CONTRIBUTION TO THE KNOWLEDGE OF THE RELATIONSHIP BETWEEN FORMATION OF DEEP SCATTERING LAYER *(DSL)* AND BIOLOGICAL COMPONENTS IN THE CENTRAL ADRIATIC

PRILOG POZNAVANJU FORMIRANJA DIFUZNOG SLOJA (DSL) U SREDNJEM JADRANU U ODNOSU NA BIOLOŠKE FAKTORE MORSKE SREDINE

Stjepan Jukić

Institute of Oceanography and Fisheries, Split

INTRODUCTION

Studies of DSL in the Mediterranean have been carried out by Moore (1950), Frassetto & Backus & Hays (1962), Frassetto & Della Croce (1965). Direct observations, by means of Bathyscaphe of variations of the zooplankton concentrations in relation to the sea depths in the western Mediterranean have been studied by Bernard (1955) and Pérès & Picard (1956).

Informations of DSL formation in the Adriatic sea are reported by Županović (1964, 1968) and Kačić (1973) where, both authors, supposed that appearance and distribution of DSL in the central open Adriatic is influenced by biological factors.

METHODOLOGY USED AND OBTAINED RESULTS

Under the scope of fisheries stock assessment investigations in the central open Adriatic, regular monthly research cruises were undertaken by vessel »Bios« (300 hp) during 1968/69 year over 20 permanent stations. During cruises appearance, distribution and behaviour of DSL were regularly controlled on board by means of »Simrad« — 580 Echo-Sounder equipment, during the day-time, when bottom trawl hauls were achieved.

Qualitative composition studies of DSL have been based on the following informations sources:

1. monthly plankton collections were collected by means of big stramin ring-trawl net of diameter 2 metres, from 150 to 0 metres. Vertical hauls were carried out (only once) over the main engine winch with a speed of 10 metres per minute;

2. food ingredients of two semi-pelagic fishes: Hake *(Merluccius merluccius L.),* first year class, and Horse Mackerel *(Trachurus trachurus* L.) adult forms. These studies were undertaken especially in the months when echo-traces of the bottom layers were well formed, i. e. visible as echo-traces on the recorder.

Collected data during 1968/69 year pointed out that DSL in the central open Adriatic is characterized by two, in a space, separated layers: upper echo-traces layer (fig. 1) and bottom echo-traces layers (fig. 2, 5). Sometimes its happened that only one layer was registered, like in the case of figures: 1, 2 and 5, while in the other cases, mostly in the spring-summer period, both layers were well formed (fig. 3, 4). Under such conditions, echo-traces of the upper layers, especially during the intensive day-light, were divided in two smaller layers (fig. 3). Before sunset, upper layers made a fairly fast vertical movements toward the sea surface. On the contrary, bottom

