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Tiny beach-dwelling crustaceans are big-time sand movers, shaping the California coast

Stand on the damp sand on a California beach and chances are you're standing on top of an active earthworks site. Sand hoppers (*Megalorchestia spp.*), the tiny, shrimp-like creatures commonly found eating away at kelp on the shore, have been found to move massive amounts of sand, excavating up to 50 kg (110 lbs) of sand per meter of shoreline per day.

"They have one of the highest rates of bioturbation of anything on the planet," said UC Santa Barbara marine scientist David Hubbard, referring to the process of displacement of sediment by living organisms.

The sheer volume of sediment moved by these crustaceans, according to Hubbard and fellow coastal researchers, puts these amphipods on par with coastal longshore processes and some major Southern California rivers. Their findings, published in the [Journal of Geophysical Research: Earth Surface](#), put new perspectives on the roles of these and other sand-dwelling creatures in the physical processes that shape the coast.

The sandy beach's tiny engineers

Though they may look stationary, sandy beaches act like rivers of sediment, constantly moving sand transported by waves, winds and currents along the coast. The beach is but one part of a bigger system called a littoral cell that cycles sediment from its sources, such as cliffs and dunes that back some beaches, or rivers and streams that carry sediment from coastal watersheds, or onshore processes that push sand from nearshore to the beach. Beaches serve as reservoirs for sand as it continues its way along the coast.

While coastal sediment transport processes are well known, the impact of the animals that live in this highly dynamic environment is less understood. It became an intriguing question for Tim Baxter, a physical geographer interested in interactions between wildlife and their physical environment in the coastal zone. When he moved from the UK to UCSB a few years ago to complete his postdoctoral work with geography professor [Ian Walker](#), Baxter found in marine scientists Dave Hubbard, [Kyle Emery](#) and [Jenny Dugan](#) a complementary curiosity about sand hoppers. These tiny crustaceans burrow 10-30 cm (4-12 inches) into the sand, or hide under washed-up seaweed, emerging after dark to feed on kelp wrack.

“We combined our interests and started thinking about the abundance of sand hoppers around UCSB, but also across California,” said Baxter, who is now a research fellow at the University of Oxford. “That got us asking, how much are they digging? What are they contributing to the sediment system and sediment transport on these beaches?”

To find out, they devised a simple field experiment at Isla Vista Beach, a bluff-backed stretch of shore adjacent to the UCSB campus. After high tide on a summer night, when the waves had smoothed the sand and the tide had begun to recede, they sectioned off an array of sampling plots with metal frames in the sand hoppers’ preferred burrowing zone.

“They don’t like saturated sand that’s like liquid — their burrows collapse immediately,” Hubbard explained. “They don’t like the powdery dry sand above the high tide line. They like the Goldilocks sweet spot in between where the burrow will stay intact because the moisture in the sand is just right.” According to the paper, unlike burrowing animals that create a single burrow and reuse it, sand hoppers create fresh burrows every day in search of the perfect sand moisture, excavating sand that has been recently reworked by wind or wave action.

After waiting overnight to let the sand hoppers do their thing, the team went back to their plots to check on the mounds of sand left by all the burrowing action.

“When we came back in the morning, we couldn’t even see some of the frames,” Hubbard recalled. “They were completely buried, and we were so glad we had put flags next to them just in case.” Despite all the years studying these creatures close up, he was still slightly shocked at how much sand they could move overnight, he added.

After collecting and weighing the excavated sand, the researchers calculated that the sand hoppers had moved up to 50 kg of it, making these centimeter-long crustaceans among the most active sediment movers in the animal world.

“It was quite impressive and we weren’t really expecting that,” Baxter said. “I think for me that was the biggest shock.”

The findings add another dimension to the role of sand hoppers in the California coastal environment. Not only are they a fundamental part of the food web, eating kelp wrack and in turn becoming food for shorebirds and fish, their burrowing habits also cycle nutrients into the deeper layers of sand.

“There’s a huge churn,” Hubbard explained. “If food like kelp or carrion gets deposited on the beach, it’s going to get buried by them, which makes it available to a different group of organisms.” Additionally, the burrows aerate the sand, providing oxygen for aerobic microbial processes, he said.

The excavations also make the sediments more available for erosional processes, Baxter added, loosening the sand to be borne away by wind or water. “It potentially increases the roughness of the surface of beaches, which has implications for the formation of landforms such as coastal sand dunes.” Coastal dunes have lately become an important nature-based strategy for dealing with coastal flooding and sea level rise, as the self-building, self-healing landforms are able to take the force of increased wave and storm action.

The sheer amount of sand displaced by the sand hoppers, the researchers found by extrapolating their results across 25 kilometers (15.5 miles) of Southern California coastline, is comparable to the daily sediment loads of some major Southern California rivers and to longshore drift processes that move sand along the intertidal

beach, Baxter said. While the field of biogeomorphology — which studies interactions between living things and their landscapes — has been gaining momentum in the last few decades, the activity of animals and plants on the landscape has still been relatively understudied compared to natural processes, he added.

“I think part of that is the influence of animals on these processes is seen as quite temporary, quite localized and small,” Baxter said. “What we are trying to show in this study is that actually these activities and interactions are operating on a lot larger scale and that their impacts are really worth highlighting.”

Research in this study was also conducted by Winter Adams and Sebastian Alvarez at UCSB. The work was supported by the National Science Foundation, the UC Office of the President Climate Action Fund and the California Ocean Protection Council.

Tags

[Ocean and Beaches](#)

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