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Article

Behavioral Pattern of Risso's Dolphin (*Grampus griseus*) in the Gulf of Taranto (Northern Ionian Sea, Central-Eastern Mediterranean Sea)

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Abstract: Relatively scant information is available on the Risso's dolphin in comparison to the other species regularly present in the Mediterranean Sea. Recently, its conservation status has been updated to Endangered by the International Union for Conservation of Nature (IUCN) in this Sea. Therefore, the need to increase information on its biology and ecology is even more urgent. This study reports the first preliminary information on the behavioral traits of the species occurring in the Gulf of Taranto (Northern Ionian Sea). Data on predominant behavioral activity states and on a set of group composition variables (group formation, cruising speed, dive duration and interaction between individuals) were collected from April 2019 to September 2021, applying the focal-group protocol with instantaneous scan sampling. Group size, depth and group composition variables were compared between activity states. Results highlight that both the group size and the several variables considered varied significantly depending on activity state. The group size was significantly smaller during feeding than resting and traveling and a characterization in terms of group formation, cruise speed, dive duration and interaction between animals is provided for the different activity states. Moreover, a list of behavioral events which occurred, as well as their relative frequency of distribution among activity states, is reported. Finally, details on the sympatric occurrences between Risso's and striped dolphins, as well as the repetitive interaction observed between adult individuals and plastic bags floating on the sea surface, are reported and discussed.

Keywords: focal-group method; *Grampus griseus*; sympatric occurrence; plastic items interaction; marine litter

1. Introduction

The importance of incorporating behavioral ecology into conservation strategies has long been debated [1] and in the last two decades, several studies have highlighted that a better understanding of the behavioral ecology of highly social species is crucial to implementing effective conservation actions [2–5]. Considering that cetaceans are highly social animals [6,7] improving knowledge of their behavioral patterns and strategies is essential. These species, in fact, assume a key ecological role in aquatic ecosystems, ensuring stability in the trophic web and preserving biodiversity e.g., [8–12]. The need to increase knowledge of behavioral aspects is even more crucial for those species occurring in riverine, brackish, mangrove and estuarine habitats or in semi-enclosed basins or embayments that may result in more pronounced responses to anthropogenic pressures and impacts than those occurring in open oceans [13].

To date in the Mediterranean Sea, the largest and deepest semi-enclosed basin in the world [14], research studies on cetacean behavior have mainly been focused on the vocal behavior and on acoustic monitoring of behavioral responses, in the presence of an anthropogenic source of stress, of different species such as striped (*Stenella coeruleoalba*) and common bottlenose dolphin (*Tursiops truncatus*), sperm (*Physeter macrocephalus*) and fin whales (*Balaenoptera physalus*) i.e., [15–20]. Baseline information about ecological aspects of behavior (i.e., behavioral patterns, daily activity budget and their spatiotemporal variations) of regular cetacean species occurring in the basin is scarce and fragmented. Several studies on this topic mainly refer to striped dolphin [21–24], common bottlenose dolphin [25–29] and fin whale e.g., [30–32], whereas no or negligible information is available for Risso's dolphin (*Grampus griseus)*.

The Risso's dolphin occurs worldwide, preferentially inhabiting temperate and tropical waters on the continental slope and outer shelf, especially in areas with steep bottom topography [33,34]. It has often been observed near submarine canyons, seamounts and oceanic trenches [35] probably due to the presence of mesopelagic cephalopod prey [36–41]. In the Mediterranean, the species is distributed throughout the basin from the Alborán Sea [42–44] to the Levantine Sea [45], if with different occurrences both in terms of abundance and distribution [46]. This is probably due to the ecological characteristics of the species and the different geomorphological and chemical-physical characteristics of the Mediterranean regions, and to a different sampling effort focused to monitor the species that is higher in the westernmost part of the basin than in the eastern one. Numerous studies on the species focus on its distribution, habitat use and abundance e.g., [46–49] and reference therein (Figure 1). Some works on genetic variability and association among photo-identified individuals have been carried out in the Ligurian Sea [46,50,51]. The daily activity budget of Risso's dolphin has never been investigated in the basin. The little existing information on this aspect of the behavioral ecology referred to data collected in Monterey Bay [52,53], in the Southern California Bight [54–56] and in the Azores Islands [57–59]. Thus, it is essential to provide information and data on the behavioral pattern of the species, also in view of the recent revision of its conservation status by the IUCN from Data Deficient [60] to Endangered [61,62].

This study aims to provide the first data on the diurnal behavioral pattern of a local population of Risso's dolphin occurring in the Gulf of Taranto, Northern Ionian Sea (Central-eastern Mediterranean Sea) and monitored since 2013 [63–72]. Moreover, evidence about the dolphin's responses in the presence of plastic items floating on the sea surface and about inter-specific interaction with other dolphin species is also reported and discussed.