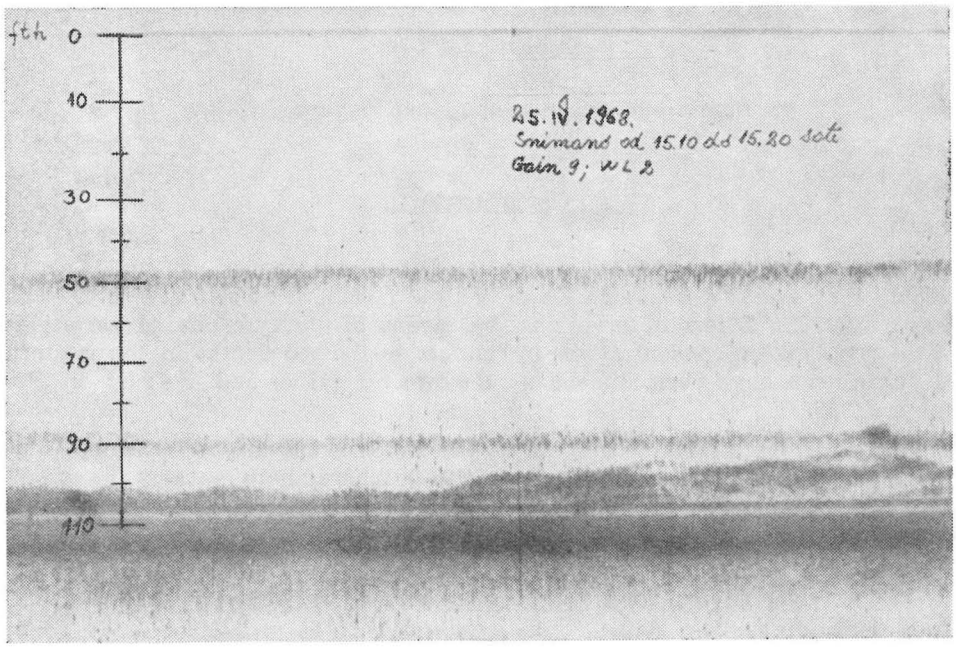

Fig. 1. — Ten minutes echo-survey fraction (from 05.40 to 05.50 hour) of the upper layer registered. Vessel speed 3 knots, Echo-sounder 30 kHz, gain 9, WL 2

Slika 1 — Desetminutni snimak (od 05.40 do 05.50 sati) gornjeg dijela difuznog sloja (DSL). Brzina broda 3 Nm/sat, frekvencija aparata 30 kHz, osjetljivost aparata 9, WL 2

layers echo-traces during the periods of dense concentration did not moved away from the sea bottom, retaining close to it during the whole day-time period (fig. 2, 3, 4, 5). Both layers were registered in continuous horizontal formations, sometimes being of 20 fth thickness (fig. 1, 5). Rearely bottom layers were of patcheness shape (fig. 4).

Qualitative and quantitative analysis of the zooplankton collections[1] (table 1) pointed out that during 1968/69 year, at a day-time interval, the following copepods dominated in the sea layers, from 150 to 0 metres: *Euchaeta hebes, Calanus helgolandicus* and *Clausocalanus sp.* during the whole year. Number of these individuals varied considerably during the year but having average values higher at spring-summer season. Besides of stated copepods following plankton species are significantly presented in the stramin net hauls: *Sagitta minima, Sagitta enflata* and groups: *Siphonophorae, Salpidae, Ostracodae (Conchoecia spinirostris).*

Qualitative analyse of food ingredients that were found in the stomachs of Hake individuals, one year old, and adult forms of Horse Mackerel (table 2) pointed out that individuals of these two fish populations during the day-time, because of trophic relationship retaine close to the sea bottom, were totaly filled out with following plankton species: *Nyctiphanes*

