

## Distribution of *Atrina fragilis* (PENNANT, 1777) (Pinnidae, Mollusca Bivalvia) in the Adriatic Sea

Ante ŠIMUNOVIĆ<sup>1</sup>, Corrado PICCINETTI<sup>2</sup>, Marija BARTULOVIĆ<sup>1</sup>  
and Ivana GRUBELIĆ<sup>1</sup>

<sup>1</sup> Institute of Oceanography and Fisheries, P.O.Box 500, 21000 Split, Croatia

<sup>2</sup> Laboratory for Marine Biology and Fisheries, Viale Adriatico 1/N, 61032 Fano, Italy

*The bivalve Atrina fragilis was collected by means of bottom trawl during 17 cruises of PIPETA Expedition in the Adriatic Sea in the period from 1982 to 1994 on the surface of 59000 km<sup>2</sup> of continental shelf. A total of 780 hauls were done. Atrina has been recorded at 20% of bottom trawl hauls. The species is the most abundant on sand-silt-clay and clayey "relict" sand in depths between 25 and 50 m. The deepest occurrence was between 251 and 256 m. In spite of intensive trawl fishing and occasional hypoxia events Atrina is renewing.*

**Key words:** bivalve, *Atrina fragilis*, distribution, bottom trawl, Adriatic Sea

### INTRODUCTION

Based upon existing literature (CARUS, 1889-1893; COEN, 1937; NOBRE, 1938-1940; NORDSIECK, 1969; PARENZAN, 1974; STARMÜHLER and SALVINI-PLAWEN, 1983; POUTIERS, 1987; JAKLIN and ZAHTILA, 1990; SABELLI *et al.*, 1990; POPPE and GOTO, 1993), we have found out that in spite of many records bivalve *Atrina fragilis* (PENNANT, 1777) hasn't been enough investigated. Although, many authors recorded its occurrence in particular zones, very few information exist about depth and sediment type of *Atrina* preference. Biological and ecological data of this species are also scarce. Due to a fact of very indigent information about *Atrina* biology and ecology, we do not give these data in the present paper. By data collected in the period between 1982 and 1994 (PIPETA Expedition) regarding *Atrina* distribution in the Adriatic and also its presence on single sediment type and depth as well as the

variation in catches in the particular research area are presented in this paper.

### MATERIAL AND METHODS

The bivalve *Atrina fragilis* was collected by means of bottom trawl during 17 cruises of PIPETA Expedition (collaboration of Laboratory for Marine Biology and Fisheries, Fano, Italy and Institute of Oceanography and Fisheries, Split, Croatia) in the Adriatic Sea in the period between 1982 and 1994. The PIPETA Expedition performed research on the surface of approximately 59000 km<sup>2</sup> of the Adriatic continental shelf. During the first six cruises the researches took place at in advance planned permanent stations on nine profiles: "A", "B", "C", "D", "E", "F", "G", "H" and "I". During the 7<sup>th</sup> cruise "L" profile was introduced, so that from 7<sup>th</sup> to 17<sup>th</sup> cruise research was carried on 10 profiles (Table 1, Fig. 1).

Table 1. PIPETA Expedition cruises in the Adriatic sea (1982 - 1994)

PIPETA EXPEDITION			
CRUISE	DATE	PROFILES	STATIONS
1 <sup>st</sup>	April - May, 1982	A - I	46
2 <sup>nd</sup>	November - December, 1982	A - I	54
3 <sup>rd</sup>	July, 1983	F - I	21
4 <sup>th</sup>	March - April, June, 1984	A - I	55
5 <sup>th</sup>	November - December, 1984	A - I	58
6 <sup>th</sup>	May - June, 1985	A - I	49
7 <sup>th</sup>	November - December, 1985	A - L	49
8 <sup>th</sup>	June - July, 1986	A - L	49
9 <sup>th</sup>	May - June, 1987	A - L	50
10 <sup>th</sup>	December, 1987 - February, 1988	A - L	50
11 <sup>th</sup>	October - November, 1988	A - L	50
12 <sup>th</sup>	December, 1990 - February, 1991	A - L	43
13 <sup>th</sup>	February - March, 1992	A - L	49
14 <sup>th</sup>	July, 1992	A - L	33
15 <sup>th</sup>	September - October, 1992	A - L	44
16 <sup>th</sup>	May - June, 1993	A - L	44
17 <sup>th</sup>	November, 1993 - January, 1994	A - L	36

