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DISTRIBUTION OF *CORBULA GIBBA* (BIVALVIA, CORBULIDAE) IN THE NORTHERN ADRIATIC SEA

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ABSTRACT

Corbula gibba *is widespread on soft bottom of the northern Adriatic Sea. It is considered a species with a wide ecological distribution, particularly abundant in zones characterized by environmental instability. Its distribution along the western side of the northern Adriatic Sea is discussed, furthermore data about its shell length, biomass and dominance in this area are analyzed.*

Key words: *Corbula gibba*, distribution, northern Adriatic Sea

DISTRIBUZIONE DI *CORBULA GIBBA* (BIVALVIA, CORBULIDAE) NEL NORD ADRIATICO

SINTESI

Corbula gibba *è un bivalve assai diffuso sui fondi molli del Nord Adriatico. E' una specie ad ampia ripartizione ecologica, particolarmente abbondante in zone caratterizzate da instabilità ambientale. Può resistere, infatti, a condizioni di ipossia delle acque di fondo e si comporta da specie pioniera nella ricolonizzazione dei fondali a seguito di crisi anossiche, inoltre risulta dominante in condizioni di arricchimento organico.*

Nel presente studio C. gibba *è risultata presente in sedimenti pelitici e pelitico sabbiosi, abbondante in prossimità dei più importanti fiumi nord adriatici (Tagliamento, Piave e Adige) ed in particolare lungo la fascia costiera a sud del fiume Po, zona caratterizzata da una forte sedimentazione di materiali fini e interessata da periodici fenomeni di ipossia e anossia. E' stato evidenziato un decremento della densità di* C. gibba *dalla costa verso il largo, legato alle caratteristiche del sedimento, alla profondità ed alle condizioni di stress ambientale. La dominanza di* C. gibba *in aree soggette ad instabilità ambientale conferma il comportamento di specie pioniera di questo bivalve, al contrario in zone non soggette a forti stress ambientali essa tende a seguire l'andamento dell'intera comunità.*

Parole chiave: *Corbula gibba*, distribuzione, Nord Adriatico

INTRODUCTION

Corbula gibba Olivi (1792) is a bivalve mollusc belonging to the Corbulidae family; it is distributed into the Atlantic area, from Northern Europe to Angola and in the Mediterranean Sea, Adriatic Sea included (Tebble, 1966).

C. gibba lives from the intertidal zone to considerable depth (Parenzan, 1976) and prefers muddy sand bottom with larger pieces of gravel and pebbles utilized for byssal-thread attachment, in order to maintain its siphons flush with the surface (Yonge, 1946).

Yonge (1946) also supposes that the asymmetry of the shell valves permits an efficient elimination of pseudo-faeces, so the obstruction originated by fine sediment is prevented and an efficient valves lock is assured.

The growth of the juveniles is very rapid (Jensen, 1988, 1990) and the specimens are retained by a 1 mm sieve in a few weeks after settlement. The length at metamorphosis is 0.25-0.33 mm (Muus, 1973) and the adults can exceed 13 mm in length (Hrs-Brenko, 1981).

It is considered to be a species with a wide ecological distribution (Bellan *et al.*, 1975), particularly abundant in zones characterized by environmental instability. *C. gibba* is resistant to severe hypoxia (Diaz & Rosenberg, 1995; Brizzi *et al.*, 1994) and it is a pioneer species in recolonization of bottoms after anoxic crises; it is predominant in polluted or enriched areas (Crema *et al.*, 1991; Hrs-Brenko *et al.*, 1994; Theodorou, 1994). Moreover, its shell is particularly resistant to mechanical stress, thanks to conchiolin layers that increase shell strength and toughness by acting as crack stoppers (Kardon, 1998). For this reason *C. gibba* is not damaged by trawl-fishing (Rumohr & Krost, 1991).

The first studies on *C. gibba* population in the Adriatic Sea were made by Hrs-Brenko (1979, 1981) along the western part of Istria, where this species is particularly abundant during hypoxic and after anoxic crises (Hrs-Brenko *et al.*, 1994).

