
**A contribution to the knowledge of the species
Holothuria tubulosa GMELIN, 1788
(Holothuria, Echinodermata) in the coastal area
of the central eastern Adriatic**

Ante ŠIMUNOVIĆ and Ivana GRUBELIĆ

*Institute of Oceanography and Fisheries, P. O. Box 500, 21000 Split, Croatia
E-mail: grubelic@jadran.izor.hr*

Due to an increased interest in the exploitation of some species of the genus Holothuria in the Adriatic, a number of biological-ecological studies of the species Holothuria tubulosa GMELIN, 1788 were carried out in order to protect the species and its habitat.

Research was carried out on different bottom types in the coastal area of the central Adriatic (from Dubrovnik to Zadar), in October 1996 and April and August 1997.

Specimens of the sea cucumber were collected by SCUBA divers using by the direct method of collecting or counting individuals along transects, down to a depth of 20 m.

Collected material was interpreted to establish distribution, relative abundance, biometric characteristics, sexual cycle and species renewal upon exploitation in a number of study areas.

Key words: *Holothuria tubulosa*, ecology, exploitation, central eastern Adriatic

INTRODUCTION

The genus *Holothuria* includes more than a hundred species (MATONIČKIN, 1981) approximately ten of which inhabit the Adriatic Sea. In this paper, the species *Holothuria tubulosa* GMELIN was studied.

According to available data, the species *H. tubulosa* is distributed in the Mediterranean and in a part of the Atlantic. Its distribution stretches from the sea surface down to an approximate depth of 100 m; being most abundant between the surface and 30 m. It inhabits all bottom types. The body length ranges from 30 to 35 cm

(TORTONESE, 1965; MATONIČKIN, 1981).

Up to now, data on the species *H. tubulosa* in the Adriatic has been mainly comprised of a large number of faunal and biocenological studies of benthic avertebrates in the Adriatic, which mainly discuss its distribution as it is affected by depth and bottom type (VATOVA, 1949; MAYER, 1937; KOLOSWARY, 1936-37; ZAVODNIK, 1960, 1980, 1992, 1997; ZAVODNIK *et al.*, 1981; GAMULIN-BRIDA, 1974; ŠIMUNOVIĆ, 1997; GRUBELIĆ, 1992, 1993).

Data on the biology of this species in the Adriatic Sea are rather rare (TORTONESE,

1965); whereas, data on the biology and management of relative species from temperate and tropical areas have recently become rather abundant due to their increased commercial importance (CAMERON and FANKBONER, 1986; CONAND, 1981; CONAND and SLOAN, 1989).

Since interest in the exploitation of the species *H. tubulosa* has increased in the area of the eastern Adriatic, biological-ecological studies of the species have been carried out in order to protect the species and its habitat.

METHODS

The biological and ecological studies of the species *H. tubulosa* were carried out on different bottoms of the coastal area in the central Adriatic, between Dubrovnik and Zadar. The 21 areas (42 transects) were examined in October 1996 and April and August 1997. Results from studies in 1994 / 95 were also used (Fig. 1).

Sea cucumber specimens were collected by SCUBA divers using the direct method of collecting or counting individuals, mainly in the coves along the individual transects. The surface area of each transect was 2 m wide with a depth of 10 or 20 m, depending on the species distribution and nature of the sea bottom.

The material collected was interpreted for the following: species distribution (the number of individuals per transect at depths of 0 - 10 m, 10 - 20 m), relative species abundance (number of individuals per sq m), biometric characteristics of the species (mean lengths and weights of samples comprised of 20 freshly caught individuals), and population renewal following exploitation of the species in individual parts of the study area.

Specimens of *H. tubulosa* (20 individuals) were collected from a permanent station on the northern part of Čiovo Island (Kaštela Bay) on a monthly basis between July 1994 and July 1995 to determine its sexual cycle as well as the



Fig. 1. Study area

ratio of the whole, gutted and dried trepang. Specimens were processed macroscopically and histologically as well as by electronic scale and vernier caliper. All of the data are kept in the Laboratory for Zoobenthos at the Institute of Oceanography and Fisheries in Split.

Results of the studies were partially interpreted and as such, are presented here.

Due to an increased interest in the exploitation of sea cucumber in the eastern Adriatic and its processing into a dried product (trepang or bêche-de-mer), our studies also included the processing of sea cucumber into trepang according to the following recipe: manually collected sea cucumber are gutted through a 4 cm long cut; after which they are boiled for about an hour in a 10 % salt solution. Following boiling, they are dried at atmospheric temperature for 10 days, or in an oven for 36 hrs at 37° C or for 24 hrs at 105° C.

RESULTS AND DISCUSSION

Distribution

Study results on the distribution of this species in the coastal area of the eastern Adriatic (between Dubrovnik and Zadar),

showed it to be distributed on all bottom types in the entire area, from the surface to a depth of 20 m (the depth to which the studies were carried out).