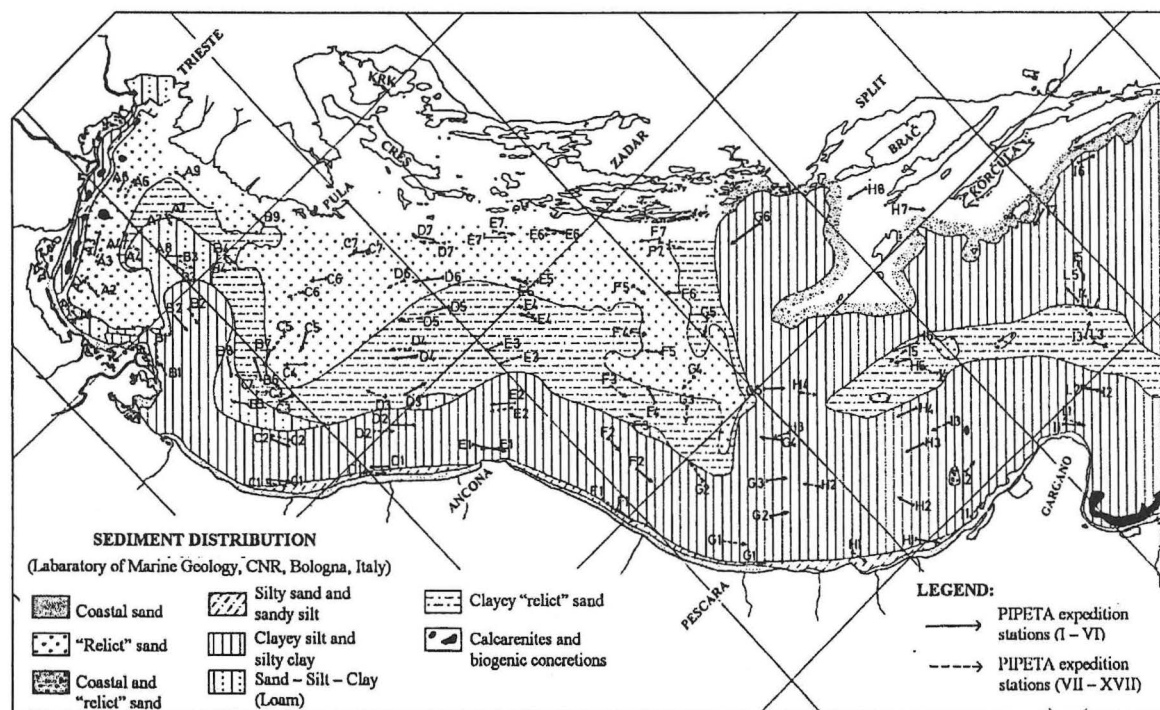


Fig.1. Stations of PIPETA Expedition 1982.-1994., plotted on the map of sediment distribution (the map is after Laboratory of Marine Geology, CNR, Bologna)

On account of introduction of new profile the coordinates of some already researched stations were significantly changed. Due to bad weather conditions and unexpected technical difficulties, the sampling at particular station

was not realized. Therefore, the number of stations at some cruises was lower than it was planned. A total of 780 hauls were done. Depth data were not available for 26 hauls. On station stratification regarding the depth and sediment

type was done later on since the station planning for all seventeen cruises was systematic. The stations were situated on the following six different sediment types: "relict" sand, clayey "relict" sand, sand-silt-clay (loam), clayey silt and silty clay, silty sand and sandy silt, coastal and "relict" sand (Fig. 1). The lowest sampling depth was 10 m and the highest 430 m. The collected data were elaborated according to the following depth zones: from 10 - 25 m, 25 - 50 m, 50 - 100 m, 100 - 150 m and deeper than 150 m.

The biological material was collected by means of an Italian commercial trawler PIPETA (300 HP), i.e. by standard Italian bottom trawl (PICCINETTI, 1972). In course of sampling an effort was made to keep technical and technological features of trawl constant. During each haul alive *Atrina* and the shells of dead ones were counted. Juveniles and adults were separated each from other. As juvenile stages we considered individuals with thin, fragile, colourless shells with well developed sculpture, and smaller than 18 cm length and 100 g weight. The catch value (Nkm<sup>-2</sup>) represents the number of individuals per unit area. *Atrina* catch was analyzed at each single station of researched area. Since the station coordinates regarding the Middle and South Adriatic Sea have changed after the sixth cruise, the catches of the first six and other eleven cruises were analyzed separately.

## RESULTS AND DISCUSSION

POPPE and GOTO (1993) referred that *Atrina fragilis* is distributed from the southern coast of the British Islands south to Spain and into the Mediterranean Sea, and NOBRE (1938-1940) added a distribution along the Atlantic shore of Africa, the Caribbean Islands, the Madeira and in the Adriatic Sea. During the PIPETA Expedition *Atrina* has been sampled in 20% trawling hauls on different sediment types and depths. In order to establish the *Atrina* distribution area the station stratification according to sediment type and depth were made (Table 2). The highest haul number with *Atrina* was obtained at clayey "relict" sand spread from 25 to 50 m depth, i.e. 74.51%. At the same depth, but on sand-silt-clay (loam) sediment 72.09% hauls contained *Atrina*. On clayey silt and silty clay sediment *Atrina* showed gradual decrease from 39.19 to 8.33% between 10 and 150 m. On "relict" sand *Atrina* was found in low percent only up to 50 m depth while on coastal and "relict" sand 4 hauls between 50 and 100 m depth were without *Atrina*. On silty sand and sandy silt, at depth to 25 m, *Atrina* was caught in 20% hauls (Table 2).

