Long-distance transport of a West Atlantic stony coral on a plastic raft

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Ecology, 99(10), 2018, pp. 2402–2404

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The occurrence of wide-spread coral species around isolated reefs and over long stretches of deep ocean cannot be explained by larval dispersal alone; their larval stage is too short for that, especially in brooding species (Nunes et al. 2011, de Souza et al. 2017). Rafting on natural substrates, such as volcanic pumice fragments, wooden logs and coconut shells has been recognized as an alternative means for transport in reef corals (Fielden 1893, Crossland 1952, Jokiel 1984). Fouling on ship hulls and oil platforms is a relatively new, anthropogenic way for coral migration and because it is fast, it escalates the risk of alien species introductions (Creed et al. 2017). The upsurge of man-made floating litter (of glass, plastic, and metal) on the ocean's surface and its potential to serve as substrate for benthic marine species can also contribute to long-distance transport of reef corals (Jokiel 1984, 1992, Hoeksema et al. 2012), but there is no direct evidence for any subsequent colonization because of that.

A surprising case of long-distance rafting by a scleractinian coral on man-made flotsam concerned a few small specimens (diameter <5.5 cm) of the northern star coral, *Astrangia poculata* (Ellis & Solander, 1786); they were attached to a metal gas cylinder found on a North Sea beach in NW Netherlands at 53° N (Hoeksema et al. 2012, 2015). The natural range of this scleractinian species is limited to the continental shoreline of southeastern USA from 25° to 42° N, in the Gulf of Mexico and the West Atlantic, with two additional records, one from Venezuela at 12° N and one from Brazil at 8° N (Dimond et al. 2013; Fig. 2).

Astrangia poculata has a facultative symbiosis with zooxanthellae of the unicellular dinoflagellate algal genus *Symbiodinium*, without which the corals do not require sun light and are able to survive in cold water (Boschma 1925, Dimond et al. 2013). This may explain why *A poculata* can reach a depth range of 0–263 m (Peters et al. 1988) and occurs in areas with winter temperatures of minimal 0.7°C (Grace 2017).

It appears that the stranding of *A. poculata* in the Netherlands is less unique than originally thought since recent beachcombing activities have resulted in an additional discovery in the East Atlantic. On 14 January 2018, 11 d after storm Eleanor, a dead, fragmented coral colony (diameter 13 cm) was found on a large piece of polyurethane foam at Biville beach (50° N 02° W), Normandy, France (Fig. 1). Originally, the plastic raft could have served as light-weight filling material inside a boat hull or as the interior part of a buoy. It is unknown whether the coral was still alive when it beached and for how long it had been floating around before it was found. The raft was abraded and some parts of the coral colony were gone. Three coral fragments have been deposited in the reference collection of Naturalis Biodiversity Center (catalogue nr. RMNH COEL. 42326).

Fig. 1. A large colony of the scleractinian coral *Astrangia poculata* found on polyurethane substrate at Biville beach, Normandy, France, January 2018.

