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A three-way association causing coral injuries in the Red Sea

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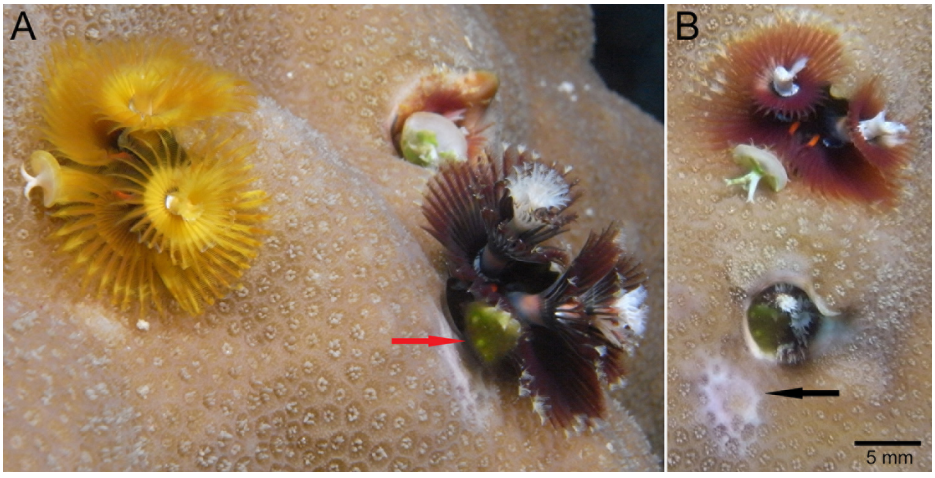

Reef-dwelling Christmas tree worms of the genus *Spirobranchus* (Polychaeta: Serpulidae) build calcareous tubes as dwellings in skeletons of various coral species (Dai and Yang 1995, Hoeksema and Ten Hove 2017, Perry et al. 2017) or occasionally on the shells of giant clams (Kupriyanova et al. 2015, van der Schoot et al. 2016). Extended worms show two colorful spiral branchiae and a peduncle, which carries an operculum that is ornamented by antler-shaped spines. When a worm retracts, its tube becomes closed off by the calcified operculum, which can serve as substrate for various kinds of small sedentary organisms (Bouillon 1974, Montebon and Yap 2009, Perry et al. 2017).

During a biodiversity survey on an offshore reef, Bitlat Nazar (22°18′35″N, 38°53′11″E), off Thuwal, Saudi Arabia (November 2014), various coral colonies were observed with dense infestations of *Spirobranchus corniculatus* f. *cruciger* (Grube, 1862), which has an operculum characterized by relatively simple spines (Panels A, B) (Willette et al. 2015, Hoeksema et al. 2016, Perry et al. 2017). Several massive *Porites* colonies showed injured spots on their surface, each in close proximity to a worm (Panel B, black arrow). The injured coral calices had abrasions with loss of soft tissue and a white or pink pigmentation as a possible inflammatory-like response (Palmer et al. 2008). When extended, the worms touched these damaged spots with their operculum (Panel A, red arrow). These injuries were predominantly present near worms with green turf algae on their operculum and only some near worms without algae. Not all worms caused damage in this way. Since algae are known to be potentially harmful to corals (Longo and Hay 2017), their presence on *Spirobranchus* opercula may increase the occurrence of injuries, depending on the duration and intensity of their contact with the coral.

This is not the first record of a marine three-way association that includes algae and that can be harmful to a host animal as primary basibiont. Another example concerns macroalgae

settling on anchor worms, *Lernaeenicus radiatus* Le Sueur, 1824 , of the family Pennellidae (ectoparasitic copepods) that live partly embedded in the flesh of Atlantic menhaden, *Brevoortia tyrannus* (Latrobe, 1802), of the herring family Clupeidae, and cause drag (Waldman 2017). The presence of epibiotic algae is facultative here and appears to increase the chance of damage inflicted to the host. This kind of relation differs from a three-party symbiosis involving *Symbiodinium* algae living as obligatory zooxanthellae inside acoel flatworms that harm their hosts (Barneah et al. 2007, Hoeksema and Farenzena 2012). The damage in corals caused by *Spirobranchus* opercula needs further investigation, which might focus on the role of the algae and examine which coral species are susceptible.

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