The obtained results during 17 cruises indicate that the area of *Atrina* distribution is much larger than area given by ŠIMUNOVIĆ (1997) in

Table 2. Total number of hauls (N) and percent of hauls (%N) with *Atrina fragilis* in relation to the sediment type and depth during the PIPETA Expedition

DEPTH (m)	TYPE OF THE SEDIMENT											
	"RELICT" SAND		CLAYEY "RELICT" SAND		SAND-SILT- CLAY (LOAM)		CLAYEY SILT AND SILTY CLAY		SILTY SAND AND SANDY SILT		COASTAL AND "RELICT" SAND	
	N	%N	N	%N	N	%N	N	%N	N	%N	N	%N
	<i>A. fragilis</i>		<i>A. fragilis</i>		<i>A. fragilis</i>		<i>A. fragilis</i>		<i>A. fragilis</i>		<i>A. fragilis</i>	
10 - 25	17	5.88	-	-	3	0.00	74	39.19	15	20.00	-	-
25 - 50	68	1.47	51	74.51	43	72.09	68	35.29	1	0.00	-	-
50 - 100	70	0.00	94	0.00	2	0.00	58	20.69	-	-	4	0.00
100 - 150	17	0.00	32	0.00	-	-	60	8.33	-	-	-	-
> 150	-	-	21	14.29	-	-	56	0.00	-	-	-	-

earlier study of the first two cruises of PIPETA Expedition.

POPPE and GOTO (1993) stated that *Atrina fragilis* lives on muddy bottom, while POUTIERS (1987) stated that species inhabits muddy and sandy-muddy bottoms. In the Adriatic Sea our results showed the highest mean catch value, i.e. 332.57 Nkm<sup>-2</sup> on sand-silt-clay, and clayey "relict" sand, 249.84 Nkm<sup>-2</sup>.

On all other sediment types the mean catch value ranges from 8.04 to 15.75 Nkm<sup>-2</sup> (Table 3).

NORDSIECK (1969), PARENZAN (1974) and POUTIERS (1987) stated that *Atrina fragilis* lives at depth up to 600 m, while POPPE and GOTO (1993) stated that it lives at depth from 150 to 600 m. However, our researches proved that in the Adriatic Sea *Atrina* inhabits abundantly depths between 25 and 50 m with highest

Table 3. Catch of the species *Atrina fragilis* in relation to the sediment type during the PIPETA Expedition (Nkm<sup>-2</sup>=number of individuals per unit area; n=number of hauls; min=minimum; max=maximum;  $\bar{x}$ =average value;  $\sigma$ =standard deviation)

CATCH (Nkm <sup>-2</sup> )	TYPE OF THE SEDIMENT				
	"RELICT" SAND	CLAYEY "RELICT" SAND	SAND-SILT- CLAY (LOAM)	CLAYEY SILT AND SILTY CLAY	SILTY SAND AND SANDY SILT
n	16	60	38	173	12
min	0.00	0.00	0.00	0.00	0.00
max	89.99	2776.92	2455.52	822.79	77.14
$\bar{x}$	8.04	249.84	332.57	15.75	15.00
$\sigma$	23.88	520.30	493.02	65.25	29.44

mean catch value, i.e. 191.75 Nkm<sup>-2</sup> (Table 4). Below 50 m depth *Atrina* was found rare and its the deepest occurrence was between 251 and 256 m during the 10<sup>th</sup> cruise at station L4.

In course of the first six cruises high mean catch values of *Atrina* were recorded at stations B4 (1134.55 Nkm<sup>-2</sup>) and B6 (1124.91 Nkm<sup>-2</sup>). The both stations are situated on clayey "relict"

Table 4. Catch of the species *Atrina fragilis* in relation to the depth during the PIPETA Expedition (Nkm<sup>-2</sup>=number of individuals per unit area; n=number of hauls; min=minimum; max=maximum;  $\bar{x}$ =average value;  $\sigma$ =standard deviation)

CATCH (Nkm <sup>-2</sup> )	DEPTH (m)				
	10 – 25	25 – 50	50 – 100	100 – 150	> 150
n	89	153	27	12	11
min	0.00	0.00	0.00	0.00	0.00
max	89.99	2776.92	38.57	12.86	38.57
$\bar{x}$	8.67	191.75	8.57	5.36	7.01
$\sigma$	15.96	429.49	11.83	6.62	13.32

Table 5. Catch of juveniles and adults *Atrina fragilis* at various stations during the PIPETA Expedition (1<sup>st</sup> - 6<sup>th</sup> cruises); (Nkm<sup>2</sup>=number of individuals per unit area; min=minimum; max=maximum;  $\bar{x}$ =average value;  $\sigma$ =standard deviation)

