A unique hominin menu dated to 1.95 million years ago

Teresa E. Steele[1]

Department of Anthropology, University of California, Davis, CA 95616-8522

Research on ancient foragers has tended to focus on their acquisition of large land mammals, but our ancestors in fact exploited a wider range of taxa. Depending on the local environment, this range included tortoises, birds, and hares from terrestrial habitats and mollusks, birds, and fish from aquatic habitats. These small terrestrial animals and aquatic species begin to appear occasionally in the archaeological record during the Middle Pleistocene (<780,000 y ago), occur irregularly until the Late Pleistocene (<130,000 y ago), and are abundant only within the past few tens of thousands of years (1–6). However, the exploitation of these resources in the Plio-Pleistocene has been difficult to detect because relevant samples are rare and have not always been studied in sufficient detail. Recent information on excavations at the 1.95 million-year-old Oldowan site of FwJJ20 in the East Turkana Basin of northern Kenya, published in PNAS, helps fill the void, and research shows that at least some early hominins, enjoyed a varied diet, including aquatic species that were typical of the well-watered surroundings of the site (7). This work highlights the opportunistic nature of early hominin foraging and the importance of sampling as many paleo-habitats as possible as well as the need for thorough analyses of all excavated animal remains.

Ever since the seminal studies of Leakey (8) of sites within Olduvai Gorge, paleoanthropologists have contemplated the relationship between ancient Oldowan stone artifacts and the animal bones that often are found with them. Leakey (8) and Leakey and Roe (9) described the faunal assemblages, discussed the possible use of bones as tools, and noted the presence of infrequent carnivore damage (8, 9), yet it was Bunn (10) and Potts and Shipman (11) who first identified cut marks on the mammal bones associated with Oldowan artifacts. They, thus, confirmed that ancient hominins probably consumed these animals and that they played a significant role in accumulating bones at Oldowan sites. However, these landmark studies, as well as more recent work (12), emphasized mammalian bones, despite the abundance of crocodiles, turtles, and fish in some assemblages from Olduvai and other equally ancient sites. The major exception was a study by Stewart (13), who used criteria derived from analyses of Late Pleistocene fish assemblages to assess the degree of hominin involvement in accumulating the fish remains at five Olduvai Gorge sites. She examined site location, taxonomic diversity, the natural history of the species under investigation, skeletal part representation, and bone-surface modification, from which she concluded that early hominins likely played a role in accumulating fish remains at Frida Leakey Koronga (FLK) North-North Level 3, FLK-*Zinjanthropus*, and Bell's Korongo (BK). Between 80% and 90% of the fish present in these assemblages were catfish, which Stewart argued could be captured with little or no technology. Catfish spawn, often in great concentrations in shallow waters, can become stranded in shallow areas as seasonal pools and channels recede. They can then be gathered by hand, which means that they would have been readily accessible to early hominins (13, 14). Despite the thoroughness of Stewart's study, however, she lacked one definitive marker of hominin exploitation of catfish—cut marks on the bones.

At FwJj20, hominins consumed a wide variety of terrestrial and aquatic forms.

A few fish remains from BK had suggestive marks, but they were too indistinct to be confidently identified. A similar situation exists with respect to turtles at Olduvai (15). The question of whether early hominins exploited fish and turtles, thus, remained open.

The analysis of Braun et al. (7) of the FwJj20 fauna provides the first definitive evidence that early hominins exploited catfish—through the presence of cut-marked bones. Turtle and crocodile remains, along with more commonly identified bovid, hippopotamus, and rhinoceros bones, also exhibit cut marks, indicating that, at FwJj20, hominins consumed a wide variety of terrestrial and aquatic forms. FwJj20 is located within the well-known Koobi Fora Formation along the eastern shores on Lake Turkana in northern Kenya. Oldowan artifacts and animal bones accumulated in a low-energy location on a delta floodplain. The faunal and plant macrofossil species and oxygen-isotope values from tooth enamel indicate that water was abundant nearby. The excavations recovered more than 2,500 stone artifacts and 3,500 animal fossils (740 of which were identifiable to taxon) within one 15-cm horizon at the site. Careful analysis revealed that stone-tool cut marks (from disarticulation, evisceration, and defleshing) outnumbered carnivore chew marks, indicating that parts of at least 10 animals were butchered at the site.

