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AN INSIGHT INTO THE DIET OF THE BULL RAY, *AETOMYLAEUS BOVINUS* (GEOFFROY SAINT-HILAIRE, 1817) IN THE NORTHERN ADRIATIC SEA

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ABSTRACT

This study provides baseline information on the feeding habits of the bull ray, Aetomylaeus bovinus (Geoffroy Saint-Hilaire, 1817), in the Gulf of Venezia. Among 1557 prey items isolated from the stomachs of bull ray specimens, gastropods represented the overwhelming majority (93.8%). Within gastropods, Aporrhais pespelecani *was the dominant species, followed by* Gibbula magus *and* Bolinus brandaris *– all characteristic elements of the biocoenosis of the muddy detritic bottom. We observed differences in prey structure between juveniles and adults, as well as sexes. Among fishes that proved to be particularly important in terms of biomass, the majority of prey items consisted of small pelagic fish, including pilchard (Sardina pilchardus) and horse mackerel (Trachurus sp.). This paper contributes new data on the feeding ecology of a lesser known and critically endangered batoid species.*

Key words: myliobatids, feeding ecology, nursery, Gulf of Venice

APPROFONDIMENTI SULLE ABITUDINI ALIMENTARI DELLA VACCARELLA, *AETOMYLAEUS BOVINUS* (GEOFFROY SAINT-HILAIRE, 1817) NELL'ADRIATICO SETTENTRIONALE

SINTESI

Lo studio riporta le abitudini alimentari della vaccarella, Aetomylaeus bovinus *(Geoffroy Saint-Hilaire, 1817), nel Golfo di Venezia. Tra le 1557 prede isolate dagli stomaci, i gasteropodi costituivano la grande maggioranza (93,8%), dominati dalla specie* Aporrhais pespelecani*, seguita da* Gibbula magus *e* Bolinus brandaris*. Queste specie sono elementi caratteristici della biocenosi del fondo detritico fangoso. Sono state osservate differenze nella struttura delle prede tra giovani e adulti e tra i sessi. Tra i pesci che sembravano essere particolarmente importanti in termini di biomassa, i piccoli pesci pelagici come la sardina (*Sardina pilchardus*) e il sugarello (*Trachurus *sp.) rappresentavano le prede più grandi. Questo lavoro contribuisce a fornire nuove informazioni sull'ecologia alimentare di una specie di razza meno conosciuta e in pericolo critico.*

Parole chiave: vaccarella, ecologia alimentare, nursery, Golfo di Venezia

INTRODUCTION

The bull ray, *Aetomylaeus bovinus* (Geoffroy Saint-Hilaire, 1817), is a benthopelagic species inhabiting coastal and warm temperate waters, occasionally found offshore, at depths of 10–150 m (Capapé & Quignard, 1975). Bull rays can tolerate greatly reduced salinities (Ebert & Stehmann, 2013) and therefore occasionally enter shallow lagoons (El Kamel *et al.*, 2009) and semi-enclosed bays (Zogaris & Dussling, 2010; Bilgili & Kabasakal, 2023). As a longevous species with late maturity and low reproductive rates – signature traits of a K-selected life history strategy (Stevens *et al.*, 2000) – the bull ray is vulnerable to overfishing, especially in nearshore habitats, where it forms small aggregations to feed (Seck *et al.*, 2002; El Kamel *et al.*, 2010, Zogaris & Dussling, 2010; Akyol *et al.*, 2017). The bull ray is poorly studied in terms of feeding ecology. The only comprehensive study on the feeding habits of *A. bovinus* was conducted by Capapé (1977) in Tunisian waters, based on analyses of 568 specimens at different stages of development.

Bull rays are observed in the northern Adriatic Sea between late spring and early autumn, while in winter they migrate towards southern areas (La Mesa *et al.*, 2017). Due to its longevity, *A. bovinus* was previously considered an indicator species for pollution with heavy metals such as Hg and MeHg (Horvat *et al.*, 2013), arsenic (Šlejkovec *et al.*, 2014), and selenium (Faganeli *et al.*, 2018). Though not commercially targeted, the species is often caught as by-catch and discarded. It is currently considered a critically endangered ray species on the global scale, whose populations suffered substantial depletion in the last years due to overfishing (Jabado *et al.* 2021). Recently, this status was also confirmed by Soldo & Lipej (2022), who evaluated the species as rare in the Adriatic Sea.

The aim of this study is to investigate the feeding habits of the bull ray in the northern Adriatic Sea (the Gulf of Trieste and neighbouring areas along the western Istrian coast). The feeding ecology of this species is significantly understudied, making any data in this regard vital. Such research is also necessary and useful in elucidating the impact of such predation on the structure of epibenthic macrofaunal assemblages.