In the Gulf of Trieste, the first studies devoted to growth rates were made by Aleffi *et al.* (1993) at two stations in the middle of the Gulf, one located in an area affected by recurring hypoxia (Orel *et al.*, 1993). More recently in the inner part of the Trieste harbour, biometric analyses were made (Goriup *et al.*, 1997) in relation to pollution and particularly to heavy metals concentration in the sediment (Adami *et al.*, 1997).

The aim of the present study was to analyze the distribution, shell length, biomass and dominance of *C. gibba* along the western part of the northern Adriatic Sea in relation to the environmental features of the area.

MATERIALS AND METHODS

Sampling was carried out at 40 stations located in the northern Adriatic Sea, from 3 to 12 May 1995, during the PRISMA research project (founded by the Italian Ministry of University, Scientific Research and Technology).

The sites were located on soft bottom affected by sedimentation of riverine fine material, and along transects perpendicular to the shore characterized by different bottom textures, from pelite to coarse sand (Brambati *et al.*, 1983), at depths ranging from 12 to 70 m.

A 0.1 m^2 Van Veen grab was used and a total of 5 samples randomly positioned were removed from the substratum at each sampling site. Grab samples were processed through sieve of 1 mm mesh size and the retained material was preserved in a solution of 4% buffered formaldehyde.

In the present study only the stations with at least 15 specimens of *C. gibba* sampled were considered to analyze its shell length, biomass and dominance. The shell length was measured with a calliper and the specimens were separated in 1 mm length classes. For each sample, about 70% of total specimens was measured, whereas for the stations with high abundance (st. 18, 26, 31), only 200 specimens were chosen randomly.

The Kolmogorov-Smirnov two-sample test was applied to the size-frequency distribution of *C. gibba* in the sampling stations, in order to verify the null hypothesis that two samples belong to the same distribution (Sokal & Rohlf, 1997).

Finally the dry weight of *C. gibba* was determined for each station, drying the soft parts at 105° for 24 hours (Štirn, 1981) and the dominance within the communities of the sampling sites was calculated as percentage.

RESULTS

Figure 1 shows the position of sampling stations and the abundances of *C. gibba*. The specimens were more abundant at the stations near the shore and particularly south to the Po river mouth, where *C. gibba* reached abundance of 2043 ind. 0.5 m^{-2} at st. 31. In table 1, the depth, sediment type (Brambati *et al.*, 1983) and number of individuals of each sampling station are given. All the specimens were divided in four depth classes and five sediment types: the major part of specimens (84%) was found in the pelitic sediment (Fig. 2) and 66% of the total at depths between 12 and 15 m (Fig. 3). Only few individuals were associated with sandy sediments and were found at depths > 25 m.