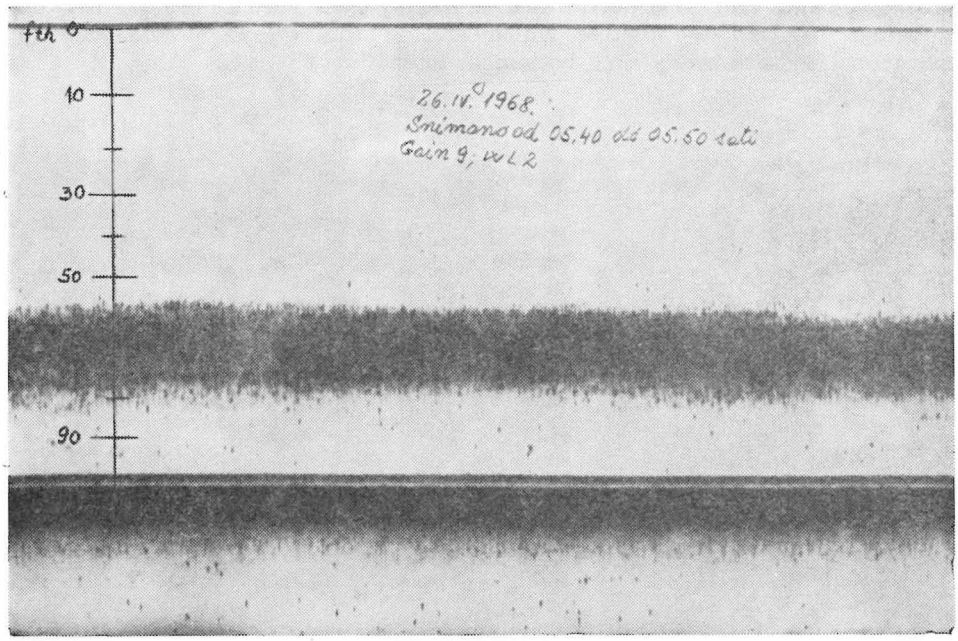

Fig. 2 — Ten minutes echo-survey fraction (from 12.52 to 13.03 hour) of the bottom layer registered. Vessel speed 3 knots, Echo-sounder 30 kHz, gain 9, WL 2

Slika 2 — Desetminutni snimak (od 12.52 do 13.03 sati) donjeg dijela difuznog sloja (DSL). Brzina broda 3 Nm/sat, frekvencija aparata 30 kHz, osjetljivost 9, WL 2

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[1] The author expresses his thanks to dr Jure Hure, planktonologist of the Biological Institut of Dubrovnik Station for his help in quantitative and qualitative determination of zooplankton collections as well as for his advices given concerning studied DSL.

couchi, Meganyctiphanes norvegica and *Lophogaster typicus*. According to the species frequency found, *Nyctiphanes couchi* individuals dominated. Besides of these species, two other Euphausids were found: *Euphausia hemigibba* and *Euphausia Krohnii*, but only few individuals. Because of very small mesh-size of the cod-end used in the trawl hauls surveys, once happened (station No 50, May 1968) that approximately 3 kg of Euphausids individuals were retained in the cod-end, when species *Nyctiphanes couchi* made a greater part of caught bulk. From this trawl haul measured total lenghts of *Meganyctiphanes norvegica* examples varied in the size interval between 25 mm (minimum) to 46 mm (maximum). Recorded lendgths are evidentlö higher of those reported by R u u d (1936) for Mediterranean during the Danish Expedition. Determinated Euphausids and Mysids in the stomachs of Hake and Horse Mackerel species were just registered at the time when dense concentrations of the bottom echo-traces layers were stated on the recorder.

Distribution of the DSL over 20 permanent stations in the central Adriatic showed that DSL was not formed on the stations that are placed between izobathes 100 and 150 metres which are, in this region of the Adriatic, characterizied with sandy-shell bottom sediments.

