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BIODIVERSITY
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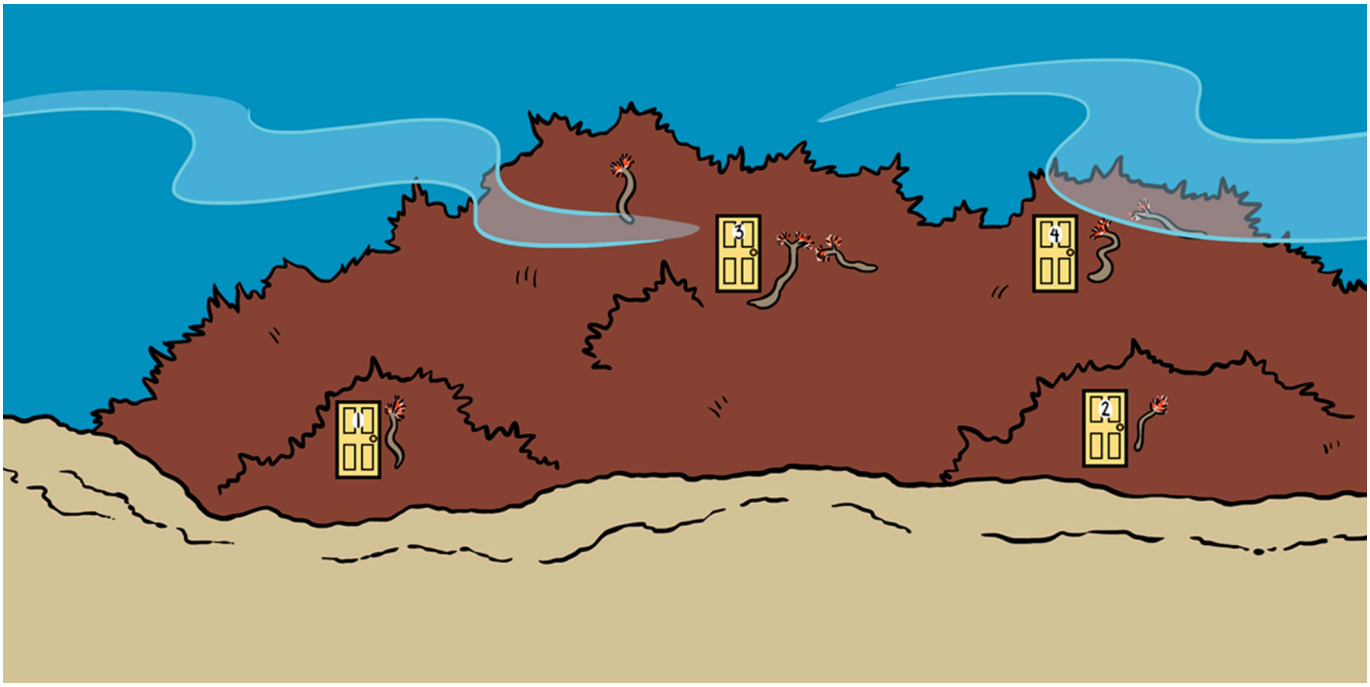

A NEW HOPE? MEDITERRANEAN ALGAE MATS ARE THRIVING WITH LIFE

Felix I. Rossbach[1*], *Edoardo Casoli*[2], *Milan Beck*[1] *and Christian Wild*[1]

[1]*Marine Ecology Department, Faculty of Biology and Chemistry, University of Bremen, Bremen, Germany*
[2]*Department of Environmental Biology, Sapienza University of Rome, Rome, Italy*

YOUNG REVIEWERS:


I. C. VAL RENDENA
AGE: 14


ISABEL
AGE: 12


MARGARIDA
AGE: 15

Our oceans are full of life and home to many different species. High species diversity often concentrates in specific areas called "biodiversity hotspots" (e.g., coral reefs). These hotspots develop with the help of a few key engineering species (e.g., corals). In the Mediterranean Sea, well-known biodiversity hotspots are seagrass meadows. Macroalgae beds represent another typical habitat but usually do not provide the same diversity as seagrass meadows. High biodiversity is essential for an ecosystem's stability and our lives: healthy coastal ecosystems provide food and shelter for fish species and stabilize the seafloor. We investigated a relatively unknown type of red macroalgae and were surprised to find it thriving with marine organisms such as sea stars, anemones, and tube worms. With the latter being an example of an extraordinary group of marine animals, we would like to take this example and show you what we learned about this new hotspot for diversity.