MATERIAL AND METHODS

The stomachs of bull rays were collected between 2005 and 2015 from rays caught as by-catch by commercial trawlers. Fishing was conducted at depths of 10 – 50 m in the Gulf of Trieste and along the western Istrian coast (Fig. 1). The sample was comprised of neonates, adult males, and adult females, including several pregnant specimens. After being defrosted in the lab, each individual was sexed. The specimens were measured (disk width – DW) and weighed. Each stomach was weighed full and emptied. Stomach contents were washed on the sieve and conserved in 95% ethanol. Prey items were analysed using an Olympus SZX16 stereomicroscope and photographed using an Olympus camera DP 74.

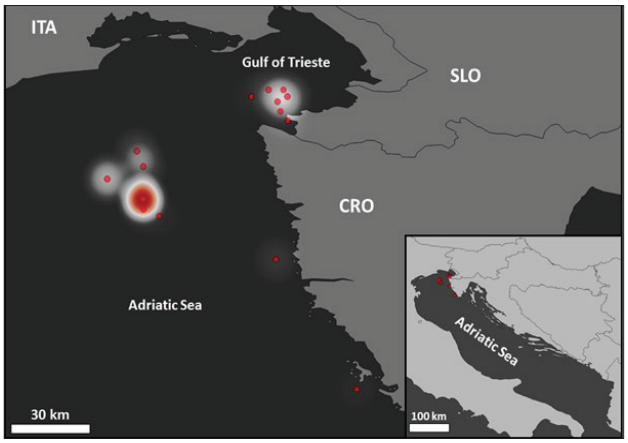

Fig. 1: Map of the studied area and its position in the Adriatic Sea. Areas where bull rays were caught are depicted as red dots. Catch density is additionally presented as a heat map.
Sl. 1: Zemljevid obravnavanega območja in njegov položaj glede na Jadransko morje. Predeli, kjer so ujeli kljunate morske golobe, so označeni z rdečimi krogci. Gostota ulova je prikazana kot kolobarji.

Prey items were identified to the lowest taxonomic level (species level where possible), using taxonomic keys and field guides (Riedel, 1991; Falciai & Minervini, 1992), and subsequently counted. A reference collection of gastropod opercula preserved at the Marine Biology Station proved extremely valuable for determination, providing additional diagnostic support. The counting of prey items was based on typical anatomical parts: claws and legs for crustaceans, carapaces for decapods, shells and feet for bivalves, opercula for gastropods (Fig. 2), and partial remains (including otoliths) for teleost species.

Data analysis

Opercula from isolated benthic gastropods were precisely measured (max length and width) and photographed under the microscope. To assess the approximate weight of each gastropod, a correlation length-weight curve obtained from the data of live collected specimens (pulled from the shells) was used. Length-weight correlation curves were calculated for the gastropod species that dominated the bull ray's diet: *Aporrhais pespelecani* (Linnaeus, 1758), *Bolinus*

