



## Dolphins Join the Culture Club

Genetic analyses show that tool use is culturally transmitted by bottlenose dolphins in Shark Bay. Michael Krützen says that this makes dolphins the only marine mammals that have demonstrated a material culture.

“Demi”, an adult female Indo-Pacific bottlenose dolphin (*Tursiops* sp.) from Shark Bay in Western Australia, breaks the surface to breathe. Researchers, waiting in anticipation nearby while they are following Demi, spring into action as she breaks the surface, trying to see what she is carrying on her rostrum (snout). Closer observation shows that the object used by Demi is a conically shaped marine sponge. Demi surfaces three or four

more times before diving to the bottom of the ocean. For a long time, marine biologists working in Shark Bay were puzzled about some dolphins carrying these objects, but several years of research have shed light on the function and transmission of this remarkable behaviour.

Ever since Jane Goodall's discovery in the early 1960s that chimpanzees from Gombe, Tanzania, used twigs as tools to fish for termites, the number of animal groups in which tool use has

been demonstrated has risen sharply. Nowadays, some bird species (herons, crows, owls, vultures), otters (sea otters) and primates (hooded monkeys, orangutans, gorillas), just to name a few, are known to use tools for all sorts of tasks: for feeding, drinking, cleaning themselves, investigating out-of-reach objects, and as weapons.

Further research outside Gombe showed not only that animals from other communities used objects for different purposes, but also a signifi-

A young dolphin pushes a sponge through the water. Female dolphins in Shark Bay use sponges to probe the underwater environment for prey. The sponges protect the dolphins from dangerous animals they cannot see, such as stonefish. "Sponging" behaviour is passed from mother to daughter.

cant divergence in the behavioural repertoire between different communities. This variation is somewhat similar to human cultures, where innovations spread through social learning (i.e. they are non-genetic) and are maintained within or between generations. In a landmark study from 1999, Andrew Whiten from the University of St Andrews in Scotland compared the behavioural repertoire of the Gombe chimpanzees with five other well-studied chimpanzee communities. They identified 39 different behaviours, some of which involved tool use, that were customary (shown by most or all relevant individuals) or habitual (shown by at least several relevant individuals) in at least one, but absent in another, ecologically similar site. The presence or absence of different customary or

habitual behaviours in ecologically similar sites led to a patchwork of traditions in different chimpanzee communities identical to human cultures. This "geographic" approach to show culture in non-human animals by excluding ecological and genetic explanations has also been applied to orangutans, where 19 behaviours vary culturally among six different orangutan populations.

The first dolphin to be observed carrying a sponge was a female named "Spongemom" in the late 1980s. At this time, Rachel Smolker was studying for her PhD in Shark Bay when a local fisherman approached her very excitedly, telling her that he had seen a dolphin with what looked like a massive tumour on its rostrum about 1 km offshore from the Monkey Mia resort. Rachel was intrigued and decided to investigate. After a while she found the dolphin and realised that the huge tumour was a marine sponge, and that the animal showed all signs of typical foraging behaviour. It seemed that the animals used the sponges for foraging. "Sponging" was discovered.

After a few years, and thanks to the collaborative effort of several researchers in Shark Bay, researchers began to learn how the tools are used. In Shark Bay, tiger sharks are abundant and observation underwater is difficult and dangerous. However, dolphin research in Shark Bay takes place all year round, and sometimes the water is so clear that researchers are able to catch a glimpse of what is going on at the bottom directly from the safety of their boats.

"Sponger" dolphins appear to use the tools to probe the underwater environment for potential prey. Lots of potentially noxious animals such as stonefish are concealed, so researchers believe that the sponges act as a protective device, like a natural glove, that allows spongers to obtain food sources that are otherwise not available to them. Once a dolphin has located a

potential prey item it drops the sponge and chases after it, then quickly returns after a successful hunt to pick up the sponge again.

Fatty acid analyses of tiny portions of the blubber of both spongers and non-spongers have revealed a significantly different diet between dolphins that use tools and those that do not. Hence it appears that sponging allows dolphins to exploit certain parts of their normal habitats that would not be available to them otherwise.