STATION	NUMBER OF HAULS	CATCH (Nkm <sup>-2</sup> )											
		TOTAL				JUVENILES				ADULTS			
		min	max	$\bar{x}$	$\sigma$	min	max	$\bar{x}$	$\sigma$	min	max	$\bar{x}$	$\sigma$
A4	5	0.00	449.96	128.56	186.08	0.00	0.00	0.00	0.00	0.00	449.96	128.56	186.08
A6	4	0.00	89.99	22.50	45.00	0.00	0.00	0.00	0.00	0.00	89.99	22.50	45.00
A7	5	0.00	359.97	125.99	140.07	0.00	0.00	0.00	0.00	0.00	359.97	125.99	140.07
B1	5	0.00	822.79	164.56	367.96	822.79	164.56	367.96	822.79	0.00	0.00	0.00	0.00
B3	5	0.00	25.71	5.14	11.50	0.00	0.00	0.00	0.00	0.00	25.71	5.14	11.50
B4	4	308.55	2776.92	1134.55	1127.55	514.24	128.56	257.12	514.24	308.55	2776.92	1005.99	1183.34
B6	2	0.00	2249.82	1124.91	1590.86	0.00	0.00	0.00	0.00	0.00	2249.82	1124.91	1590.86
B7	2	0.00	257.12	128.56	181.81	0.00	0.00	0.00	0.00	0.00	257.12	128.56	181.81
C1	5	0.00	12.86	2.57	5.75	0.00	0.00	0.00	0.00	0.00	12.86	2.57	5.75
C2	5	0.00	102.85	30.85	46.00	0.00	0.00	0.00	0.00	0.00	102.85	30.85	46.00
C3	5	0.00	1774.14	593.95	756.62	0.00	0.00	0.00	0.00	0.00	1774.14	593.95	756.62
D1	5	0.00	89.99	41.14	40.04	89.99	33.43	46.00	89.99	0.00	25.71	7.71	11.50
D2	5	0.00	25.71	12.86	9.09	0.00	0.00	0.00	0.00	0.00	25.71	12.86	9.09
E1	5	0.00	38.57	10.28	16.76	12.86	2.57	5.75	12.86	0.00	25.71	7.71	11.50
F1	5	0.00	12.86	2.57	5.75	12.86	2.57	5.75	12.86	0.00	0.00	0.00	0.00
G1	6	0.00	25.71	6.43	10.76	0.00	0.00	0.00	0.00	0.00	25.71	6.43	10.76
H1	6	0.00	12.86	2.14	5.25	12.86	2.14	5.25	12.86	0.00	0.00	0.00	0.00
I1	6	0.00	25.71	12.86	9.09	25.71	5.14	11.50	25.71	0.00	12.86	7.71	7.04
I2	5	0.00	25.71	7.71	11.50	25.71	5.14	11.50	25.71	0.00	12.86	2.57	5.75
I3	5	0.00	449.96	128.56	186.08	0.00	0.00	0.00	0.00	0.00	449.96	128.56	186.08

sand at depth between 25 and 50 m. At these stations and at almost all other stations adult individuals predominated (Table 5).

At some stations on profiles A, B and C during the first six cruises large quantities of adult *Atrina* shells were caught. At station A8 were only two hauls and the highest mean catch value of empty shells, i.e. 2326.96 Nkm<sup>-2</sup>. There were no alive individuals caught at this station. Also, very high mean catch value was recorded at station A4 (2100.69 Nkm<sup>-2</sup>) (Table 6).

From 7<sup>th</sup> to 17<sup>th</sup> cruise the highest mean catch value was at station B3, i.e. 480.35 Nkm<sup>-2</sup>.

The station is situated on sand-silt-clay (loam) sediment at depth between 25 and 50 m. Mainly juvenile individuals were caught. It is interesting that at this station during the first six cruises the catch was negligible (Table 7).

A high number of only juvenile shells was caught at station B2, mean catch value was 5037.26 Nkm<sup>-2</sup>. In course of all 17 cruises, at this station situated on clayey silt and silty clay, at depth between 25 and 50 m, alive specimens were not registered at all (Table 8).

The variations in trawling catches at studied stations in the northern Adriatic Sea were

Table 6. Catch of juveniles and adults empty shells of *Atrina fragilis* at various stations during the PIPETA Expedition (1<sup>st</sup> - 6<sup>th</sup> cruise); (Nkm<sup>2</sup>=number of individuals per unit area; min=minimum; max=maximum;  $\bar{x}$  =average value;  $\sigma$  =standard deviation)

STATION	NUMBER OF HAULS	CATCH (Nkm <sup>-2</sup> )											
		TOTAL				JUVENILES				ADULTS			
		min	max	$\bar{x}$	$\sigma$	min	max	$\bar{x}$	$\sigma$	min	max	$\bar{x}$	$\sigma$
A4	5	0.00	5489.56	2100.69	2881.40	0.00	0.00	0.00	0.00	0.00	5489.56	2100.69	2881.40
A7	5	0.00	1619.87	372.83	705.10	0.00	0.00	0.00	0.00	0.00	1619.87	372.83	705.10
A8	2	1619.87	3034.04	2326.96	999.97	0.00	0.00	0.00	0.00	1619.87	3034.04	2326.96	999.97
B2	4	0.00	1992.70	543.17	970.07	0.00	0.00	0.00	0.00	0.00	1992.70	543.17	970.07
B3	5	321.40	2249.82	1185.33	794.45	0.00	0.00	0.00	0.00	321.40	2249.82	1185.33	794.45
B4	4	0.00	4113.96	1173.12	1979.43	0.00	0.00	0.00	0.00	0.00	4113.96	1173.12	1979.43
B6	2	0.00	1581.30	790.65	1118.15	0.00	0.00	0.00	0.00	0.00	1581.30	790.65	1118.15
B7	2	0.00	617.09	308.55	436.35	0.00	0.00	0.00	0.00	0.00	617.09	308.55	436.35
C3	5	0.00	1234.19	491.10	463.57	0.00	0.00	0.00	0.00	0.00	1234.19	491.10	463.57
D1	5	0.00	179.99	36.00	80.49	0.00	179.99	36.00	80.49	0.00	0.00	0.00	0.00
D2	5	0.00	89.99	38.57	39.63	0.00	0.00	0.00	0.00	0.00	89.99	38.57	39.63