An Opportunistic Diet

This research furthers our understanding of early hominin behavior in a number of ways. It highlights the opportunistic nature of Oldowan subsistence. Early hominins exploited a wide variety of habitats and now it appears, a diversity of resources within these habitats. Modern humans thrive on diverse foods, and a diverse diet may have been key to our lineage's success (16), although the aquatic component may have deep roots given that some nonhuman primates consume some aquatic foods (17). Braun et al. (7) justifiably did not address whether the FwJj20 carcasses were obtained through hunting or scavenging. It is likely that the crocodiles, hippopotamuses, and rhinoceroses were scavenged, although soon enough after death that there was still flesh remaining. The mode of acquisition of other species, such as the catfish and turtles, is more ambiguous. They may have been scavenged or gathered live, because only minimal technology is required to catch them. Future work is needed to determine if the patterns found at FwJj20 are more widespread and if they are typical of Oldowan subsistence.

Implications for Brain Growth

Establishing the degree to which Plio-Pleistocene hominins included aquatic resources in their diet is important if we are to accept the proposal that the nutrients provided by these foods were important for brain expansion during human evolution (18–20). Some nutrients that may be essential for brain growth are much more abundant in fish and shellfish than in meat. Consequently, aquatic resources may have fueled brain development and allowed individuals from groups with access to these resources to be more competitive behaviorally. Although

Author contributions: T.E.S. wrote the paper.

The author declares no conflict of interest.

See companion article on page 10002 in issue 22 of volume 107.

[1]E-mail: testeele@ucdavis.edu.

intriguing, this proposal is controversial, because the human body may (21) or may not (22) be able to synthesize key nutrients found in aquatic resources from other components. This proposal is also ambiguous about which phase of human evolution is implied, and it suggests that successful hominins should be more closely associated with lake and ocean shores than the archaeological record suggests (21, 23). Clearly, better-defined models and nutritional data are needed.

Antiquity of Aquatic Resource Use

Aquatic resources become regularly visible in the diets of some groups of hominins only after 160,000 y ago, as seen at some Middle Stone Age sites along the South African coast (5, 24, 25). At these sites, ancient humans exploited mollusks, fur seals, penguins, and other marine birds—resources that may be gathered, hunted with spear technology, or scavenged. Even at this time, the known use of aquatic resources is limited to South African coastal sites, some contemporaneous sites along the north African coast (26), some lake margin sites in East Africa where catfish were more regularly taken (13, 27, 28), and a handful of near-coastal sites in Europe occupied by contemporaneous Neanderthals (29–31). An important implication of the FwJj20 assemblage is that aquatic resources that require little or no technology to obtain may have been a regular component of hominin diets whenever the environmental circumstances were appropriate and that the evidence before 160,000 y ago may be sparse for reasons of geological context and preservation rather than human behavior. Alternatively, human diet may have changed significantly around 160,000 y ago when evidence for mollusk consumption begins to be more abundant (5). Routine consumption of fish other than catfish does not appear in the archaeological record until after about 40,000 y ago (1, 3) and may reflect changes in technology that allowed people to more regularly and efficiently capture fish from deeper and faster moving waters.

The FwJj20 assemblage is significant for highlighting the dietary diversity of our early hominin ancestors. The challenge now is to determine if FwJj20 represents an Oldowan pattern or a unique occurrence, and if it signals a pattern, then it must be determined if the pattern persisted.

