To find energy-rich food, like tropical ripe fruit, is a challenge for chimpanzees

January 22 2016

Female chimpanzee having Grewia fruit. Credit: © M. Colbeck

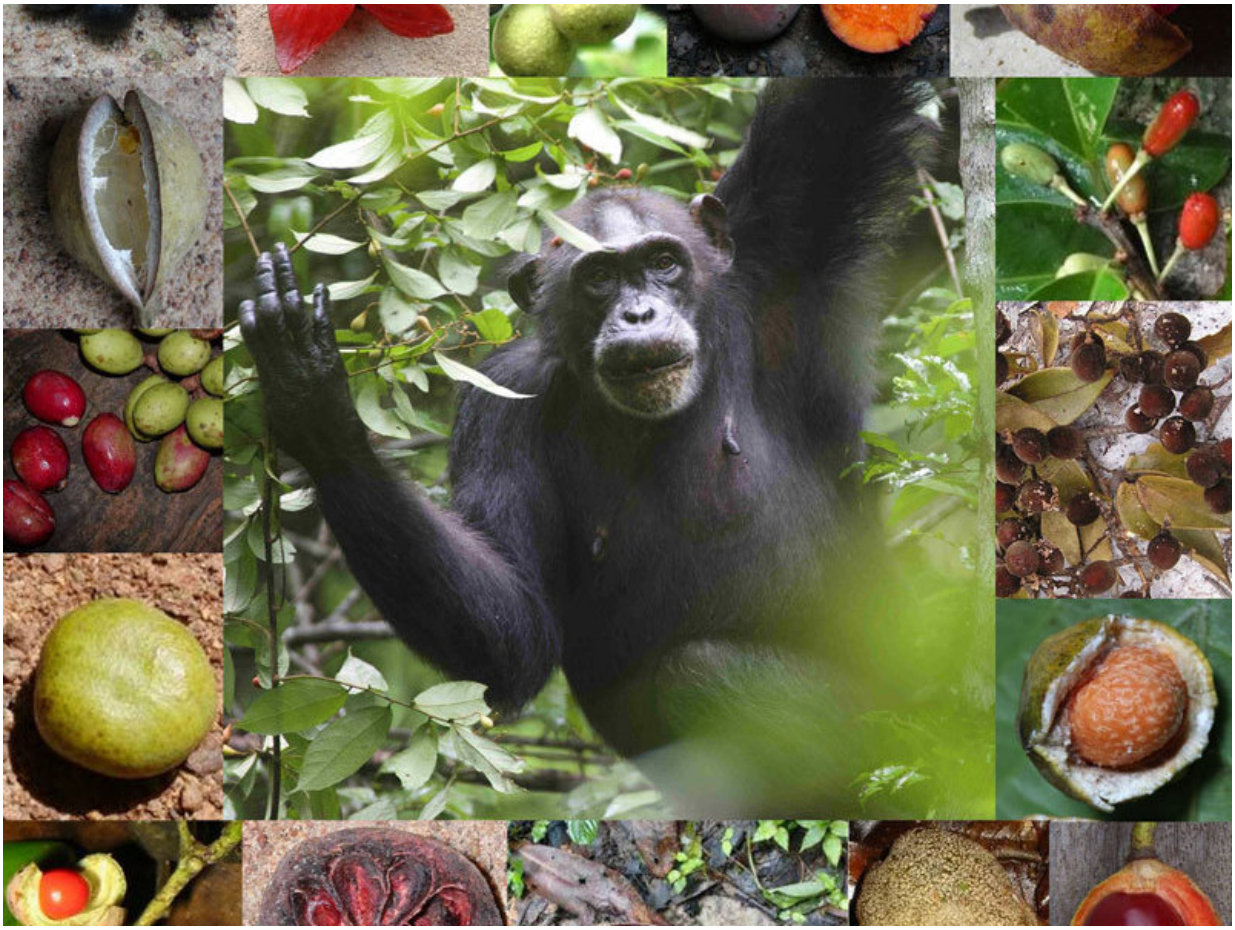
In our supermarkets we buy raspberries in winter and chestnuts in summer. But how challenging would life become, if we needed to consume large amounts of fruit for our daily meal and had to collect

them ourselves? With a largely plant-based diet, simple stomachs, and the additional cost of maintaining relatively large brains, chimpanzees face a serious challenge in their daily search for energy and nutrients. Using data on the monthly availability of young leaves, unripe and ripe fruits in three tropical rain forests in East, Central and West Africa, a consortium of researchers of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, Harvard University, McGill University, the University of St. Andrews and the Université Félix Houphouët Boigny, estimated how difficult it is for chimpanzees to find food and to predict its availability in individual trees. This study reports which cognitive strategies chimpanzees can use to gain privileged access to the most energy-rich but ephemeral food.