Table 7. Catch of juveniles and adults *Atrina fragilis* at various stations during the PIPETA Expedition (7<sup>th</sup> - 17<sup>th</sup> cruise); (Nkm<sup>2</sup>=number of individuals per unit area; min=minimum; max=maximum;  $\bar{x}$  =average value;  $\sigma$  =standard deviation)

STATION	NUMBER OF HAULS	CATCH (Nkm <sup>-2</sup> )											
		TOTAL				JUVENILES				ADULTS			
		min	max	$\bar{x}$	$\sigma$	min	max	$\bar{x}$	$\sigma$	min	max	$\bar{x}$	$\sigma$
A4	9	0.00	925.64	234.27	283.47	0.00	308.55	85.71	110.78	0.00	925.64	148.56	296.47
A6	10	0.00	38.57	3.86	12.20	0.00	0.00	0.00	0.00	0.00	38.57	3.86	12.20
A7	11	0.00	1092.77	303.87	323.77	0.00	1092.77	158.95	319.15	0.00	694.23	144.92	210.63
B1	11	0.00	25.71	7.01	10.54	0.00	25.71	3.51	8.31	0.00	25.71	3.51	8.31
B3	11	0.00	2455.52	480.35	786.63	0.00	2314.10	397.37	776.95	0.00	514.24	82.98	149.08
B4	11	51.42	578.53	185.83	164.47	0.00	154.27	44.41	58.74	0.00	578.53	141.42	164.44
C1	10	0.00	12.86	2.57	5.42	0.00	12.86	1.29	4.07	0.00	12.86	1.29	4.07
C2	11	0.00	179.99	49.09	49.73	0.00	51.42	4.67	15.51	0.00	128.56	44.41	36.98
C3	11	0.00	1054.20	301.53	283.21	0.00	0.00	0.00	0.00	0.00	1054.20	301.53	283.21
C4	10	0.00	77.14	14.14	24.58	0.00	0.00	0.00	0.00	0.00	77.14	14.14	24.58
D1	11	0.00	77.14	11.69	23.32	0.00	77.14	10.52	23.58	0.00	12.86	1.17	3.88
D2	11	0.00	38.57	12.86	15.21	0.00	0.00	0.00	0.00	0.00	38.57	12.86	15.21
E1	11	0.00	38.57	14.02	14.61	0.00	12.86	1.17	3.88	0.00	38.57	12.86	12.86
F1	11	0.00	25.71	8.18	10.40	0.00	25.71	7.01	10.54	0.00	12.86	1.17	3.88
G1	10	0.00	12.86	2.57	5.42	0.00	0.00	0.00	0.00	0.00	12.86	2.57	5.42

Table 7. *cont'd*

H1	9	0.00	25.71	8.57	9.09	0.00	0.00	0.00	0.00	0.00	25.71	8.57	9.09
I1	10	0.00	51.42	10.28	15.80	0.00	0.00	0.00	0.00	0.00	51.42	10.28	15.80
I3	9	0.00	12.86	2.86	5.67	0.00	0.00	0.00	0.00	0.00	12.86	2.86	5.67
L1	10	0.00	12.86	5.14	6.64	0.00	0.00	0.00	0.00	0.00	12.86	5.14	6.64
L4	7	0.00	38.57	9.18	16.12	0.00	38.57	5.51	14.58	0.00	25.71	3.67	9.72

Table 8. Catch of juveniles and adults empty shells of *Atrina fragilis* at various stations during the PIPETA Expedition (7<sup>th</sup> - 17<sup>th</sup> cruise); (Nkm<sup>2</sup>=number of individuals per unit area; min=minimum; max=maximum;  $\bar{x}$ =average value;  $\sigma$ =standard deviation)

