LETTERS

Edited by **Jennifer Sills**

Arrival routes of first Americans uncertain

In their Perspective "Finding the first Americans" (3 November 2017, p. 592), T. J. Braje *et al.* argue that people first entered the Americas about 25,000 to 15,000 years ago by way of the Pacific coast. We believe that current evidence yields far less certainty than Braje *et al.* suggest—and more likely supports a later arrival by inland and/or coastal routes.

Contrary to Braje *et al.*, genetic evidence indicates that Native American ancestors diverged from Siberian populations ~24,900 to ~18,400 years ago, followed by population expansion into the Americas ~16,000 to ~13,500 years ago (*1*). Only two Native American lineages have been identified south of Beringia: a northern lineage constrained to northern North America, and a southern lineage directly linked with Clovis—the earliest unequivocal widespread cultural manifestation south of the ice sheets (*2*). Thus, a Native American lineage in the Americas between 25,000 and 15,000 years ago is inconsistent with current data. There is no consensus on the validity of purported pre–16,000-year-old sites, which vary in accurate dating, unambiguous artifacts, and clear association between them (*3*). Moreover, there are few technological connections among 16,000- to 13,500-year-old pre-Clovis sites, or with later Paleoindian artifacts; thus, the relationships between these sites and later Native Americans remain ambiguous.

The coastal colonization route Braje *et al.* advocate remains a viable hypothesis for a later arrival date, but several issues should be addressed (*4*). Despite the rise of sea levels in the Holocene, much of the late Pleistocene coast from Puget Sound to Alaska remains above sea level (*5*), yet surveys have failed to discover coastal sites securely dated older than 12,500 years ago (*4*). Furthermore, widespread empirical patterns are inconsistent with the coastal hypothesis: All known populations in Siberia, Russian Far East, and Beringia had terrestrial-oriented economies and technologies, as did widespread Paleoindian groups (*6*, *7*), with limited evidence of coastal exploitation in lower latitudes (*8*). This empirical patterning suggests that they were more likely to follow a land route through Siberia, Beringia, and the Americas south of the ice sheets. Current studies indicate that deglaciation began 19,000 years ago and that an ice-free corridor, largely vegetated and free of proglacial lakes, existed by at least 15,000 to 14,000 years ago (*9*, *10*).

Braje *et al.* suggest that stemmed projectile points in different contexts provide evidence for a coastal expansion before 16,000 years ago, but this is not a consensus view. Stemming is a widespread form of weapon design that was innovated numerous times and thus cannot be used to argue for cultural affiliation. No technological analysis has established a valid connection between these disparate assemblages, and there remains debate on the dating of North American stemmed points (*11*) because most securely dated sites are younger than Clovis.

Braje *et al.* assert that there is near complete agreement among archaeologists on these issues. However, the most recent survey (*12*) showed that archaeologists are divided, with many thinking that both interior and coastal routes were used, and expressing skepticism about several proposed pre-Clovis sites. Genetic and archaeological data suggest expansion from Siberia into the Americas around 16,000 to 13,500 years ago, consistent with terrestrial and/or coastal migrations. This evidence base explains the absence of consensus among scientists regarding both routes and timing of the peopling of the Americas.

In this watercolor, Clovis Paleoindians journey eastward toward the Americas.

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REFERENCES

1. B. Llamas *et al.*, *Sci. Adv.* **2**, e1501385 (2016).
2. M. Rasmussen *et al.*, *Nature* **506**, 225 (2014).
3. T. Goebel, M. R. Waters, D. H. O'Rourke, *Science* **319**, 1497 (2008).
4. B. A. Potter *et al.*, *Quat. Int.* **444**, 36 (2017).
5. D. H. Shugar *et al.*, *Quat. Sci. Rev.* **97**, 170 (2014).

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6. T. Goebel, *Archeol. Pap. Am. Anthropol. Assoc.* **12**, 117 (2002).
7. L. C. Bement, B. J. Carter, in *Clovis: On the Edge of a New Understanding*, A. M. Smallwood, T. A. Jennings, Eds. (Texas A&M Press, College Station, 2015), pp. 263–276.
8. J. M. Erlandson, *Early Hunter-Gatherers of the California Coast* (Springer, 2013).
9. K. Munyikawa, T. M. Rittenour, J. K. Feathers, *Palaeogeogr. Palaeoclimatol. Palaeoecol.* **470**, 147 (2017).
10. D. H. Huntley, A. S. Hickin, O. B. Lian, *Can. J. Earth Sci.* **54**, 52 (2017).
11. T. Goebel, J. L. Keene, in *Archaeology in the Great Basin and Southwest: Papers in Honor of Don D. Fowler*, J. Parezo, J. C. Janetski, Eds. (University of Utah Press, Salt Lake City, UT, 2014), pp. 35–60.
12. A. Wheat, *SAA Rec.* **12**, 10 (2012).