Representation of the species varied depending on substrate, depth and locality exposure. Thus, it was found to be best represented in coves down to a depth of 10 m (Table 1) and slightly sloping mobile bottoms where the sediment (mainly sand) is richer in organic matter. We should point out that the data on species distribution in the area of Makarska, Podgora and Tučepi do not reflect the actual state since the species had been exploited prior to our sampling and the catch data indicated that it had been rather well represented.

An analysis of the results showed that two areas can be distinguished in respect to quality and numbers: the area south of Split (Resnik - Zaton) and the area north of Split (Marina - Zadar). The area south of Split may be generally characterised by fewer specimens of greater weight as compared to the area north of Split where the specimens were far more numerous but of considerably smaller weight (Table 1).

The analysis of 236 sea cucumber specimens collected between the surface and a depth of 10 m in different study areas showed this

Table 1. Mean values of biometric measurements of the species *H. tubulosa* in the study area (N: number of individuals; W20p: sample weight (kg); W: mean weight (kg) for a depth of 0-10 m; * areas of great shoals; ** data for 1994/95)

Date	October 1996				April 1997				August 1997			
	N 0-10m	N 10-20m	W 20 p.	W	N 0-10m	N 10-20m	W 20 p.	W	N 0-10m	N 10-20m	W 20 p.	W
Zaton	40	14	6.15	0.31	45	18	6.00	0.30	40	20	6.00	0.30
Drvenik	71	29	6.50	0.33	65	30	6.20	0.31	75	35	6.50	0.33
Podgora	** 0	** 55	** 5.50	** 0.28	21	25	5.26	0.26	18	10	6.18	0.31
Tučepi	** 3	** 40	** 6.00	** 0.30	190	50	3.79	0.19	100	40	3.35	0.17
Makarska	-	-	-	-	20	20	6.36	0.32	20	30	4.87	0.24
Makarska I	0	7	4.55	0.23	0	6	4.25	0.21	0	20	4.60	0.23
Stobreč	19	100	2.30	0.12	20	-	5.71	0.29	20	-	5.67	0.28
Nehaj*	238	-	4.22	0.21	140	-	2.91	0.15	120	-	4.29	0.21
Resnik*	48	-	3.80	0.19	100	-	2.82	0.14	106	-	3.57	0.18
Marina	68	38	2.35	0.12	110	-	3.65	0.18	85	-	3.18	0.16
Rogoznica*	365	-	1.55	0.08	440	-	1.90	0.09	230	-	1.75	0.09
Šparadići	245	23	2.02	0.10	250	16	1.71	0.09	160	35	2.00	0.10
Srima*	410	-	3.53	0.18	320	-	3.35	0.17	300	-	2.20	0.11
Prosika	125	85	5.98	0.30	80	20	5.23	0.26	76	28	5.45	0.27
Drage	225	165	1.27	0.06	380	-	2.06	0.10	300	-	2.00	0.10
Biograd*	300	-	3.10	0.16	250	-	3.08	0.15	200	-	3.31	0.17
Turanj*	280	-	2.75	0.14	130	-	3.83	0.19	150	-	2.63	0.13
Sukošan*	520	-	3.98	0.20	450	-	2.59	0.13	350	-	3.42	0.17
Bibinje*	520	-	2.00	0.10	500	-	1.89	0.09	450	-	2.09	0.11
Borik	410	115	4.80	0.24	210	86	4.70	0.24	260	68	4.00	0.20
Zadar	145	285	4.83	0.24	96	150	3.13	0.16	110	120	3.20	0.16

depth to be inhabited by the species *Holothuria tubulosa*, *H. polii* and *H. forskali*. *H. tubulosa* is dominant in this part of the littoral zone (79 %; Table 2). The percentage ratio of these three species changes considerably with an increase in depth (under preparation).

Table 2. Percentage presence of the species *H. tubulosa*, *H. polii* and *H. forskali* at a depth of 0-10 m in the study area

Species	<i>H. tubulosa</i>	<i>H. polii</i>	<i>H. forskali</i>
% presence:	79	14	7

Abundance

The presence of sea cucumbers in individual areas in October 1996 and April and August 1997 is given as the number of individuals per transect at depths of 0 - 10 m and 10 - 20 m (Table 1), while relative abundance is shown as the mean number of individuals per sq m in a wider area, collected from the surface down to a depth of 10 m from a part of the littoral zone which is most exploited for sea cucumber (Fig. 2).

The obtained results show that the number of individuals per sq m was significantly lower in the area south of Split (0.00 - 0.36 m⁻²) than the number of individuals per sq m in the area north of Split (0.59 - 0.93 m⁻²).

Biometric properties

The quality of the species in the individual areas was given as the mean weight of samples of 20 specimens and the mean weight respectively (Table 1).

Obtained values show that the specimens from the area south of Split (Resnik -Zaton) are generally higher in weight than those found north of Split (Marina - Zadar). This is shown by the mean weights of 20 specimens which range from 4.55 - 6.33 kg for the area south of Split and 2.36 - 3.59 kg for the area north of Split (Fig. 3) and the mean weight of individual specimens ranging from 0.23 to 0.32 kg for the area south of Split and from 0.12 to 0.18 kg for the area north of Split (Fig. 4).