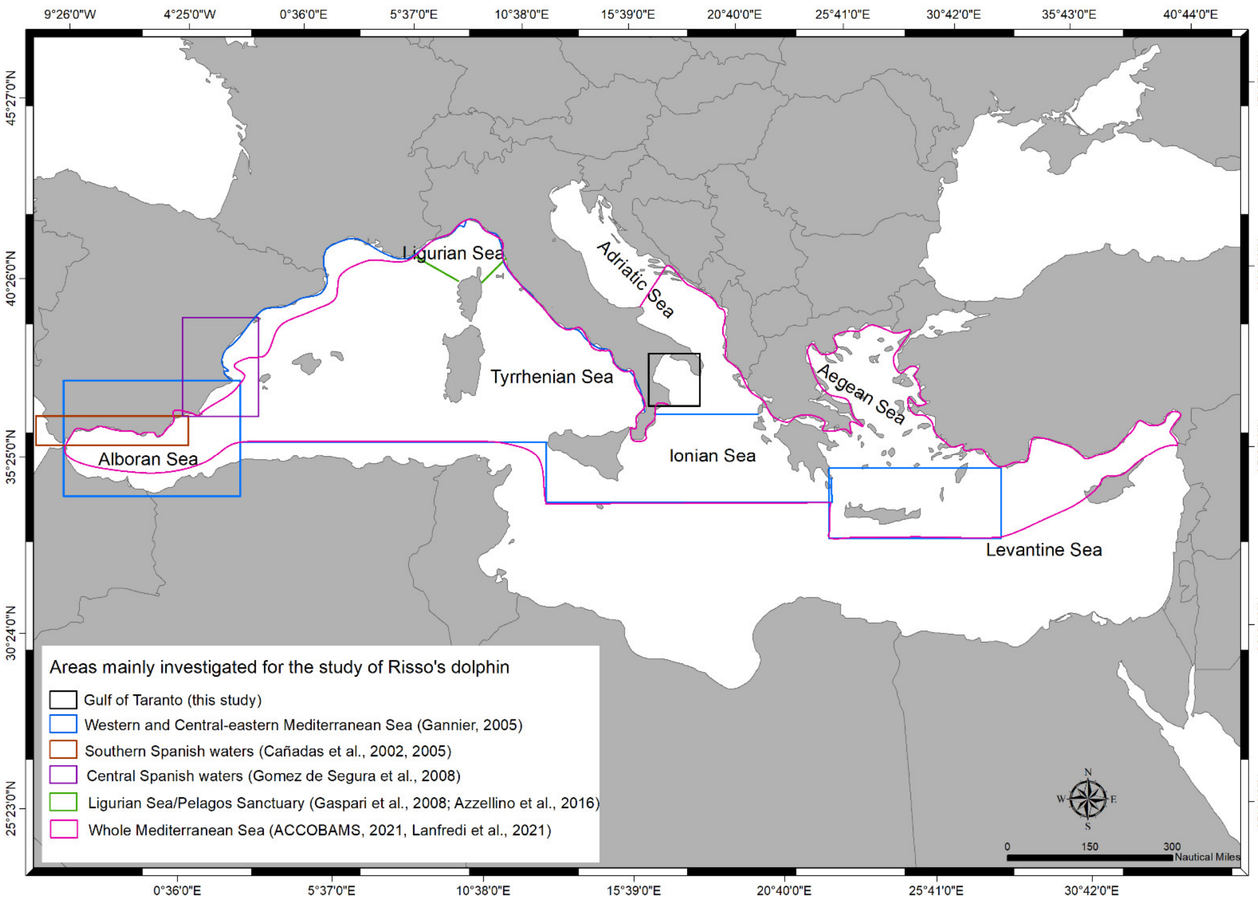

Figure 1. Map of areas monitored in the Mediterranean over time to study Risso's dolphin.

2. Materials and Methods

2.1. Study Area

The study area covers 960 km^2 in the northernmost portion of the Gulf of Taranto that extends for 14,000 km^2 from Santa Maria di Leuca to Punta Alice (Figure 2). It is characterized by a narrow continental shelf with a steep slope and several channels in the western sector, as well as by descending terraces toward the submarine canyon known as the "Taranto Valley" in the eastern one. The complex morphology of the area, together with the circulation of water masses, involving the occurrence of seasonal and decadal upwelling currents [73–76], plays a significant role in sustaining productivity and the abundant presence of benthopelagic cephalopods [77–80]. These characteristics make the entire Gulf a hot spot of cetacean biodiversity [81], in which *G. griseus* represents an important top predator able to play top-down control roles activating trophic cascades in the food web [82,83]. Additionally, several human pressures or threats affect the basin resulting in possible direct and indirect impacts on cetaceans [84,85].

2.2. Data Collection

Sighting data of Risso's dolphin were collected from April 2019 to September 2021 during standardized surveys carried out on board a 12 m catamaran. Trips were carried out only in favorable sea-weather conditions (Douglas scale ≤ 3 and Beaufort scale ≤ 4) applying an effort of approximately 5 h per day along 35 nautical miles, maintaining a cruising speed between 7 and 8 knots. The scientific team on board included three observers. The first was engaged in searching activity for targets around 180° while the others supported the activities of the former, searching in a sector from the track line to 90° on the starboard and port sides, respectively.