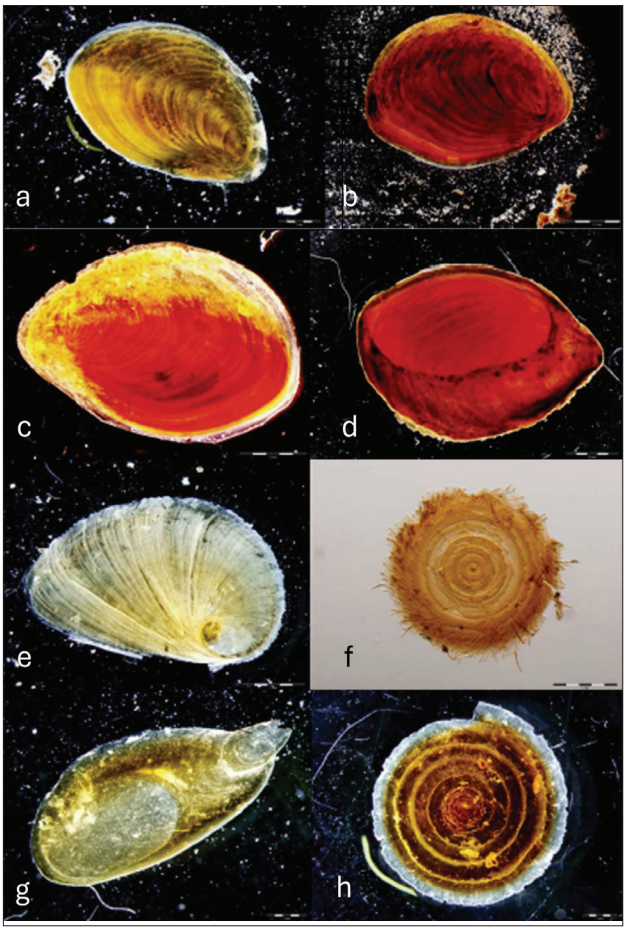

Fig. 2: Opercula of various gastropods present in the diet of the bull ray. Legend: a and b – *Bolinus brandaris*, ***c and d –*** *Hexaplex trunculus*, ***e –*** *Cerithium vulgatum*, ***f –*** *Turritella communis*, ***g –*** *Aporrhais pespelecani*, ***and h –*** *Gibbula magus*. ***Scale bar = 1 mm.***
Sl. 2: Poklopci (operkuli) različnih polžev, ki se pojavljajo v prehrani kljunatega morskega goloba. Legenda: a in b – *Bolinus brandaris*, ***c in d –*** *Hexaplex trunculus*, ***e –*** *Cerithium vulgatum*, ***f –*** *Turritella communis*, ***g –*** *Aporrhais pespelecani* ***in h –*** *Gibbula magus*. ***Merilo = 1 mm.***

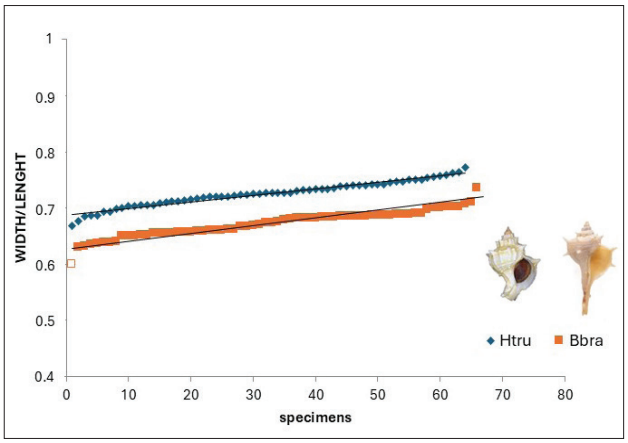

Fig. 3: Relationship between width and length of opercula of two similar species *Hexaplex trunculus* ***(blue diamonds) and*** *Bolinus brandaris* ***(orange squares), obtained from specimens as by-catch from the fishermen. This relationship was useful to discriminate the opercula of the two muricid species found in the stomachs of the bull rays.***
Sl. 3: Odnos med dolžino in širino poklopcev pri dveh sorodnih vrstah volekov *Hexaplex trunculus* ***(modri karo) in*** *Bolinus brandaris* ***(oranžni kvadratki), na podlagi živih primerkov, ulovljenih kot prilov ribičev. Ta odnos je bil uporaben za razlikovanje poklopcev obeh volekov, najdenih v prehrani kljunatega morskega goloba.***

brandaris (Linnaeus, 1758), *Gibbula magus* (Linnaeus, 1758), and *Hexaplex trunculus* (Linnaeus, 1758).

The opercula of *B. brandaris* and *H. trunculus* exhibit numerous morphological similarities, making them challenging to distinguish. To ensure accurate identification, every operculum assignable to either species was carefully examined under the microscope and compared against reference specimens collected from the natural environment (those used for the correlation length-weight curves). The majority of muricid opercula were conclusively identified as *B. brandaris*. In addition to opercular shape, the width-to-length ratio proved valuable for species discrimination in ambiguous cases (Fig. 3), as *B. brandaris* and *H. trunculus* have different opercular proportions. For the few specimens that could not be confidently identified, we recorded them as generic *Murex* sp.

The feeding habits of the bull ray were described using relative frequency of occurrence (PF = number of stomachs containing prey *i*/total number of full stomachs × 100), relative numerical abundance (PN = number of prey *i*/total number of prey × 100), and relative gravimetric composition (PB = weight of prey *i*/total weight of all prey x 100). To minimise potential errors inherent in individual parameters, all measures were integrated into a single composite Index of Relative Importance (IRI%) calculated as:

[$IRI = PF \times (PN + PB)$] (Pinkas *et al.*, 1971),

which reduces potential misinterpretations from relying on any single given value. Prey biomass was obtained either from species-specific correlation diagrams (length-weight relationships) or literature estimates (Ravara, 2012). According to Capapé & Quignard (1974), we defined sexual maturity at 800 mm disk width (DW) for males and 900–1000 mm for females, classifying individuals below these thresholds (DW< 800 mm in males and DW< 900 mm in females) as juveniles. Dietary diversity was assessed using the Shannon-Wiener diversity index:

$$H' = - (\Sigma\ pi * ln\ pi)$$

Diversity was also assessed separately according to sex and size classes. To evaluate the diet overlap between juveniles and adults and between males and females, we used the Morisita-Horn index (Krebs, 1989):

$$C_H = 2*(\sum p_{ij}\ p_{ik}) / (\sum p^2_{ij} + \sum p^2_{ik})$$

where C_H is the simplified Morisita-Horn index representing the overlap between predators *j* and *k*; P_{ij} is the proportion of prey *i* in the total prey consumed by predator *j*; P_{ik} is the proportion of prey *i* in the total prey consumed by predator *k*; and *n* is the total number of prey categories. The index ranges from 0 (no dietary overlap) to 1 (complete dietary overlap), with values over 0.6 indicating significant resource sharing.