STATION	NUMBER OF HAULS	CATCH (Nkm <sup>-2</sup> )											
		TOTAL				JUVENILES				ADULTS			
		min	max	$\bar{x}$	$\sigma$	min	max	$\bar{x}$	$\sigma$	min	max	$\bar{x}$	$\sigma$
A4	9	0.00	3291.17	875.64	975.11	0.00	899.93	189.98	377.66	0.00	3291.17	685.66	1021.49
A7	11	0.00	3432.58	878.89	1118.71	0.00	3432.58	634.62	1152.69	0.00	1709.86	244.27	513.67
B2	11	0.00	19284.17	5037.26	6491.15	0.00	19284.17	5037.26	6491.15	0.00	0.00	0.00	0.00
B3	11	0.00	2314.10	896.42	834.05	0.00	2056.98	456.98	805.15	0.00	2082.69	439.45	619.17
B4	11	0.00	835.65	377.50	267.10	0.00	385.68	35.06	116.29	0.00	835.65	342.44	278.02
C1	10	0.00	38.57	3.86	12.20	0.00	0.00	0.00	0.00	0.00	38.57	3.86	12.20
C2	11	0.00	257.12	35.06	78.85	0.00	0.00	0.00	0.00	0.00	257.12	35.06	78.85
C3	11	0.00	2455.52	531.78	827.70	0.00	0.00	0.00	0.00	0.00	2455.52	531.78	827.70
C4	10	0.00	617.09	79.71	192.30	0.00	0.00	0.00	0.00	0.00	617.09	79.71	192.30
C6	11	0.00	437.11	39.74	131.79	0.00	0.00	0.00	0.00	0.00	437.11	39.74	131.79
D1	11	0.00	25.71	2.34	7.75	0.00	0.00	0.00	0.00	0.00	25.71	2.34	7.75
D2	11	0.00	64.28	12.86	23.00	0.00	0.00	0.00	0.00	0.00	64.28	12.86	23.00
E1	11	0.00	64.28	5.84	19.38	0.00	0.00	0.00	0.00	0.00	64.28	5.84	19.38
G1	10	0.00	12.86	1.29	4.07	0.00	0.00	0.00	0.00	0.00	12.86	1.29	4.07
H5	10	0.00	102.85	18.00	38.43	0.00	0.00	0.00	0.00	0.00	102.85	18.00	38.43
I1	9	0.00	3291.17	875.64	975.11	0.00	899.93	189.98	377.66	0.00	3291.17	685.66	1021.49

analyzed. We have found out that *Atrina* repopulates well (Fig. 2).

JAKLIN and ZAHTILA (1990) stated that in the northern Adriatic Sea at stations SJ-005, SJ-007 and SJ-107 mass mortality of benthic organisms occurred in November 1989. A detailed inspection of destroyed bottom communities by divers in January 1990, at station SJ-107 showed many empty shells of *A. fragilis* and *Solenocurtus strigilatus*. Previously in normal population authors mentioned, 1-2 alive *Atrina* per m<sup>2</sup> of bottom surface. The area at sta-

tion SJ-107 (PRECALI, 1987) is in the area of B4 station of PIPETA Expedition (ŠIMUNOVIĆ *et al.*, 1999). The area around B4 station could be considered as a natural resource of *Atrina* from where animals renew their population constantly. In this intensive trawling area fishermen have a big problem with *Atrina* that rips their nets and they usually destroy caught *Atrina* making this bottom area full of empty shells and its pieces. Therefore, besides of JAKLIN and ZAHTILA's (1990) opinion that 10% *Atrina* sur-