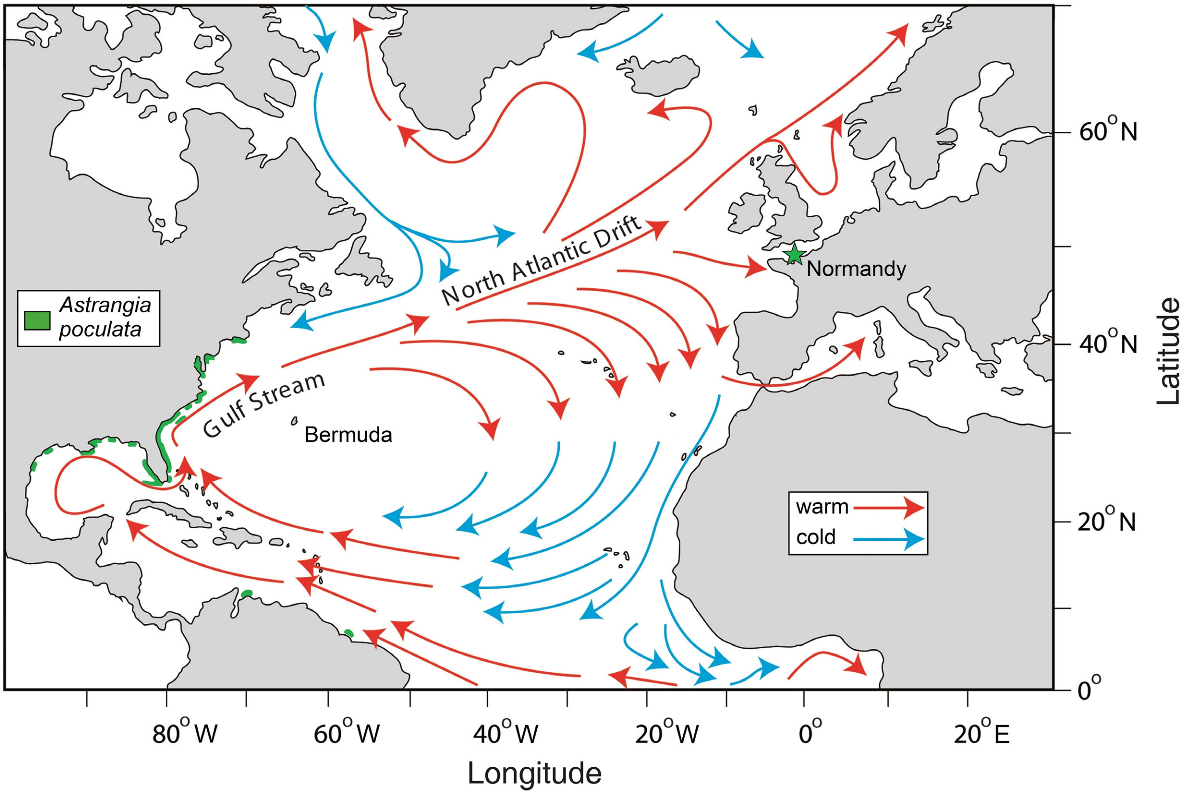

FIG. 2. Native range of *Astrangia poculata* (after Dimond et al. 2013) and its beach locality in Normandy (star) in relation to major ocean currents (after Hoeksema et al. 2012).

The growing presence of plastic objects on the ocean surface will undoubtedly increase their potential as floating substrate for corals. The major question is whether a higher frequency of rafting *A. poculata* may eventually lead to the settlement of this species outside its present native range. This coral species is able to survive under harsh conditions and can live on rafts for years (judging by its size) and cross the Atlantic over 6,500 km, but apparently has not even managed to colonize Bermuda (Fig. 2). This West Atlantic island is only slightly remote from the native range of *A. poculata* but has no record of this species (Cairns et al. 1986). Bermuda is situated in the course of the Gulf Stream, 1,070 km away from the US continent, which is only 1/6th of the distance to Normandy (Fig. 2). It has a temperature regime and reef environment appropriate for zooxanthellate corals (Cairns et al. 1986, Hoeksema et al. 2012). The Mediterranean Sea may also have suitable environmental conditions for *A. poculata,* but the species has also not been recorded from there (Hoeksema and Ocaña Vicente 2014). It is also absent off western Africa, which has other coral species in common with the Caribbean Sea (Nunes et al. 2011, de Souza et al. 2017).

Despite its rafting potential, there is no clear explanation for the apparent absence of *A. poculata* in the East Atlantic considering that currents may need 14–18 months to run across the Atlantic (Hoeksema et al. 2012) and the present specimen is large enough to have lived that long. When rafts erode and become disintegrated (Fig. 1), living coral fragments may easily get dislodged from their substrate and land on the sea floor. Maybe we are dealing with observation bias and settlement and colonization records are just a matter of time and research effort. First observations on newly introduced coral species are accidental, as observed in the Mediterranean Sea (Hoeksema and Ocaña Vicente 2014). With an increasing abundance of plastic debris along coastlines, beachcombers, snorkelers and scuba divers may eventually become more successful in finding non-native biota. They could monitor for alien species after storms and check whether rafting organisms were still alive when they arrived. In this way, more insight may be obtained regarding the probability of flotsam as a vector for coral species introductions as previously observed in fouling corals (Creed et al. 2017).