To assess the trophic level of the bull ray, a TROPH index was calculated using TrophLab software (Pauly *et al.*, 2000), available through FishBase (www. fishbase.org):

$$TROPHi = 1 + \Sigma^{G}_{j=1} DCij \times TROPHj$$

TROPHj represents the fractional trophic level of prey *j*, and *DCij* denotes the proportion of *j* in the diet of consumer species *i*.

RESULTS

Biometry

A total of 42 bull ray specimens were measured and weighed, of which 19 were identified as males and 22 as females, while in one juvenile specimen the sex could not be determined. Maximum recorded disc width (DW) was 222 cm for females and 115 cm for males, with minimum DWs of 27 cm and 37 cm, respectively. The correlation between size and weight was statistically significant ($y=0.0233x^2 + 10.49x-11590$; $r^2=0.92$). Females were larger and heavier than males (Figure 4), with individual weights exceeding 100 kilograms.

Overall diet

The feeding habits of a total of 41 bull ray specimens were analysed. In one specimen, stomach content analysis was not possible, and 10 stomachs (24.4%) were found to be empty. Of the 1557 prey items isolated from the stomachs, gastropods represented the overwhelming majority (93.8%). Analysis of the opercula against the comparative collection confirmed *Bolinus brandaris* as the highly predominant muricid species. The most preyed upon gastropod was *Aporrhais pespelecani* (PN%=50.61%), present in 75% of all stomachs, followed by *B. brandaris* (PN%=19.33%; PF%=60.71), and *Gibbula magus* (PN%=18.37; PF%=53.57). Other gastropods, including *Hexaplex trunculus, Turritella communis*, and *Cerithium vulgatum*, were negligible in terms of relative abundance and only occurred in a single stomach. In adult bull rays, fish represented a substantial portion of prey biomass (45.30%), second only to gastropods (52.86%), while in juveniles, gastropods prevailed (PB=86.08%).

Among other taxonomic groups, teleosts accounted for 2.70%, hermit crabs 1.99%, and polychaetes 1.16%. Sipunculids and bivalves were negligible in terms of relative abundance (0.19% and 0.13%, respectively). Fish prey mostly consisted of small pelagic species, including pilchard (*Sardina pilchardus*) and horse mackerel (*Trachurus* sp.), and even a few specimens of anchovy (*Engraulis encrasicolus*) and gilt sardine (*Sardinella aurita*). The bull ray's TROPH value was calculated as 3.40±0.58.

Diet differences between sexes

Both sexes specialise in gastropod predation, with males predominantly catching *Aporrhais pespelecani* (PN – 70.5% *vs.* 36.1%; IRI% – 29.4 *vs.* 3.7%) and females favouring muricids such as *Bolinus brandaris* (PN – 31.9% *vs.* 11%; IRI% – 28.9% *vs.* 4.3%). Notably, fish – a secondary food category – were only preyed on by females (Figs. 5 and 6). Females exhibited greater dietary diversity than males (The Shannon-Wiener diversity index *H';* 1.73 vs 1.02). However, the Morisita-Horn index showed substantial dietary overlap between sexes (0.79) which indicates shared prey resources. The calculated TROPH values for males were 3.37±0.58 and 3.43±0.58 for females.

Diet differences between juveniles and adults

Both juveniles and adults primarily consume gastropods, the dominant prey category in their diets. Juveniles mainly feed on *Gibbula magus* (PN – 34.5% *vs.* 5.5%; IRI% – 77.9 *vs.* 32.2%), while adults show preference for *Bolinus brandaris* (PN – 33.4% *vs.* 1.6%; IRI% – 33.4% *vs.* 0.4%). Juveniles prey more heavily upon anomurans (especially *Paguristes eremita*) than adults (Fig. 7), which is evident when we compare the frequency of occurrence. Adults consumed more fish – which are more important in terms of biomass – suggesting an ontogenetic dietary shift (Fig. 7). The pattern mirrors intersexual differences, likely influenced by the fact that females represent the majority of the adult population. In the sample examined, adults had a more diversified diet than juveniles (*H';* 1.44 *vs.*

Tab. 1: Diet composition of bull rays in the study area: N – number of prey items of different species, PN – relative abundance (%), PB – relative biomass (%), PF – frequency of occurrence and IRI% – index of relative importance (%). Specimens which we were not able to identify as* Hexaplex *or* Bolinus *are grouped under* Murex *sp. and marked with an asterisk.
Tab. 1: Prehrana kljunatega morskega goloba na obravnavanem območju: N – število različnih vrst plena, PN – relativna abundanca (%), PB – relativna biomasa (%), PF – frekvenca pojavljanja in IRI% – indeks relativne pomembnosti plena (%). Primerki, ki jih nismo uspeli določiti kot čokate ali bodičaste voleke, smo združili v kategorijo* Murex *sp. in jih označili z zvezdico.

