Name(s) of Project Leader(s)

Satoshi Mitarai, Ph.D.
Associate Professor, Marine Biophysics Unit

Project-related Websites

https://groups.oist.jp/mbu/research

Project Title:

Larval Dispersal and Connectivity of Marine Populations

Project Description:

Quantification of marine population connectivity is key to understanding global and longer-term changes of the marine ecosystem. The primary objectives of this project are i) to study dispersal mechanisms of marine species in order to learn how far larvae travel and how quickly they colonize new sites, and ii) to test these predictions of dispersal with recruitment and population genetic data that define the biogeographic characteristics of selected marine species. By

understanding the dispersal processes, we hope to contribute to marine conservation planning, e.g., by facilitating optimal design of marine protected areas, which may prevent the collapse of vulnerable ecosystems in Okinawa and even the complete global loss of rare species.

Life Below Water (SDG14) is fundamentally interconnected through ocean currents. Connectivity is one of the fundamental research themes of the Marine Biophysics Unit and is a fundamental process that protects marine environments and species from the damaging effects of human industry and climate change (SDG13). Connectivity is a research theme within the Marine Biophysics Unit that focusses on connectivity and conservation within coastal regions of the Ryukyu archipelago and across areas of open ocean beyond national jurisdiction. Focal environments are coral reefs, mangrove habitats and hydrothermal vents. All of these ecosystems are currently threatened by industrial development and understanding connectivity can inform Responsible Consumption and Production (SDG12). Additionally, the oceanographic processes that sustain connectivity in the ocean are subject to change with the climate. Understanding how connectivity has changed in the past and will change under projected climate scenarios will prepare us for future threats to Life Below Water.

Cooperation Agreement with the Coast Guard

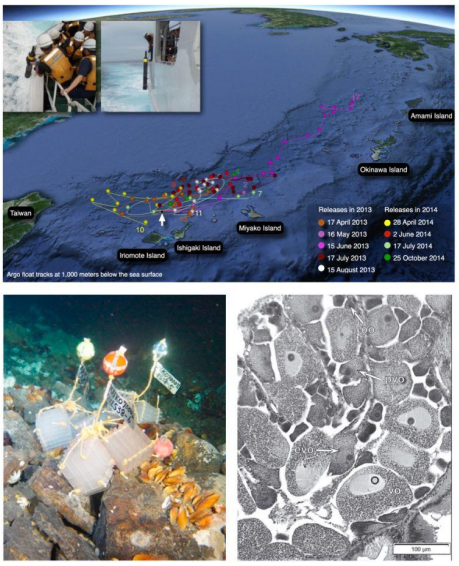
As an application of the developed research tools, the Marine Biophysics Unit has been contributing to i) the improvement of drift prediction accuracy, and ii) sophistication of ocean tide model and ocean current simulation in the sea around Okinawa, through the cooperation agreement with the 11th Regional Coast Guard Headquarters, since March 2012.

Ocean Plastic Dispersal

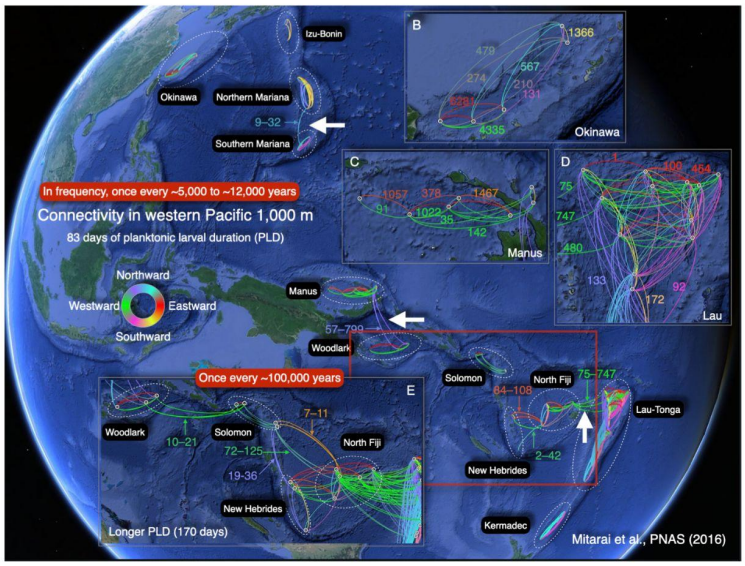
In collaboration with the OIST ECO (Environmentally Conscious OISTers) club, Marine Biophysics Unit members have taught lessons on how marine debris travels around the world on ocean and engaged in beach cleans to remove said debris from ocean circulation.