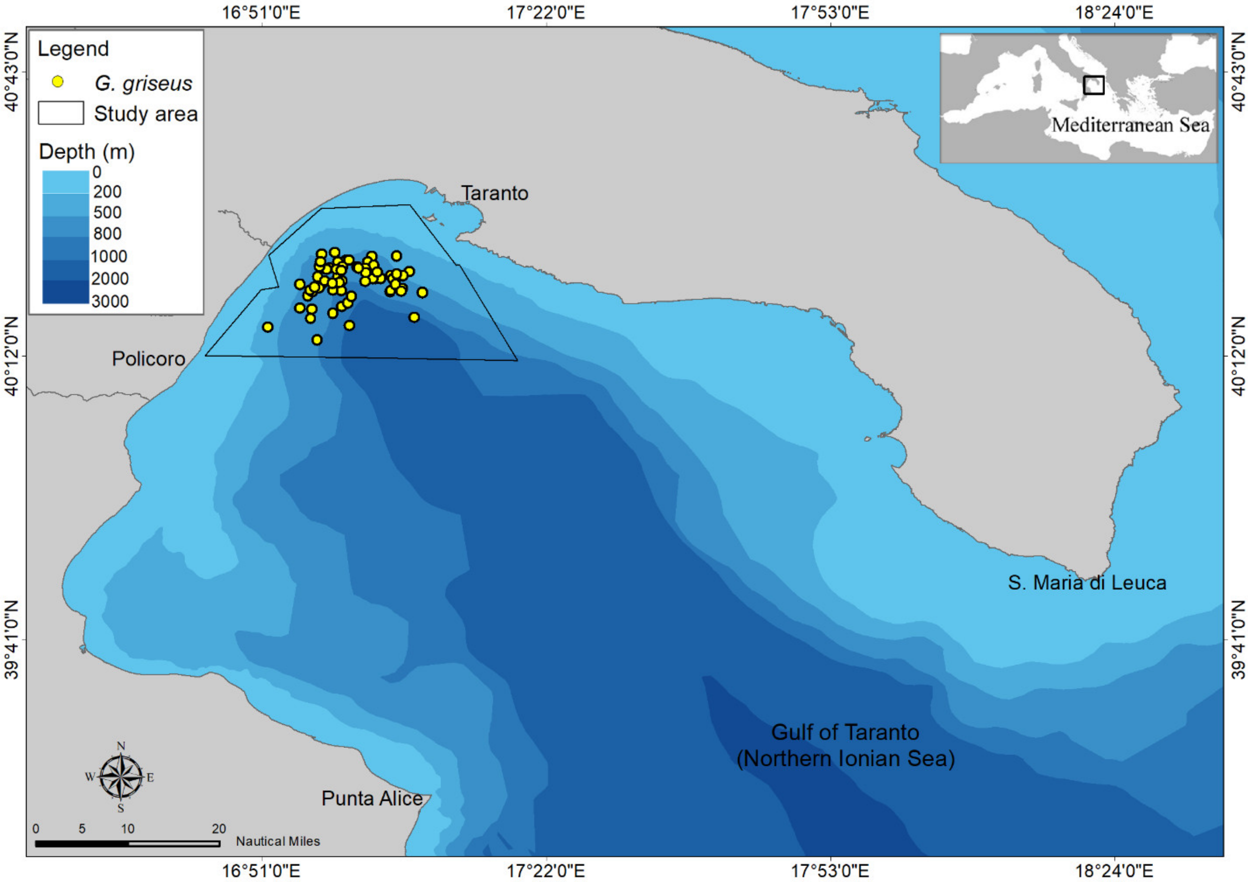

Figure 2. Map of the Gulf of Taranto (Northern Ionian Sea, Central-eastern Mediterranean Sea) with indication of sightings of Risso's dolphin and the study area investigated in 2019–2021.

Once a target was sighted, the dolphin group was followed switching to off-effort [86], maintaining a minimum distance of about 50 m from it to avoid alteration in its behavioral activity. When the dolphins approached more closely, the speed of the research vessel was reduced gradually until the engine was switched off. Sighting date, time of first contact, GPS position, group size and depth (m) were all recorded. Information about the age and sex of individuals observed was collected according to the protocol applied in Carlucci et al. [65] supported by photo-identification data collected using a Nikon D3300 (Nikon Corporation, Tokyo, Japan) digital camera equipped with a Nikon AF–P Nikkor 70–300 mm, f4.5–6.3G ED lens.

The collection of data concerning the activity states and behavior of groups of Risso's dolphin encountered was carried out applying the focal-group protocol with instantaneous scan sampling [87,88]. This protocol is preferred to the focal-individual protocol in the presence of cetacean species characterized by large groups in which it is difficult observe and immediately recognize each single individual [87,89]. A focal group is defined as all dolphins within a radius of 100 m of each other, observed in apparent association, moving in the same direction, and engaged in similar behavioral activity [90–92].

The focal group was scanned every 3 min for a total session of at least 15 min. For each instantaneous scan, the predominant group activity state among those identified by Shane [92]: feeding, resting, socializing and traveling (Table 1) was recorded. Predominant activity state means the behavioral state in which more than 50% of the dolphins within the focal group were involved. Moreover, information on a set of variables characterizing the focal group (group composition variables) such as group formation (gf), cruising speed (sp), dive duration (dd) and interaction among individuals (ai) was collected using a digital voice recorder (Table 1). These variables are those included in a standardized ethogram [87]. In addition, field notes on behavioral events observed (Table 2) as well as of dolphin's responses in the presence of plastic items floating on sea surface and other dolphin species are also reported.

Table 1. Description of activity states and of a set of variables, characterizing the focal group, recorded during sightings of Risso's dolphin carried out in the Gulf of Taranto.

Variables	Definition
Activity state	Description of observed behaviors [92]
Feeding (F)	Dolphin involved in chasing or capture of prey items close to the surface or showing erratic movements at the surface, multidirectional diving and rapid circle swimming.
Resting (R)	Dolphins observed in a tight group staying close to the surface, emerging at regular intervals and moving very slowly. Events of logging can be observed.
Socializing (S)	Physical interactions ranging from chasing to body contact, such as rubbing and touching or copulation between dolphins. Aerial behavior such as breaching frequently observed.
Traveling (T)	Dolphins moving steadily in a directional path, at normal to high speed.
Group formation (gf)	Description (this study)
Very tight formation (gf1)	Distance between individuals of approximately 0–2 m (less than one adult body length).
Tight formation (gf2)	Distance between individuals ranging from 2 to 15 m.
Loose formation (gf3)	Distance between individuals ranging from 15 to 50 m.
Spread formation (gf4)	Distance between individuals greater than 50 m and individuals weakly coordinated.
Cruising speed (sp)	Description (this study)
Low (sp1)	Individuals moving at a speed lower than 3 knots.
Normal (sp2)	Individuals moving at a speed ranging from 3 to 6 knots.
High (sp3)	Individuals moving at a speed higher than 6 knots.
Dive duration (dd)	Description (this study)
Regular surfacing intervals (dd1)	Dolphins surface quite regularly at 10–15 sec intervals.
Little time at surface (dd2)	Most of observation time spent underwater, mostly diving.
Mostly at surface (dd3)	Most of observation time spent on the surface, mostly floating.
Interaction among individuals (ai)	Description (this study)
Active inter-animal contact (ai1)	Two or more dolphins actively in contact with one another; splashes may obscure the details of their interaction.
Minimum contact (ai2)	Minimum and slight contact between individuals.
No contact (ai3)	No contact between individuals.