The mean lengths of fresh specimens are also an indicator of sea cucumber quality in the wider area of our study. They correspond to the weight values; the mean lengths of specimens ranged from 15.47 - 21.31 cm for the area south of Split and 11.79 - 14.83 cm for the area north of Split (Fig. 5).

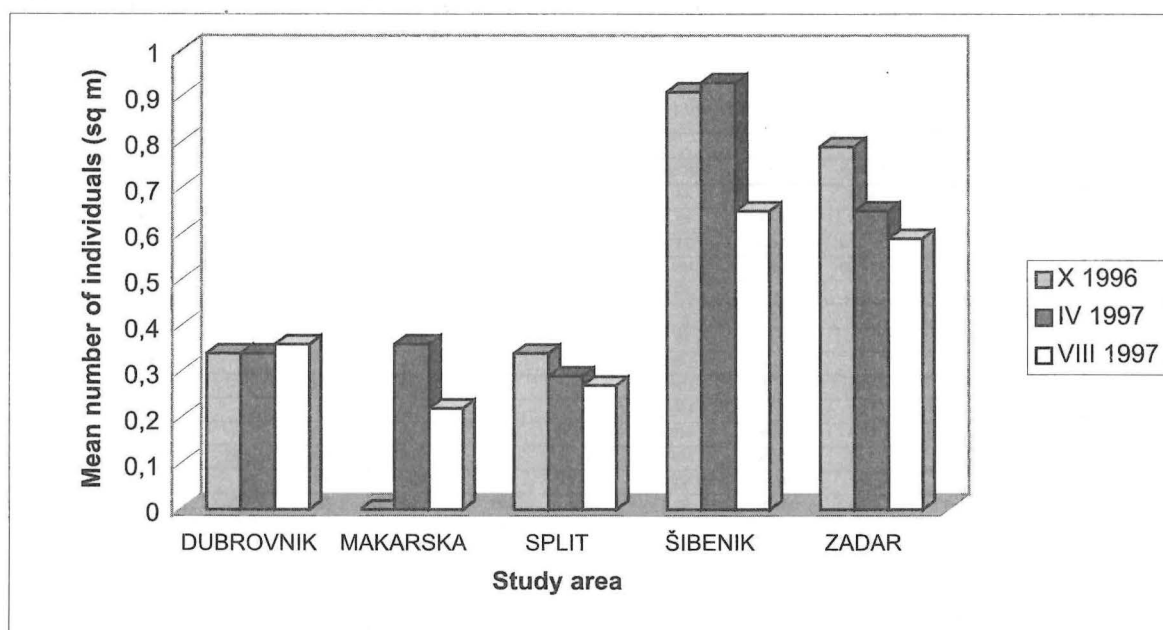


Fig. 2. Presence of sea cucumbers per unit area (sq m) in a wider study area

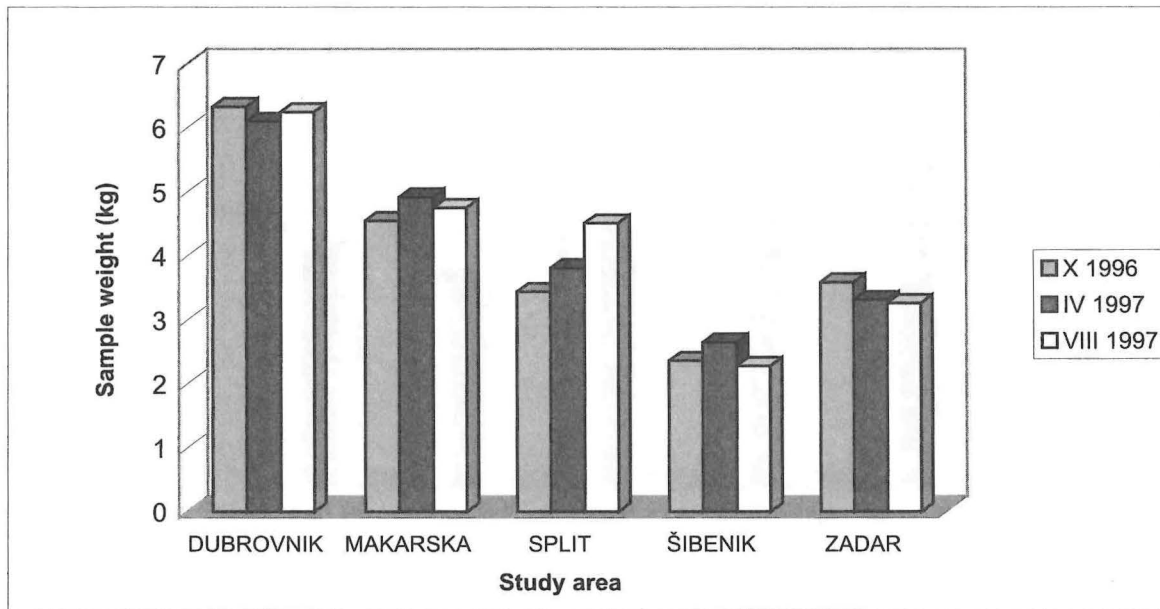


Fig. 3. Mean weight (kg) of 20 piece samples from a depth of 0-10 m

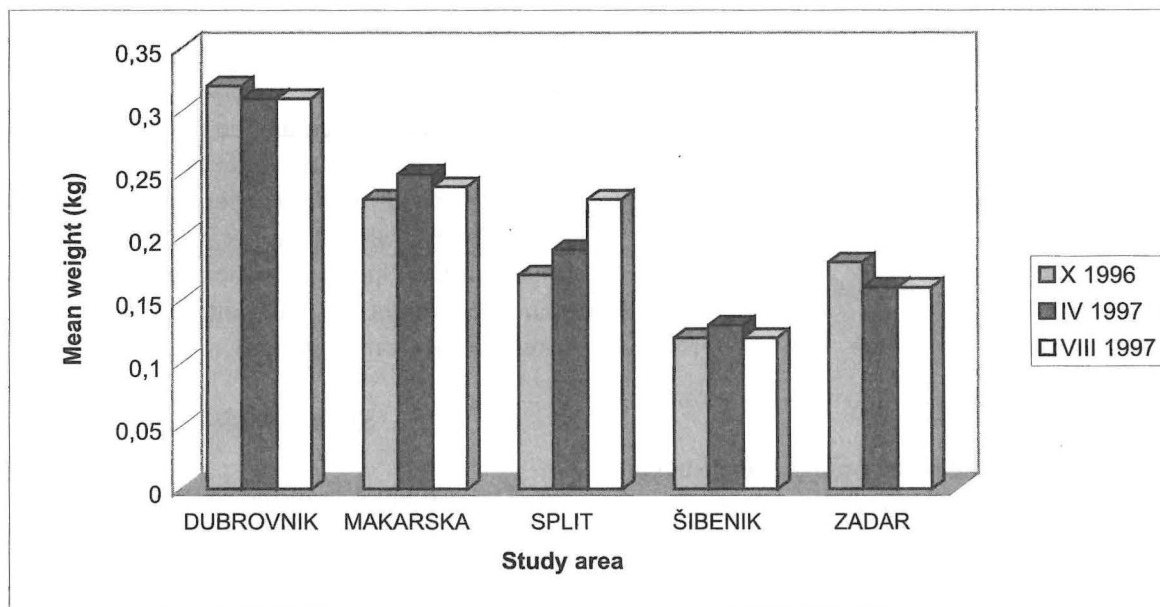


Fig. 4. Mean weight (kg) of sea cucumbers from a depth of 0-10 m

The largest specimen was collected from the area of the town of Ploče. Measured in the relaxed state on the sea bottom it was 53 cm long and 6.5 cm wide.

