Journal of Island & Coastal Archaeology, 6:155–159, 2011

ISSN: 1556-4894 print / 1556-1828 online
DOI: 10.1080/15564894.2010.537733

NEWS AND NOTES

Hunting Impacts on the Sea Otter (*Enhydra lutris*) Population in Clam Lagoon (Adak Island, Aleutian Islands) 7,000 Years Ago? Results of Preliminary Stable Isotopes Analysis

Olga A. Krylovich
Laboratory of Biogeocenology and Historical Ecology, A.N. Severtsov Institute of Ecology and Evolution, Russian Academy of Sciences, Moscow, Russia

Archaeological site ADK-171 is situated along the precipitous coast of the almost closed "Clam Lagoon" on Adak Island, in the Aleutian Islands (Figure 1). The site was excavated by members of the Central Aleutian Archaeological and Paleobiological Project (CAAPP). The excavated midden has clear stratigraphy with two discrete layers. Radiocarbon dates show that the cultural midden at ADK-171 was formed approximately 7,000 years ago during a relatively short time period of about 100–200 years (Savinetsky et al. 2010). These dates confirm that ADK-171 is the oldest site in the Aleutian archipelago containing significant deposits of faunal remains.

Examination of invertebrate remains (Savinetsky et al. 2010) from archaeological sites on Adak Island showed that one of the causes of littoral invertebrate dynamics over the Holocene was biocoenotic relationships. Nuttall's cockle (*Clinocardium nuttali*) and sea urchins (*Strongylocentrotus polyacanthus*) were intensively harvested by ancient Clam Lagoon settlers. At the beginning of the settlement, cockles and sea urchins were not numerous in the lagoon, but after a short period these two species became much more

Address correspondence to Olga A. Krylovich, Laboratory of Biogeocenology and Historical Ecology, A.N. Severtsov Institute of Ecology and Evolution, Russian Academy of Sciences, 33, Leninsky pr., Moscow 117071, Russia. E-mail: okrylovich@gmail.com