Representative Image(s) and/or Figures

Calculating Dispersal from Unique Submarine Hot Spring Ecosystems



"Observation studies to quantify physical transport, larval recruitment and production" – Mitarai et al., 2016, Nakamura et al., 2014, 2018



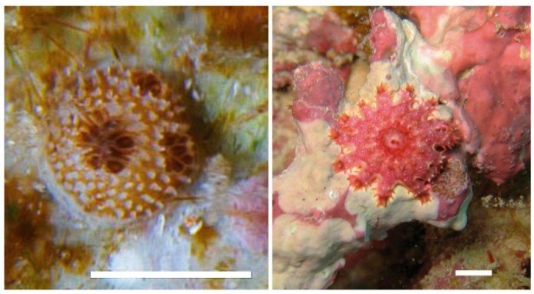
"In the rare cases where deep-sea organisms have managed to spread across oceans, biologists now have a detailed map as to how they likely got there" – Mitarai et al., 2016

Outreach Activities

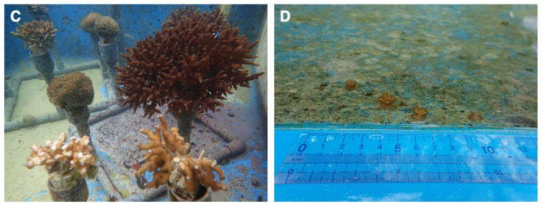
"Development of a tidal current forecast for the Kerama Islands with the 11th Regional Coast Guard Headquarters, 2020"

"Students of the Marine Biophysics Unit giving a lesson on ocean dispersal for Onna Elementary School combined with a beach clean at their nearby beach"

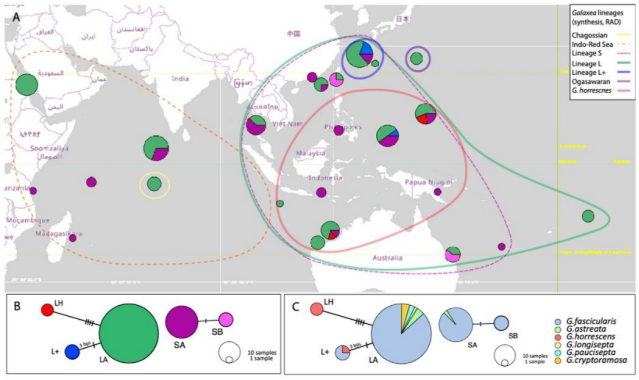
Connectivity of Coral Reef Populations



"Acroporid corals and predatory starfish showed similar patterns of recruitment" – Nakamura et al., 2015



"First evidence of asexual recruitment of Pocillopora acuta in Okinawa Island" – Nakajima et al., 2020



"Evolutionary biogeography of the reef-building coral genus Galaxea across the Indo-Pacific ocean" – Wepfer et al., 2020

Project Collaborators

Larval Dispersal

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Kazuhiko Sakai (University of the Ryukyus)
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Population Genetics

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Project Publications

Larval Dispersal

N. Takeda, M. Kashima, S. Odani, Y. Uchiyama, Y. Kamidaira, S. Mitarai, Identification of coral spawn source areas around Sekisei Lagoon for recovery and poleward habitat migration by using a particle-tracking model. Sci. Rep. 11, 6963 (2021).

