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1 Exploring and monitoring deep-sea using underwater video systems

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Abstract – The ecology team of the Biology Department of the University of Bari has developed the MEMO (Marine Environment MOnitoring system) baited lander to explore the Mediterranean marine ecosystems. MEMO is equipped with 2 video cameras, a multiparametric probe and a current meter. It can work down to 1000 m in depth for 24 consecutive hours. From 2010, the MEMO lander has been deployed in some deep-sea sensitive and vulnerable habitats of the Mediterranean Sea, as part of national and international research projects. Data on the environmental parameters (depth, salinity, temperature and current) and on the distribution, size and behaviour of the benthopelagic fauna have been recorded. The different studies provided new contributions to the knowledge of biodiversity in the deep waters and in fragile and structurally complex habitats, such as coralligenous, cold-water corals and canyons in the Mediterranean Sea.

I. INTRODUCTION

Although Underwater Video Systems (UVS) suffer from the fact that quantification and even identification of species can be doubtful, their low impact has become fundamental in the study of deep-sea sensitive and vulnerable habitats, such as those built by cold-water corals, where grabs, sledges and fishing gears would damage the benthic organisms unacceptably [e.g. 1,2,3,4,5]. UVS are innovatory since they allow to know the seafloor features at meso-scale level (i.e. a spatial scale of 10-1000 m), even in less accessible habitats, such as canyons and seamounts. In addition, UVS allow to record species difficult to sample with traditional tools and to detect human impacts, as required by environmental management plans, such as the EU Marine Strategy Framework Directive (MSFD).

The practical application of an UVS used by the ecology team of the Department of Biology of the University of Bari to explore the Mediterranean marine ecosystems is reported in this paper.

II. MATERIAL AND METHODS

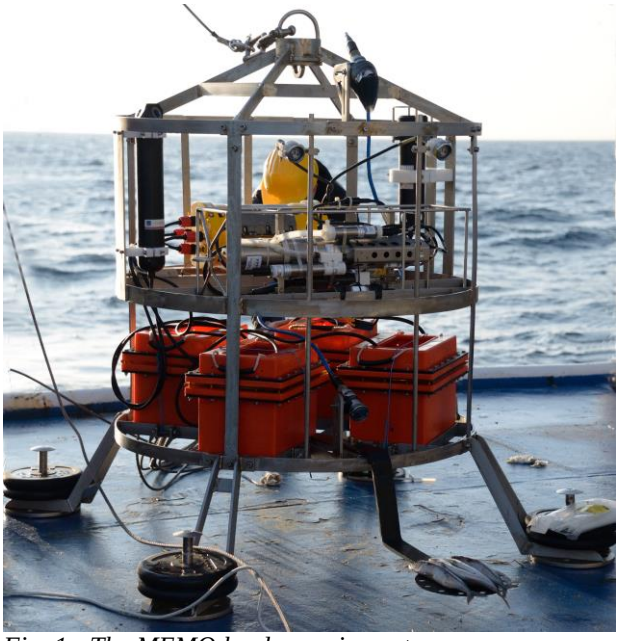

Fig. 1 - The MEMO lander equipment.

The ecology team of the Department of Biology of the University of Bari has developed the MEMO (Marine Environment MOnitoring system) baited lander, as part of the EU_7FP CoralFISH, with the aim of investigating the seafloor characteristics, environmental parameters and biological diversity in the deep-sea ecosystems. The MEMO lander consists of a stainless steel frame (ø 2.15 m; h 1.65 m); 2 video cameras (HD Multi SeaCam) with 2 white LED lights, an electronic compass, inclinometer and altimeter; a multiparametric probe (Sea-Bird Electronics Seacat Profiler 19 plus) for the measurement of pressure, temperature, conductivity, oxygen, pH and turbidity; a Doppler current meter (Nortek Aquadopp 2000); 4 Deep-Sea batteries (12 V-80 Ah); an acoustic modem (Teledyne Benthos ATM-900 Series); an electronic control unit (Communication Technology, Ltd) capable of managing the entire system (Fig. 1). On the seabed MEMO is linked by a zinc-coated steel cable to

