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Multiple stable isotope tracers of fog use by Namib Desert plants

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The Namib Desert on the southwestern coast of Africa is hyperarid in terms of rainfall (<25 mm/yr), but experiences up to 100 days of coastal fog each year. Active use of fog as a water source has been shown previously in Namib biota from (1) behavioral and water content studies of several Tenebrionid beetle species, and (2) tritiated water additions, which proved the ability to take up finely sprayed water via the succulent leaves of *Trianthema hereoensis* and via the thin shallow roots of *Stipagrostis sabulicola* – both common to the Namib dune fields. This current study uses natural abundance levels of the stable isotopes of oxygen and hydrogen in extracted plant water and other potential water sources (groundwater, rain, soil water, and fog) to estimate fog uptake by ten species common to the three broad habitat units of the Namib: dunes, gravel plains, and ephemeral riverbeds. Interspecies differences in fog uptake were found to be more prominent than intraspecies differences, despite gradients in fog deposition among the collection sites. The results indicate a minimum fog water uptake of 10-30% in most shrubs and grasses, whereas trees, notably including the long-lived gymnosperm *Welwitschia mirabilis*, were isotopically similar to groundwater, suggesting negligible utilization of fog. The fog-forming low-stratus cloud bank along the southwestern coast of Africa is associated with upwelling of the cold, highly productive Benguela Current. The marine productivity leads to the release of dimethyl sulfide, which is a common precursor to cloud condensation nuclei. If this process is significant, the fog would deliver isotopically-enriched sulfur to the Namib ecosystem. Here, the utility of δ^{34}S as a tracer of fog deposition was tested through a survey of δ^{34}S in the same water, soil and plant material used in the water isotope investigation. There is a weak marine signal in sites closer to the coast; interspecies differences are less distinct than in the water isotopes. Additionally, δ^{34}S data was gathered from size-segregated aerosols collected continuously for ten days, which included two fog events. Aerosol concentration is higher on non-fog days, but the δ^{34}S values do not indicate a distinct shift from marine to terrestrial sulfur after a fog event. Overall, water isotopes give a stronger and more direct measure of fog input to the Namib ecosystem than sulfur isotopes.