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NanoSIMS study of trophic interactions in the coral-dinoflagellate endosymbiosis

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Tropical and subtropical reef-building corals generally form a stable endosymbiotic association with autotrophic single-celled dinoflagellate algae, commonly known as "zooxanthellae", which is crucial for the development of coral reef ecosystems. In the present work, the spatial and temporal dynamics of trophic interactions between corals and their dinoflagellates was investigated in situ and at a subcellular level in the reef-building coral Pocillopora damicornis. Transmission electron microscopy (TEM) and quantitative NanoSIMS isotopic imaging of tissue ultra-thin sections (70 nm) were combined to precisely track the assimilation and the fate of 15N-labeled compounds (ammonium, nitrate and aspartic acid) within each symbiotic partner of the coral-dinoflagellate association. Among our main results, we found that (i) both dinoflagellate algae and coral tissue rapidly assimilate ammonium and aspartic acid from the environment, (ii) however only the dinoflagellates assimilate nitrate, (ii) nitrogen is rapidly and temporary stored within the dinoflagellate cells into uric acid crystals, and (iii) the dinoflagellate endosymbionts translocate nitrogenous compounds to their coral host. This study paves the way for exploring in details the wide range of metabolic interactions between partners of any symbiosis in the biosphere.