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Response

In our Perspective, we argue that the earliest Americans followed a coastal migration route. Potter *et al.* counter that an inland, ice-free corridor route was more likely. The genetic and archaeological evidence that Potter *et al.* discuss support both the timing and coastal route for the peopling of the Americas presented in our Perspective. Potter *et al.* are disappointed, however, that we did not also emphasize the possibility of an interior ice-free corridor migration and more tightly constrain colonization to after 16,000 years ago. This misses the main points of our Perspective: A Pleistocene coastal migration into the Americas has been bolstered tremendously by the discovery of early coastal and near coastal sites in the Americas, and more research, particularly underwater archaeology, is badly needed.

Potter *et al.* imply that in the most recent survey "archaeologists were divided, with many thinking both interior and coastal routes were used." In fact, 86% of respondents selected "coastal migration," compared with 65% for "interior passage migration" (*1*). This represents a sea change from 30 years ago when funding dollars and research efforts were funneled toward ice-free corridor models of New World colonization, resulting in decades of marginalization of research into early coastal migrations and adaptations (*2*).

Potter *et al.* underestimate the complexity of finding intact late Pleistocene coastal sites. Even in geological contexts where Pleistocene shorelines remain aboveground (such as in Alaska and British Columbia), coastal erosion and other forces tend to ravage or obscure early sites. In contrast to the sustained and intensive efforts to identify early sites in interior regions, the search for Pleistocene sites in coastal settings is just getting started. A growing number of such sites have been identified in places where systematic efforts to find late Pleistocene to early Holocene coastal sites have been made: the Pacific Northwest, the islands of Alta and Baja California, and coastal Peru and Chile (*3*–*6*).

Recent genomic evidence suggesting a migration into the Americas from Northeast Asia between ~16,000 and 13,500 years ago does not preclude a coastal migration, and ages based on molecular clocks are approximations due to unpredictable variation in mutation rates. Potter *et al.* suggest that we argue for a migration earlier than 16,000 years ago based on the distribution of stemmed projectile points. We did argue that northeast Asian stemmed point technologies may support Native American origins sometime in the past 20,000 years—like genetic data—but that more work is needed to link these Asian technologies to similar but younger terminal Pleistocene toolkits in the Americas.

Potter *et al.* subscribe to a window of colonization between about 16,000 and 13,500 years ago, the latter half of which is almost certainly incorrect given the widely accepted 14,500-year-old occupation at Monte Verde (*7*). A coastal route was open by ~17,000 years ago, whereas luminescence dates suggest that the ice-free corridor was open and viable by 15,000 to 14,000 years ago (*8*), or slightly later (*9*). The latter route would have allowed little time for human migrants to reach and establish residency at terminal Pleistocene sites in Oregon (*10*), Florida (*11*), Peru (*4*), Chile (*7*), and other far-flung regions.

The timing and viability of the ice-free corridor route remains uncertain, and arguments that the initial peopling of the Americas followed a terrestrial route hinge on its reconstruction. Questions remain about the coastal migration theory as well, and current evidence suggests that there likely were multiple dispersals, routes, and time frames for the peopling of the Americas.

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REFERENCES

1. A. Wheat, *SAA Archaeol. Rec.* **12**, 10 (2012).
2. J. M. Erlandson, *J. Archaeol. Res.* **9**, 287 (2001).
3. M. R. Des Lauriers, *Island of Fogs: Archaeological and Ethnohistorical Investigations of Isla Cedros, Baja California* (University of Utah Press, Salt Lake City, UT, 2010).
4. T. D. Dillehay *et al.*, *Sci. Adv.* **3**, e1602778 (2017).
5. J. M. Erlandson *et al.*, *Science* **331**, 1181 (2011).
6. D. H. Sandweiss, in *Handbook of South American Archaeology*, H. Silverman, W. Isbell, Eds. (Springer Press, Berlin, 2008), pp. 145–156.
7. T. D. Dillehay *et al.*, *PLoS ONE* **10**, https://doi.org/10.1371/journal.pone.0141923 (2015).
8. K. Munyikawa, T. M. Rittenour, J. K. Feathers, *Palaeogeogr. Palaeoclimatol. Palaeoecol.* **470**, 147 (2017).
9. M. W. Pedersen *et al.*, *Nature* **537**, 45 (2016).
10. D. L. Jenkins *et al.*, *Science* **337**, 223 (2012).
11. J. J. Halligan *et al.*, *Sci. Adv.* **2**, e1600375 (2016).

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Postpublication peer review: A crucial tool

The current peer-review model used throughout science is not perfect (*1*). Whether it be the result of poor experimental design, accident, or academic misconduct, publication of irreproducible, incorrect, or fabricated results occurs more frequently than it should [check Retraction Watch for recent examples (*2*)]. This leads not only to a waste of precious time and financial resources as scientists try to replicate or build on flawed research but also to damage to the reputation of science and to much larger societal impacts (such as the loss of public trust in science and loss of federal funding).