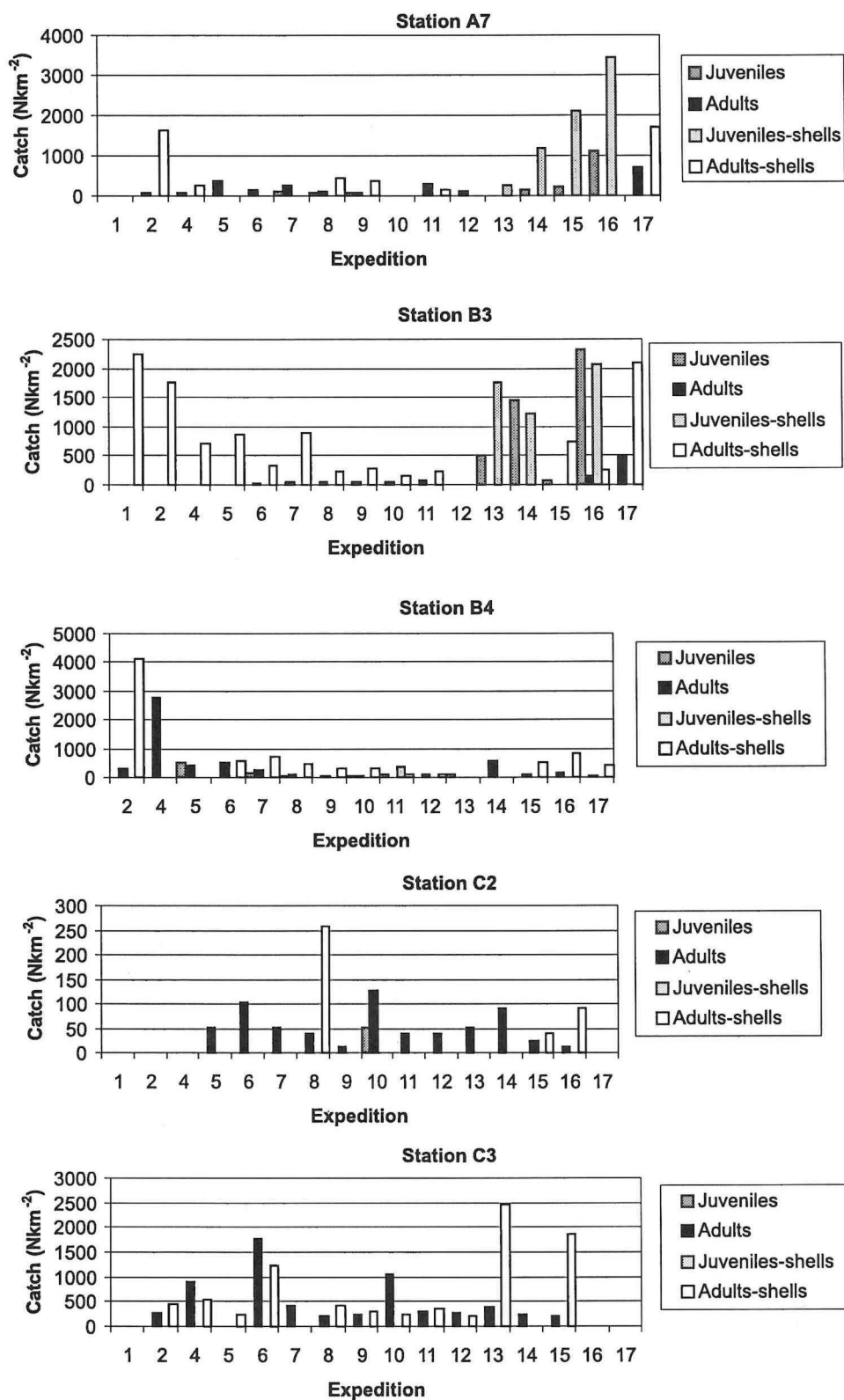


Fig. 2. Catch ( $Nkm^{-2}$ ) of the species *Atrina fragilis* at selected stations in the North Adriatic during the PIPETA Expedition (1<sup>st</sup> - 17<sup>th</sup> cruise)

vived hypoxia also other impact factors, as fishermen activity, may destroy animals.

It is well known that environmental factors as the depth and sediment type are responsible for distribution of benthic organisms. Since in the northern Adriatic Sea the sediments are "mosaically" distributed with many "border" lines between two types of sediments, a variation in *Atrina* space distribution could be expected (Fig. 1).

The problem appears with trawling activities in this part of the Adriatic Sea, when bottom trawl passes over several sediment types. In this case *Atrina* could be transported by bottom trawl from its natural habitat to areas with ecologically inadequate conditions for survival. Similar situation shows rapido trawling which mixes all sediment layers as well as it does bottom trawl moving thus the animals to other place. However, this species is present numerously in the area of B4 station with clayey "relict" sand sediment. It is moved by trawl fishing so that we can find it in surrounding area in all sediment types. In spite of constant trawling in this area, occasional hypoxia events, animal movement by trawling to ecologically inadequate areas, fishermen destroy of individuals before they are thrown back into the sea, we can say that this species has been constantly renewing.

HALL-SPENCER *et al.* (1999) studied an impact of rapido trawling on benthic communities in Venice Bay where they recorded *Atrina* in

the extensive area on sandy sediment at 25 m depth together with dense *Aequipecten opercularis* populations and slight density of *Pecten jacobaeus*. Further on, the authors stated that *Atrina* shells create convenient substratum for many species attachment such as juvenile pectinids, serpulids, hydroids and bryozoans. ŠIMUNOVIĆ (1995) points that in investigated area the eggs of indeterminate species were attached to shells of dead *Atrina*, rarely eggs of *Sepia officinalis* and *Loligo vulgaris*, three gastropod and one bivalve species. Molluscs ratio on one half of shell is the following at station B3: 18-20 *Anomia ephippium*, 8-10 *Calyptraea chinensis*, 0-1 *Crepidula unguiformis* and 0-1 *Capulus hungaricus*. On alive *Atrina* we have rarely observed attached *Chlamys varia* and juveniles of *Aequipecten opercularis*, though, the northern Adriatic area is rich with *A. opercularis* populations (PICCINETTI *et al.*, 1986). We have no explanation for this occurrence.

## CONCLUSIONS

During the PIPETA cruises in the Adriatic Sea, bivalve, *Atrina fragilis* has been recorded at 20% of bottom trawl hauls. The species is the most numerous on sand-silt-clay (loam) and clayey "relict" sand in depths between 25 and 50 m, while it is rare on other sediment types. In spite of intensive trawl fishing and occasional hypoxia events *Atrina* is renewing.