L. A. Levin, C.-L. Wei, D. C. Dunn, D. J. Amon, O. S. Ashford, W. W. L. Cheung, A. Colaço, C. Dominguez-Carrió, E. G. Escobar, H. R. Harden-Davies, J. C. Drazen, K. Ismail, D. O. B. Jones, D. E. Johnson, J. T. Le, F. Lejzerowicz, S. Mitarai, T. Morato, S. Mulsow, P. V. R. Snelgrove, A. K. Sweetman, M. Yasuhara, Climate change considerations are fundamental to management of deep-sea resource extraction. Glob. Chang. Biol. (2020), doi:10.1111/gcb.15223.

N. S. Vogt-Vincent, S. Mitarai, A Persistent Kuroshio in the Glacial East China Sea and Implications for Coral Paleobiogeography. Paleoceanography and Paleoclimatology. 35, 897 (2020).

L. S. Mullineaux, A. Metaxas, S. E. Beaulieu, M. Bright, S. Gollner, B. M. Grupe, S. Herrera, J. B. Kellner, L. A. Levin, S. Mitarai, M. G. Neubert, A. M. Thurnherr, V. Tunnicliffe, H. K. Watanabe, Y.-J. Won, Exploring the Ecology of Deep-Sea Hydrothermal Vents in a

Metacommunity Framework. Frontiers in Marine Science. 5 (2018), doi:10.3389/fmars.2018.00049.

Y. Uchiyama, S. Odani, M. Kashima, Y. Kamidaira, S. Mitarai, Influences of the Kuroshio on Interisland Remote Connectivity of Corals Across the Nansei Archipelago in the East China Sea. J. Geophys. Res. C: Oceans. 123, 9245–9265 (2018).

S. G. Monismith, M. K. Barkdull, Y. Nunome, S. Mitarai, Transport Between Palau and the Eastern Coral Triangle: Larval Connectivity or Near Misses. Geophys. Res. Lett. 45, 4974–4981 (2018).

Y. Kamidaira, Y. Uchiyama, S. Mitarai, Eddy-induced transport of the Kuroshio warm water around the Ryukyu Islands in the East China Sea. Cont. Shelf Res. 143, 206–218 (2017).

S. Mitarai, H. Watanabe, Y. Nakajima, A. F. Shchepetkin, J. C. McWilliams, Quantifying dispersal from hydrothermal vent fields in the western Pacific Ocean. Proc. Natl. Acad. Sci. U. S. A. 113 (2016), doi:10.1073/pnas.1518395113.

H. Watanabe, T. Yahagi, Y. Nagai, M. H. Seo, S. Kojima, J. I. Ishibashi, H. Yamamoto, K. Fujikura, S. Mitarai, T. Toyofuku, Different thermal preferences for brooding and larval dispersal of two neighboring shrimps in deep-sea hydrothermal vent fields. Mar. Ecol. 37, 1282–1289 (2016).

M. Nakamura, C. Chen, S. Mitarai, Insights into life-history traits of Munidopsis spp. (Anomura: Munidopsidae) from hydrothermal vent fields in the Okinawa Trough, in comparison with the existing data. Deep Sea Res. Part 1 Oceanogr. Res. Pap. 100 (2015), doi:10.1016/j.dsr.2015.02.007.

M. Nakamura, H. Watanabe, T. Sasaki, J. Ishibashi, K. Fujikura, S. Mitarai, Life history traits of Lepetodrilus nux in the Okinawa Trough, based upon gametogenesis, shell size, and genetic variability. Mar. Ecol. Prog. Ser. 505 (2014), doi:10.3354/meps10779.

Recruiment

M. Nakamura, Y. Nakajima, H. K. Watanabe, T. Sasaki, H. Yamamoto, S. Mitarai, Spatial variability in recruitment of benthos near drilling sites in the Iheya North hydrothermal field in the Okinawa Trough. Deep Sea Res. Part I. 135, 65–73 (2018).

