

## Some New Data on the Zooplankton Standing Crop Measurements in the Adriatic

### Neki novi podaci o količinama zooplanktona u Jadranu

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There are very few papers dealing with the quantitative distribution of the zooplankton in the Adriatic. Some data on biomass (wet weight), settling volume and number of organisms have been published by Gamulin (1954), and recently by Battaglia, & Mozzi, Varagnolo (1960).

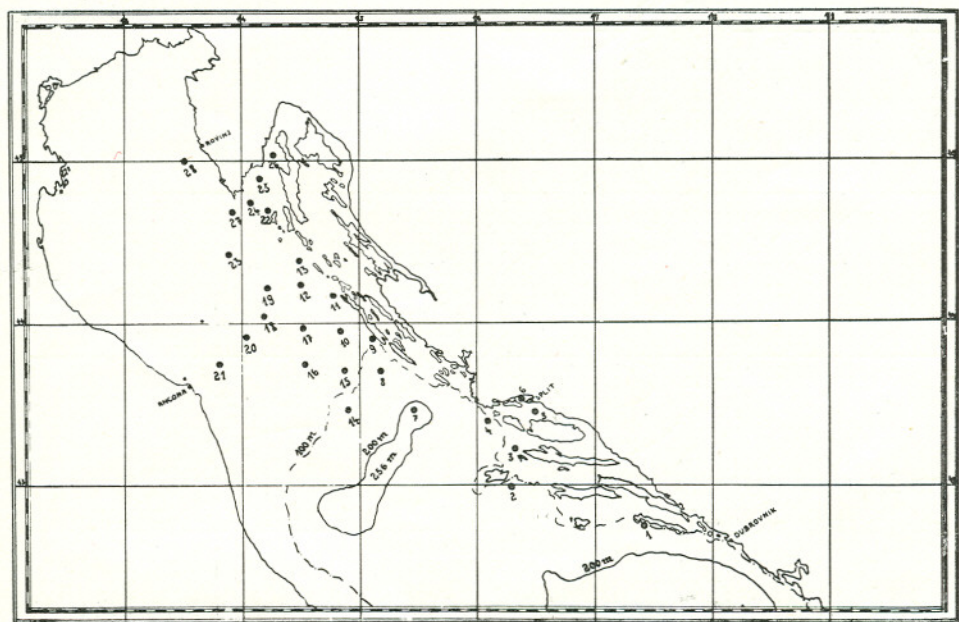


Figure 1. Plankton stations.

Certain efforts to fill this gap have been done in the Middle Adriatic during the last few years (Vučetić, 1960). The present paper contains some new data on dry weight of zooplankton crop in the North Adriatic (north of  $43^{\circ}30'N$ ), obtained during sardine-echo survey cruises in 1960. The position of the 28 stations where plankton samples were taken can be seen in Figure 1.

The material was collected with Hensen-egg net (73/100—No. 3) and Nansen net (100—No. 8, No. OXX). The vertical hauls were made from four to five metres off the bottom to the surface with a hauling speed 0.5 m/sec. After having made a comparison of different methods for the estimation of zooplankton standig crop (Vučetić, 1957) we decided to use the dry weight method for the quantitative measurement. The weighted samples were dried at  $110^{\circ}C$  until constant weight was obtained. Along with the dry weight measurement we also made counting of samples but we plan to measure the size of the more important zooplankton organisms too. The abundance of zooplankton is expressed in  $mg/m^3$  of the dry weight in Table I. The effective filtration of nets was taken from Table 9 contained in the paper by Laevastu (1958).

To render our data more comparable we have prepared Table II using the June/July data only. The exception was made with stations 22, 24, 25 and 26 for which the information referring to the winter period only are given. Some data on the number of copepods found in  $1 m^3$  have also been given in the same Table.