taxa		N	PN%	PB%	PF%	IRI%
Mollusca	*Aporrhais pespelecani*	788	50.61	20.03	75.00	53.24
	Gibbula magus	286	18.37	10.91	53.57	15.76
	Hexaplex trunculus	13	0.83	4.86	10.71	0.61
	Bolinus brandaris	301	19.33	6.68	60.71	15.87
	»Murex« sp.*	55	3.53	17.62	39.29	8.35
	Muricidae	1	0.06	0.32	3.57	0.01
	Turitella communis	1	0.06	0.02	3.57	<0.01
	Cerithium vulgatum	1	0.06	0.06	3.57	<0.01
	Cerithidae/Naticidae	15	0.96	0.97	14.29	0.28
	Bivalvia	2	0.13	0.07	3.57	0.01
Crustacea	Anomura	3	0.19	0.32	10.71	0.05
	Paguristes eremita	19	1.22	3.09	17.86	0.77
	Pagurus anachoretus	1	0.06	0.11	3.57	0.01
	Paguridea	8	0.51	0.73	14.29	0.18
Annellida	Polychaeta	18	1.16	0.07	14.29	0.18
	Sipunculida	3	0.19	0.05	7.14	0.02
Pisces	*Engraulis encrasicolus*	2	0.13	0.95	7.14	0.08
	Sardina pilchardus	24	1.54	23.90	14.29	3.65
	Sardinella aurita	1	0.06	0.21	3.57	0.01
	Trachurus sp.	14	0.90	4.34	14.29	0.75
	Solea sp.	1	0.06	4.69	3.57	0.17

1.08). The Morisita-Horn index analysis revealed no significant difference between the diets of juveniles and adults, since the overlap in the diet was 0.74. The calculated TROPH values for juveniles were 3.38±0.58, and 3.42±0.41 for adult specimens.

DISCUSSION

The feeding habits of the bull ray were assessed on a rather small sample (41), consisting entirely of bycatch specimens occasionally entangled in fishing nets. However, some studies suggest that as few as 15–30 non-empty stomachs may be enough to adequately describe prey diversity in certain shark species (Alonso *et al.,* 2002; Lucifora *et al.,* 2006). Our analysis included 41 stomachs, of which 10 were empty. The empty stomachs belonged to the smallest specimens – DW 27 cm (female) and DW 37 cm (male) – with DWs below the reported size of specimens at birth (Seck *et al.,* 2002). We can therefore presume that pregnant bull rays aborted their pups during fishing interaction, as cases of parturition induced by

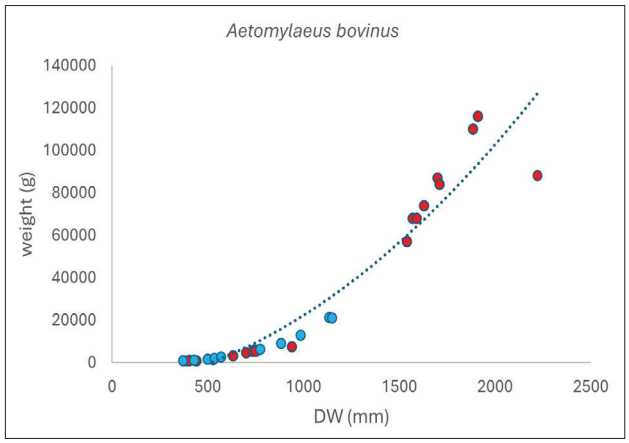

Fig. 4: Size-weight relationships in the bull rays from the studied area. Legend: DW – disk width (mm), red circles – females, blue circles – males.
Sl. 4: Dolžinskomasni odnos kljunatih morskih golobov na obravnavanem območju. Legenda: DW – premer diska (mm), rdeči krogci – samice, modri krogci – samci.