Table 2. Description of the behavioral events recorded during the sightings of Risso's dolphin occurring in the Gulf of Taranto.

Events (e)	Description
Tail slap (e1)	Flukes raised above the surface and ventral side slapped downward, usually making a loud, percussive sound [92].
Tail slap on back (e2)	Flukes raised above the surface and dorsal side slapped downward, usually making a loud, percussive sound [92].
Flipper slap (e3)	Pectoral flipper slapping the surface [92].
Small breach/leap (e4)	Body clears the water (not entire body) [92].
Full breach/leap (e5)	Body clears the water (entire body) [92].
Spyhopping (e6)	Brief vertical or near-vertical elevation of body and head-up exposure, followed by sinking return to water [93].

Fluking (e7)	Dolphin arches back and exposes flukes [92].
Chase (e8)	Single rapid forward movement on surface played by single individuals that produces a linear splash and directed towards another individual, not followed by any immersion (this study).
Torpedo (e9)	Single rapid forward movement on surface played by a single individual that produces a linear splash, followed by the immersion of the animal [33].
Logging (e10)	Floating at or just below the water surface moving slowly in one direction [58].

2.3. Data Analysis

All behavioral data collected were analyzed considering the entire session of at least 15 min as a sampling unit, identifying the activity state as the most recorded variable [88,94]. Sightings where predominant activity during the entire session could not be identified and/or detailed information on gf, sp, dd and ai could not be recorded, have been excluded from the analysis.

The frequency of occurrence of each activity state was calculated as the ratio between the number of observations of an activity state and the total number of observations which occurred during the study period. Possible differences in median values of depth and group size recorded during different activity states were tested by means of the non-parametric Kruskall–Wallis (KW) [95] and the Mann–Whitney tests using Matlab (MathWorks, Natick, MA, USA). Finally, a Mann–Whitney test was applied under the null hypothesis that group formation, cruising speed, dive duration and interaction among individuals were not significantly different between activity states.

3. Results

A total effort of 480 h was spent on board during 96 standardized daily surveys providing 98 sightings of Risso's dolphin along 3360 nautical miles covered. Sightings occurred in a depth range between 335 and 1000 m with a mean value of 642 ± 1130 m. The group size ranged between 2 and 42 Risso's dolphins with a mean value of 19 ± 9 individuals. Traveling was the most frequent activity state recorded during observations (57%, $n = 56$), followed by resting (27%, $n = 26$), socializing (9%, $n = 9$) and feeding (7%, $n = 7$). No significant differences were observed in median values of depth between the different activity states recorded (KW test = 0.66, p-value = 0.88, df = 3) whereas the group size varied significantly between activities (KW test = 16.33, p-value < 0.001, df = 3). In particular, the median value of group size recorded during feeding was significantly smaller than those recorded during resting (rank sum statistic = 41, p-value < 0.001) and traveling (ranksum statistic = 1.95×10^3, p-value < 0.001).

3.1. Results of Single-Component Analysis

Detailed information about variables: group formation, cruising speed, dive duration and interaction among individuals were recorded in 85 out of 98 sightings, of which 7 were associated to feeding activity, 23 to resting, 5 to socializing and 50 to traveling.

The group formation recorded during feeding activity was significantly different than those observed during resting and traveling (Figure 3, Table 3). In detail, a more compact group formation (gf1 and gf2) was observed mainly during resting and traveling whereas a group formation more spread out (gf3 and gf4) was observed mainly during feeding. Similarly, a looser formation of groups (gf3) was observed more often during traveling than in resting.