buoys which keep the cable under tension (back up buoys) and then to a surface floating signalling buoy. The system is lowered to the seabed by winch and the surface buoy remains connected for recovery. Continuous connection is maintained via the acoustic modem with an on board PC software platform, making images and sensor data available and located on the vessel. The MEMO lander can work down to 1000 m in depth for 24 consecutive hours and can be baited. By mean of an *ad hoc* methodological approach of image analysis, the videos recorded by both video-cameras during each deployment have been analysed using the software Adobe Premier Pro and information on abundance and behaviour of benthopelagic species, including those of fishery interest, have been collected. Moreover, sizes of recorded specimen were measured from images using Image J 1.46q, a Java-based public domain program.

III. RESULTS AND CONCLUSIONS

A. Practical applications

From 2010 the MEMO lander has been deployed in some deep-sea sensitive and vulnerable habitats of the Mediterranean Sea, such as the Santa Maria di Leuca (SML) cold-water coral (CWC) province (Northern Ionian Sea), the Bari Canyon (Southern Adriatic Sea) and the Nora Canyon (Southern Sardinian Sea), as part of national and international researches and monitoring projects [6,7,8,9,10]. Data on the characteristics of substrate together with depth (m), salinity (psu), temperature (°C) and current (m/s) were recorded. MEMO allowed to record information on the megafauna biodiversity, species composition and abundance as well as small scale-distribution and behaviour according to different habitat explored.

A total of 14 individuals of *Paromola cuvieri* (Crustacea, Decapoda) were recorded at depths between 547 and 648 m in the SML CWC province [6]. Thirteen specimens recorded were females, one male and all were shown to scavenge the bait. All the specimens carried a sponge on their exoskeleton using the fifth pereiopods.

The specimens were distinguishable by the size and shape of the carried sponge. These observations demonstrated both passive covering behaviour and active behaviour of discouraging approach and attack from competitors or predators, respectively. This study represents the first *in situ* documentation of *P. cuvieri* behaviour interacting with other deep-sea species, such as the shark bluntnose sixgill (*Hexanchus griseus*) and the teleost fish blackbelly rosefish (*Helicolenus dactylopterus*) (Fig. 2), in the Mediterranean Sea.

Investigating the benthopelagic fauna of SML CWC province, a total of 20 benthopelagic species (1 cephalopod, 6 decapod crustaceans, 5 chondrichthyes and 8 osteichthyes) were identified between 547 and 790 m [7]. The fish blackspot seabream (*Pagellus bogaraveo*) was exclusively observed in the coral habitat. The fishes European conger (*Conger conger*) and *H. dactylopterus* (Fig. 3) were the most abundant species in this type of habitat, as recently reported [11,12]. A positive significant relationship between the species abundance and the current speed was detected in the investigated habitats.

Fig. 2 - Digital frames showing the active behaviour of Paromola cuvieri *and its interaction with* Hexanchus griseus *(up) and* Helicolenus dactylopterus *(down) recorded by MEMO lander in the SML coral province.*

The occurrence and behaviour of the sharks: the gulper (*Centrophorus granulosus*), the kitefin (*Dalatias licha)* (Fig. 4), the velvet belly (*Etmopterus spinax)* and the bluntnose sixgill (*Hexanchus griseus*) (Fig. 4) in the SML CWC province were recorded [8].

During four baited lander deployments carried out in the Bari Canyon, at depths of 443-788 m, a total of 12 benthopelagic fish species (five chondrichthyes and seven osteichthyes) were identified [9, 10]. The blackspot seabream was the most often observed fish species (Fig. 5). Groups of up to 40 individuals of this fish were attracted to the bait and were shown in single frames. The individuals were observed both exploring the area and feeding actively on the bait (Fig. 5). Detection of *P. bogaraveo* individuals increased significantly when the current velocity decreased.