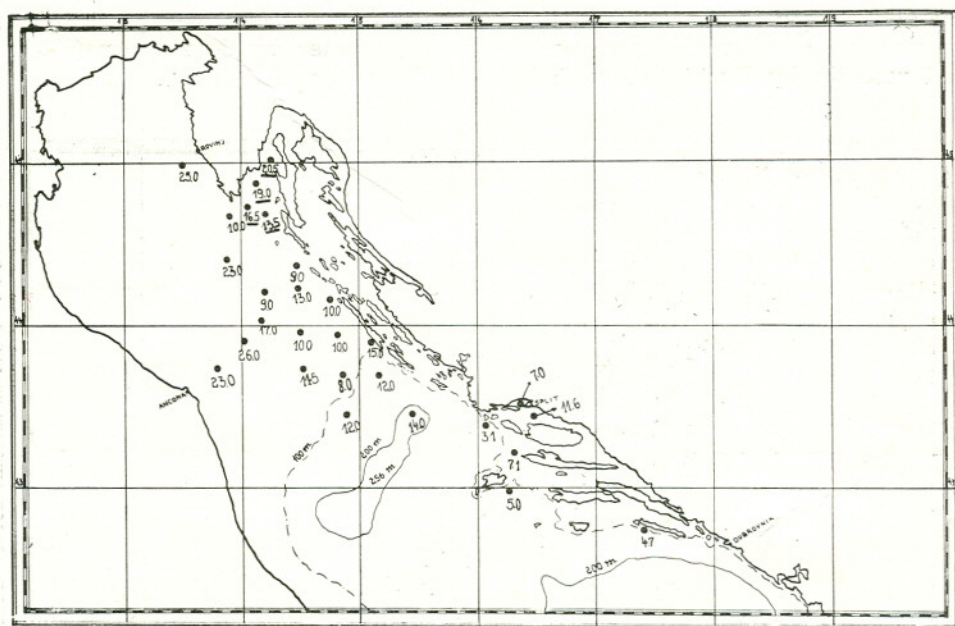


Figure 2. Dry zooplankton  $mg/m^3$  in June/July, underlined number in November/December.

As evident from Figure 2. higher values for dry zooplankton have been found in the North Adriatic than in the Middle Adriatic. The June/July (1960) average for the North Adriatic (Stations 8–21, 22, 23, 27 and 28) was  $14.3$

T A B L E I

| Station: | Locality: | Season: | Dry weight<br>in mg/m <sup>3</sup> : | Remarks: |                             |
|----------|-----------|---------|--------------------------------------|----------|-----------------------------|
| 1.       | (1/G)     | 1951    | Min.                                 | 2.0      | Hensen egg'net<br>(St. 1-7) |
|          |           |         | Max.                                 | 12.6     |                             |
|          |           |         | Average                              | 11.6     |                             |
|          |           | 1952    | Min.                                 | 2.2      |                             |
|          |           |         | Max.                                 | 15.9     |                             |
|          |           |         | Average                              | 8.6      |                             |
|          |           | 1953    | Min.                                 | 0.5      |                             |
|          |           |         | Max.                                 | 7.0      |                             |
|          |           |         | Average                              | 4.3      |                             |
|          |           | 1954    | Min.                                 | 1.4      |                             |
|          |           |         | Max.                                 | 7.2      |                             |
|          |           |         | Average                              | 4.9      |                             |
| 2.       | (2/S)     | 1959    | Min.                                 | 2.3      |                             |
|          |           |         | Max.                                 | 8.6      |                             |
|          |           |         | Average                              | 4.8      |                             |
|          |           | 1960    | Min.                                 | 2.1      |                             |
|          |           |         | Max.                                 | 10.6     |                             |
|          |           |         | Average                              | 5.0      |                             |
| 3.       | (3/P)     | 1959    | Min.                                 | 0.4      |                             |
|          |           |         | Max.                                 | 10.0     |                             |
|          |           |         | Average                              | 5.1      |                             |
|          |           | 1960    | Min.                                 | 2.3      |                             |
|          |           |         | Max.                                 | 9.0      |                             |
|          |           |         | Average                              | 5.6      |                             |
| 4.       | (4/M)     | 1954    | Min.                                 | 2.9      |                             |
|          |           |         | Max.                                 | 20.0     |                             |
|          |           |         | Average                              | 6.2      |                             |
|          |           | 1955    | Min.                                 | 4.5      |                             |
|          |           |         | Max.                                 | 14.1     |                             |
|          |           |         | Average                              | 6.6      |                             |
|          |           | 1956    | Min.                                 | 1.6      |                             |
|          |           |         | Max.                                 | 7.0      |                             |
|          |           |         | Average                              | 3.6      |                             |
|          |           | 1957    | Min.                                 | 1.6      |                             |
|          |           |         | Max.                                 | 6.2      |                             |
|          |           |         | Average                              | 3.0      |                             |
| 5.       | (5/O)     | 1954    | Min.                                 | 7.3      |                             |
|          |           |         | Max.                                 | 22.0     |                             |
|          |           |         | Average                              | 13.7     |                             |
|          |           | 1955    | Min.                                 | 4.6      |                             |
|          |           |         | Max.                                 | 11.3     |                             |
|          |           |         | Average                              | 7.0      |                             |
| 6.       | (6/K)     | 1954    | Min.                                 | 2.6      |                             |
|          |           |         | Max.                                 | 26.6     |                             |
|          |           |         | Average                              | 12.6     |                             |
|          |           | 1956    | Min.                                 | 3.3      |                             |
|          |           |         | Max.                                 | 14.4     |                             |
|          |           |         | Average                              | 6.6      |                             |
|          |           | 1957    | Min.                                 | 2.2      |                             |
|          |           |         | Max.                                 | 5.5      |                             |
|          |           |         | Average                              | 4.7      |                             |