## REFERENCES

- CARUS, J. V. 1889 -1893. Prodrum faunae Mediterraneae sive descriptio animalium maris mediterranei incolarum, 2. E. Schweizerbart'sche Verlagshandlung. E. Koch (Editor). Stuttgart, 854 pp.
- COEN, G. 1937. Nuovo saggio di una Sylloge molluscorum Adriaticorum. R. Com. Talass. ital., Memoria, 240: 173 pp. + 10 Plates.
- HALL-SPENCER, J. M., C. FROGLIA, R. J. A. ATKINSON and P. G. MOORE. 1998. The impact of Rapido trawling for scallops, *Pecten jacobaeus* (L.), on the benthos of the Gulf of Venice. ICES Journal of Marine Science, 56: 111-124.
- JAKLIN, A. and E. ZAHTILA. 1990. 1989 anoxia and mass mortality of macrobenthos in the northern Adriatic Sea. 1st Int. Symp. "Ecological problems in the Adriatic Sea", Split, 7-9 November, 1990, pp. 44-45.
- NOBRE, A. 1938 -1940. Moluscos marinhos e das aguas salobras. Fauna malacol. de

- Portugal. Minho Barcelos (Editor). Porto, 800 pp. + 87 Plates.
- NORDSIECK, F. 1969. Die europäischen Meeresmuscheln (Bivalvia). Gustav Fischer Verlag, Stuttgart, 256 pp.
- PARENZAN, P. 1974. Carta d'identità delle conchiglie del Mediterraneo. 2. Bivalvi. Bios-Taras (Editor), Taranto, 277 pp.
- PICCINETTI, C. 1972. In: Catalogue of Fishing gear designs, London, pp. 40-41.
- PICCINETTI, C., A. ŠIMUNOVIĆ and S. JUKIĆ. 1986. Distribution and abundance of *Chlamys opercularis* (L.) and *Pecten jacobaeus* L. in the Adriatic Sea. FAO Fish. Rep., 345: 99-105.
- POPPE, G. T. and Y. GOTO. 1993. European Seashells. Vol. 2, Verlag Christa Hemmen, Wiesbaden, Germany, 221 pp.
- POUTIERS, J. M. 1987. Bivalves (Acephales, Lamellibranches, Pelecypodes). Méditerranée et Mer Noire. In: FAO-ECEE 1, pp. 371-512.
- PRECALI, R. 1987. 2. Monitoring sjevernog Jadrana. In: PRECALI, R., Z. KONRAD (Editors). Opći program za Jadransko more Jugoslavensko-talijanske mješovite komisije za zaštitu Jadranskog mora i obalnih područja od zagađenja. Izvještaj o radu za 1986. godinu, Rovinj, pp. 7-9.
- SABELLI, B., R. GIANNUZZI-SAVELLI and D. BEDULLI. 1990. Catalogo annotato dei molluschi marini del Mediterraneo 1. Libreria Naturalistica Bolognese (Editor), 348 pp.
- STARMÜHLER, F. and L. SALVINI-PLAWEN. 1983. Klasse: Bivalvia (Lamellibranchiata, Muscheln). In: Riedl R. (Editor). Fauna und Flora der Adria. Verlag P. Parey, Hamburg-Berlin, pp. 343-379.
- ŠIMUNOVIĆ, A. 1995. Ecological study of Prosobranchiata (Gastropoda) in the eastern part of the Adriatic Sea and their relationship to benthic biocoenoses. Acta Adriat., 36 (1/2): 82 pp.
- ŠIMUNOVIĆ, A. 1997. Quantitative and qualitative investigations of benthic communities in the areas of mobile bottoms of the Adriatic Sea. Acta Adriat., 38 (1): 77-194.
- ŠIMUNOVIĆ, A., C. PICCINETTI and M. ZORE-ARMANDA. 1999. Kill of benthic organisms as a response to an anoxic state in the northern Adriatic (a critical review). Acta Adriat., 40(1): 37-64.

Accepted: 2 March 2001

## Raspodjela vrste *Atrina fragilis* (PENNANT, 1777) (Pinnidae, Mollusca Bivalvia) u Jadranskom moru

Ante ŠIMUNOVIĆ<sup>1</sup>, Corrado PICCINETTI<sup>2</sup>, Marija BARTULOVIĆ<sup>1</sup> and Ivana GRUBELIĆ<sup>1</sup>

<sup>1</sup> Institut za oceanografiju i ribarstvo, P.P. 500, 21000 Split, Hrvatska

<sup>2</sup> Laboratorij za biologiju mora i ribarstvo, 61032 Fano, Italija

### SAŽETAK

Uzorci vrste *Atrina fragilis* su sakupljeni iz koćarskih prilova tijekom 17 putovanja ekspedicije PIPETA u Jadranu, u razdoblju od 1982. do 1994. godine na površini od oko 59000 km<sup>2</sup> kontinentalnog šelfa. Obrađeno je 780 potega dubinskom koćom na različitim sedimentima i dubinama. Vrsta *Atrina fragilis* ulovljena je na 20% potega. Vrsta je najbrojnija na pijesku-siltu-glini i glinovitom "reliktnom" pijesku. Najveća zastupljenost vrste je u dubinskom pojasu od 25 m do 50 m. Vrsta je najdublje zabilježena između 251 i 256 m. Premda su područja najveće zastupljenosti vrste ujedno i područja intenzivnog koćarenja, vrsta se obnavlja.