Acknowledgments

We thank two reviewers and the editor for their constructive comments.

Literature Cited

Boschma, H. 1925. On the feeding reactions and digestion in the coral polyp *Astrangia danae*, with notes on its symbiosis with zoöxanthellae. Biological Bulletin 49:407–439.

Cairns, S. D., J. C. den Hartog, C. Arneson, and K. Rützler. 1986. Class Anthozoa (Corals, Anemones). Pages 159–194 *in* W. Sterrer, editor. Marine fauna and flora of Bermuda. A systematic guide to the identification of marine organisms. Wiley, New York, New York, USA.

Creed, J. C., et al. 2017. The invasion of the azooxanthellate coral *Tubastraea* (Scleractinia: Dendrophylliidae) throughout the world: history, pathways and vectors. Biological Invasions 19:283–305.

Crossland, C. 1952. Madreporaria, Hydrocorallinae, *Heliopora* and *Tubipora.* British Museum (Natural History) Great Barrier Reef Expedition 1928–29. Scientific Reports 6:86–257.

de Souza, J. N., F. L. D. Nunes, C. Zilberberg, J. A. Sanchez, A. E. Migotto, B. W. Hoeksema, X. M. Serrano, A. C. Baker, and A. Lindner. 2017. Contrasting patterns of connectivity among endemic and widespread fire coral species (*Millepora* spp.) in the tropical Southwestern Atlantic. Coral Reefs 36:701–716.

Dimond, J. L., A. H. Kerwin, R. Rotjan, K. Sharp, F. J. Stewart, and D. Thornhill. 2013. A simple temperature-based model predicts the upper latitudinal limit of the temperate coral *Astrangia poculata*. Coral Reefs 32:401–409.

Fielden, H. W. 1893. Transportation of coral by the Gulf Stream. Zoologist 17:352–353.

Grace, S. 2017. Winter quiescence, growth rate, and the release from competition in the temperate scleractinian coral *Astrangia poculata* (Ellis & Solander 1786). Northeastern Naturalist 24(Sp. 7): B119–B134.

Hoeksema, B. W., and O. Ocaña Vicente. 2014. First record of the Central Indo-Pacific reef coral *Oulastrea crispata* in the Mediterranean Sea. Mediterranean Marine Science 15:429–436.

Hoeksema, B. W., P. J. Roos, and G. C. Cadée. 2012. Trans-Atlantic rafting by the brooding reef coral *Favia fragum* on man-made flotsam. Marine Ecology Progress Series 445:209–218.

Hoeksema, B. W., P. J. Roos, and G. C. Cadée. 2015. Corrigendum to: Trans-Atlantic rafting by the brooding reef coral *Favia fragum* on man-made flotsam. Marine Ecology Progress Series 541:279.

Jokiel, P. L. 1984. Long distance dispersal of reef corals by rafting. Coral Reefs 3:113–116.

Jokiel, P. L. 1992. How corals gain new foothold in new environments. Coral Reefs 11:192.

Nunes, F. L. D., R. D. Norris, and N. Knowlton. 2011. Long distance dispersal and connectivity in amphi-Atlantic corals at regional and basin scales. PLoS ONE 6:e22298.

Peters, E. C., S. D. Cairns, M. E. Q. Pilson, J. W. Wells, W. C. Jaap, J. C. Lang, C. E. Vasleski, and L. S. P. Gollahon. 1988. Nomenclature and biology of *Astrangia poculata* (= *A. danae*, = *A. astreiformis*) (Cnidaria: Anthozoa). Proceedings of the Biological Society of Washington 101:234–250.

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Manuscript received 30 April 2018; revised 9 May 2018; accepted 14 May 2018. Corresponding Editor: John Pastor.

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