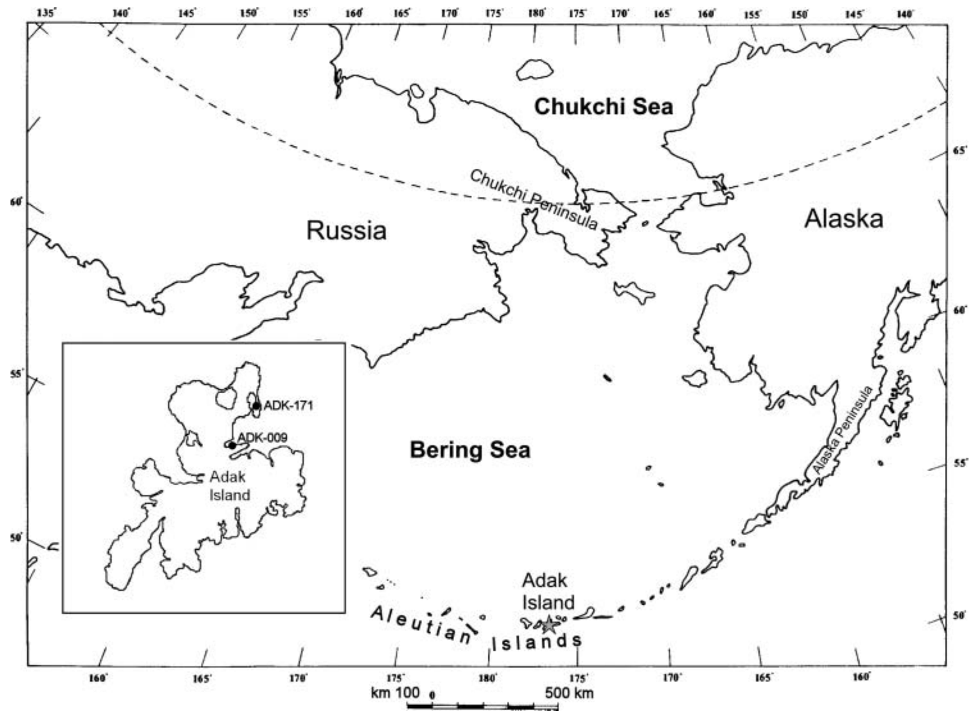

***Figure 1.** Map of the Aleutian Islands (Alaska) and Adak Island with ADK-171 and ADK-009.*

abundant. Sea urchins and cockles are also preferred food items for sea otters (*Enhydra lutris*). An increase in the abundance of these two species over time suggests better living conditions for these invertebrates, and/or decreased predation by sea otters. However, our excavations did not recover enough bones of sea otters to estimate chronological changes in their abundance. Erlandson et al. (2005) attributed sharp increases in the number of large red abalone shells in California Channel Island middens about 7,500 years ago to Native American hunting of sea otters.

One of the primary goals of my work was to determine if changes occurred in ancient Clam Lagoon sea otters populations by analyzing carbon and nitrogen stable isotopes of sea otter bone collagen from site ADK-171. To compare isotope signatures from different habitats, our team took material from another archaeological site on Adak Island (ADK-009) (Figure 1), situated on the coast of the open sea (Figure 1). Radiocarbon dates indicate that the cultural layers at ADK-009 were formed between the sixth and seventeenth centuries AD. I examined 20 bones of sea otters from ADK-171 for stable isotopes analysis and 4 bones from ADK-009.

Samples of collagen were analyzed using isotope mass spectrometer Finnigan Delta V Plus in the A.N. Severtsov Institute of Ecology and Evolution RAS. Results are expressed as $\delta^{13}C$ or $\delta^{15}N$. The standards are Vienna Pee Dee Belemnite limestone for carbon and atmospheric N_2 for nitrogen.

Carbon nitrogen ratios calculated for analyzed collagen samples (mean $= 2.7$, sd $= 0.03$) confirm that analyzed collagen is pristine and has not undergone degeneration (DeNiro 1985).

Differences between the mean $\delta^{13}C$ values for ADK-171 and ADK-009 sea otter bone collagen signatures (Table 1, Figure 2) are statistically significant (one factor

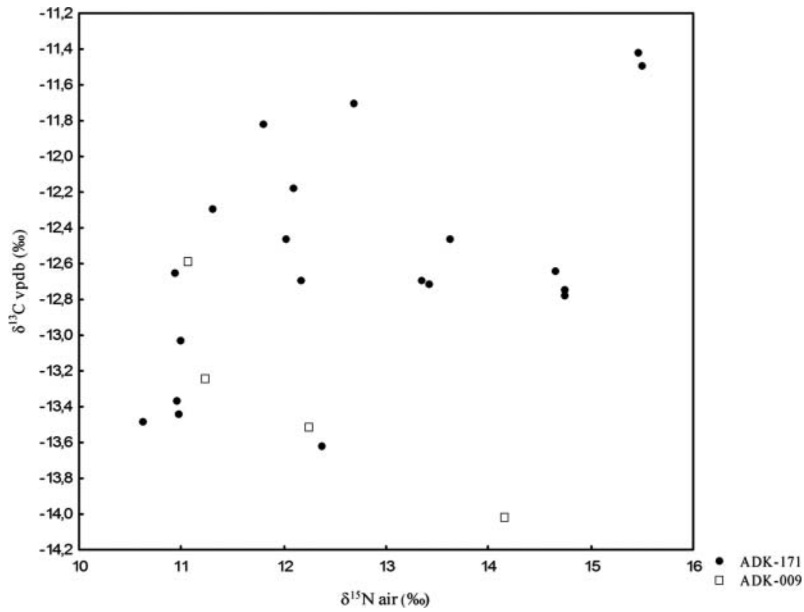

Figure 2. *$\delta^{13}C$ and $\delta^{15}N$ values of sea otter bone collagen from two archaeological sites—ADK-171 and ADK-009 (Adak Island, Aleutian Islands).*