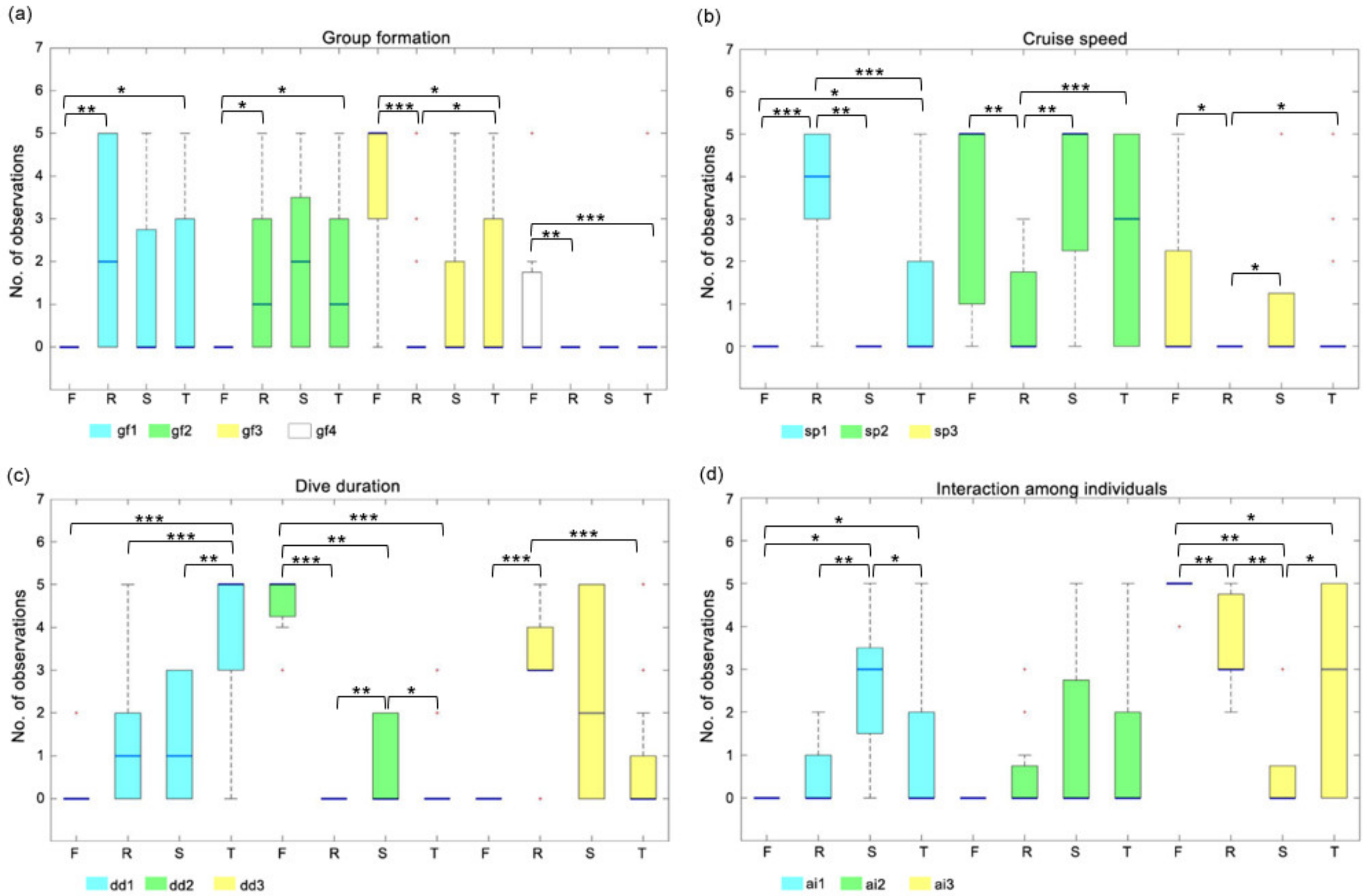

Figure 3. Box plot of the number of observations for each group composition variables: (**a**) group formation (gf), (**b**) cruise speed (sp), (**c**) dive duration (dd) and (**d**) interaction between animals (ai) considering each activity state. The blue bold line is the median value; box limits are quartiles; whiskers represent minimum and maximum values and small red points identify outliers. Significant differences found are reported and the significance level is indicated by asterisks: * *p*-value < 0.05; ** *p*-value < 0.01; *** *p*-value < 0.001.

Table 3. Results of Mann–Whitney test (U) performed under the null hypothesis that group formation (gf), cruising speed (sp), dive duration (dd) and interaction among individuals (ai) were not significantly different between activity states. *p*- and U-values were reported. Significant values were reported in bold and asterisks indicate the significance level: * *p*-value < 0.05; ** *p*-value < 0.01; *** *p*-value < 0.001.

	FEEDING vs. SOCIALIZING				SOCIALIZING vs. RESTING			
	gf1	**gf2**	**gf3**	**gf4**	**gf1**	**gf2**	**gf3**	**gf4**
p-value	0.303	0.091	0.101	0.318	0.447	0.774	0.316	NaN
U-value	38.500	35.000	55.500	53.000	60.000	77.500	85.000	72.500
	sp1	sp2	sp3		sp1	sp2	sp3	
p-value	1.000	1.000	1.000		**0.001** **	**0.005** **	**0.040** *	
U-value	45.500	45.000	46.500		20.000	114.000	84.000	
	dd1	dd2	dd3		dd1	dd2	dd3	
p-value	0.162	**0.003** **	0.091		0.702	**0.003** **	0.527	
U-value	37.000	63.000	35.000		79.000	95.500	62.000	
	ai1	ai2	ai3		ai1	ai2	ai3	
p-value	**0.020** *	0.303	**0.003** **		**0.005** **	0.407	**0.003** **	
U-value	31.500	38.500	63.000		114.000	84.000	23.500	
	FEEDING vs. RESTING				SOCIALIZING vs. TRAVELING			
	gf1	**gf2**	**gf3**	**gf4**	**gf1**	**gf2**	**gf3**	**gf4**

p-value	**0.009** **	**0.021** *	**0.000** ***	**0.001** **	0.910	0.828	0.857	0.800
U-value	59.500	66.500	169.500	143.000	136.000	147.500	134.000	137.500
	sp1	sp2	sp3		sp1	sp2	sp3	
p-value	**0.000** ***	**0.006** **	**0.011** *		0.062	0.350	0.900	
U-value	35.000	159.000	131.500		82.500	171.000	143.500	
	dd1	dd2	dd3		dd1	dd2	dd3	
p-value	0.094	**0.000** ***	**0.000** ***		**0.003** **	**0.016** *	0.070	
U-value	77.500	189.000	38.500		47.500	181.500	191.000	
	ai1	ai2	ai3		ai1	ai2	ai3	
p-value	0.111	0.150	**0.005** **		**0.049** *	0.641	**0.028** *	
U-value	84.000	87.500	163.000		202.000	153.500	67.500	
	FEEDING vs. TRAVELING				RESTING vs. TRAVELING			
	gf1	**gf2**	**gf3**	**gf4**	**gf1**	**gf2**	**gf3**	**gf4**
p-value	**0.033** *	**0.013** *	**0.013** *	**0.000** ***	0.133	0.820	**0.041** *	0.517
U-value	126.000	108.500	297.500	273.500	969.000	832.500	705.500	839.000
	sp1	sp2	sp3		sp1	sp2	sp3	
p-value	**0.028** *	0.347	0.505		**0.000** ***	**0.000** ***	**0.023** *	
U-value	122.500	240.500	223.000		1186.000	527.500	736.000	
	dd1	dd2	dd3		dd1	dd2	dd3	
p-value	**0.000** ***	**0.000** ***	0.118		**0.000** ***	0.240	**0.000** ***	
U-value	49.000	377.500	154.000		420.500	816.500	1271.500	
	ai1	ai2	ai3		ai1	ai2	ai3	
p-value	**0.033** *	0.102	**0.012** *		0.079	0.457	0.351	
U-value	126.000	150.500	301.000		720.500	800.500	927.500	

Regarding the variable cruise speed (sp), the entire vector (sp1, sp2, sp3) recorded during resting was significantly different when compared to other activity states (Figure 3, Table 3). In particular, a lower cruise speed (sp1) was recorded mainly during resting than other activities characterized by a higher cruising speed (sp2, sp3).

