

Coordinated hunting association between dusky grouper, *Epinephelus marginatus* (Lowe, 1834) and Mediterranean moray, *Muraena helena* Linnaeus, 1758 in the Mediterranean Sea

(Periciformes: Epinephelidae and Anguilliformes: Muraenidae)

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Interspecific coordinated hunting between groupers (Epinephalidae) and moray eels (Muraenidae) is well documented in various tropical regions, including the Red Sea, but has not yet been reported for the Mediterranean Sea. Here, I describe an opportunistic observation of a coordinated hunting association between the dusky grouper, *Epinephelus marginatus* and the Mediterranean moray, *Muraena helena* made in the bay of Argentario (Sardinia, Italy). Remarkably, the *M. helena* individual was observed touching the dusky grouper’s belly with its head. Whether this represented a signal to initiate the subsequent coordinated hunting remains to be investigated.

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Introduction

Following associations of species of the family Epinephelidae (groupers) with other teleost fish, such as moray eels (Muraenidae) (Karplus 1978, Dubin 1982, Diamant & Sphigel 1985, Strand 1988), snake eels (Ophichthyidae) (Dubin 1982, Gerhardinger et al. 2006) and also octopuses (Diamant & Sphigel 1985, Machado & Barreiros 2008), have long since been documented from tropical and subtropical regions of the world, including the Red Sea, Caribbean, Great Barrier Reef, Gulf of California, southern Brazil and the Azores Archipelago. Some of these following associations, e.g., between groupers and moray eels as well as multispecies hunting association with octopuses, were revealed to be more than just coincidental encounters between nuclear and following individuals. Rather, they represent true cases of coordinated interspecific hunting, mediated by complex signalling behaviours involving active

recruitment, referential gestures as well as partner control mechanisms (Bshary et al. 2006, Vail et al. 2013, Sampaio et al. 2021, 2024). Since the species engaging in coordinated hunting associations possess specific complementary hunting strategies, e.g., moray eels can penetrate crevices to corner the prey, whereas hunting in open water is easier for groupers, interspecific hunting associations can enhance overall hunting success for each of the partner species (Bshary et al. 2006, Vail et al. 2013).

The present study reports the, to my knowledge, first documented case of coordinated hunting activity between an *Epinephelus marginatus* (Lowe, 1834) and a *Muraena helena* Linnaeus, 1758 in the Mediterranean Sea. Coordinated hunting has not been documented for either species, although there are several reports of following behaviour for *E. marginatus* from Brazil and the Azores (e.g. Gerhardinger et al. 2006, Machado & Barreiros 2008).

Material and methods

The opportunistic observation of a coordinated hunting association between *E. marginatus* and *M. helena* was made in the bay of Argentiera (Sardinia; see Fig. 1A), at a rocky reef at a depth of around 6 meters approximately 160 meters from the shore ($\sim 40.740593^\circ / 8.145716^\circ$). This single opportunistic observation was made on 20th of September 2024 in the early afternoon. In total, the species pair was followed using standard snorkeling gear for about 20 minutes. Photographs and videos (see Supplementary Material) of the observation were made with a Sony RX100 III camera using a waterproof housing (Sea frogs).

Result and discussion

The opportunistic observation began with the discovery of a *M. helena* individual browsing along the rocky seabed. When I dived down, it initially retreated into one of the many rocky crevices before it left it again to directly approach an *E. marginatus* individual, which was roughly two meters away and which I had not noticed before. The moray had a length of approximately 75 cm whereas the grouper measured only about one third of the moray (see Fig. 1B). The small size of the grouper suggests that it was a juvenile female (Condini et al. 2017). The moray swam directly towards the grouper, and after nudging the dusky grouper's belly with its head, the two fish started to swim closely together towards the rocky bottom (unfortunately, this nudging part of the interaction was not videotaped). This is remarkable mainly because previous observations of coordinated hunting between Red Sea groupers, *Plectropomus pessuliferus* (Fowler, 1904) and moray eels, *Gymnothorax javanicus* (Bleeker, 1859) indicate that the grouper (*P. pessuliferus*) usually acts as the initiating partner by actively signalling (head shaking at a high frequency) towards the moray eels, whereas the moray eels were never observed to signal towards groupers (Bshary et al. 2006). A similar behaviour was reported between the highfin grouper *Epinephelus maculatus* (Bloch, 1790) and the reef octopus *Octopus cyanea* Gray, 1849 in the Great Barrier Reef (Australia). In this case, the grouper swam towards the octopus, which possibly initiated the hunting cooperation, although this remained unclear (Unsworth & Cullen-Unsworth 2012). While another study from the Red Sea reported physical contact between the moray eel *Gymnothorax griseus* (Lacepède, 1803), and the two grouper species *E. pinephelus fasciatus* (Forsskal, 1775) and *Variola louti* (Fabricius, 1775) during interspecific hunting associations, however the actively signalling/touching partners were not indicated in the study