INTRODUCTION

Earth's oceans are full of life—they are home to many different species. Certain locations in the ocean, such as coral reefs, have a high **diversity** of species, meaning many different types of organisms live there. In the Mediterranean Sea, seagrass meadows are well-known diversity hot spots—but there are others! High diversity is essential for an ecosystem's health and stability. Healthy coastal ecosystems provide food and shelter for fish species, including species that humans eat, so it is important that the diversity of ocean ecosystems be maintained. We investigated a less-studied type of ocean habitat to understand its diversity—beds of red **macroalgae**. We were surprised to find that these habitats are thriving with marine organisms such as sea stars, anemones, and tube worms! In the remainder of this article, we will explain why macroalgae are important habitats, and we will focus on the diversity of one fascinating group of inhabitants—the tube worms.

DIVERSITY

A measure of the variety of species in a habitat. Considering the number of different species and their abundances.

MACROALGAE

Large marine organisms that can perform photosynthesis, like plants do on land.

SESSILE MARINE ANIMALS NEED SPACE!

In the ocean, we can find many animals that have evolved to live attached to the ocean floor or some other surface—they are called **sessile** animals. Unlike animals found on land, sessile animals cannot move around during their adult life. Corals are the most well-known example of sessile marine animals, but other examples are barnacles and sponges. The high number of sessile animals in the ocean requires a lot of free space for them to settle down. This can create a space shortage, and as a result, any free area will quickly be colonized by sessile animals. This free space can be anything, from rocks and man-made structures like jetties or ships to other living organisms like plants and macroalgae.

SESSILE

Attached to a surface and unable to move around. Sessile animals typically have a filtering mechanism to get food, since they cannot graze or hunt for prey.

ANNELIDS

Worms that have a body built by many similar sections, called segments, and therefore look like they have rings around their bodies. The earthworm is a well-known annelid.

A SPECIAL KIND OF MARINE WORM

Worms that live in the ocean, called marine worms, come in all shapes and sizes. One group of worms, called **annelids**, is characterized by their **segmented** bodies. This means that their bodies consist of a long chain of similar parts—like the wagons of a long train. Sessile annelids called tube worms attach themselves to a surface when they are larvae, and they cannot move around once they become adults. These worms build solid tubes around themselves for protection against predators. Since they cannot move around, they filter tiny food particles from the passing currents with delicate, feather-like tentacles called **radioles** (Figure 1). Two things are very important for tube worms: an excellent spot to attach to and access to passing water currents so they can filter out enough food. The perfect home for a tube worm is a water-current-exposed surface, like the leaves of seagrasses or the bodies of marine macroalgae that grow upright in the water [1].

SEGMENTED

In biology, this means a body is divided into a series of similar parts. Like many passenger wagons on a train.

RADIOLES

Feather-like tentacles that help marine worms to catch food and to take up oxygen from the water.

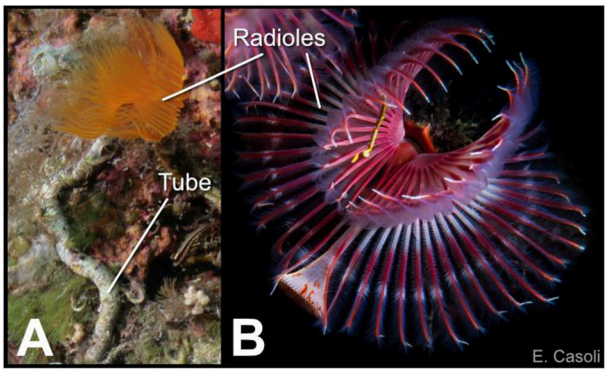

Figure 1

(A) A tube worm attached to a rock. The white tube has a similar texture to a clam shell. The orange radioles catch tiny food particles from the water currents. **(B)** Radioles can be very colorful in some tube worm species. Looking closely, you can see that each radiole has tiny branches that help catch food particles (Photograph credit: E.C.).

THE RED ALGAE APARTMENT COMPLEX

Red algae are photosynthetic organisms that can use sunlight to produce energy to grow—like plants do on land. Macroalgae species, including red algae, form dense mats and provide habitats for many species (Figure 2). Their leaves and bodies provide living space and can also change the environment for their inhabitants. For example, they keep out predators or strong water currents [2], just like a real house! Because of their ability to shape the environment, these species are called **ecosystem engineers** [3]. Well-known examples of ecosystem engineers on land include trees, which create homes for birds, and beavers, which create ponds with their dams.

ECOSYSTEM ENGINEERS

A species that creates or modifies a habitat. These species may have huge impacts on the diversity of an area.