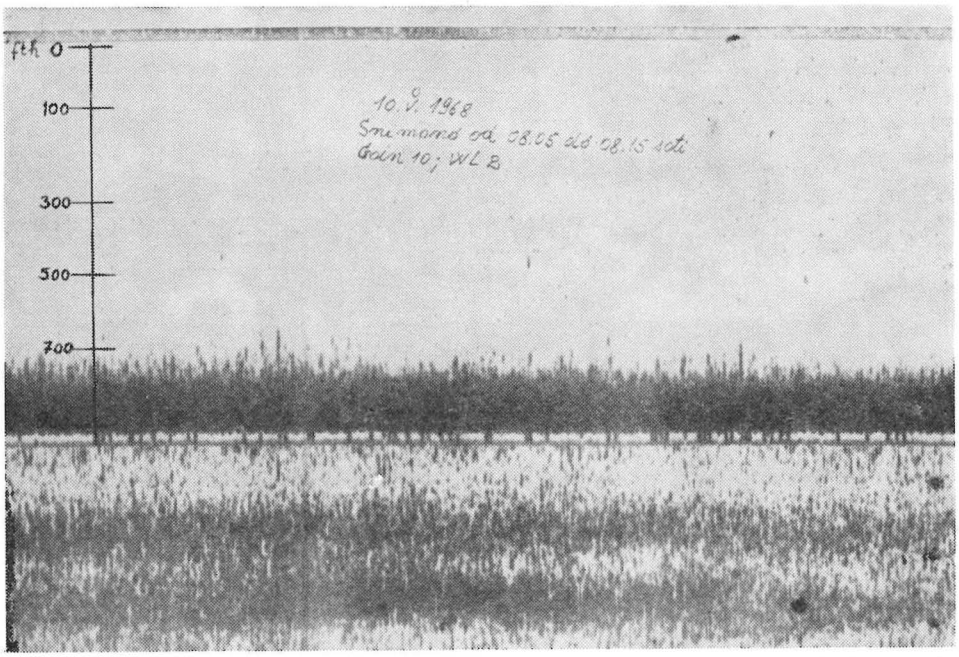

Fig. 3 — Ten minutes echo-survey fraction (from 15.10 to 15.20 hour) of the double u p p e r and b o t t o m layers registered. Vessel speed 3 knots, Echo--sounder 30 kHz, gain 9, WL 2

Slika 3 — Desetminutni sniimak (od 15.10 do 15.20 sati) gornjeg i donjeg dijela difuznog sloja (DSL). Za razliku od donjeg sloja, gornji je dio podjeljen u dva manja horizontalna sloja. Brzina broda 3 Nm/sat, frekvencija aparata 30 kHz, osjetljivost 9, WL 2

Table 1 — Quantitative and qualitative analysis of zooplancton composition caught by means of big stramin ring-net of ∅ 2 m, from 150 to 0 metres during 1968/69 year

Tabela 1 — Kvantitativna i kvalitativna analiza sastava zoonktona tokom 1968/69 godine, sakupljen uz pomoć straminske mreže od ∅ 2 metra, vertikalnim potezima od 150 do 0 metara

Date	1/26/1969	2/27/1969	3/30/1969	4/24/1968	5/28/1969	7/23/1969	8/8/1968	10/12/1968	12/22/1968	
Hauling time	15.30—	17.00—	14.30—	16.20—	13.00—	17.00—	13.30—	09.00—	12.00—	
(Stramin ring-trawl ∅ 2 m)	15.50	17.20	14.50	16.40	13.20	17.20	13.50	09.20	12.20	
Registered groups and species	Number	Number	Number	Number	Number	Number	Number	Number	Number	Total
MEDUSAE	48	64	128	64	192	128	200	120	32	976
SIPHONOPHORAE	176	176	352	1072	1200	256	100	5240	320	8892
POLYCHAETA	—	—	7	—	—	16	—	—	—	23
OSTRACODA										
Conchoecia spinirostris (CLAUS)	—	320	16	—	48	272	91	840	15	1602
COPEPODA										
Calanus helgolandicus (CLAUS)	960	1360	10	8200	704	60	900	100	600	12894
Calanus tenuicornis DANA	30	320	1500	40	512	600	600	—	—	3602
Nannocalanus minor (CLAUS)	180	320	700	280	96	480	100	100	440	2696
Paracalanus sp.	30	40	50	—	—	60	100	100	82	462
Clausocalanus sp.	540	1400	2350	480	1656	4800	4000	500	880	16646
Eucalanus sp.	—	—	—	—	32	—	—	—	—	32
Ctenocalanus vanus GIESBRECHT	270	120	400	—	64	1860	200	100	100	3134
Euchaeta hebes GIESBRECHT	240	—	1000	7800	315	1200	7300	500	1840	20195
Euchaeta marina (PRESTANDREA)	—	—	50	—	—	—	—	—	80	130
Centropages typicus KRÖYER	390	520	100	—	120	660	200	1900	120	4010
Temora stylifera (DANA)	870	40	50	—	288	240	300	1610	1920	5318
Oithona sp.	90	160	400	—	24	2100	2100	100	200	5174
Oncea sp.	90	320	300	—	144	3360	400	100	43	4757
Corycaeus sp.	540	360	250	—	24	300	400	500	1040	3414
Copepoda juv.	—	—	—	—	200	—	—	—	—	200
DECAPODA LARVAE	284	272	96	—	112	160	23	660	64	1671
Hyperiidea	16	—	—	—	—	—	32	—	10	58
CHAETOGNATHA										
Sagitta enflata GRASSI	112	96	48	32	8	144	21	1920	96	2477
Sagitta minima GRASSI	160	288	720	128	132	1632	112	1200	128	4500
Sagitta bipunctata QUOY-GAIMARD	16	48	17	16	9	—	—	480	—	586
Sagitta serratodentata KROHN	—	—	51	—	—	—	—	60	—	111
COPELATA	—	160	128	32	—	224	—	—	—	784
PTEROPODA	—	—	5	—	—	—	—	—	—	5
DOLIOLIDA	16	16	80	48	432	80	200	60	16	948
SALPIDA	—	—	—	608	96	160	100	600	16	1580
PISCES OVA	40	4	32	9	—	32	—	2	10	120
PISCES LARVAE	—	2	16	—	—	—	—	—	32	50
Total	6238	8966	10606	18800	6431	20864	21479	19332	9224	121940