Y. Nakajima, P.-S. Chuang, N. Ueda, S. Mitarai, First evidence of asexual recruitment of Pocillopora acuta in Okinawa Island using genotypic identification. PeerJ. 6, e5915 (2018).

M. Nakamura, N. H. Kumagai, K. Sakai, K. Okaji, K. Ogasawara, S. Mitarai, Spatial variability in recruitment of acroporid corals and predatory starfish along the Onna coast, Okinawa, Japan. Mar. Ecol. Prog. Ser. 540, 1–12 (2015).

M. Nakamura, K. Okaji, Y. Higa, E. Yamakawa, S. Mitarai, Spatial and temporal population dynamics of the crown-of-thorns starfish, Acanthaster planci, over a 24-year period along the central west coast of Okinawa Island, Japan. Mar. Biol. 161, 2521–2530 (2014).

Population Genetics

P. H. Wepfer, Y. Nakajima, M. Sutthacheep, V. Z. Radice, Z. Richards, P. Ang, T. Terraneo, M. Sudek, A. Fujimura, R. J. Toonen, A. S. Mikheyev, E. P. Economo, S. Mitarai, Evolutionary biogeography of the reef-building coral genus Galaxea across the Indo-Pacific ocean. Mol. Phylogenet. Evol. 151, 106905 (2020).

Y. Nakajima, P. H. Wepfer, S. Suzuki, Y. Zayasu, C. Shinzato, N. Satoh, S. Mitarai, Microsatellite markers for multiple Pocillopora genetic lineages offer new insights about coral populations. Sci. Rep. 7 (2017), doi:10.1038/s41598-017-06776-x.

Y. Nakajima, A. Nishikawa, A. Iguchi, T. Nagata, D. Uyeno, K. Sakai, S. Mitarai, Elucidating the multiple genetic lineages and population genetic structure of the brooding coral Seriatopora (Scleractinia: Pocilloporidae) in the Ryukyu Archipelago. Coral Reefs. 36, 415–426 (2017).

Y. Nakajima, Y. Zayasu, C. Shinzato, N. Satoh, S. Mitarai, Genetic differentiation and connectivity of morphological types of the broadcast-spawning coral Galaxea fascicularis in the Nansei Islands, Japan. Ecol. Evol. 6 (2016), doi:10.1002/ece3.1981.

Y. Nakajima, C. Shinzato, N. Satoh, S. Mitarai, Novel polymorphic microsatellite markers reveal genetic differentiation between two sympatric types of Galaxea fascicularis. PLoS One. 10, 1–12 (2015).

Y. Nakajima, C. Shinzato, M. Khalturina, H. Watanabe, F. Inagaki, N. Satoh, S. Mitarai, Cross-species, amplifiable microsatellite markers for neoverrucid barnacles from deep-sea hydrothermal vents developed using next-generation sequencing. Int. J. Mol. Sci. 15, 14364–14371 (2014).

Soliciting External/Internal Engagement

Please contact me and/or my research unit members for: scientific consultation & advice, volunteering opportunities, funding opportunities, and general inquiries.

Links to Related Resources

Calculating Dispersal from Unique Submarine Hot Spring Ecosystems

https://www.oist.jp/news-center/news/2016/3/18/hot-larvae-calculating-dispersal-unique-submarine-hot-spring-ecosystems

https://www.hakaimagazine.com/news/epic-migration-along-bottom-sea/

Canon Foundation Research Grant

https://www.oist.jp/press-room/news/2011/3/30/dr-mitarai-and-collaborators-receive-canon-foundation-research-grant

https://www.oist.jp/news-center/photos/mr-fujio-mitarai-chiarman-and-chief-executive-canon-inc-middle-and-members-oist

Cooperation with the 11th Regional Coast Guard Headquaters

https://www.facebook.com/oistedu/posts/were-very-proud-of-the-marine-biophysics-unit-led-by-prof-satoshi-mitarai-who-ye/3689289654435960/

https://www.oist.jp/press-room/news/2012/4/2/oist-concludes-cooperation-agreement-11th-regional-coast-guard-headquarters