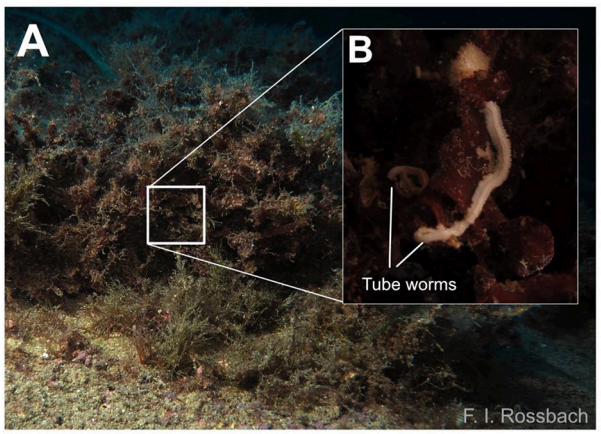

Figure 2

(A) A red algae mat growing on an underwater rock at 30 m water depth. **(B)** Zooming in, you can see that there are various animals growing on the algae. The white stripes in this picture are the tubes of tube worms (Photograph credit: F.R.; modified from the source article).

Red algae mats function like giant apartment buildings with all kinds and sizes of flats. At the bottom of the mats, closer to the ocean floor, water movement is reduced, and it is much darker than it is in the top layers [2]. The leafy areas on top of an algae mat (Figure 3A) provide more prominent places for settlement, and they are exposed to water currents. Red macroalgae grow only a few centimeters per year and can live more than 2 years [4], so they form relatively stable long-term

habitats. As a result, every animal species can find an apartment tailored to its needs, and a diverse community can develop.

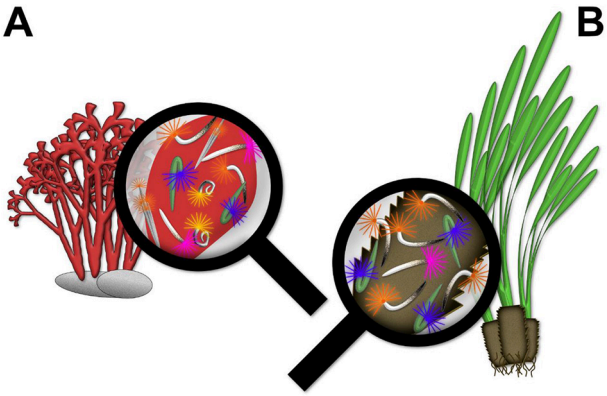

Figure 3

Figure 3

(A) Red macroalgae and **(B)** seagrass habitats for tube worms. Both are home to many individual tubeworms. But the compositions of the communities are different. We found similar numbers of tube worms on the algae and the stems of the seagrass. But the distribution was more balanced on the red algae. Can you spot the differences?

When we began our study, red algae mats had not been studied very much. We were surprised to find many groups of sessile organisms living in red algae mats, each in high **abundance** (numbers) and with high diversity. Since tube worms are such fascinating animals, we wanted to learn more about them and about their relationship with the red algae.

ABUNDANCE

The number of individual organisms per area.

THE INHABITANTS OF THE ALGAE MATS

To look at the importance and health of the habitat formed by red algae, we investigated several factors: the total number of tube worms present, the number of different species of tube worms that lived there (diversity), and how many tube worms of each species were there (abundance).

We found high numbers of tube worms inside the 5 cm thick mats of red macroalgae. The numbers we found were similar to those found in another well-studied tube worm habitat: seagrass mats. However, we found more types of tube worm species on the macroalgae, meaning tube worm diversity was higher in the macroalgae compared to seagrass. We also looked at the abundance of each different species that we found. We observed that only a few tube worm species were very abundant on the seagrass. However, on the macroalgae, many different species of tube worms were present in large numbers (Figure 3). These results show that macroalgae mats are a valuable habitat for tube worms.

In a healthy and stable habitat, the distribution of different species is more balanced than in a damaged habitat [4]. The more even distribution of tube worm diversity on the red macroalgae shows that the community is probably more resilient to any disturbances, like

pollution or climate change. That makes it less likely that a rare group of tube worms will disappear completely.

CONCLUSION

Many species—including tube worms—are losing their homes because of human activity near the coast, and some habitats have already disappeared. For example, the seagrass in the Mediterranean Sea is in danger because of climate change and water pollution [5]. Larger sessile animals, like Mediterranean corals, have died off after warming events in the last few years [6]. Macroalgae have been observed to take over damaged areas in tropical reefs, but this shift is often accompanied by a loss of diversity loss [7], meaning the ecosystem becomes less healthy and resilient. But our studies showed that macroalgae could provide homes for many different species—creating a habitat with similar or even higher diversity than previously known habitats like seagrass. Red algae mats have not been studied very much, and we were surprised to find such large numbers of tube worms and so many other animal species. While environmental changes generally lead to loss of habitat and decreased diversity, macroalgae mats might be a hidden gem of diversity, giving us hope that natural richness can still survive in unexpected locations. There is still a lot to discover!