Since the body length and consequently the weight vary greatly among the representatives of the *Holoruthia* genus, the weight-length ratio was examined following different processes of

individuals to obtain more precise characteristics of the species in order to protect it as well as possible.

Therefore, it is important to point out that the same specimens measured in the relaxed state in their natural environment were approximately 1/3 shorter in the laboratory upon transportation in separate and marked bags. The

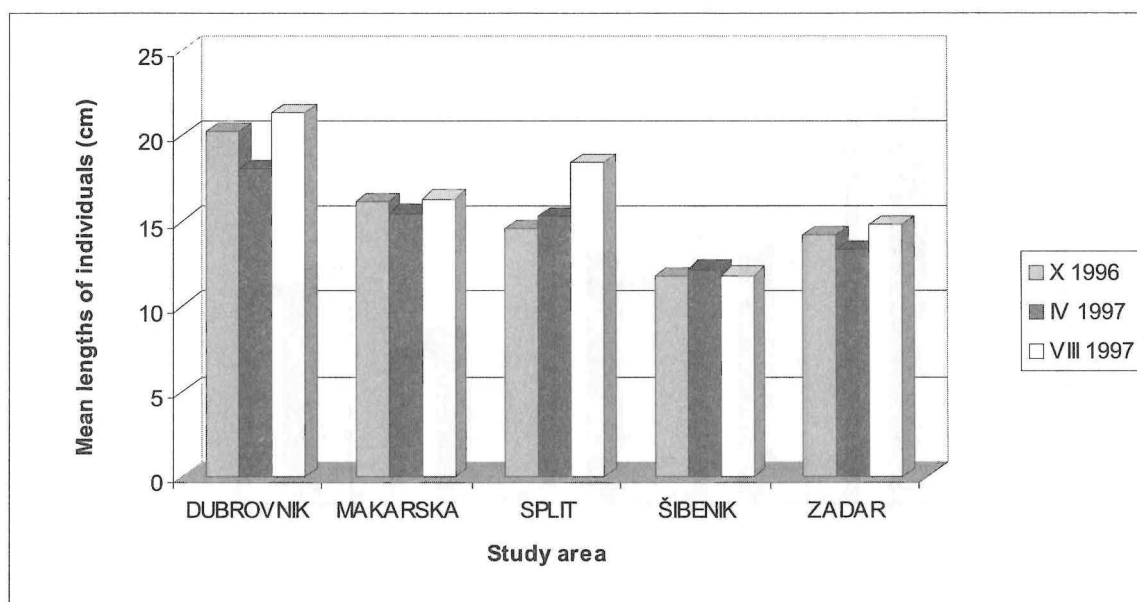


Fig. 5. Mean length (cm) of individuals from a depth of 0-10 m

mean length of freshly caught specimens measured in the laboratory was 2.5 times greater in relation to gutted and dried specimens at 37° C for 36 hrs (Table 3).