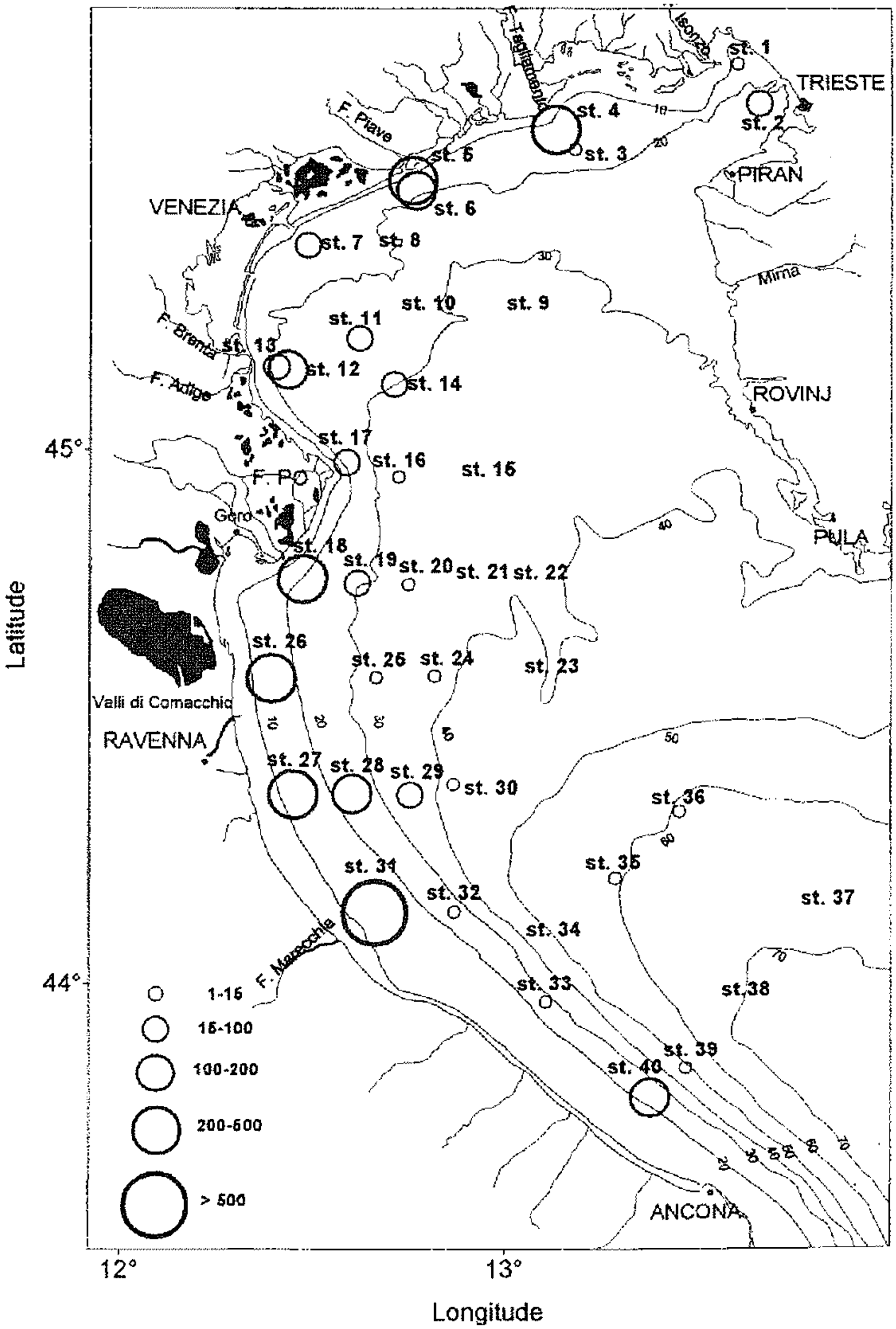

Fig. 1: Location of sampling stations and abundance of C. gibba (ind. 0.5 m⁻²).
Sl. 1: Lokacija vzorčišč in relativna gostota školjke C. gibba (ind. 0,5 m⁻²).

The mean-length for every site was calculated (Tab. 2): it varied from 6.57 (± 1.07) at st. 29, to 10.42 (± 1.30) at st. 2 (Gulf of Trieste); the biggest specimen, sampled in st. 2, measured 13.5 mm.

The Kolmogorov-Smirnov test applied to size-frequency distribution of the populations revealed significant differences between sampling stations, compared two by two (Sokal & Rohlf, 1997). The results are given in table 3, where "1" indicates stations with different distribution of the populations, whereas "0" indicates the same distribution at the two sites. Altogether, the 59.6% of comparisons gave significant differences between stations; in particular, st. 2 and st. 31 frequency distribution of shell length differed from those at all other stations.

The Kruskal-Wallis test applied on dominance expressed as percentage of the two groups (Tab. 4), consisting of stations north (st. 2-14) and south (st. 17-40) to the Po river mouth, revealed significant differences (Tab. 5); on the contrary the same analysis applied on biomass values (Tab. 4) did not show any significant differences (Tab. 5).

DISCUSSION AND CONCLUSION

C. gibba is widespread on soft bottoms of the northern Adriatic Sea. Vatova (1949) includes it in *"Chione gallina"* and *"Schizaster chiajei"* zoocenosis, but the abundances were lower than at present time.

