1. Project Information

Proposal reference number[1]	IFREMER REF: 21/1001606 Sicily Channel Observatory (SiCO)
Project Acronym (ID)[2]	DeepDeg
Title of the project[3]	Development of a reliable system to assess biodegradation of different materials in the European deep sea (DeepDeg)
Host Research Infrastructure[4]	CNR ISMAR
Starting date - End date[5]	10.02. 2021 – Dec. 31st 2023
Name of Principal Investigator[6] **Home Laboratory** **Address** **E-mail address** **Telephone**	Andreas Eich, Christian Lott, Miriam Weber HYDRA Marine Sciences GmbH Steinfeldweg 15 77815 Bühl Germany m.weber@hydramarinesciences.com +491624354131

2. Project objectives[7] (250 words max.)

- To conduct a pilot experiment to demonstrate the feasibility of using the exposure method adapted from shallow water systems for repeated deployments and retrievals of samples in deep sea environments.
- To analyze and compare the specific degradation time of different materials in the deep sea by measuring material loss.
- To collect sufficient data to apply statistical modeling on the degradation data set and calculate material- and site-specific half-life for plastic films, fibrous materials, and fabric materials.
- To compare degradation speed under environmental settings of the Sicily Channel.
- To obtain the baseline to plan then additional experiments to compare degradation rates of different materials in various ocean basins, depths, and habitats.

3. Main achievements and difficulties encountered (250 words max.)[8]

The main achievements of the project include the successful demonstration of the feasibility of using the adapted method from shallow water systems for repeated deployments and retrievals of samples in deep sea environments. This has provided valuable insights into the specific disintegration time of different materials in the deep sea, shedding light on material loss. Additionally, a comparison of disintegration under environmental settings in the Sicily Channel has yielded valuable information on the reduction of pollution and environmental impact. Furthermore, these achievements have laid a good baseline for planning further experiments in various ocean basins, depths, and habitats, contributing to a comprehensive understanding of material residence time in marine environments. However, one of the main difficulties encountered was the collection of sufficient data to apply statistical modelling on the disintegration data set, particularly for fast disintegrating materials and small or thin items from which several data points are needed for subsequent modelling and calculation of material- and site-specific half-life for plastic films, fibrous materials, and fabric materials. The proposed solution is to either deploy only minimum 2mm thick demonstrators or sample more frequently than every 6 months.

[1] Reference number assigned to the proposal by the TA-Office.

[2] User-project identifier used in the proposal.

[3] Title of the approved proposal. The length cannot exceed 255 characters

[4] Name of the installation/infrastructure accessed with this project. If more than one installations/infrastructures are used by the same project, please list them in the box.

[5] Specify starting and end date of the project (including eventual preparatory phase before the access).

[6] Fill in with the full contact of the Principal Investigator (user group leader).

[7] Write the short-term, medium and long-term objectives of the project. Use no more than 250 words.

[8] Describe briefly the main achievements obtained and possible impacts, as well as possible difficulties encountered during the execution of the project. Use no more than 250 words.

4. Dissemination of the results[9]

The results of the JERICO -S3 project will now be analysed and published in a scientific publication in the near future.

5. Technical and Scientific preliminary Outcomes (2 pages max.)[10]

See attachment.

Bühl, 26.1.24

[Location], [Date (dd/mm/yyyy]

Location and date

Miriam Weber

Signature of principal investigator

[9] Describe any plan you have to disseminate and publish the results resulting from work carried out under the Transnational Access activity in JERICO -S3: scientific articles, books - or part of them -, patents, as well as reports and communication to scientific conferences, meetings and workshops. Highlight peer-reviewed publications. **Note that any publications resulting from work carried out under the JERICO -S3 TA activity must acknowledge the support of the European Commission – H2020 Framework Programme, JERICO -S3 under grant agreement No. 871153.**

[10] Describe in detail results and main findings of your experiment at the present stage.

Final Report to JERICO-S3 - Main Technical and Scientific Outcomes:

1. Custom-built metal frames have been successfully tested for holding the samples, demonstrating readiness for deep-sea deployment (Fig. 1 and 2).
2. The frames were successfully used repeatedly in the Sicily Channel (SICO) (Fig. 1, 2).
3. Due to the pandemic a HYDRA scientist did not participate in cruises to deploy and retrieve the samples. Ensuring accurate documentation and sampling was achieved through training of CNR-ISMAR colleagues (Dr. Giuseppe Suaria). After deployment, the samples were retrieved by the facility operator and shipped back to HYDRA for further analysis.
4. 343 samples were deployed during the experiments. No sample was lost. Documentation at each retrieval (Fig. 3).
5. Most of the samples which were expected to disintegrate were disintegrated to 100% or nearly 100% (Tab. 1).
6. As expected, the negative control, LDPE film, showed no disintegration. It also showed no signs that the downward and upward application caused mechanical changes to the samples. Similarly, as expected, no degradation was observed in 3 of the TexDeg samples because these fabrics are non-biodegradable.
7. The filter paper, the positive control, was already 100% disintegration after 612 days in the SICO. We can only estimate how quickly it effectively disintegrated 12 and 18 months, as it is not possible to analyze the samples in between.
8. The natural material wood was, as expected, the slowest to disintegrate. In SICO no disintegration could be recorded (0%) after 612 days, however at CoCM after 1249 days.
9. The exposed cotton T-shirt, the MaterBi shopping bag, the Profissimo organic waste collection bag, the PHB Mirel film, and the disintegrading TexDeg samples showed 100% or close to 100% disintegration. The cigarette filters were not disintegrated after 612 days, and the biodegradable labeled cigarette filters had disintegrated by 80±26% (smoked) or 67±40% (non-smoked).
10. The disintegration of the samples was more advanced in the CoCM site than in the SICO. This is primarily due to the exposure time of 1060 and 612 days respectively. The TexDeg fabrics were exposed for 707 (CoCM) and 612 (SICO) days respectively. Here too, the disintegration in the CoCM was further than in the SICO. The 3 months longer exposure time could be the reason, and/or also better conditions for degradation. Metadata collected during the cruises, such as the nutrient concentration of the surrounding water, the microbial community in the environment, temperature, oxygen, salinity, etc. will be used for further interpretation of the disintegration data.

These outcomes demonstrate the successful development and testing of the custom-built frames, as well as the planned deployment and retrieval process, which will contribute to the accurate measurement and analysis of material degradation in marine deep-sea environments.

Figure 1: PHB film sample prior and post assembling in protection frames and mesh. Mounted onto steel frame ready for deployment at Sicily channel (SICO).

Figure 2: Retrieval of the steel frame with mounted samples at Sicily Channel (SICO) in October 2022, and documentation of fouling.

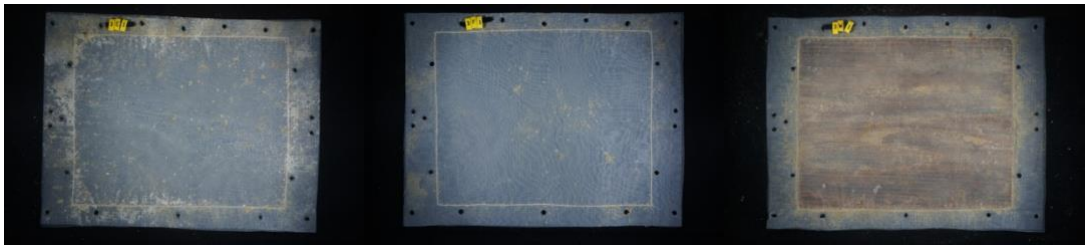

Figure 3: Documentation of samples after dismantling from protective mesh and frame. Photo documentation with the fine protective mesh: 3E1: white PHB film (100%), 3F1: white Cellulose filter paper (100%); 3W1: thin brown wood plate (0%=intact), exposed at Sicily channel (SICO).

Table 1: Estimated disintegration (mean value and standard devation) of LDPE shopping bag, thin wood plate, cellulose filterpaper, 7 textiles samples, MaterBi shopping bag, Profissimo compost collection bag, PHA film, and 2 types of cigarette filters (smokes, and non-smoked), after exposure of 612 days at 532 m depth in the channel of Sicily (SICO), respectively. Green colour indicates similar results between Corsica and Sicily channel, red colour not.

			Estimed disintegration		
Test material / product (replicates)	**form/ type**	**exposure site**	**exposed days**	**MV**	**SD**
LDPE (3n)	film	Sicily Channel	612	0	0
Wood (3n)	sheet	Sicily Channel	612	0	0
Filterpaper (3n)	sheet				
Filterpaper (3n)	sheet	Sicily Channel	612	100	0
Filterpaper (3n)	sheet				
TexDeg sample 1 (1n)	fabric	Sicily Channel	612	90	NA
TexDeg sample 2 (1n)	fabric	Sicily Channel	612	70	NA
TexDeg sample 3 (1n)	fabric	Sicily Channel	612	0	NA
TexDeg sample 4 (1n)	fabric	Sicily Channel	612	0	NA
TexDeg sample 5 (1n)	fabric	Sicily Channel	612	0	NA
TexDeg sample 6 (1n)	fabric	Sicily Channel	612	100	NA
T-Shirt (3n)	fabric	Sicily Channel	612	100	0
MaterBi (3n)	film	Sicily Channel	612	100	0
Profissimo (3n)	film	Sicily Channel	612	97	3
PHA (3n)	film	Sicily Channel	612	92	3
Cigarette filter, non-smoked (3n)	cigarette filter	Sicily Channel	612	0	0
Cigarette filter, smoked (3n)	cigarette filter	Sicily Channel	612	0	0
Biodegradable Cigarette filter, non-smoked (3n)	cigarette filter	Sicily Channel	612	67	40
Biodegradable Cigarette filter, smoked (3n)	cigarette filter	Sicily Channel	612	80	26