| Station: | Locality:            | Season:    | Dry weight<br>in mg/m <sup>3</sup> : | Remarks:                 |
|----------|----------------------|------------|--------------------------------------|--------------------------|
|          |                      | 1959       | Min. 4.0<br>Max. 10.3<br>Average 5.6 |                          |
|          |                      | 1960       | Min. 4.4<br>Max. 13.3<br>Average 7.3 |                          |
| 7.       | (7/B)                | Blitvenica | 1960 Juli                            | 14                       |
| 8.       | (8/I)                | Dugi otok  | 1960 May                             | 10                       |
|          |                      |            |                                      | Nansen net<br>(St. 7-28) |
| 9.       | (9/II)               | Dugi otok  | 1960 June                            | 13                       |
|          |                      |            | 1960 May                             | 15                       |
|          |                      |            | 1960 June                            | 10                       |
|          |                      |            | 1960 July                            | 20                       |
|          |                      |            | 1960 Sept.                           | 17                       |
|          |                      |            | 1960 Nov.                            | 6                        |
| 10.      | (10/III)             | Dugi otok  | 1960 May                             | 11                       |
|          |                      |            | 1960 June                            | 10                       |
| 11.      | (11/IV)              | Dugi otok  | 1960 May                             | 10                       |
|          |                      |            | 1960 June                            | 9                        |
|          |                      |            | 1960 July                            | 11                       |
|          |                      |            | 1960 Sept.                           | 12                       |
| 12.      | (12/V)               | Dugi otok  | 1960 May                             | 18                       |
|          |                      |            | 1960 June                            | 13                       |
| 13.      | (13/VI)              | Dugi otok  | 1960 May                             | 11                       |
|          |                      |            | 1960 June                            | 19                       |
|          |                      |            | 1960 Sept.                           | 12                       |
|          |                      |            | 1960 Nov.                            | 12                       |
|          |                      |            | 1960 Dec.                            | 5                        |
| 14.      | (14/VII)             | Dugi otok  | 1960 May                             | 29                       |
|          |                      |            | 1960 June                            | 9                        |
|          |                      |            | 1960 July                            | 15                       |
|          |                      |            | 1960 Sept.                           | 20                       |
|          |                      |            | 1960 Novem.                          | 4                        |
| 15.      | (15/VIII)            | Dugi otok  | 1960 May                             | 12                       |
|          |                      |            | 1960 June                            | 8                        |
| 16.      | (16/IX)              | Dugi otok  | 1960 May                             | 23                       |
|          |                      |            | 1960 June                            | 10                       |
|          |                      |            | 1960 July                            | 13                       |
|          |                      |            | 1960 Sept.                           | 16                       |
|          |                      |            | 1960 Novem.                          | 4                        |
| 17.      | (17/X)               | Dugi otok  | 1960 May                             | 18                       |
|          |                      |            | 1960 June                            | 10                       |
| 18.      | (18/XI)              | Dugi otok  | 1960 May                             | 15                       |
|          |                      |            | 1960 June                            | 14                       |
|          |                      |            | 1960 July                            | 20                       |
|          |                      |            | 1960 Sept.                           | 24                       |
|          |                      |            | 1960 Novem.                          | 7                        |
| 19.      | (19/XII)             | Dugi otok  | 1960 May                             | 36                       |
|          |                      |            | 1960 June                            | 9                        |
| 20.      | (20/AXI)             | Ancona     | 1960 July                            | 26                       |
| 21.      | (21/A)               | Ancona     | 1960. July                           | 23                       |
| 22.      | (22/K <sub>1</sub> ) | Kvarner    | 1960 Nov.                            | 18                       |
|          |                      |            | 1960 Dec.                            | 9                        |
| 23.      | (23/P <sub>2</sub> ) | Pula       | 1960 July                            | 23                       |