Table 3. Mean lengths of sea cucumbers upon different processes

	Whole sea cucumber	Trepang (37°C, 36 ^h)
Mean length (cm)	15.70 ± 2.04	6.36 ± 0.50
Ratio	2.5	1

The weight ratios of freshly caught ungutted specimens with water, gutted specimens without water, specimens dried in an oven (37° C, 36 hrs), specimens dried at atmospheric temperature (10 days) and dried matter (105° C, 24 hrs) are given in Table 4.

Table 4. Ratios of weights of the species *H. tubulosa* after different processes

Sea cucumber	Weight ratio
Freshly caught : Gutted	2 : 1
Gutted : Trepang (oven, 37°C 36 ^h)	5 : 1
Freshly caught : Trepang (oven, 37°C 36 ^h)	11 : 1
Gutted : Trepang (air dried)	6 : 1
Freshly caught : Dry matter (oven, 105°C 24 ^h)	18 : 1

When presenting the biometric data and their ratios for the species *Holothuria tubulosa* and its relatives, it is necessary to point out that values may vary depending on the sampling site and season: the quality of the specimens south of Split is much higher (larger specimens with thicker body walls) than that of the specimens found north of Split, and in the colder part of the year the weight of the gonadal tissue was insignificant (resting period).

Sexual cycle

The sexual cycle of the species *Holothuria tubulosa* was monitored from July 1994 to July 1995. Samplings were done on a monthly basis near Split. Samples of 20 sea cucumbers were processed macroscopically and histologically.

Macroscopically processed gonadal tissue showed the following sex ratio:

$$\text{♀} : \text{♂} = 1.5 : 1.$$

A rough analysis of histological preparations (preliminary results) showed *H. tubulosa* to be sexually mature during the warmer part of

the year, whereas a reduction of gonadal tissue was noted during the winter period. This does not correspond with data which states that the species is mature all year round (TORTONESE, 1965).

Some studies regarding the sexual cycle of the species *H. tubulosa* in the open and deeper part of the Adriatic show that the sexual cycle of specimens from this area does not completely coincide time-wise with that of the specimens found in the coastal area of the eastern Adriatic (data currently under analysis).

Commercial interest

Dried sea cucumber (trepan, bêche-de-mer) is considered a delicacy in the Far East and restaurants all over the world. Trepan is rich in protein and minerals. It has been assigned aphrodisiac qualities and trepan soup is believed to have healing properties for bronchitis, bronchial asthma and other respiratory difficulties (JACOB, 1973).

The nutritional value of trepan of the species *H. tubulosa* is as follows: 4.1 g % protein, 0.3 g % carbohydrates and 3.75 g % fat, with a total of 97.487 J (MATONIČKIN, 1981).

Interest in the commercial exploitation of the species of the *Holothuria* genus in the Adriatic can be traced back to the beginning of this century (SELLA, A. and M. SELLA, 1940). The data from this period refer mainly to the individuals from the northern Adriatic. The species *H. tubulosa* in particular was believed to be of commercial interest due to its size and body structure. Attempts were made to assess its quantities and, as stated by STEUER (1936), about 250000 individuals were found along the eastern Istrian coast. After further assessment, this figure was found to be six times greater (SELLA, A. and M. SELLA, 1940). It was also reported that most of the individuals caught for trepan ranged in weight from 125 to 400 g, with a mean weight of 250 g. The mean distribution of the species in those areas was one specimen per 1 - 2 sq m.

According to our studies, the exploitation of sea cucumbers commenced in the central Adriatic in 1994. A total of 1398 kg of this species was collected from depths of 5 - 12 m in an area up to 2.4 NM (1 NM = 1852 m) offshore along the coast of Makarska and exported as trepan to the Far East. According to our study results on a sample from the Split area collected in January 1998, approximately 120332 specimens of this species or 15643 kg of freshly caught sea cucumbers were removed from the sea. This was also indicated by our results which showed a poor presence of the species in the Makarska area (Table 1). With respect to the fact that the species *H. tubulosa* is phenotypically considerably larger and of greater weight in the wider area of Makarska (Table 1; Figs. 3, 4, 5), the number of individuals removed from the sea would be somewhat smaller for that area.

If we accept the existing data which states that a single sea cucumber digests 50 - 100 kg of sediment in a one year period, then 120332 individuals process 6000 - 12000 T of sediment per year. By burrowing itself, feeding on, swallowing and digesting the organic part of sediment, the species aerates the substrate. At the same time, it increases the quantity of positively utilised organic matter in marine ecosystems. Today, with the considerable increase in pollution of shallow seas, means that this species plays a very important role in the stability of marine ecosystems.