ANOVA, $p < .05$). However, for $\delta^{15}N$ readings, statistically significant differences were not found ($p = .54$). Studies of terrestrial and marine animals have demonstrated that ratios of stable carbon isotopes ($^{13}C/^{12}C$) reflect the source of organic carbon fixed through photosynthesis at the base of a given food web and may indicate the location at which animals forage in the marine environment (Burton & Koch 1999; Hobson et al. 1997). Ratios of stable nitrogen isotopes ($^{15}N/^{14}N$) reflect the trophic level at which an animal feeds. Therefore, we can distinguish the sea otters' bones by their $\delta^{13}C$ signature, from lagoon vs. open sea coast environments; we see difference of carbon turnover in each of those habitats. Low variations in $\delta^{15}N$ between ADK-171 and ADK-009 indicate equal trophic positions of sea otters in two different habitats.

Some of our most interesting results are apparent in the comparison of $\delta^{13}C$ signatures for the two layers of site ADK-171 (Table 2, Figure 3). Some of the otters in the upper layer produced isotope signatures similar to otters from lower layer and other bones had signatures more similar to the small sample of otters from the open coast

Table 1. **Mean $\delta^{13}C$ and $\delta^{15}N$ values of sea otter bone collagen from archaeological sites ADK-171 and ADK-009 (Adak I., Aleutian Islands).**

Site	*N*	Mean $\delta^{13}C \pm$ S.D.	Mean $\delta^{15}N \pm$ S.D.
ADK-171	20	−12.59‰ ± 0.64	12.72‰ ± 1.62
ADK-009	4	−13.34‰ ± 0.59	12.17‰ ± 1.42

Table 2. **Mean δ^{13}C values of sea otters bone collagen from two layers of ADK-171 archaeological site (Adak I., Aleutian Islands).**

δ^{13}C	Mean δ^{13}C ± S.D.	Minimum	Maximum	Variance
Lower layer ($n = 9$)	$-12,49 \pm 0.3$	−12,77	−11,82	0,099
Upper layer ($n = 11$)	$-12,66 \pm 0.8$	−13,62	−11,42	0,678

site ADK-009 (Table 2, Figure 3). Mean values for the two layers at ADK-171 are very similar, but variance of δ^{13}C in the upper layer is much larger than that in the lower layer (F-test, $F = 6.9, p < .05$).

Based on preliminary findings, I propose that the variety we discovered in δ^{13}C signatures from sea otters in the upper layer is related to variation in the sea otter population rather than variation in the carbon sources found in lagoon food webs. I hypothesize that such diversity could be caused by an increased influx of migrant otters from the open coast into the lagoon, increased otter hunting by Clam Lagoon residents in open coast habitats, or both. This influx may be connected with rarifying of sea otter population in the lagoon, as the result of hunting by the early human settlers on the island. This suggestion is supported by an increase in the cockle and sea urchin populations in Calm Lagoon in ancient times. In a recent paper by Corbett et al. (2008), differences between isotopic signatures of sea otters from different islands over time, is explained by ecosystem changes that occurred as a result of human exploitation. In addition, in modern populations of sea otters there are substantial variations in both δ^{13}C and δ^{15}N values (Newsome et al. 2009). To help clarify the situation within population variation in isotopes values, I plan to conduct stable isotope analysis of fish and invertebrate