Orel *et al.* (1987), studying benthic populations between the Gulf of Trieste and the Po river mouth, found it at about 90 sites, characterized by the biocenoses of "Vase Terrigene Cotière" and "Fonds Détritique Cotiers" (Pérès & Picard, 1964).

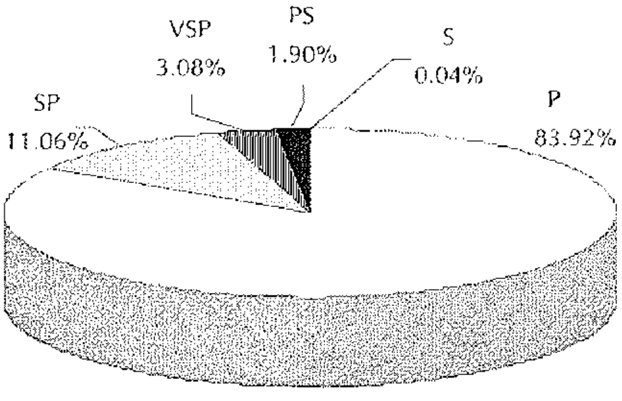

Fig. 2: Percentage of specimens in relation to the sediment types.
S: sand, PS: pelitic sand, VSP: very sandy pelite, SP: sandy pelite, P: pelite
Sl. 2: Odstotek primerkov glede na tipe sedimenta.
S: pesek, PS: pelitski pesek, VSP: zelo peščen pelit, SP: peščen pelit, P: pelit

***Tab. 1: Depth and sediment type of all sampling stations in relation to the individual number of** C. gibba.*
S: sand, PS: pelitic sand, VSP: very sandy pelite, SP: sandy pelite, P: pelite
***Tab. 1: Globina in tip sedimenta na vseh vzorčiščih glede na posamezno število školjke** C. gibba.*
S: pesek, PS: pelitski pesek, VSP: zelo peščen pelit, SP: peščen pelit, P: pelit

	ind. 0.5 m^{-2}	depth (m)	sediment
st. 1	14	13	P
st. 2	51	23	SP
st. 3	2	14	S
st. 4	205	16	SP
st. 5	274	12	P
st. 6	131	16	SP
st. 7	87	15	SP
st. 8	0	21	S
st. 9	0	31	VSP
st. 10	0	31	PS
st. 11	55	26	PS
st. 12	165	22	SP
st. 13	55	21	P
st. 14	27	28	PS
st. 15	0	32	SP
st. 16	5	30	SP
st. 17	69	18	P
st. 18	409	21	P
st. 19	49	27	P
st. 20	8	30	P
st. 21	0	38	VSP
st. 22	0	40	PS
st. 23	0	41	PS
st. 24	11	37	VSP
st. 25	5	31	P
st. 26	380	14	P
st. 27	245	12	P
st. 28	162	23	P
st. 29	18	34	P
st. 30	1	40	VSP
st. 31	2043	12	P
st. 32	9	26	P
st. 33	8	23	P
st. 34	0	27	P
st. 35	1	60	PS
st. 36	5	62	PS
st. 37	0	70	VSP
st. 38	0	69	VSP
st. 39	2	45	P
st. 40	143	23	P

Tab. 2: Size-frequency distribution and mean length of the measured samples.
Tab. 2: Velikostna porazdelitev in povprečna dolžina izmerjenih primerkov.