Concerning the variable dive duration, traveling was characterized by the highest number of observations in which dolphins surfaced quite regularly (dd1) compared to all other activities. Feeding is characterized by a dive duration (dd2) higher than those recorded during other activity states. The median value of observations in which dolphins spent most of their time at the surface, mostly floating (dd3) was significantly higher during resting than those recorded during traveling and feeding activities.

Concerning the interaction among individuals (ai), the number of observations in which dolphins showed active inter-animal contact (ai1) was significantly higher during socializing than those recorded during other activity states and was higher during traveling than feeding activity (Figure 3, Table 3). Consistently, during socializing the median value of observations in which no contact between individuals (ai3) was recorded was significantly lower than those recorded in all other activities. Differently, feeding activity showed the highest median value of observation in ai3 compared to other activities (Figure 3, Table 3).

3.2. Behavioral Events and Occurrences

The most frequent behavioral event observed during sightings was fluking (n = 35) followed by small breaching (n = 25), logging (n = 20), torpedo (n = 17), full breaching (n = 13), tail slap (n = 12), flipper slap (n = 10), spyhopping (n = 6) and tail slap on back (n = 5) (Figure 4). Fluking and small breaching were observed during all activity states, despite the first being observed mainly during feeding while the second was seen mainly during socializing activity together with full breaching and chase events. Events such as tail slap, flipper slap and chase were recorded during all activities except for feeding, while torpedo and logging occurred especially during feeding and resting activities, respectively.

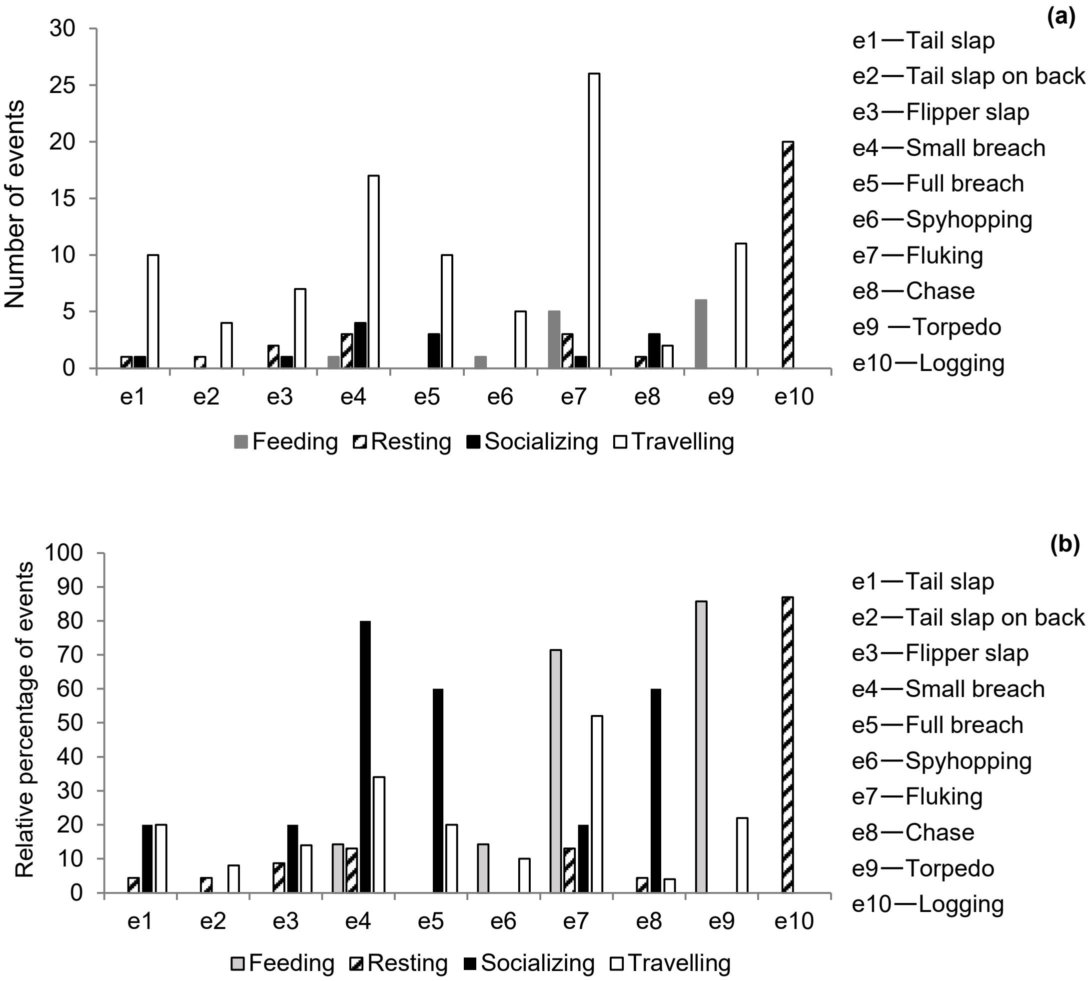

Figure 4. (**a**) Type and number of behavioral events recorded during 98 sightings of Risso's dolphin occurred in the Gulf of Taranto from 2019 to 2021; (**b**) relative percentage of behavioral events for each activity state recorded.