Tropical forest habitats and their distribution have a major impact on primate evolution, since the majority of primate species and all great apes forage on food produced by tropical forest trees. Given their lack of specialized morphological and physiological dietary adaptations, great apes are, in contrast to many old world monkeys, unable to digest chemically defended forest foods such as many mature leaves and certain seeds. This increases their reliance on the consumption of energy-rich food, such as young leaves or ripe fruit, when they are available. A low percentage of ripe fruit in the diet has negative effects on female reproductive physiology, including conception, and other life history traits.

Karline Janmaat of the Max Planck Institute for Evolutionary Anthropology and her colleagues merged three sets of long-term data collected from three tropical rain forests located in East, Central, and West Africa spanning from five to 20 years and investigated the temporal fruiting patterns of rain forest trees. The researchers quantified how difficult it is for chimpanzees to find energy-rich young leaves, unripe and ripe fruit and, in particular, large ripe fruit crops in individual trees. Their study revealed a chimpanzee's challenge is not so much to

find food plants, since they are surprisingly abundant, but to find those that actually produce food. Calculations revealed that chimpanzees were 17 times more challenged to find ripe fruit, the most energy-rich food source, than unripe fruit. Moreover, trees with large crops of ripe fruit were at least nine times scarcer than other trees: in pristine forests only one large ripe fruit crop was encountered every 10 kilometers of straight-line travel, on average. In fruit scarce months no such trees were encountered.



Chimpanzee female eating Grewia fruit, and a variety of rainforest fruit eaten by chimpanzees in Uganda, Côte d'Ivoire and Gabon. Credit: © K. Janmaat, S. Metzgar, M. Colbeck, Z. G. Bi, J. Head

Less food for chimps than expected

"When I saw chimpanzees outrun others to reach feeding trees and leave their nests before sunrise to reach high-energy fruit, I realized that the persistent idea of abundance created by giant fruit trees and lush foliage was an illusion", says Janmaat. "This unique collaboration has finally enabled us to provide evidence that explains the chimpanzees' intriguing monitoring behaviors and to develop well-grounded hypotheses that test how clever chimpanzees are compared to other primates with less complex or smaller brains".

Furthermore, Janmaat and colleagues found that individual trees varied tremendously in their productive output; in some extreme cases individuals bore ripe fruit more than seven times as often as other trees of the same species. Moreover, the duration during which individual trees carried more than 50 percent of ripe fruit varied widely: In the case of Sarcocephalus pobeguinii in the Taï forest, one tree produced more than half of its maximal crop during four in 53 months, while another produced only small amounts of fruit (all scores less than 50 percent) during the same 53 months. Considering that some species showed much more variation than others, the researchers think it to be likely that chimpanzees have a species-specific knowledge of fruit production histories of some individual trees. This knowledge might help them to avoid travelling towards trees that are likely empty and to optimize monitoring times.

"The sounds of the field team calling out the data leaves an impression: 'Young leaves: zero. Immature fruit: zero. Ripe fruit: zero.' While a preponderance of zeros poses challenges to statistical ecologists, the challenges to those who must rely on obtaining large amounts of fruit for survival are much more consequential", says co-author Leo Polansky.

Strategies for food retrieval

To buffer periods of food scarcity some chimpanzees use tools to crack energy rich nuts or to extract honey from underground bee nests. The results of this study indicate that there may be another way to maximize their energy intake, namely by employing a suite of cognitive mechanisms that enable them to outcompete other animals in exploiting easily accessible energy-rich and ephemeral foods, such as ripe fruit. This suite can include abilities to generalize or classify food trees, remember the relative metrics of quantity and frequency of fruit production across years, and flexibly plan return times to feeding trees to optimize high-energy food consumption in individual trees, and efficient travel between them.

"Traditionally we have been thinking that the life in the savannah is hard and that therefore our ancestors needed to become intelligent when they left the forest. Now, this view did not concur with the intelligence we see in our closest living cousin, the chimpanzees. This new study shows convincingly that the challenge of finding ripe fruit can be more demanding in the forest then we have thought before", says Christophe Boesch, director of the Department of Primatology at the Max Planck Institute for Evolutionary Anthropology.

More information: Karline R. L. Janmaat, Christophe Boesch, Richard W. Byrne, Colin A. Chapman, Zoro B. Goné Bi, Josephine S. Head, Martha M. Robbins, Richard W. Wrangham, and Leo Polansky, Spatio-temporal complexity of chimpanzee food: How cognitive adaptations can counteract the ephemeral nature of ripe fruit. *American Journal of Primatology*; 21 January, 2016. DOI ist: 10.1002/ajp.22527

Provided by Max Planck Society