	length classes (mm)												measured	mean	
	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	samples	length	S.D.
st. 2	0	0	0	0	0	1	2	16	17	10	3	1	50	10.42	1.3
st. 4	1	0	2	1	18	28	26	33	31	8	2	0	150	8.81	2.84
st. 5	0	0	1	10	17	28	47	72	23	2	0	0	200	8.64	1.91
st. 6	1	0	1	1	2	20	19	28	36	7	3	1	119	9.35	2.64
st. 7	0	0	1	2	5	10	5	11	25	3	0	0	62	9.15	2.89
st. 11	0	0	0	0	3	5	10	3	8	6	1	0	36	9.33	2.77
st. 12	0	1	3	15	27	35	9	12	14	12	5	0	133	8.09	4.43
st. 13	0	0	3	7	17	8	9	4	2	1	0	0	51	7.25	2.55
st. 14	0	0	0	0	0	6	9	6	0	2	0	0	23	8.76	1.29
st. 17	0	0	0	0	7	23	24	9	2	0	0	0	65	8.13	0.92
st. 18	0	0	0	0	12	72	69	38	7	2	0	0	200	8.31	0.99
st. 19	0	0	0	0	0	6	7	5	12	7	2	0	39	9.83	2.23
st. 26	0	0	1	1	3	34	56	63	39	2	1	0	200	9.02	1.36
st. 27	0	0	0	2	14	42	72	43	18	8	1	0	200	8.66	1.58
st. 28	0	0	0	3	7	34	33	35	22	8	1	0	143	8.85	1.99
st. 29	0	0	0	5	6	2	2	0	0	0	0	0	15	6.57	1.07
st. 31	0	0	0	5	56	80	23	16	16	3	1	0	200	7.77	1.84
st. 40	0	0	0	1	4	35	39	42	12	0	0	0	133	8.65	1.11

Tab. 3: Kolmogorov-Smirnov test: "1" indicates the stations with different distribution of the length.
Tab. 3: Kolmogorov-Smirnov test: "1" označuje vzorčišča s školjkami različnih dolžin.

	st. 2	st. 4	st. 5	st. 6	st. 7	st. 11	st. 12	st. 13	st. 14	st. 17	st. 18	st. 19	st. 26	st. 27	st. 28	st. 31	st. 40
st. 2	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
st. 4		0	0	0	0	0	1	1	0	1	1	0	0	0	0	1	0
st. 5			0	1	1	0	1	1	0	1	1	1	0	0	0	1	0
st. 6				0	0	0	1	1	0	1	1	0	0	1	0	1	1
st. 7					0	0	0	1	0	1	1	0	1	1	0	1	1
st. 11						0	1	1	0	1	1	0	0	0	0	1	1
st. 12							0	0	1	0	0	1	1	1	1	0	1
st. 13								0	1	1	1	1	1	1	1	0	1
st. 14									0	0	0	1	0	0	0	1	0
st. 17										0	0	1	1	0	1	1	0
st. 18											0	1	1	0	1	1	0
st. 19												0	1	1	1	1	0
st. 26													0	1	0	1	0
st. 27														0	0	1	0
st. 28															0	1	0
st. 31																0	1
st. 40																	0

***Tab. 4: Biomass values and percentage dominance of the stations with at least 15 specimens of** C. gibba.*
***Tab. 4: Biomasa in odstotkovna dominanca na vzorčiščih z najmanj 15 primerki školjke** C. gibba.*

	ind. 0.5 m^{-2}	dry weight g 0.5 m^{-2}	% dominance
st. 2	51	0,344	16
st. 4	205	1,311	37
st. 5	274	1,631	26
st. 6	131	0,989	32
st. 7	87	0,638	10
st. 11	55	0,328	9
st. 12	165	0,744	34
st. 13	55	0,226	10
st. 14	27	0,051	4
st. 17	69	0,335	14
st. 18	409	2,211	73
st. 19	49	0,370	15
st. 26	380	3,261	65
st. 27	245	2,195	43
st. 28	162	0,989	64
st. 29	18	0,033	8
st. 31	2043	11,493	66
st. 40	143	1,170	44

During the present study, *C. gibba* was found on pelitic and sandy-pelitic sediments, being abundant in proximity to the main northern Adriatic rivers (Tagliamento, Piave and Adige) and especially along the shoreline south to the Po river, characterized by high rates of riverine fine material sedimentation and affected by periodic hypoxia and/or anoxia (Rinaldi *et al.*, 1992). There is an evident decreasing gradient from coast to the offshore zone (Fig. 1, Tab. 1) that appear related to the sediment type, depth and stress conditions.

Viceversa the analysis applied on the shell length does not reveal any trend similar to that regarding its abundance. Only st. 2 and st. 31 were separated from all others, probably because the former has the biggest specimens, as already found by Aleffi *et al.* (1993) and the latter shows the highest individuals number, about 45% of total sampled specimens.