There was remarkable occurrence of the repetitive interaction of adult individuals with plastic debris, mainly bags floating on the sea surface, in which Risso's dolphins were observed carrying plastic debris on their dorsal and pectoral fins and flukes. In some cases, more than one individual was observed interacting with the same debris during a single sighting. This type of event was observed eight times in 2019 and four times in 2021 and in detail, twice during socializing events, three times during resting and seven times during traveling. On three occasions, the plastic bag was collected and it clearly showed signs of bites (Figure 5).

In addition, the sympatric observation of Risso's and the striped dolphin (*Stenella coeruleoalba*) occurred in 14 sightings, of which 6 were in 2019, 4 in 2020 and 4 in 2021. In particular, in two sightings which occurred in 2019 a mixed-species association was observed. In the first sighting, 8 adult Risso's dolphins, engaged in socializing activity with clear mating attempts made by males, were observed at distances of between 50 and 500 m from 50 striped dolphins also engaged in socializing. After that, a smaller group of striped dolphins (8 to 10) moved at a distance of a few meters (from 2 to 20 m) from Risso's dolphins for 5 to 10 min engaged in social events, such as porpoising and small leaps. No change in Risso's dolphin behavior was recorded and no physical interaction between the species was observed at the surface. Similarly in the second sighting, 50 striped dolphins engaged in socializing activity moved in the direction of a group of 20 Risso's dolphins engaged in traveling activity, remaining at a distance of 15–20 m from them for 30 to 40 min. After that, the striped dolphins moved away from the Risso's dolphins. In this case, no physical interaction between the species was observed at the surface. The other sightings in which a co-occurrence of the species was reported differ from each other by the inter-species distance between groups that in 2019 ranged from 50 to 500 m, in 2020 from 10 to 300 m and in 2021 from 30 to 200 m. No physical interaction between the two species was observed at the surface in any of the sightings.

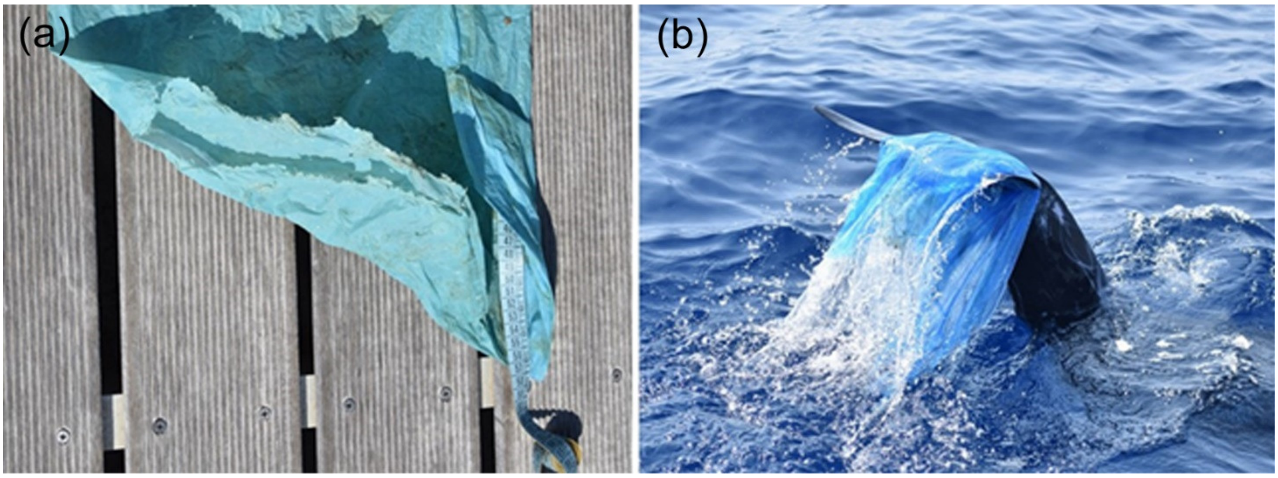

Figure 5. A 58 cm long plastic bag collected during a sighting in July 2019, with clear signs of bites (**a**); a large plastic bag photographed on the flukes of an individual during a sighting in September 2019 (**b**).

4. Discussion

Understanding the spatial-temporal variability in the distribution of key species such as cetaceans is essential to assure their long-term survival, protection and conservation from emerging threats. To do this, it is crucial understand how a species uses its habitat. This study aims to provide baseline information on how Risso's dolphin exploits the Gulf of Taranto, already identified as a suitable habitat for this and other cetacean species [22,65,96–101].

Notwithstanding the small sample size of this study, the results confirm that both the group size and the depth range of sightings of Risso's dolphin observed in the Gulf of Taranto are consistent with observations carried out in other areas of the Central-eastern [43,48,102,103] and the Western Mediterranean Sea [42,43,46,47,104–107], as well as in Atlantic waters off the UK [108] and the Azores Islands [57,58,109,110], and in the Pacific waters of the Southern California Bight [55].

This study confirmed that traveling was the most frequent activity state recorded during daily sightings, as also observed in California [54,55] and the Azores Islands [57,58]. This evidence seems to confirm the hypothesis that the high occurrence of traveling and resting activities during daylight correspond to the transit from a prevalent nocturnal feeding activity [54–56]. In effect, this phenomenon in the Mediterranean Sea seems to be supported by evidence reported in studies carried out in the Ligurian Sea [111] and in deep pelagic waters of the Ionian Sea [112]. However, a wider collection of behavioral data relating to this species, corroborated by acoustic recordings, as well as the need to extend the sampling period during afternoon and evening hours seems to be necessary to fully understand the daily behavioral budget of this species and to verify whether the tendency towards nocturnal feeding is also confirmed in the study area.