Table 2 — Quantitative and qualitative analysis of food ingredients of the Hake (*Merluccius merluccius* L.), first year class, and adult Horse Mackerel (*Trachurus trachurus* L.) individuals caught by means of bottom trawl net during a day-time when dense concentrations bottom-layers echo--traces were registered.

Tabela 2 — Kvantitativno-kvalitativna analiza sastava hrane u oslića (Merluccius merluccius L.*), prvo godište, i saruna (Trachurus trachurus* L.*) lovljeni pomoću dubinske povlačne mreže (koče) za vrijeme dnevne svjetlosti, kada je na navedenim postajama bio jasno formiran donji dio difuznog sloja.*

Date	5/10/1968		1/30/1969		4/25/1968	
Hauling time	08.00—09.00		12.00—13.00		15.00—16.00	
Registered groups and species	Hake —	H. Mackerel N=1	Hake N=6	H. Mackerel N=3	Hake N=4	H. Mackerel N=5
EUPHAUSIACEAE						
Meganyctiphanes norvegica M. SARS	—	123	41	265	50	cc
Euphausia hemigibba H. J. HANSEN	—	—	—	5	—	—
Nyctiphane couchi BELL	—	240	97	759	80	cc
Euphausia Krohnii BRANDT	—	—	—	3	—	r
MYSIDACAE						
Lophogaster typicus M. SARS	—	—	32	—	15	—

N = number of examined stomachs; cc = stomachs full of species but uncounted because of its digestion; r = rarely

N = broj analiziranih želudaca; cc = želudac potpuno ispunjeni hranom, ali pak zbog stupnja probavljenosti brojčane vrijednosti izostavljene; r = rijetki primjerci

Table 3 — Hydrographic data of temperature, salinity and density collected during 1968/69 year

Tabela 3 — Prikaz hidrografskih podataka (temperatura, salinitet, gustoća) sakupljenih tokom 1968/69 godine