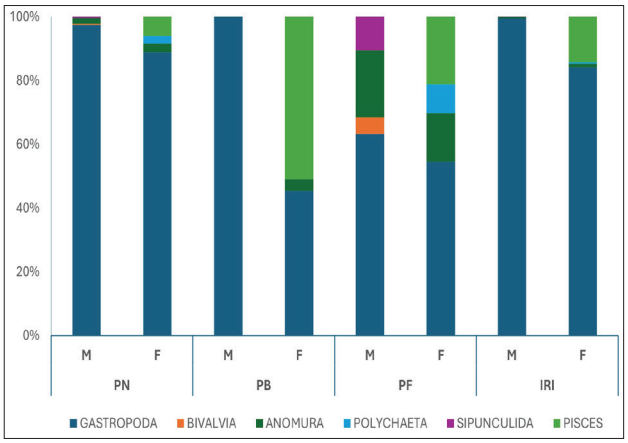

Fig. 5: Comparison of diet compositions in male (M) and female (F) bull rays from the studied area: PN – relative abundance (%), PB – relative biomass (%), PF – frequency of occurrence, and IRI% – index of relative importance (%).
Sl. 5: Primerjava prehrane samcev (M) in samic (F) kljunatega morskega goloba na obravnavanem območju: PN – relativna abundanca (%), PB – relativna biomasa (%), PF – frekvenca pojavljanja in IRI% – indeks relativne pomembnosti plena (%).

capture are well-documented (Adams *et al.*, 2018; de Sousa Rangel *et al.*, 2020).

The number of stomachs analysed in our study seems to be adequate to provide relevant insight into the feeding habits of the bull ray. Our results show that with 31 full stomachs, 90% of the asymptotic species richness was reached (*see* Fig. 8). Our results are generally consistent with one of the few available studies on the species' diet published by Capapé (1977), who found the bull ray preying mainly on four food categories: bivalves, cephalopods, gastropods, and fish. In his study, which was based on a substantially larger sample of stomachs, additional, even peculiar animal taxa were identified among the prey items of the bull ray, such as polychaetes, sipunculids, and echinoderms.

Mollusc specialisation

The bull ray consumes gastropods and bivalves by crushing their shells with strong dental plates and can therefore be defined as a batoid specialised in durophagous feeding (Wilga & Motta, 2000). The dominant gastropod species preyed upon by bull rays – *Aporrhais pespelecani, Gibbula magus*, and *Bolinus brandaris* – are characteristic and abundant in the biocoenosis of the muddy detritic bottom, where their shells also represent an essential substrate for the settlement of multi-species biogenic clumps (Stachowitsch & Fuchs, 1995). This biocoenosis geographically corresponds to the area where fishing vessels operated when catching bull rays, so we can assume that the diet of the bull ray reflects the availability of shelled prey species in the environment. *Aporrhais pespelecani,* the most frequently consumed and most abundant prey species, is known for its burrowing behaviour (Yonge, 1937). In a recent study carried out in the Sea of Marmara (Türkiye), hard-shelled molluscs were also identified as the main food items of another, closely related batoidean, *Myliobatis aquila* (Gül & Demirel, 2020). Adult bull rays preyed on more muricids (*Hexaplex trunculus, Bolinus brandaris, Murex* sp.) than juveniles, both in term of relative abundance (PN%=40.8 *vs.* 2.3) and biomass (PB%=37.0 *vs.* 6.3). This may be explained by the fact that adults, having larger and stronger jaws, are better equipped to feed on muricids, which are characterised by their thick shells. Juvenile bull rays showed a preference for other species, such as *A. pespelecani* and *G. magus* (PN%=56.81 *vs.* 34.49, respectively), which were also the overall most frequently consumed prey (PF%=92.86 *vs.* 57.14).

The occurrence of anomurans in the diet of the bull ray is likely related to the frequent use of empty muricid shells as shelters by certain hermit crabs. *Paguristes eremita*, the dominant anomuran found in the diet of the bull rays from the present study, is the largest and most robust anomuran species in the area and is known to inhabit heavier gastropod shells with a wider aperture (family Muricidae) (Manjon-Cabeza & García Raso, 1999). In our study, anomurans were predominantly found in the diet of juveniles; however, it is difficult to assess whether the consumption of *P. eremita* and other anomurans was intentional or incidental. Other related species, such as the bullnose ray (*Myliobatis freminvillei*), have also been reported to occasionally feed on anomurans (Szczepansky & Bengtson, 2014). No data are currently available to

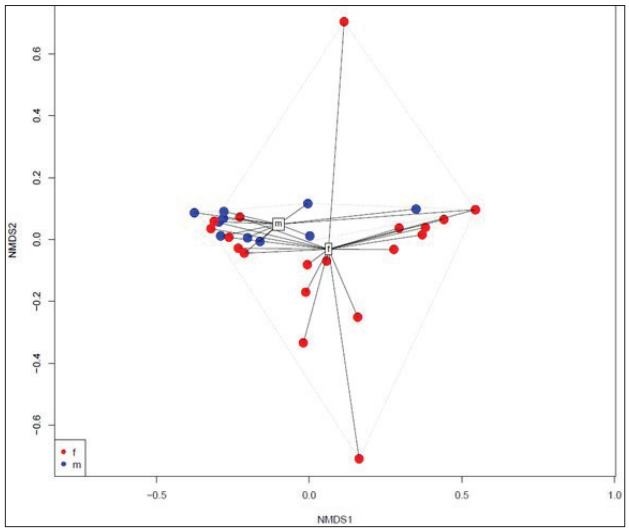

Fig. 6: Differences/similarities in prey composition and abundance with respect to factor sex (blue circles =males, red circles=females) in the NMDS space.
Sl. 6: Razlike/podobnosti v vrstni sestavi in številčnosti plena glede na spol (modri krogci=samci, rdeči krogci=samice).