Currently, the results indicate that Risso's dolphin does not have a bathymetric preference for carrying out the different activity states in the study area, the opposite of that which has been reported for the striped dolphin in the same area, where the species changes its depth and percentage occurrence of activity states during the day [22]. In any case, any other comment would not be appropriate at this point in time given the short time series of the data collected. Conversely, it is highlighted that the size of the groups engaged in feeding is lower than those involved in resting and traveling. Differences between activity states also arise from the comparison of the group composition variables considered. The results suggest that the feeding activity is characterized mostly by a loose formation of individuals, whereas resting and traveling are mostly characterized by a tight group formation. This result is consistent with those observed for long-finned pilot whales *Globicephala melas* in Norway, which show a surface behavior during feeding in which the group splits into smaller ones with more loosely arranged individual spacing [113,114]. The occurrence of smaller groups during feeding does not exclude that there is co-operation and co-ordination between individuals during this activity state, as suggested for Risso's dolphins studied in the Azores [110,115,116] and for long-finned pilot whales in Norway [114]. The cruising speed recorded during resting activity showed significant differences from those observed in other activities. Resting activity is characterized by a cruise speed of individuals lower than 3 knots, differently from other activities characterized by a more sustained speed (from 3 and 6 knots) that can also exceed 6 knots during feeding. This result is consistent with those observed for common bottlenose dolphin in the Northern Adriatic Sea [27] and for the long-finned pilot whales in waters off Santa Catalina Island, California [54]. In both areas the two species showed slow progress during activities related to resting and higher speed during feeding and traveling activities. Significant differences also emerged from testing different dive durations categories. When Risso's dolphins are engaged in feeding, individuals spend most of their time underwater compared to other activities, showing torpedo events that, according to observations carried out in the Azores, are typical movements displayed during feeding by solitary individuals before going down at a 90° angle [33]. Differently, resting is characterized by individuals that spend most of their time under observation at the surface, mostly floating and showing the typical event of logging as reported for Risso's dolphin observed in the Azores [58]. Lastly, traveling is characterized by individuals that surface quite regularly at 10–15 sec intervals. Differences in dive duration during feeding and other activities has also been observed in the common bottlenose dolphins studied in the Northern Adriatic Sea by Bearzi et al. [27] confirming results obtained in this study. Finally, significant differences in the interaction among individuals during socializing have been highlighted compared to other activities, as expected given its behavioral definition [92]. In fact, socializing is characterized by active inter-animal contact between individuals with the occurrence of events of small, full breaching and chase.

The recording of co-occurrences and mixed-species groups of Risso's and striped dolphin in the Gulf of Taranto is not surprising, although this has never been previously reported, because the occurrence of interspecific associations between two or more species is not rare [117]. However, the sympatric ecology of such dolphin associations has not been studied in detail [117] and neither has the occurrence of mixed-species associations [118,119]. The latter are usually defined as temporary associations between individuals of different species involved in similar activities for periods ranging from several minutes to hours, days or even years, that are formed to avoid predators, to gain foraging and/or some social or reproductive advantage. Risso's dolphin is one of the three most commonly reported cetacean species in mixed-species associations in the literature and, after the common bottlenose and the common dolphin, is the species with the highest diversity of partner species [120]. Currently, in the Mediterranean Sea the only case of sympatric occurrence of the Risso's dolphin with other species has been reported by [121] in the Gulf of Corinth where two Risso's dolphins form a mixed-species group with striped and short-backed common dolphins (*Delphinus delphis*). Often the two Risso's dolphins were observed actively chasing and herding short-backed common dolphins. Other associations of the Risso's dolphin with other odontocetes have also been observed in other areas such as the Southern California Bight [122] and Azores [118]. In the Gulf of Taranto, this type of occurrence could be explained by the sharing of feeding grounds where these odontocetes find their preferred prey such as bathyal benthopelagic squids [78]. This hypothesis is supported by the high trophic niche overlap between Risso's and striped dolphins, as estimated by trophic web modeling implemented in the area and focused on the assessment of odontocetes trophic roles [78]. Several species of squid are consumed by both dolphin species, increasing their potential encounters, even if the diet of striped dolphin is more diversified compared to that of Risso's dolphin, because it also exploits great abundances of mesopelagic, demersal fishes and occasionally benthopelagic shrimp [40,41,123]. Although in this area the mixed-species association could be driven by trophic reasons, other reasons such as social benefits, as suggested by [121], could influence these processes. Thus, further investigation is required.

Another noteworthy event recorded repeatedly in the study area is the occurrence of interactions of adult individuals of Risso's dolphin with plastic bags floating on the sea surface. Despite no direct ingestion of plastic bags having been observed, the clear signs of bites on the items suggest their possible ingestion as already reported for this [47,124] and other species [125]. Data on the ingestion of marine litter by cetaceans shows an increase in the number of cases reported over the last five decades. In addition, plastic items represent the main fraction of litter composition [126]. This study supports the evidence that plastic debris is one of the main threats affecting cetacean species [127] as well as the biodiversity of the entire Mediterranean basin in general [128,129]. Although the reason for the interaction between Risso's dolphins and other cetacean species and plastic debris remains unclear, it may be related to the investigation of inappropriate prey items due to debilitation or starvation [47,130] or as play, as observed for free-ranging rough-toothed dolphin (*Steno bredanensis*) and estuarine dolphin (*Sotalia fluviatilis*), as well as for common bottlenose dolphin in captivity [131]. Although the magnitude of the effect of this problem on dolphin and whale species is not yet known, the implementation of concrete action to mitigate impacts of harmful anthropogenic threats (i.e., plastic debris release at sea) is urgent.

More studies on the behavioral pattern of cetaceans aiming to understand how they exploit habitats and interact with resources at their disposal, as well as with xenobiotics, are needed to identify any impacts or threats to the health of individuals and/or of populations, and consequently allow the implementation of mitigating actions and conservation programs of target species and their suitable habitats [132].

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