World market

The biggest importers and trade of trepan are those found in Singapore and Hong Kong. According to SHENOY (1977), a completely dry sea cucumber is dark brown to black on the dorsal side and whitish on the ventral side. In this state, trepan is classified by length and packed into jute sacks, weighing 60 - 100 kg. Their proportion in world catches is shown in Table 5.

The size of trepan (bêche-de-mer) varies from 6 to 15 cm in world catches.

Table 5. Classification of trepang by length and % proportion in world catch (SHENOY, 1977)

Trepang	Length	Catch proportions
large	10 – 15 cm	15 – 20 %
medium	7 – 10 cm	about 30 %
small	below 7 cm	50 %

Due to the aforementioned information, it is obvious that the quality of trepang obtained by processing the species *H. tubulosa* from the study area of the Adriatic Sea is quite satisfactory, since the sample of the whole sea cucumber from an area of poorer quality from the vicinity of Split of 15.70 ± 2.04 cm gave trepang a mean length of 6.36 ± 0.5 cm.

Population renewal

The qualitative - quantitative state of the sea cucumber population in the study area from Dubrovnik to Zadar, where this species has been exploited since 1994, may be observed from the data obtained in 1994, 1996 and 1997. The number of individuals per transect and the number of individuals per sq m, respectively, as well as sample weights and mean weights of sea cucumbers were taken as indicators of the state in any given locality (Table 1; Figs. 2, 3, 4).

It is evident that the areas not exploited, such as the southernmost stations (Zaton - Drvenik) and almost all of the stations north of Split (Marina - Zadar), show relative stability of the sea cucumber population both in regards to the number of individuals and species quality: the weight and length of samples is quite uniform at different time intervals.

The areas in which the sea cucumber was exploited show different situations as affected by catch intensity. Following the qualitative - quantitative studies of the species carried out in October 1996, April and August 1997, along with the data from 1994, it may be stated with certainty that some localities in the Makarska area and Kaštela Bay near Split are overexploited.

Our field trip in 1994 upon having been informed of intensive sea cucumber exploitation in the Makarska area, showed that the species was almost completely removed down to a depth of 10 m (Table 1). We managed to catch only 15 individuals (14 *H. tubulosa*, 1 *H. polii*) for calculations of biometric properties. The sampling was repeated in 1996 and 1997, which confirmed a personal communication that sea cucumbers were caught in the same area of Makarska on six successive occasions.

In other areas of Makarska in which, after another personal communication, the species *H. tubulosa* was intensively fished, sea cucumber numbers were rather high (0.95 specimens per sq m). However, analysis of the species showed only specimens of the species *H. forskali*, which is not of commercial interest, due to its structure and size. Due to sea bed properties, this species probably migrated from greater depths to an area once rich in the species *H. tubulosa*, which had been almost completely exploited (barely 19 individuals of the species *H. tubulosa* were recorded from the wider area normally rich in this species).

Immediately after the 1994 catch, we managed to find only 20 specimens of the species of approximately 6.00 kg in weight in the area of Tučepi. After a period of inactivity on this ground, the return of a large number of *H. tubulosa* individuals (Table 1) but of considerably smaller weight occurred at the end of 1996 and 1997. The sample of 20 individuals ranged in weight from 3.79 to 3.35 kg, which indicates population renewal in the 1994 - 1997 period. This corresponds with the data which states that the development of an adult sea cucumber requires three years.

In the area of Kaštela Bay (Nehaj and particularly Resnik), where the sea bed, according to some earlier studies (July, 1994), was rich in the species *H. tubulosa*, in October 1996, immediately after the catch, the species was not found from the surface to a depth of 4 m and to approximately 100 m offshore. At depths of 4 - 10 m, the sea cucumber population was still

abundant; a collected sample of sea cucumber which remained following the first exploitation was of good quality: the mean value of the samples was 4.22 - 3.80 kg. Sampling done in April 1997, following the repeated catch showed reduced population numbers and poorer quality of the remaining sea cucumbers: the mean values of sample weight ranged from 2.91-2.82 kg. After a personal communication, the sea cucumber was not caught in the area any longer, which was proven by a sampling done in August 1997, when the population numbers were almost the same as in April 1997. Whereas, the quality of individuals was even better: the mean weight of the sample ranged from 4.29 to 3.57 kg. This points to population renewal in an area which was not successively devastated over a shorter interval (Table 1).

CONCLUSIONS

The species *Holothuria tubulosa* is present throughout the study area from Zadar to Dubrovnik. It is most abundant in coves down to a depth of 10 m.

Its quality varies from one area to another. The area from Zadar to Split is mainly characterised by numerous (the number of individuals was 0.59 - 0.93 per sq m), smaller (mean length 11.79 - 14.83 cm) specimens of smaller weight (mean weight 0.12 - 0.18 kg) in relation to those from the area between Split and Dubrovnik, characterised mainly by fewer (number of individuals 0.00 - 0.36 per sq m) but longer (mean length 15.47 - 21.31 cm) individuals of greater weight (mean weight 0.23 - 0.32 kg).