The European conger was recorded at each deployment. Clear scavenger behaviour was also observed in this teleost fish and in the shark *E. spinax*.

The shark species *C. granulosus* and *H. griseus* were also recorded but, although attracted by the bait, they were never seen feeding on it. Other fish species, harvested on fishing grounds, such as *Merluccius merluccius*, *H. dactylopterus* and *Polyprion americanus* (Fig. 6), were also recorded.

From 2015, the MEMO lander has also been used as part of the monitoring activity foreseen by the MSFD to detect changes in the ecosystem not only in cold-water coral habitat and canyons but also in coralligenous and maerl habitats.

All these studies represent *in situ* documentation, at very low impact, of the megafauna in deep-sea sensitive and vulnerable habitats, providing new insights into its small scale distribution, behaviour, linkage between species and habitats as well as indicating that CWC areas and canyons could act as refuge sites for species that are vulnerable to fishing on the open slope.

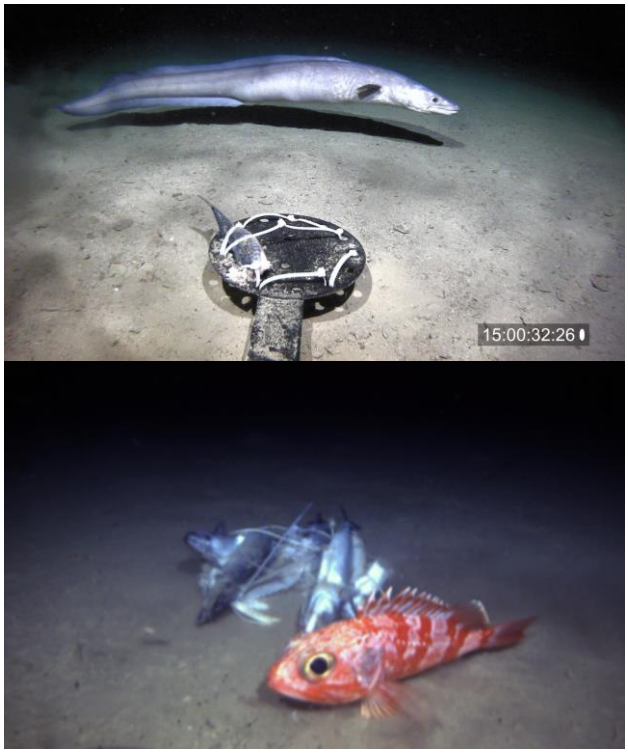

Fig. 3 - Digital frames of Conger conger *(up) and* Helicolenus dactylopterus *(down) recorded by MEMO lander in the SML coral province.*

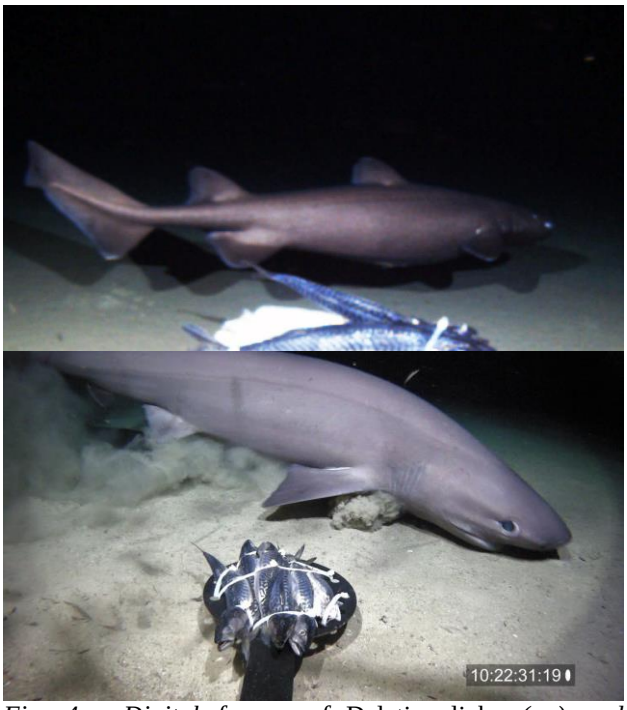

Fig. 4 - Digital frames of Dalatias licha *(up) and* Hexanchus griseus *(down) recorded by MEMO lander in the SML coral province.*