|     | Station:             | Locality: | Season: |      | Dry weight<br>in mg/m <sup>3</sup> : | Remarks: |
|-----|----------------------|-----------|---------|------|--------------------------------------|----------|
| 24. | (24/K <sub>2</sub> ) | Kvarner   | 1960    | Nov. | 16                                   |          |
|     |                      |           | 1960    | Dec. | 17                                   |          |
| 25. | (25/K <sub>3</sub> ) | Kvarner   | 1960    | Nov. | 23                                   |          |
|     |                      |           | 1960    | Dec. | 15                                   |          |
| 26. | (26/K <sub>4</sub> ) | Kvarner   | 1960    | Nov. | 16                                   |          |
|     |                      |           | 1960    | Dec. | 25                                   |          |
| 27. | (27/P <sub>1</sub> ) | Pula      | 1960    | July | 10                                   |          |
| 28. | (28/R)               | Rovinj    | 1960    | July | 25                                   |          |

T A B L E II

|     | Station:          | Locality:   | Depth: | Season:   |      | Dry weight/mg/m <sup>3</sup> : | Number of<br>copepods<br>on m <sup>3</sup> : |
|-----|-------------------|-------------|--------|-----------|------|--------------------------------|----------------------------------------------|
| 1.  | 1/G               | Gonoturska  | 60     | June-July | 1952 | 4.7                            | 465                                          |
| 2.  | 2/S               | Stončica    | 100    | June-July | 1960 | 5.0                            | 148                                          |
| 3.  | 3/P               | Pelegriin   | 70     | June-July | 1960 | 7.1                            | 280                                          |
| 4.  | 4/M               | Maslinica   | 80     | June-July | 1957 | 3.1                            | 370                                          |
| 5.  | 5/O               | Omiš        | 50     | June-July | 1954 | 11.6                           | 433                                          |
| 6.  | 6/K               | Kaštela bay | 30     | June-July | 1960 | 7.0                            | 711                                          |
| 7.  | 7/B               | Blitvenica  | 100    | June-July | 1960 | 14.0                           | 216                                          |
| 8.  | 8/I               | Dugi otok   | 90     | June      | 1960 | 12.0                           | 649                                          |
| 9.  | 9/II              | Dugi otok   | 60     | June-July | 1960 | 15.0                           | 577                                          |
| 10. | 10/III            | Dugi otok   | 60     | June      | 1960 | 10.0                           | 438                                          |
| 11. | 11/IV             | Dugi otok   | 50     | June-July | 1960 | 10.0                           | 453                                          |
| 12. | 12/V              | Dugi otok   | 55     | June      | 1960 | 13.0                           | 727                                          |
| 13. | 13/VI             | Dugi otok   | 45     | June      | 1960 | 9.0                            | 581                                          |
| 14. | 14/VII            | Dugi otok   | 80     | June-July | 1960 | 12.0                           | 350                                          |
| 15. | 15/VIII           | Dugi otok   | 70     | June      | 1960 | 8.0                            | 514                                          |
| 16. | 16/IX             | Dugi otok   | 70     | June      | 1960 | 10.0                           | 505                                          |
| 17. | 17/X              | Dugi otok   | 70     | June-July | 1960 | 11.5                           | 542                                          |
| 18. | 18/XI             | Dugi otok   | 65     | June-July | 1960 | 17.0                           | 653                                          |
| 19. | 19/XII            | Dugi otok   | 55     | June      | 1960 | 9.0                            | 406                                          |
| 20. | 20/A XI           | Ancona      | 77     | July      | 1960 | 26.0                           | 153                                          |
| 21. | 21/A              | Ancona      | 60     | July      | 1960 | 23.0                           | 264                                          |
| 22. | 22/K <sub>1</sub> | Kvarner     | 40     | Nov.-Dec. | 1960 | 13.5                           | 333                                          |
| 23. | 23/P <sub>2</sub> | Pula        | 55     | July      | 1960 | 23.0                           | 557                                          |
| 24. | 24/K <sub>2</sub> | Kvarner     | 45     | Nov.-Dec. | 1960 | 16.5                           | 480                                          |
| 25. | 25/K <sub>3</sub> | Kvarner     | 45     | November  | 1960 | 19.0                           | 580                                          |
| 26. | 26/K <sub>4</sub> | Kvarner     | 45     | November  | 1960 | 20.5                           | 666                                          |
| 27. | 27/P <sub>1</sub> | Pula        | 45     | July      | 1960 | 10.0                           | 533                                          |
| 28. | 28/R              | Rovinj      | 35     | July      | 1960 | 25.0                           | 365                                          |

mg/m<sup>3</sup> and for the Middle Adriatic (stations 2, 3, 6 and 7) it was 8.1 mg/m<sup>3</sup>. The underlined data in Figure 2 refer to winter months (Dec./Nov.).