Over a 14-year period, more than 20 adult female spongers and 11 of their offspring were identified by Shark Bay researchers who conducted more than 9500 boat surveys and made more than 14,000 sightings. Researchers found that almost all adult spongers are female, and that mainly daughters take up sponging once they become adults. Males do not seem to take up this behaviour because their social structure is quite different from females as adults. Genetic analyses revealed that all but one sponger belong to the same maternal lineage, called a "matriline", and are hence descendants of a single female ancestor. Some non-sponging dolphins are members of the same matriline.

Given these findings, it seems to be plausible that this behaviour is culturally transmitted between dolphins. In other words, dolphins learn this behaviour from their mothers and then, in turn, pass it on to their daughters.

To substantiate the claim of a material culture in dolphins, one would have to rule out genetic and ecological explanations for sponging behaviour. Furthermore, evidence needs to be gathered to show that sponging is not based on individual learning, such as a random dolphin picking up a sponge, playing with it and discovering that it can be used as a tool. In this case there would be no social component to the learning process. However, the capability of social learning is a prerequisite for culture.

Ecological constraints play an important role in an animal's diet. Obviously, an animal can only forage for food that is abundant in the habitat it experiences. Usually, habitat differences can explain a lot of variation found between groups.

For instance, an orangutan requires a certain tool to open a fruit. In habitats of other orangutan populations, the same fruits are much softer and do not require tools to be opened; just biting them will do the trick. In this case, the apparent differences in opening the same fruit are not culturally but ecologically determined. In Shark Bay, numerous dolphins of either sex that have never been seen sponging use the same habitat, the so-called sponger channels, for their regular foraging. The

behaviour rather than on social learning and observation, as previously thought. Naïve crows that were hand-raised and had never seen another crow in their life suddenly manufactured tools out of twigs in order to obtain mealworms placed in an apparatus by humans. The results strongly indicate an underlying genetic propensity causing the birds to individually learn this behaviour – they had no opportunity to copy it.

For dolphins in Shark Bay, researchers asked if a hypothetical genetic type (a so-called “genotype”) that caused sponging would follow Mendelian rules of inheritance on the family level and how it would spread through the entire population. Would this then agree with the actual obser-

species?

The ability to socially learn is a requirement for the cultural transmission of any behaviour. If a prime candidate for social learning had to be named, dolphins would surely spring to mind. They are good at imitating not only their conspecifics but also, for example, human models. Primatologists enviously admit that dolphins surpass even their primate counterparts in this ability. Although individual learning could be a viable alternative explanation, it seems rather unlikely as one would not expect the strong observed correlation between membership of a particular matriline and sponging behaviour.

Given that dolphins are excellent social learners, and genetic and ecological explanations for sponging behaviour can be ruled out, dolphins in Shark Bay appear to be the first marine mammals to join the material culture club. This has strong implications for the evolution of culture, as it seems that material cultures can evolve independently in diverse habitats and do not seem to be restricted to primates.

Demi, however, does not seem to care about the fuss scientists make of her kind. Unmoved by the excitement on the research vessel, she soon disappears into the distance, tending her unique business.

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## “Sponger” dolphins appear to use the tools to probe the substrate for potential prey.

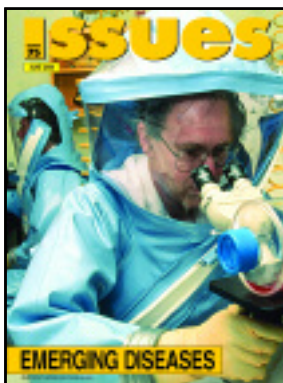
co-occurrence rules out any ecological determinant because it appears that dolphins do not require tools to exploit this habitat successfully.

Ruling out potential genetic factors, such as a genetic propensity that might cause dolphins to use tools, is more difficult. Although frequently brushed aside, genetic explanations can account for complex behaviours involving tools.

A recent study by Ben Kenward, then at the University of Oxford, showed that tool use in New Caledonian crows is based on instinctive

variations in the population? The researchers showed that none of 10 possible inheritance mechanisms agreed with observations in the population. Furthermore, genetic data showed that preferential mating, proposed by some researchers for the occurrence of different behaviours within a social group, cannot account for sponging behaviour.

Since there seem to be no ecological and genetic explanations, does sponging qualify as the first case of material culture in a marine mammal



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VOLUME 75  
JUNE 2006

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