 10 years, the number of research papers on fish has increased dramatically. Just over a decade ago James Kieffer and Patrick Colgan from Queen's University, Ontario, reviewed learning and memory in fishes in a single short manuscript (*Reviews In Fish Biology And Fisheries*, vol 2, p 125). They were able to cite some 70 papers. A recent issue of *Fish and Fisheries* (September 2003) was devoted to learning, and cited well over 500 research papers. The introductory chapter described fish as “steeped in social intelligence, pursuing Machiavellian strategies of manipulation, punishment and reconciliation...exhibiting stable cultural traditions and cooperating to inspect predators and catch food”.

That's just for starters. Recent research has uncovered fish species that





use tools, build houses and, above all, have an impressive ability for long-term memory. This allows them to maintain complex social relationships, and even gather information by eavesdropping on others. For example, species of fish that search for prey by emitting pulses of electricity can home in on the successful foraging pulses emitted by other individuals and snaffle their prey. The structure of the fish brain is varied and rather different from ours, yet it functions in a very similar way.

In 2001, I published an article in *Animal Cognition* (vol 4, p 109) discussing long-term memory in the Australian freshwater rainbowfish. The fish were trained to locate a hole in a net as it approached down the length of a fish tank. After five attempts, they could reliably find the hole in the net. About 11 months later they were re-tested and their ability to escape was undiminished, even though they had not seen the

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apparatus during the intervening period. Not bad for a fish that only lives two to three years in the wild.

In a series of other experiments, my colleagues and I have shown that larger groups learn to avoid the net faster than smaller groups because fish in a shoal learn by observing one another. Social learning opens the door for the transfer of information between individuals and from generation to generation. This cultural transmission can lead to the development of stable cultural traits. For instance, several species of coral reef fish have "preferred" migration paths between feeding and resting sites that have been shown to be culturally transmitted.

Clearly fish also rely on memory to keep track of social structures. For example, when a fish watches two others having a fight, it not only gathers information about the contestants' social ranks but it also establishes its own rank relative to the combatants.

Many of the components of these aggressive displays can also be used to attract females. If two male Siamese fighting fish are fighting, their displays contain many more aggressive elements, like nips and chases, but if a female is watching, the lads alter the repertoire and make it a bit more sexy.

Many fish build nests for rearing young just as birds do; others have permanent burrows or preferred hiding spots. But how do you cope if you are constantly on the move, looking for food? Rock-moving wrasse build new homes every night by collecting bits of rubble off the seafloor. Once construction is complete the wrasse settles down to sleep and abandons the dwelling the next morning.

Other fish use tools for foraging. Archerfish fire spurts of water to dislodge insects, while other species crush sea urchins with rocks. Some grazing fish tend well-kept gardens where they constantly remove unwanted algae and encourage the growth of "tasty" species. Some fish, however, have to turn to less reliable relationships for their food supply. Cleaner wrasse eat dead bits of skin and parasites from the bodies of other fish. If the wrasse nips its client's skin, the client will leave and find another, more careful cleaner. It is in the wrasse's best interest to entice a client back to its cleaning station. How does it do this? A nice back rub seems to do the trick.

It is clear that fish visiting these cleaning stations keep track of where the best stations are. And there are many other studies showing that fish have a fantastic spatial memory, equal in all respects to any other vertebrate. They can, for instance, form cognitive maps which they use to take short cuts from one location to another, navigating via cues such as polarised light, the electromagnetic field, sounds and smells, and visual beacons and other landmarks.

Despite all these amazing feats, fish biologists have a long way to go before we convince the public that fish are intelligent. First, we must impress upon scientists a modern view of evolution. Then we must reverse hundreds of years of prejudice. Fish may seem quite pathetic when they are flopping around on the deck of a boat, but get down into their world and you'll soon realise that they are remarkable creatures. ●