These higher values can, to some degree, be attributed perhaps to the qualitative difference between the North and Middle Adriatic plankton and to the different behaviour of the species occurring there. The North Adriatic zooplankton is composed of neritic species mostly eurythermal and euryhaline ones, with maximum population occurring during the summer months, exactly when most of our data were obtained in this area.

T A B L E III

| Locality:                                             | Dry zooplankton mg/m <sup>3</sup> : |       | g/m <sup>2</sup> : |                           |
|-------------------------------------------------------|-------------------------------------|-------|--------------------|---------------------------|
| ADRIATIC (1952-1960)<br>(Station 1-28)                | min.                                | 4.7   |                    | (Vučetić,<br>this paper)  |
|                                                       | max.                                | 26.0  |                    |                           |
|                                                       | average                             | 13.0  | 0.49               |                           |
| NORTH SEA (1947-1957)<br>(Station N Flamborough line) | min.                                | 43.0  |                    | (Wimpenny,<br>1952, 1957) |
|                                                       | max.                                | 97.0  |                    |                           |
|                                                       | average                             | 59.6  | 1.73               |                           |
| ENGLISH CHANNEL<br>(4 miles of Plymouth, 1949)        | min.                                | —     |                    | (Harvey, 1950)            |
|                                                       | max.                                | —     |                    |                           |
|                                                       | average                             | —     | 1.7                |                           |
| N. W. BARENTS SEA<br>(1953-1959, May/September)       | min.                                | —     |                    | (Corlet, 1961)            |
|                                                       | max.                                | —     |                    |                           |
|                                                       | average                             | —     | 11.6               |                           |
| BLOCK ISLAND SOUND<br>(1949)                          | min.                                | 0.04  |                    | (Deevey, 1952)            |
|                                                       | max.                                | 44.0  |                    |                           |
|                                                       | average                             | 19.34 | 0.58               |                           |

It may be useful to express the standing crop of plankton as dry weight per cubic metre or under square metre in the area compared with corresponding figures from elsewhere. Taking the data as a whole (Table III) it is possible to give an average value for all stations in the Adriatic and compare it with the North Sea average value (Wimpenny, 1952, 1957), English Channel (Harvey, 1950), Barents Sea (Corlet, 1961) and Block Island Sound (Deevey, 1952).

It is obvious that the zooplankton standing crop values in Adriatic are very low which is in accordance with the data on the abundance of nutrient salt (Ercegović, 1936; Buljan, 1953; Battaglia and &, 1960).

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## NEKI NOVI PODACI O KOLIČINAMA ZOOPLANKTONA U JADRANU

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### Kratak sadržaj:

U ovom preliminarnom radu izneseni su neki novi podaci o količinama zooplanktona u sjevernom Jadranu (sjevernije od 43°30'N), uglavnom sakupljeni za vrijeme krstarenja, u svrhu ispitivanja srdele. Osim toga pri izradi tabela koristili su se i podaci svih ranijih mjerenja izvršenih u razdoblju od 1951—1960. g. u srednjem i Sjevernom Jadranu. Usve je obuhvaćeno 28 postaja.

Materijal je sakupljen Hensenovom (73/100—No. 3) i Nansenovom (100—No. 8, No. OXX) mrežom. Vertikalni potezi uzeti su na udaljenosti od 4—5 m od dna do površine, a brzina povlačenja bila je 0,5 m/sek. Osim vaganja, zbog dobivanja suhe težine zooplanktona (metodikom vidi Vučetić, 1957) vršeno je i brojanje po grupama i vrstama, a namjerava se i izvršiti mjerenje najvažnijih planktonskih organizama, u prvom redu nekih kopepoda.

Da bi podaci bili bolje uporedivi, uzeti su kod izrade tabele II samo vrijednosti za razdoblje juni-juli. Za postaje 22, 24, 25 i 26 iznimno su donesene vrijednosti za novembar-decembar jer drugih podataka nije bilo.

Dobivene su veće vrijednosti suhe težine zooplanktona za sjeverni dio Jadrana (14,3 mg/m<sup>3</sup>) nego za srednji Jadran (8,1 mg/m<sup>3</sup>), a što se slaže i sa dosadašnjim nalazima za raspodjelu hranljivih soli u Jadranu (Ercegović, 1936; Buljan, 1953; Battaglia, &, 1960).

Srednjak svih vrijednosti suhe težine zooplanktona u Jadranu znatno je niži od odgovarajućih vrijednosti za druga mora (Tabela III).

Primljeno juli 1961.