(Diamant & Sphigel 1985). A further study from the Red Sea reported headstand signals of groupers as referential gestures to moray eels and wrasses to indicate the location of potential prey and to initiate interspecific hunting (Vail et al. 2013). Whether or not the observed body contact of *M. helena* and *E. marginatus* really was the initiating signal for subsequent coordinated hunting (see below), must remain open as the species pair was likely already searching for prey before I had spotted the *M. helena*. Further, this nudging behaviour of the moray was observed only once during the entire observation.

The two individuals (see Fig. 1D) swam together over the rocky bottom while remaining within less than one grouper body length of each other (see Supplementary Video S1: sec. 24; see Fig. 1B). When the moray encountered a presumably promising crevice or fissure, it would either poke its head into the opening or enter it completely (see e.g. Supplementary Video S1: sec. 28; Fig. 1C). During this behaviour the grouper typically remained nearby, either waiting directly in front of the crevice or positioning itself close to another opening of the same structure (see e.g. Supplementary Video S1: sec. 31). No strikes, gulping of prey or chewing behaviour were observed for either species. My observation was, however, interrupted several times due to my need for oxygen; it therefore remains open whether the hunting association was successful during the observation period. It is noteworthy in the latter context, that even when the pair had separated due to my disturbance, which happened several times when I came too close (see e.g. Supplementary Video S1: sec. 50, 125 and 134), they reunited immediately after I withdrew, suggesting that the hunting association was actively maintained by both partners. Indeed, several studies found evidence that following or hunting associations between groupers and moray eels are at least beneficial for the groupers (Diamant & Sphigel 1985) but are likely reciprocally beneficial for both partners (Bshary et al. 2006). This appears to be the case for collaborative interspecific hunting events of octopuses, groupers and goatfish as well, which were shown to be functionally highly complex including role specializations and partner control mechanisms such as targeted punches from the octopus (Sampaio et al. 2021, 2024).

Further, no aggressive or agonistic behaviour was observed between the *E. marginatus* and the *M. helena*, or between groupers as it was reported from a following association between a juvenile dusky grouper and goldspotted snake eels *Myrichthys ocellatus* (Lesueur, 1825) (Gerhardinger et al. 2006). However, no other *E. marginatus* nor other *M. helena* specimens were seen during the observation.