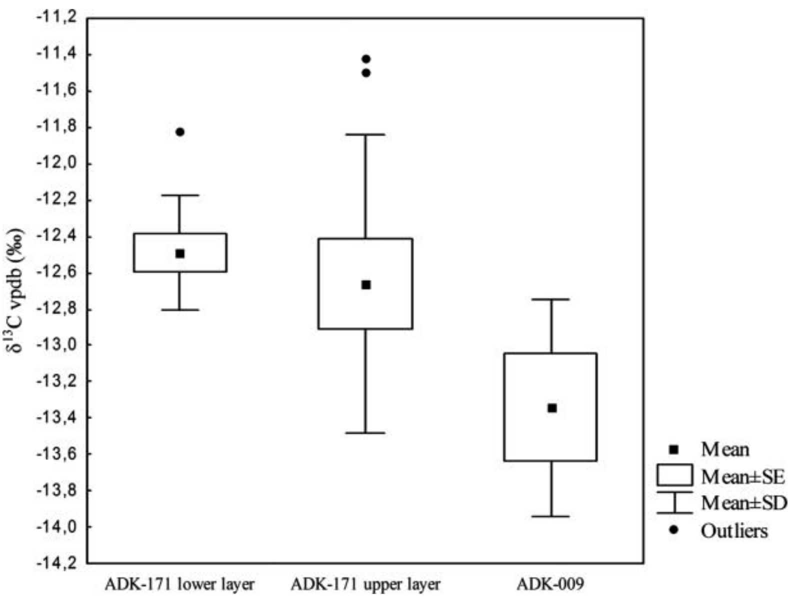

Figure 3. *δ^{13}C values of sea otter bone collagen from two layers of ADK-171 archaeological site and ADK-009 archaeological site (Adak Island, Aleutian Islands).*

remains from sites ADK-009 and ADK-171 and on sea otter bones from other islands in the future.

ACKNOWLEDGEMENTS

The author is grateful to all members of the Central Aleutian Archaeological and Paleobiological Project (CAAPP), especially to Dixie L. West for conducting the expedition on Adak Island and to Aleut Corporation. This study was supported by the National Science Foundation, grant no. OPP-0353065 (Office of Polar Programs, Social Sciences Division), and by the Russian Foundation for Basic Research (grant # 09-04-00196), and the programs "Origin of the Biosphere and evolution of geobiological systems", "Biological diversity", and "Biological Resources of Russia: Basic grounds of biological resources management".

REFERENCES

Burton, R. K. and P. L. Koch. 1999. Isotopic tracking of foraging and long distance migration in northeastern Pacific pinnipeds. *Oecologia* 119:578–585.

Corbett D. G., C. D. Clementz, M. Koch, P. L. Angela, D. C. Lefevre, and D. West. 2008. Aleut hunters, sea otters, and sea cows: Three thousand years of interactions in the Western Aleutian Islands, Alaska. Human impacts on ancient marine ecosystems: A global perspective. In *Human Impacts on Ancient Marine Ecosystems: A Global Perspective* (T. C. Rick and J. M. Erlandson eds.):43–76. Berkeley: University of California Press.

DeNiro, M. J. 1985. Postmortem preservation and alteration of *in vivo* bone collagen isotope ratios in relation to palaeodietary reconstruction. *Nature* 317:806–809.

Erlandson, J. M., T. C. Rick, M. Graham, J. Estes, T. Braje, and R. Vellanoweth. 2005. Sea otters, shellfish, and humans: 10,000 years of ecological interaction on San Miguel Island, California. *Proceedings of the Sixth California Islands Symposium* (D. K. Garcelon and C. A. Schwemm, eds.):58–69. Arcata: Institute for Wildlife Studies & National Park Service.

Hobson, K. A, J. L. Sease, R. L. Merrick, and J. F. Piatt. 1997. Investigating trophic relationships of pinnipeds in Alaska and Washington using stable isotope ratios of nitrogen and carbon. *Marine Mammal Science* 13:114–132.

Newsome, S. D., M. T. Tinker, D. H. Monson, O. Oftedal, K. Ralls, M. L. Fogel, and J. A. Estes. 2009. Using stable isotopes to investigate individual diet specialization in California sea otters (Enhydra lutris nereis). *Ecology* 90(4):961–974.

Savinetsky A. B., D. L. West, Zh. A. Antipushina, B. F. Khassanov, N. K. Kiseleva, O. A. Krylovich, and A. M. Pereladov. 2010. The reconstruction of ecosystems history of Adak Island (Aleutian Islands) during the Holocene. In *The People Before: The Geology, Paleoecology and Archaeology of Adak Island, Alaska* (D. Weast, V. Hatfield, E. Wilmerding, L. Gualtieri, and C. Lefevre, eds.). Anchorage: Alaskan Anthropological Association, Aurora Press.