An emerging online tool for combating these issues is postpublication peer review (PPPR). PPPR sites such as F1000, ResearchGate, PubPeer, and PubMed Commons, as well as *Science*'s own eLetters, provide environments for user comments and discussion and are responsible for catching flawed research that has slipped through traditional peer review (*3*). In addition to identifying fraudulent data, pointing out errors, and providing criticism (which generally take the form of negative comments), PPPR also enables positive feedback (such as verifying the reproducibility of results), which is valuable but is currently provided much less frequently (*4*). This disparity likely stems from the reality that overworked scientists do not have time for activities that provide little to no recognition (*5*). However, most scientists already participate in informal (offline) PPPR. We discuss the results of papers with our colleagues, present papers in group meetings, and critically analyze papers in journal clubs. With a little more effort, a formal record of our reviews (negative and positive) can be made online for the betterment of science.

There is a risk to publicly challenging the work of established scientists (in particular, younger scientists may face retribution), but it can be mitigated by providing feedback in a respectful, positive, and professional manner (*4*, *6*). These are risks that need to be taken. The scientific community needs to take action to maintain the integrity of our published work. With continued implementation and development (*7*),

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PPPR can become a new cornerstone in the self-correcting mechanism of science.

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REFERENCES

1. R. Smith, *J. R. Soc. Med.* **99**, 178 (2006).
2. Retraction Watch (http://retractionwatch.com).
3. P. Knoepfler, *Trends Gent.* **31**, 221 (2015).
4. H. Bastian, *PLOS Med.* **11**, e1001772 (2014).
5. M. Markie, *Insights* **28**, 107 (2015).
6. E. Pain, *Science Careers* (2013); www.sciencemag.org/careers/2013/04/interactive-peer-review-what-s-it-reviewers.
7. J. A. Teixeira da Silva, A. Al-Khativ, J. Dobranszki, *Sci. Eng. Ethics* **23**, 1213 (2017).

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TECHNICAL COMMENT ABSTRACTS

Editor's note: The Comment by DeSilva and Response by Rosas *et al.* were published online in the 9 March issue.

Comment on "The growth pattern of Neandertals, reconstructed from a juvenile skeleton from El Sidrón (Spain)"

Jeremy M. DeSilva

Rosas *et al.* (Reports, 22 September 2017, p. 1282) calculate El Sidrón J1 to have reached only 87.5% of its adult brain size. This finding is based on an overestimation of Neandertal brain size. Pairwise comparisons with a larger sample of Neandertal fossils reveal that it is unlikely that the brain of El Sidrón would have grown appreciably larger.

Full text: dx.doi.org/10.1126/science.aar3611

Response to Comment on "The growth pattern of Neandertals, reconstructed from a juvenile skeleton from El Sidrón (Spain)"

Antonio Rosas, Luis Ríos, Almudena Estalrrich, Helen Liversidge, Antonio García-Tabernero, Rosa Huguet, Hugo Cardoso, Markus Bastir, Carles Lalueza-Fox, Marco de la Rasilla, Christopher Dean

The comment by DeSilva challenges our suggestion that brain growth of the El Sidrón J1 Neandertal was still incomplete at 7.7 years of age. Evidence suggests that endocranial volume is likely to represent less than 90% adult size at El Sidrón as well as Neandertal male plus Krapina samples, in line with further evidence from endocranial surface histology and dural sinus groove size.

Full text: dx.doi.org/10.1126/science.aar3820

Comment on "Synthesis and characterization of the pentazolate anion *cyclo*-N_5^- in $(N_5)_6(H_3O)_3(NH_4)_4Cl$"

Rong-Yi Huang and Heng Xu

Zhang *et al.* (Reports, 27 January 2017, p. 374) reported synthesis of a *cyclo*-N_5^- ion putatively stabilized in a solid-state salt by hydrogen bonding from surrounding counterions. We performed theoretical calculations suggesting that HN_5 would be favored over the anion in the reported pentazolate salt via proton transfer.

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Response to Comment on "Synthesis and characterization of the pentazolate anion *cyclo*-N_5^- in $(N_5)_6(H_3O)_3(NH_4)_4Cl$"

Chao Jiang, Lei Zhang, Chengguo Sun, Chong Zhang, Chen Yang, Jun Chen, Bingcheng Hu

Huang and Xu argue that the *cyclo*-N_5^- ion in $(N_5)_6(H_3O)_3(NH_4)_4Cl$ we described in our Report is theoretically unfavorable and is instead protonated. Their conclusion is invalid, as they use an improper method to assess the proton transfer in a solid crystal structure. We present an in-depth experimental and theoretical analysis of $(N_5)_6(H_3O)_3(NH_4)_4Cl$ that supports the results in the original paper.

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