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Crafty Crows Use Tools To Fish For Nutritious Morsels

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Tool use is so rare in the animal kingdom that it was once believed to be a uniquely human trait. While it is now known that some non-human animal species can use tools for foraging, the rarity of this behavior remains a puzzle. It is generally assumed that tool use played a key role in human evolution, so understanding this behavior's ecological context, and its evolutionary roots, is of major scientific interest. A project led by researchers from the Universities of Oxford and Exeter examined the ecological significance of tool use in New Caledonian crows, a species renowned for its sophisticated tool-use behavior. The scientists found that a substantial amount of the crows' energy intake comes from tool-derived food, highlighting the nutritional significance of their remarkable tool-use skills. A report of the research appears in this week's Science.

To trace the evolutionary origins of specific behaviors, scientists usually compare the ecologies and life histories of those species that exhibit the trait of interest, searching for common patterns and themes. "Unfortunately, this powerful technique cannot be used for studying the evolution of tool use, because there are simply too few species that are known to show this behavior in the wild," says Dr Christian Rutz from Oxford University's Department of Zoology, who led the project. But, as he explains further, some light can still be shed on this intriguing question. "Examining the ecological context, and adaptive significance, of a species' tool-use behavior under contemporary conditions can uncover the selection pressures that currently maintain the behavior, and may even point to those that fostered its evolution in the past. This was the rationale of our study on New Caledonian crows."

Observing New Caledonian crows in the wild, on their home island in the South Pacific, is extremely difficult, because they are easily disturbed and live in densely forested, mountainous terrain. To gather quantitative data on the foraging behavior and diet composition of individual crows, the scientists came up with an unconventional study approach. New Caledonian crows consume a range of foods, but require tools to extract wood-boring longhorn beetle larvae from their burrows. These larvae, with their unusual diet, have a distinct chemical fingerprint—their stable isotope profile—that can be traced in the crows' feathers and blood, enabling efficient sample collection with little or no harm to the birds. "By comparing the stable isotope profiles of the crows' tissues with those of their putative food sources, we could estimate the proportion of larvae in crow diet, providing a powerful proxy for individual tool-use dependence," explains Dr Rutz.

The analysis of the samples presented further challenges. Dr Stuart Bearhop from Exeter University's School of Biosciences, who led the stable-isotope analyses, points out: "These crows are opportunistic foragers, and eat a range of different foods. The approach we used is very similar to that employed by forensic scientists trying to solve crimes, and has even appeared on CSI. We have developed very powerful statistical models that enabled us to use the unique fingerprints, or stable isotope profiles, of each food type to estimate the amount of beetle larvae consumed by individual New Caledonian crows."

The scientists found that beetle larvae are so energy rich, and full of fat, that just a few specimens can satisfy a crow's daily energy requirements, demonstrating that competent tool users can enjoy substantial rewards. "Our results show that tool use provides New Caledonian crows with access to an extremely profitable food source that is not easily exploited by beak alone," says Dr Rutz. And, Dr Bearhop adds: "This suggests that unusual foraging opportunities on the remote, tropical island of New Caledonia selected for, and currently maintain, these crows' sophisticated tool technology. Other factors have probably played a role, too, but at least we now have a much better understanding of the dietary significance of this remarkable behavior."

The scientists believe that their novel methodological approach could prove key to investigating in the future whether particularly proficient tool users, with their privileged access to larvae, produce offspring of superior body condition, and whether a larva-rich diet has lasting effects on future survival and reproduction. "The fact that we can estimate the importance of tool use from a small tissue sample opens up exciting possibilities. This approach may even be suitable for studying other animal tool users, like chimpanzees," speculates Dr Rutz.

Notes:

A report of the research, entitled 'The ecological significance of tool use in New Caledonian crows' is to be published in Science on Friday, September 17, 2010 (authors: Christian Rutz, Lucas A. Bluff, Nicola Reed, Jolyon Troscianko, Jason Newton, Richard Inger, Alex Kacelnik, Stuart Bearhop).

The researchers studied the New Caledonian crow (Corvus moneduloides), a species that has attracted attention with its unusually sophisticated use of tools for extracting invertebrates from holes and crevices. The species is endemic to the tropical island of New Caledonia in the South Pacific, where fieldwork was conducted.

New Caledonian crows use stick tools to probe for longhorn beetle larvae (Agrianome fairmairei) in decaying trunks of candlenut trees (Aleurites moluccana). The larva-extraction technique of crows relies on exploiting defensive responses of their prey, similar to the well-known 'termite fishing' of chimpanzees. Crows insert a twig or leaf stem into a burrow, 'teasing' the larva by repeatedly poking it with the tool until it bites the tip of the tool with its powerful mandibles, and can be levered out.

The use of stable isotopes to examine the diets of wild animals is a well-established research technique. It relies on the premise "you are what you eat". Thus, the unique stable isotope profile of a food source can often be traced in the tissues of a consumer. Using relatively simple conversion factors (and some assumptions), it is possible to use this information to calculate the amount of any given food type in the diet of an animal. The Exeter-based research group has recently been involved in developing powerful Bayesian analysis techniques that are suitable for estimating animal diets in more complex situations, for example when consumers are known to eat many different food types. This advance was key to their collaboration with the Oxford-based scientists, who study the ecology and behavior of the New Caledonian crow – a species that, like many other crows and ravens, is an opportunistic, generalist forager.

Previous studies on New Caledonian crows have shown that: wild crows manufacture and use at least three distinct tool types (including the most sophisticated animal tool yet discovered); the species has a strong genetic predisposition for basic stick-tool use (tool-related behavior emerges in juvenile crows that had no opportunity to learn from others); crows have a preferred way of holding their tools (comparable to the way that humans are either left- or right-handed); adult crows can make or select tools of the appropriate length or diameter for experimental tasks; at least some birds can 'creatively' solve novel problems; and wild crows may socially transmit certain aspects of their tool-use behavior (but claims for 'crow tool cultures' are still contentious).

An earlier paper in Science by Dr Christian Rutz's team (published in 2007) described the use of miniaturized, animal-borne video cameras to study the undisturbed foraging behavior of wild, free-ranging New Caledonian crows.

This work was funded by the UK's Biotechnology and Biological Sciences Research Council (BBSRC) and Natural Environment Research Council (NERC). Dr Christian Rutz is a BBSRC David Phillips Fellow at the Department of Zoology, University of Oxford, and Dr Stuart Bearhop is a Senior Lecturer in the School of Biosciences, University of Exeter.

Stable isotope measurements were carried out by Dr Jason Newton, Senior Research Fellow and Manager of the NERC Life Science Mass Spectrometry Facility in East Kilbride. The Facility exists to provide access for UK scientists in the biological, environmental and other sciences to training and research facilities, offering an integrated and comprehensive suite of stable isotope techniques and expertise.

Image Caption: A captive New Caledonian crow forages for food using a stick tool. Credit: Dr. Simon Walker

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