1. Erlandson JM (2001) The archaeology of aquatic adaptations: Paradigms for a new millennium. *J Archaeol Res* 9:287–350.
2. Klein RG (1979) Stone Age exploitation of animals in southern Africa. *Am Sci* 67:151–160.
3. Klein RG (2009) *The Human Career: Human Biological and Cultural Origins* (University of Chicago Press, Chicago), 3rd Ed.
4. Klein RG, Cruz-Uribe K (1983) Stone Age population numbers and average tortoise size at Byneskranskop Cave 1 and Die Kelders Cave 1, southern Cape Province, South Africa. *S Afr Archaeol Bull* 38:26–30.
5. Marean CW, et al. (2007) Early human use of marine resources and pigment in South Africa during the Middle Pleistocene. *Nature* 449:905–908.
6. Stiner MC, Munro ND, Surovell TA (2000) The tortoise and the hare. Small-game use, the broad-spectrum revolution, and paleolithic demography. *Curr Anthropol* 41:39–79.
7. Braun DR, et al. (2010) Early hominin diet included diverse terrestrial and aquatic animals 1.95 Ma ago in East Turkana, Kenya. *Proc Natl Acad Sci USA* 107:10002–10007.
8. Leakey MD (1971) *Olduvai Gorge: Excavations in Beds I and II, 1960-1963* (Cambridge University Press, Cambridge, UK), Vol 3.
9. Leakey MD, Roe DA (1994) *Olduvai Gorge: Excavations in Beds III, IV and the Masek Beds, 1968-1971* (Cambridge University Press, Cambridge, UK), Vol 5.
10. Bunn HT (1981) Archaeological evidence for meat-eating by Plio-Pleistocene hominids from Koobi Fora and Olduvai Gorge. *Nature* 291:574–577.
11. Potts R, Shipman P (1981) Cutmarks made by stone tools on bones from Olduvai Gorge, Tanzania. *Nature* 291:577–580.
12. Domínguez-Rodrigo M, Barba Egido R, Egeland CP, eds (2007) *Deconstructing Olduvai: A Taphonomic Study of the Bed I Sites* (Springer, New York).
13. Stewart KM (1994) Early hominid utilization of fish resources and implications for seasonality and behaviour. *J Hum Evol* 27:229–245.
14. Greenwood PH, Todd EJ (1970) Fish remains from Olduvai. *Fossil Vertebrates of Africa*, eds Leakey LSB, Savage RJG (Academic, London), Vol 2, pp 225–241.
15. Auffenberg W (1981) The fossil turtles of Olduvai Gorge, Tanzania, Africa. *Copeia* 1981:509–522.
16. Hockett B, Haws J (2003) Nutritional ecology and diachronic trends in Paleolithic diet and health. *Evol Anthropol* 12:211–216.
17. Kempf E (2009) Patterns of water use in primates. *Folia Primatol (Basel)* 80:275–294.
18. Crawford MA (1992) The role of dietary fatty acids in biology: Their place in the evolution of the human brain. *Nutr Rev* 50:3–11.
19. Broadhurst CL, Cunnane SC, Crawford MA (1998) Rift Valley lake fish and shellfish provided brain-specific nutrition for early Homo. *Br J Nutr* 79:3–21.
20. Broadhurst CL, et al. (2002) Brain-specific lipids from marine, lacustrine, or terrestrial food resources: Potential impact on early African *Homo sapiens*. *Comp Biochem Physiol B Biochem Mol Biol* 131:653–673.
21. Carlson BA, Kingston JD (2007) Docosahexaenoic acid, the aquatic diet, and hominin encephalization: difficulties in establishing evolutionary links. *Am J Hum Biol* 19:132–141.
22. Cunnane SC, Plourde M, Stewart KM, Crawford MA (2007) Docosahexaenoic acid and shore-based diets in hominin encephalization: A rebuttal. *Am J Hum Biol* 19:578–581.
23. Carlson BA, Kingston JD (2007) Docosahexaenoic acid biosynthesis and dietary contingency: Encephalization without aquatic constraint. *Am J Hum Biol* 19: 585–588.
24. Avery G, et al. (2008) The Ysterfontein 1 Middle Stone Age Rockshelter and the evolution of coastal foraging. *S Afr Archaeol Soc Goodwin Ser* 10:66–89.
25. Volman TP (1978) Early archaeological evidence for shellfish collecting. *Science* 201:911–913.
26. Steele TE, Álvarez-Fernández E (2010) Initial investigations into the exploitation of coastal resources in North Africa during the Late Pleistocene at Grotte des Contrebandiers, Morocco. *Trekking the Shore: Changing Coastlines and the Antiquity of Coastal Settlement*, eds Bicho N, Haws J, Davis LG (Springer, New York).
27. Brooks AS, et al. (1995) Dating and context of three middle stone age sites with bone points in the Upper Semliki Valley, Zaire. *Science* 268:548–553.
28. Yellen J, et al. (2005) The archaeology of Aduma Middle Stone Age Sites in the Awash Valley, Ethiopia. *PaleoAnthropology* 10:25–100.
29. Bicho N, Haws J (2008) At the land's end: Marine resources and the importance of fluctuations in the coastline in the prehistoric hunter-gatherer economy of Portugal. *Quat Sci Rev* 27:2166–2175.
30. Stiner MC (1994) *Honor Among Thieves: A Zooarchaeological Study of Neandertal Ecology* (Princeton University Press, Princeton), pp 1–447.
31. Stringer CB, et al. (2008) Neanderthal exploitation of marine mammals in Gibraltar. *Proc Natl Acad Sci USA* 105:14319–14324.