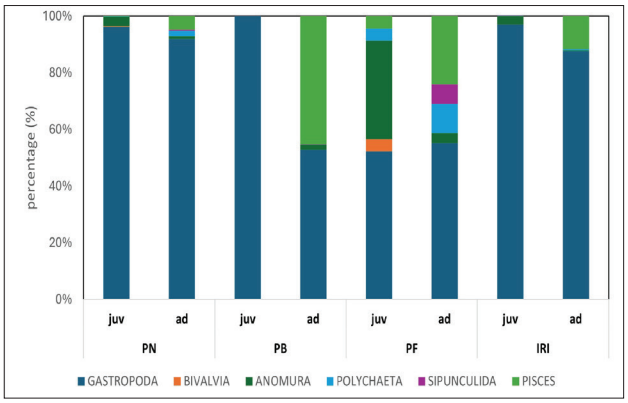

Fig. 7: Comparison of diet composition between juveniles (juv.) and adult specimens (ad.) of bull rays in the study area: PN – relative abundance (%), PB – relative biomass (%), PF – frequency of occurrence and IRI% – index of relative importance (%).
Sl. 7: Primerjava prehrane mladičev (juv.) in odraslih primerkov (ad.) kljunatega morskega goloba na obravnavanem območju: PN – relativna abundanca (%), PB – relativna biomasa (%), PF – frekvenca pojavljanja in IRI% – indeks relativne pomembnosti plena (%).

determine whether some myliobatids can discriminate between shells occupied by anomurans and those containing gastropods.

The TROPH values for bull rays (3.37-3.43) were higher than those for a related durophagous species, the common eagle ray (*Myliobatis aquila*) (Lipej *et al.*, *in press*) – calculated at 3.20±0.44 to 3.25±0.39 – but lower than the values reported for the blackspotted smoothound *Mustelus punctulatus* (3.70 ±0.6) (Lipej *et al.*, 2012).

The feeding habits of the bull ray are, to some extent, similar to those of its relative, the common eagle ray *Myliobatis aquila*, which is also specialised in hunting molluscs, which represent 75% of its diet (Lipej *et al.*, *in press*). However, while the eagle ray is mainly targeting bivalves, our findings show that the bull ray feeds mainly on gastropods. Among gastropods, eagle rays primarily consume species such as *Cerithium vulgatum* and *Turritella communis* (collectively ~20% of relative abundance), which were rarely preyed on by bull rays (each less than 0.1% of PN%). This dietary divergence between two related species inhabiting the same environment may reduce their competition.

Fish in the diet

Although fish represented only a small amount in terms of relative abundance, this food category is important in terms of biomass. Our results demonstrate an ontogenetic shift in the diet from gastropods to fish (*sensu* Koen Alonso *et al.*, 2002; Ellis & Musick, 2007).

The species found in the diet of the bull ray are the dominant small pelagic taxa commonly caught in the study area. The only exception is the sole (*Solea sp.*), which is a benthic species. This aligns with findings reported by Capapé (1977) from Tunisian waters, where small pelagic species frequently occurred in the diet of bull rays. Due to size and gape limitations, bull rays and their relatives may only prey on fishes smaller than 50 cm in total length (Wetherbee *et al.*, 2012), meaning small species or larger species at early

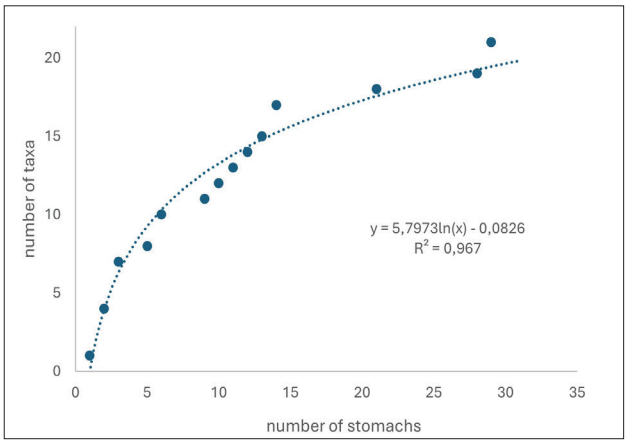

Fig. 8: The cumulative number of prey types identified with increasing sample size (number of stomachs).
Sl. 8: Kumulativno število določenih primerkov plena glede na naraščajoč vzorec (število želodcev).