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ORIGINAL SOURCE ARTICLE

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REFERENCES

1. Casoli, E., Bonifazi, A., Ardizzone, G., and Gravina, M. F. 2016. How algae influence sessile marine organisms: the tube worms case of study. *Estuar. Coast. Shelf. Sci.* 178:12–20. doi: 10.1016/j.ecss.2016.05.017

2. Schmidt, N., El-Khaled, Y. C., Rossbach, F. I., and Wild, C. 2021. Fleshy red algae mats influence their environment in the Mediterranean Sea. *Front. Mar. Sci.* 8:1–12. doi: 10.3389/fmars.2021.721626
3. Jones, C. G., Lawton, J. H., and Shachak, M. 1994. Organisms as ecosystem engineers. *Oikos* 69:373–86. doi: 10.3945/ajcn.113.075994
4. Hewitt, J. E., Thrush, S. F., and Dayton, P. D. 2008. Habitat variation, species diversity and ecological functioning in a marine system. *J. Exp. Mar. Bio Ecol.* 366:116–22. doi: 10.1016/j.jembe.2008.07.016
5. Vassallo, P., Paoli, C., Rovere, A., Montefalcone, M., Morri, C., and Bianchi, C. N. 2013. The value of the seagrass *Posidonia oceanica*: a natural capital assessment. *Mar. Pollut. Bull.* 75:157–67. doi: 10.1016/j.marpolbul.2013.07.044
6. Cerrano, C., and Bavestrello, G. (2008). Medium-term effects of die-off of rocky benthos in the Ligurian Sea. What can we learn from gorgonians? *Chem. Ecol.* 24:73–82. doi: 10.1080/02757540801979648
7. Graham, N. A. J., Jennings, S., MacNeil, M. A., Mouillot, D., and Wilson, S. K. (2015). Predicting climate-driven regime shifts versus rebound potential in coral reefs. *Nature* 518:94–97. doi: 10.1038/nature14140

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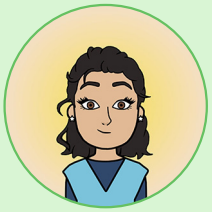
CONFLICT OF INTEREST: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

YOUNG REVIEWERS

I. C. VAL RENDENA, AGE: 14

We are a small class going to a school in the middle of the Dolomites in the northern part of Italy. This is our last year at secondary school, so we are enjoying this last year together. The most of us love skiing and snowboarding in the winter, and hiking and football during summer time. We have a cool science teacher who loves nature and

she teaches us all about biodiversity and climate change so we enjoy our lessons a lot.



ISABEL, AGE: 12

Hello, I am Isabel. I am 12 years old and I really like writing stories. I also like reading and playing drums. I am really interested in diplomacy.

MARGARIDA, AGE: 15

My name is Margarida, I am 15 years old and I like reading, climbing and writing. I love science, especially astrophysics and I have absolutely no idea what I want to do when I grow up. I also really like biology.

AUTHORS

FELIX I. ROSSBACH

Felix is a marine biologist and research diver who wants to understand how marine ecosystems work and how different species interact to build a thriving community. He is specifically interested in learning about the roles of key species that shape the living space for others. He loves photography, diving, and sharing his discoveries with other ocean enthusiasts. *felixivorossbach@gmail.com

EDOARDO CASOLI

Edoardo Casoli is a research fellow at the Sapienza University of Rome, where he teaches "Structure and Functioning of Marine Ecosystems" and "Impact of Climate Change on Marine Biodiversity." He is interested in the ecology of marine communities and focuses on the effects of human activities and climate change on organisms living on the seafloor. He is passionate about underwater photography, a powerful tool to connect people with science and promote marine ecosystems conservation.

MILAN BECK

During his studies in marine biology, Milan traveled all the way to the Mediterranean and the Arctic to understand the impacts of climate change on various marine macroalgal habitats. He is especially interested in working with and developing new technical solutions to research these coastal habitats in a more effective and non-invasive way.

CHRISTIAN WILD

Christian Wild is a professor of marine ecology at the University of Bremen, Germany, and he initiated this project when he realized the exceptional biodiversity associated with red algae mats. Whenever he looked into the mats using a stereo microscope, he saw organisms he had never observed. The number of different species reminded him of coral reefs, the focus ecosystems of his research group.