Fig. 5 - Digital frames of Pagellus bogaraveo *feeding on the bait recorded by MEMO lander in the Bari Canyon.*

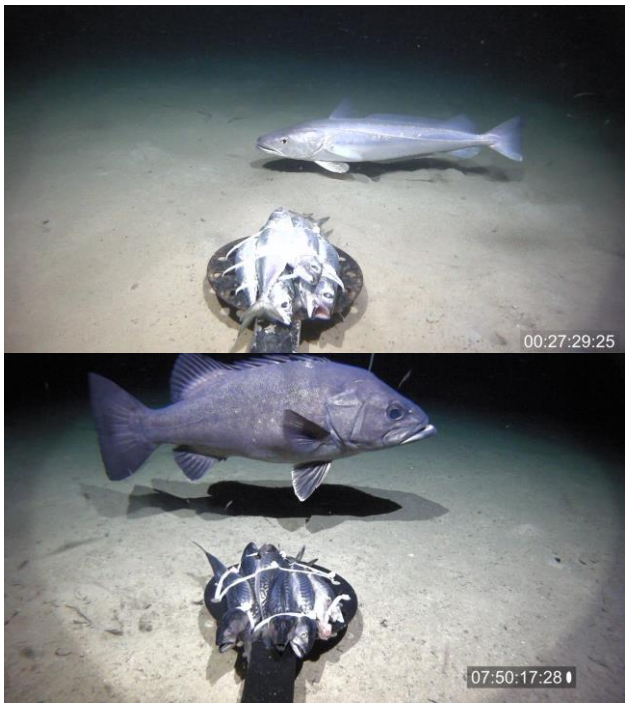

Fig. 6 - Digital frames of Merluccius merluccius *(up) and* Polyprion americanus *(down) recorded by MEMO lander in the Bari Canyon.*

B. Methodological limitations

Underwater video systems are highly suitable for observing bottom features and counting fish in fragile and structurally complex habitats, such as CWC communities, canyons and seamounts. However, several difficulties and limitations should be taken into consideration during analysis of mobile benthopelagic fauna [5]. One of the key difficulties dealing with deep waters is low faunal density, which requires a very large sampling effort in order to have valid estimates. Low densities make statistical comparison between areas difficult because of the high variance in replicate counts. In addition, identifying invertebrates and fishes to species level only from video can also be challenging in areas with a high species diversity. Although landers produce a small disturbance in collecting this type of data, they have their own limitations. Baited landers will only attract scavenging invertebrates and fishes, so are highly selective. Precise positioning of the lander can also prove difficult. Due to the complex topography of the CWC and canyon habitats, free fallings landers may sometimes miss their target or land directly on the corals causing damage and increasing the risk of entanglement [13].

C. Research perspectives

The ecology team of the Department of Biology of the University of Bari has recently started to use the Remotely Operated Vehicle (ROV) MULTIPLUTO which is provided by thrusters, a front video camera, LED lights, a robotic sampling arm and other sampling devices (Fig. 7). The MULTIPLUTO can work down to 2000 m in depth.

The ROV could be a good complementary tool of the lander to investigate deep-sea habitats since it explores a larger area, recording the sessile fauna (corals, sponges) distributed on the seafloor. However, the ROV shows limitations related mainly to noise and light created by the gear typology that may either scare away or attract invertebrates and fishes causing under or over estimations of the true abundances [e.g. 1,14,3,15].

Fig. 7 - The Remotely Operated Vehicle (ROV) MULTIPLUTO.

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