life stages. The presence of pelagic species in the diet of predominantly benthic-feeding bull rays may be related to the availability of these species as dead discards abandoned on the sea floor or bull rays feeding on specimens with which they were entangled in the fishing nets during trawling operations. Fish cages are also an important source of food that attracts elasmobranchs (Barash *et al.,* 2018; Akyol *et al.*, 2022; Kurtay *et al.*, 2023). Akyol *et al*. (2022) reported bull rays feeding on dead fish around a sea-cage fish farm in Iskenderun Bay (Türkiye), noting that the rays showed no interest in the pellets used to feed cultured fish. In the study area, discards of small pelagic fish from pelagic trawlers occurred regularly and may represent a significant food source for bull rays.

The importance of the Gulf of Trieste and adjacent areas as bull ray habitat

While the bull ray was once considered a relatively rare batoid species in the Adriatic Sea (Jardas, 1985), subsequent studies based on the capture of numerous specimens confirmed its presence in the Gulf of Trieste (Dulčić *et al.*, 2008; Lipej *et al.,* 2009) and throughout the broader northern Adriatic region (La Mesa *et al.*, 2017). Dulčić *et al*. (2008) confirmed regular bull ray occurrence in the area, though like other elasmobranch species of low or no commercial value, specimens are typically discarded at sea (Mavrič *et al.*, 2004). The presence of several gravid females with developed embryos and numerous juvenile specimens indicates the area's importance for the reproduction of the species. Further investigation is needed to evaluate its potential nursery function, as speculated by some authors (Dulčić *et al.*, 2008; Lipej *et al.*, 2009). This speculation gains support from Capapé & Quignard's (1975) findings that the species reproduces from March till October, with gestation lasting six months. Notably, the study area hosted some record-sized individuals (1540–2220 mm DW, 68–116 kg), the largest ever documented (Dulčić *et al*. 2008; Lipej *et al.,* 2009).

Over the recent years, increasing myliobatid sightings have been reported through social media, including observations of bull rays in shallow waters. The Gulf of Trieste – a rather shallow basin with many riverine inflows enhancing its productivity – appears to attract bull rays to brackish areas such as lagoons, river mouths, and estuaries. This behaviour aligns with reports by Zogaris & Dussling (2010) of two occurrences of bull rays in the Amvrakikos Gulf (Greece) in August 2000 (two dead specimens found, probably discarded by fishermen) and August 2004 (12 live specimens sighted). This giant shallow lagoon-like gulf supports a rich and abundant mollusc community that evidently attracts bull rays. Similarly, El Kamel *et al.* (2009, 2010) reported the captures of juvenile and adult *A. bovinus* in the Tunisian Lagoon of Bizerte, associating them with the local presence of abundant mollusc populations (Zaouali, 1979) – a known prey preference for the bull ray. Higher occurrences of bull rays have also been observed off the estuaries of three main river systems in northern Italy (the Po, Adige, and Brenta Rivers) (La Mesa *et al.*, 2017) – areas productive due to riverine nutrient input and characterised by a high abundance of molluscs, crustaceans, and small pelagics (e.g., anchovies), which constitute major components of the bull ray's diet. Recently, sightings of bull rays have also been reported by local media in the marine protected area of Miramare (Ciriaco, 2020; Anonymous, 2023) and at Punta Madona in Piran (2023–2025), where divers observed individual bull rays as well as "cemeteries" of broken mollusc shells close to the shore (*pers. observations*).

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VPOGLED V PREHRANJEVALNE NAVADE KLJUNATEGA MORSKEGA GOLOBA, *AETOMYLAEUS BOVINUS* (GEOFFROY SAINT-HILAIRE, 1817) V SEVERNEM JADRANU

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POVZETEK

Raziskava poroča o osnovnih podatkih o prehranjevalnih navadah kljunatega morskega goloba Aetomylaeus bovinus *(Geoffroy Saint-Hilaire, 1817) v Beneškem zalivu. Med 1557 primerki plena, izoliranimi iz želodcev, so veliko večino predstavljali polži (93,8 %). Med njimi je prevladovala vrsta* Aporrhais pespelecani*, sledili sta ji* Gibbula magus *in* Bolinus brandaris. *Te vrste so značilni elementi biocenoze muljastega detritnega dna. Opazili smo razlike v strukturi plena med mladimi in odraslimi primerki ter med spoloma. Med ribami, ki so se izkazale za pomembne predvsem z vidika biomase, so največ plena predstavljale male pelagične ribe, kot sta sardela (*Sardina pilchardus*) in šur (*Trachurus *sp.). Članek prispeva nove podatke o prehranjevalni ekologiji manj znane in kritično ogrožene vrste skatov.*

Ključne besede: morski golobi, prehranjevalna ekologija, jaslice, Beneški zaliv

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