The species analysis of the *Holothuria* genus collected between the surface and a depth of 10 m in the study area showed this depth to be dominated by *Holothuria tubulosa* (79 %). The percentage ratio changes with the increase in depth.

The body length of sea cucumber individuals varies considerably. The length of an individual measured in a relaxed state on the sea bottom was about 1/3 shorter in the laboratory

upon transportation. The mean length of freshly caught specimens measured in the laboratory was 2.5 times greater in relation to gutted and dried specimens (37°C for 36 hrs).

The largest specimen measured in a relaxed state on the sea bottom was 53 cm long and 6.5 cm wide.

The mean weight ratios following different processes are as follows: weight of freshly caught specimen to the weight of gutted specimen (no guts no water) was 2 : 1, weight of gutted specimen to the weight of a dried specimen (37°C, 36 hrs) was 5 : 1, weight of freshly caught specimen to a weight dried specimen (37°C, 36 hrs) was 11 : 1, weight of gutted specimen to the weight of a specimen dried at atmospheric temperature was 6 : 1 and weight of freshly caught specimen to dry matter weight (105°C, 24 hrs) was 18 : 1.

The species *H. tubulosa* is sexually mature during the warmer part of the year; whereas, no gonadal tissue is found during the winter. The female to male ratio was 1.5 : 1.

Results of qualitative-quantitative studies of the state of the population of *H. tubulosa* in the study area from Dubrovnik to Zadar, in which this species has been exploited with varying intensity, show relative stability of the populations, both as to the number of individuals as well as to the quality in the areas in which it was not caught; the areas in which it was caught showed different situations as affected by catch intensity: the areas from which it was exploited on several successive occasions show signs of overfishing and poor renewal, the areas in which it was caught once in three years show satisfactory species renewal.

Food preparation of trepang:

The most common method of preparation: dry sea cucumber (trepang) is washed, soaked for several hrs, boiled for about an hour, salted and spiced or cut into noodles and stewed for some time.

REFERENCES

- CAMERON, J. L. and P. V. FANKBONER. 1986. Reproduction biology of the commercial California sea cucumber *Parastichopus californicus* (Stimpson) (Echinodermata: Holothurioidea). I. Reproductive periodicity and spawning behaviour. *Can. J. Zool.*, 64: 168 -175.
- CONAND, C. 1981. Sexual cycle of three commercially important holothurian species (Echinodermata) from the lagoon of New Caledonia. *Bull. Mar. Sci.*, 31: 523 - 543.
- CONAND, C. and N. A. SLOAN. 1989. World fisheries for echinoderms. In: J. F. Caddy (Editor). *Marine invertebrate fisheries: their assessment and management*. J. Wiley & Sons, New York, pp. 647 - 663.
- GAMULIN-BRIDA, H. 1974. Biocoenoses benthiques de la Mer Adriatique. *Acta Adriat.*, 15 (9): 1 - 102.
- GRUBELIĆ, I. 1992. Comparative studies of littoral biocoenoses of the Kornati Islands. *Acta Adriat.*, 33 (1/2): 127 - 161.
- GRUBELIĆ, I. 1993. Prilog poznavanju sastava zoobentoskih naselja u priobalnom području Makarske. *Acta Biokovica*, 6: 53 - 64.
- JACOB, P.J. 1973. Sea Cucumbers. *Seafood Export Journal*, 5 (11): 21.
- KOLOSARY, G. 1936 / 37. Die Echinodermen des Adriatischen Meeres. *Festscher. Strand. E., Riga*, 2: 433 - 474.
- MATONIČKIN, I. 1981. Beskralježnjaci, biologija viših avvertebrata. Školska knjiga. Zagreb, 535 - 557.
- MAYER, B. 1937. Die Holothurien der Adria. *Thalassia*, 2: 9 pp.
- SELLA, A. and M. SELLA. 1940. L' industria del trepang. *Thalassia*, 4 (5): 1 - 116.
- SHENOY, A. S. 1977. Holothurians and its commercial utility. *Seafood Export Journal*, 9 (12): 17 - 20.
- STEUER, A. 1936. Arbeiten d. Deutsch-italienischen Inst. f. Meeresbiol. zu Rovigno d'Istria (Italien) über angewandte marine Biologie, Forschungen u. Fortschritte. 12 Jahrg. (15), Berlin, 116 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.
- TORTONESE, E. 1965. Fauna d'Italia - Echinodermata. Calderini. Bologna, 422 pp.
- VATOVA, A. 1949. La fauna bentonica dell' Alto e Medio Adriatico. *Nova Thalassia*, 1 (3): 1 - 110.
- ZAVODNIK, D. 1960. Echinodermata der Insel Krk. *Acta Adriat.*, 9 (2): 1 - 20.
- ZAVODNIK, D. 1980. Distribution of Echinodermata in the North Adriatic insular region. *Acta Adriat.*, 21 (2): 437 - 468.
- ZAVODNIK, D. 1992. Prilozi morskoj flori i fauni lošinjske otočne skupine. VII. Bodljikaši (Echinodermata). *Otočki ljetopis CRES - LOŠINJ*, 8: 257 - 264.
- ZAVODNIK, D. 1997. Echinodermata of the marine National park "Kornati" (Adriatic Sea). *Period. biol.*, 99 (3): 367 - 380.
- ZAVODNIK, D., A. ŠPAN, N. ZAVODNIK, A. ŠIMUNOVIĆ and B. ANTOLIĆ. 1981. Benthos of the western coast of the island Krk (Rijeka Bay, the North Adriatic Sea). *Thalassia Jugoslav.*, 17 (3/4): 285 - 337.