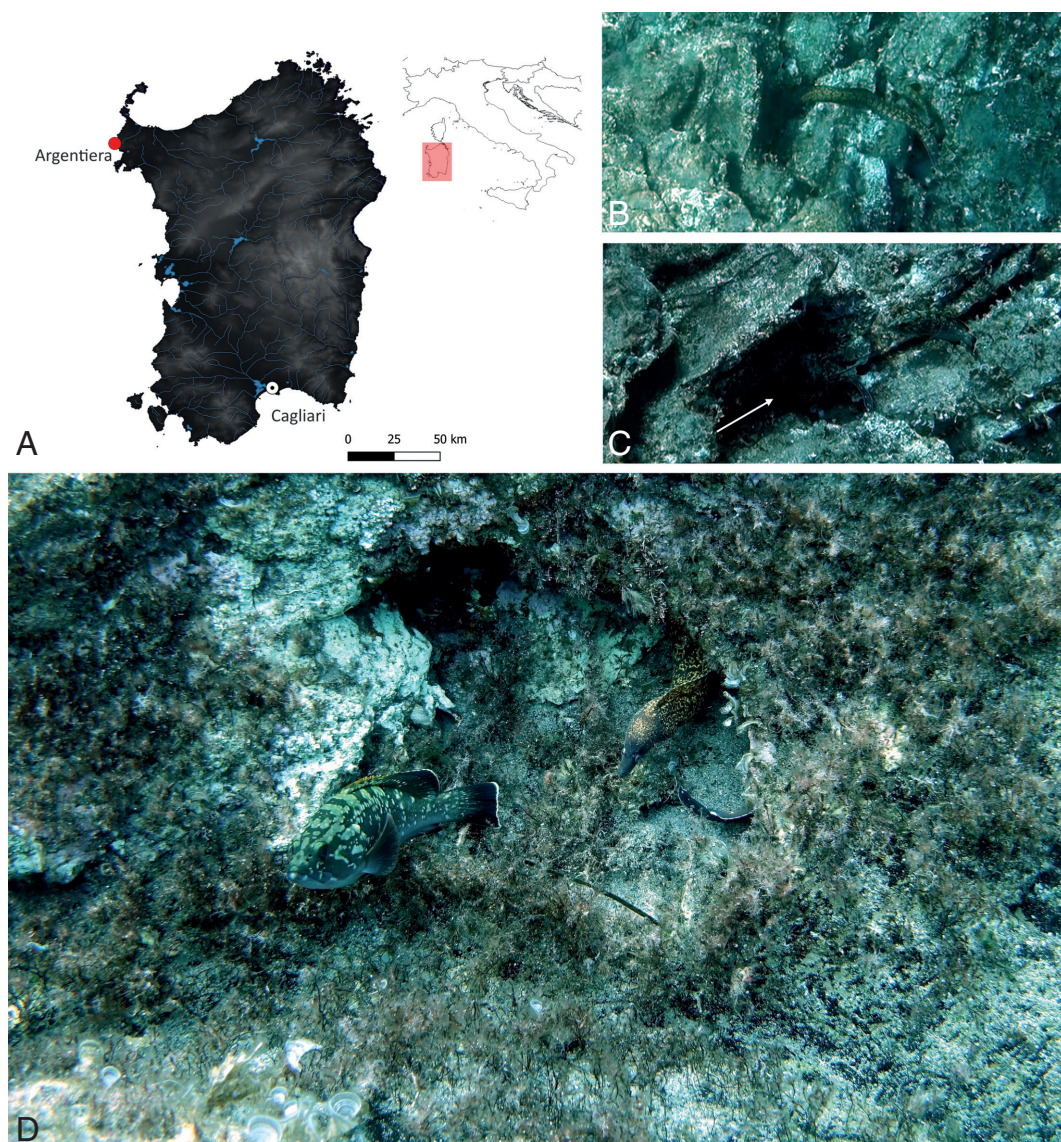


Fig. 1. A. Map of Sardinia (Italy) showing the location of Argentiera, where the coordinated hunting association between *Epinephelus marginatus* and *Muraena helena* was discovered. The baseline map is based on shapefiles that were obtained from DIVA-GIS (<http://diva-gis.org/Data>). B. The pair of *M. helena* and *E. marginatus* (above the moray) that formed the coordinated hunting association, swimming closely together over the rocky seabed. C. The moray entered a presumably promising crevice while the grouper waited close to the opening of the same crevice. The white arrow points toward the tail of the moray. D. Close-up of the observed species pair. Note: Figures B and C were extracted as still images from the video footage. A white balance was applied to all under-water images.

Although this study is based only on a single opportunistic observation and thus requires confirmation, it nevertheless expands the documented

records of interspecific foraging associations between groupers and moray eels for the Mediterranean Sea and demonstrates that such behaviour occurs outside

tropical coral reefs. It also suggests that this kind of interspecific behaviour may be more common than previously thought.

However, it is most likely rarely observed and has therefore been overlooked. The fact that *M. helena* was observed engaging in, what I am convinced was active signalling to the *E. marginatus* individual – by touching its belly with its head – warrants further research attention, as groupers are commonly reported as the actively signalling partners (see e.g. Bshary et al. 2006, Unsworth & Cullen-Unsworth 2012, Vail et al. 2013). Unfortunately, it remains unclear as to how common interspecific hunting associations between dusky groupers and Mediterranean morays in the region of Argentario actually are. It was observed only once during a total of four snorkelling sessions (> 1.5 hour) which were completed in the area. Recreational fishing pressure, primarily from small wooden boats, appears to be substantial in the area (pers. observation) and may affect local populations of *E. marginatus* and *M. helena*. It might thus be promising to investigate whether similar hunting associations occur in the nearby Marine Protected Areas (MPAs) Capo Caccia–Isola Piana and Isola dell’Asinara.

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Appendix

<https://youtu.be/RYfi3e6o3P0>

Supplementary Video S1: Compilation of the video footage taken during the chance observation of the coordinated hunting association between *E. marginatus* and *M. helena* in the Mediterranean Sea. Some of the videos were taken from the water’s surface. To facilitate orientation in these cases, the species pair is highlighted by a red circle.