In the area north to the Po river, where the faunistic composition of the macrobenthic communities are richer than in the coastal southern area (Aleffi, 1997), *C. gibba* resulted abundant but not dominant. The variance analysis applied on percentage dominance values showed significant differences between stations north and south to the Po river mouth (Tab. 5). The dominance of *C. gibba* south to the river Po has been observed in previous studies and linked to the features of the area: high organic-matter input, high sedimentation rates, periodic bottom hypoxia and anoxia (Crema *et al.*, 1991; Tahey *et al.*, 1996; Tomassetti *et al.*, 1997; Albertelli *et al.*, 1998; Moodley *et al.*, 1998).

Tab. 5: Kruskal-Wallis test for percentage dominance and biomass (g dry wt) compared between the groups of stations north and south to the Po river mouth.
Tab. 5: Kruskalov-Wallisov test odstotkovne dominance in biomase (g suhe teže) ter primerjava med skupinami vzorčišč severno in južno od ustja reke Pad.

Attribute	% dominance	Biomass
Data transform	None	None
H	3.947 *	1.996
p	0.047	0.158
df	1	1

Its dominance in the areas affected by environmental instability, as south to the Po river mouth, confirms the pioneer species behaviour. In these areas, in fact, *C. gibba* has no competitors and its abundance increases considerably; probably favoured by its particular morphology (Yonge, 1946) that permits it to survive in areas with high sedimentation rates. On the contrary, in the areas not subjected to environmental stress, *C. gibba* follows the trend of the entire benthic community, as already noted in the Gulf of Trieste (Aleffi *et al.*, 1993).

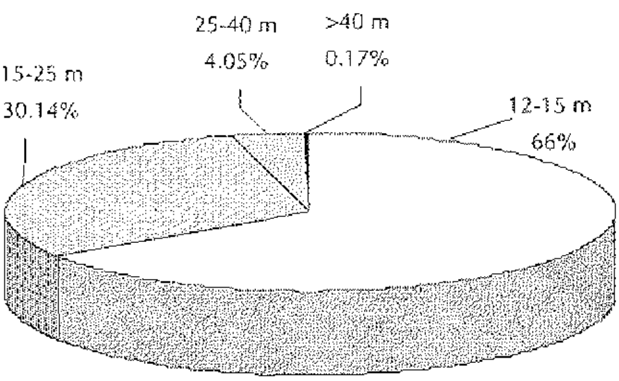

Fig. 3: Percentage of specimens in relation to the depth.
Sl. 3: Odstotek primerkov glede na globino morja.

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RAZŠIRJENOST ŠKOLJKE *CORBULA GIBBA* (BIVALVIA, CORBULIDAE) V SEVERNEM JADRANU

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POVZETEK

Školjka Corbula gibba *je splošno razširjena na mehkem dnu severnega Jadrana. Velja za široko ekološko razširjeno vrsto; še posebno številna je v območjih, značilnih po spremenljivosti okolja.* C. gibba *je pravzaprav odporna proti hudi hipoksiji in je pionirska vrsta v vnovičnem poseljevanju morskega dna po krizah, ki jih povzroča anoksija. Poleg tega je prevladujoča v onesnaženih območjih.*

C. gibba *je bila med pričujočim preučevanjem najdena na pelitskih ali peščeno-pelitskih sedimentih. Močno je razširjena v bližini glavnih severnojadranskih rek (Tilment, Piava in Adiža) in še posebno vzdolž obrežja južno od reke Pad z značilno močno sedimentacijo drobnega rečenega materiala ter občasno hipoksijo in apoksijo. Od obrežja se proti odprtemu morju spušča greben, kar vpliva na tip sedimenta, globino in stresne razmere v tem območju. Prevlada školjke v območjih, izpostavljenih okoljski nestabilnosti, kot na primer južno od ustja reke Pad, potrjuje vedenje pionirske vrste. Po drugi strani pa v območjih, ki niso izpostavljeni okoljskim stresom, ta školjka sledi trendu popolnoma bentoške združbe.*

Ključne besede: *Corbula gibba*, razširjenost, severni Jadran

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