Accepted: 15 May 1998.

Prilog poznavanju vrste *Holothuria tubulosa* GMELIN, 1788

(*Holothuria*, Echinodermata)

u priobalju istočnog dijela srednjeg Jadrana

Ante ŠIMUNOVIĆ i Ivana GRUBELIĆ

Institut za oceanografiju i ribarstvo, P.P. 500, 21000 Split, Hrvatska

E-mail: grubelic@jadran.izor.hr

SAŽETAK

Zbog porasta interesa za eksploatacijom nekih vrsta roda *Holothuria* u Jadranu, poduzeta su biološko - ekološka istraživanja vrste *Holothuria tubulosa* sa svrhom da se vrsta i njeno stanište zaštititi.

Istraživanje je sprovedeno na različitim dnima u obalnom dijelu istočnog Jadrana od Dubrovnika do Zadra, na 21 području (42 transekta) u listopadu 1996, te travnju i kolovozu 1997. g., uz korištenje nekih rezultata istraživanja iz 1994. g.

Uzorke trpova su sakupili autonomni ronionci direktnom metodom, sakupljanjem ili brojanjem jedinki uzduž transekata, površine 2 m širine x 10 ili 20 m dubine, ovisno o rasprostranjenju vrste, odnosno karakteru morskoga dna.

Rezultati istraživanja pokazali su da je vrsta *H. tubulosa* prisutna na cijelom području istraživanja; najbrojnija je u uvalnom dijelu do 10 m dubine.

Analiza vrsta roda *Holothuria* na području istraživanja od površine do 10 m dubine pokazala je da je vrsta *H. tubulosa* u tom dijelu najbrojnija (79 %), dok se porastom dubine postotni odnos zastupljenosti vrsta mijenja.

Što se tiče kvalitete i zastupljenosti vrste, mogu se razlikovati dva područja: područje sjeverno od Splita karakterizirano je uglavnom brojnim (broj jedinki je 0.59 - 0.93 m⁻²), manjim (srednjak dužine je 11.79 - 14.83 cm) i lakšim (srednjak težine je 0.12 - 0.18 kg) primjercima, a područje južno od Splita uglavnom manje brojnim (broj jedinki je 0.00 - 0.36 m⁻²), dužim (srednjak dužine je 15.47 - 21.31 cm) i težim (srednjak težine je 0.23 - 0.32 kg) primjercima.

Za vrijeme istraživanja najveći trp zabilježen je na području Ploča: u opuštenom stanju na morskom dnu bio je dug 53 cm i širok 6.5 cm.

Dužina tijela i težina jedinki veoma je promjenjiva. Dužina jedinki mjerenih u opuštenom stanju na morskom dnu i nakon transporta u laboratoriju prosječno je za 1/3 manja, dok je srednjak dužine svježe ulovljenih trpova mjerenih u laboratoriju prije i nakon vađenja utrobe i sušenja (370 C, 36h) 2.5 puta veći.

Odnosi srednjih vrijednosti težina vrste nakon različitog tretmana su slijedeći: težina svježe ulovljenog trpa i težina očišćenog trpa (bez utrobe i vode) je 2 : 1, težina očišćenog i težina osušenog (370 C, 36h) je 5 : 1, težina svježe ulovljenog i težina osušenog (370 C, 36h) je 11 : 1, težina očišćenog i težina osušenog na zraku je 6 : 1, a težina svježe ulovljenog i težina suhe tvari (1050C, 24h) je 18 : 1.

Vrsta *H. tubulosa* spolno je zrela u toplijem dijelu godine, dok je u zimskom periodu uglavnom bez gonadnog tkiva. Odnos ženskog i muškog spola je 1.5 : 1.

Rezultati istraživanja kvalitativno-kvantitativnog stanja u populaciji vrste *H. tubulosa* na području istraživanja od Zadra do Dubrovnika gdje se vršio izlov trpova različitog intenziteta, pokazuju relativnu stabilnost u populaciji, kako po broju primjeraka tako i po kvaliteti vrste, na područjima gdje se trp nije izlovljavao. Područja gdje se trp izlovljavao pokazuju različitosti ovisno o intenzitetu lova: područje na kojem se trp lovio više puta uzastopno pokazuje znakove prelova i slabog obnavljanja, područje na kojem se trp lovio intenzivno jedan put pokazalo je prirodno obnavljanje vrste u razdoblju od 3 godine.