Depth (m)	January	March	April	May	July	August	October	December
				t°C				
0	13.33	12.70	17.00	19.85	21.15	21.55	19.99	15.20
10	13.50	12.66	15.41	18.48	19.80	21.26	19.77	15.30
20	13.84	12.56	14.44	18.81	17.36	17.42	19.50	15.76
30	13.80	12.76	14.42	18.44	16.94	16.91	17.07	15.78
50	13.83	12.66	14.34	15.86	15.53	15.51	15.69	15.70
75	13.82	12.68	13.87	14.85	14.86	14.88	15.07	15.58
100	13.85	12.83	13.50	14.34	14.28	14.29	14.54	15.48
150	13.87	12.85	12.58	13.61	11.80	14.65	15.20	14.78
175	13.91	12.58	12.22	11.70	11.20	11.98	13.48	13.92
				Sal ‰				
0	38.55	38.71	38.13	37.12	38.06	38.26	38.06	38.49
10	38.62	38.73	38.57	37.36	38.26	38.46	38.60	38.55
20	38.69	38.75	38.51	37.92	38.51	38.78	38.78	38.58
30	38.71	38.75	38.57	38.39	38.66	38.82	38.80	38.60
50	38.78	38.73	38.58	38.68	38.77	38.93	38.91	38.62
75	38.89	38.73	38.44	38.78	38.93	38.96	38.91	38.64
100	38.73	38.75	38.55	38.71	38.95	38.96	38.77	38.64
150	38.89	38.75	38.58	38.71	38.80	38.98	38.71	38.68
175	38.96	38.77	38.42	38.69	38.86	38.73	38.69	38.73
				τ t				
0	29.09	29.35	27.93	26.44	26.80	26.84	27.12	28.63
10	29.10	29.36	28.65	26.98	27.32	27.07	27.59	28.65
20	29.09	29.41	28.81	27.33	28.13	28.32	27.80	28.57
30	29.11	29.36	28.87	27.78	28.35	28.48	28.42	28.58
50	29.16	29.39	28.90	28.63	28.77	28.90	28.85	28.62
75	29.25	29.37	28.89	28.93	29.05	29.07	28.99	28.66
100	29.12	29.34	29.05	28.99	29.19	29.20	29.00	28.69
150	29.24	29.34	29.27	29.16	29.60	29.13	28.80	28.87
175	29.28	29.42	29.23	29.53	29.76	29.50	29.16	29.10

Table 4 — Distribution and appearance of Deep Scattering Layers (DSL) in the open central Adriatic during 1968/69 year registered by means of Echo-sounder »Simrad« type 580

Tabela 4 — Pojava i distribucija difuznog sloja (DSL) u srednjem otvorenom Jadranu tokom 1968/69 godine registrirana upotrebom ultra zvučnog detektora »Simrad«-580

Station No.	Depth (m)	Type of bottom	Year 1968/69 January	February	March	April	May	July	August	October	December
40	181	Clay/loam	+	+	+	+	+	+	+	+	+
43	220	Clay/loam	+	+	+	+	+	+	+	+	+
44	220	Clay	+	+	+	+	+	+	+	+	+
46	226	Loam	+	+	+	+	+	+	+	+	+
47	199	Loamy/clay	+	+	+	+	+	+	+	+	+
48	188	Clay/loam	+	+	+	+	+	+	+	+	+
50	262	Clay	+	+	+	+	+	+	+	+	+
52	188	Loamy/clay	+	+	+	+	+	+	+	+	+
53	181	Clay	+	+	+	+	+	+	+	+	+
54	168	Clay	+	+	+	+	+	+	+	+	+
56	192	Clay/loam	+	+	+	+	+	+	+	+	+
57	170	Loamy/clay	+	+	+	+	+	+	+	+	+
58	157	Loamy/clay	+	+	+	+	+	+	+	+	+
61	159	Loamy	+	+	+	+	+	+	+	+	+
62	157	Clay	+	+	+	+	+	+	+	+	+
66	130	Loamy	—	—	—	—	—	—	—	—	—
67	126	Sand	—	—	—	—	—	—	—	—	—
71	122	Sand	—	—	—	—	—	—	—	—	—
72	110	Sand	—	—	—	—	—	—	—	—	—
76	111	Sand	—	—	—	—	—	—	—	—	—

+ = positive stations where either »upper« or »bottom« layers were registered
— = negative stations, layers were not registered at all
+ = *pozitivne postaje, na kojima je registriran difuzni sloj, bilo pak gornji ili donji sloj*
— = *negativne postaje, difuzni sloj nije registriran*

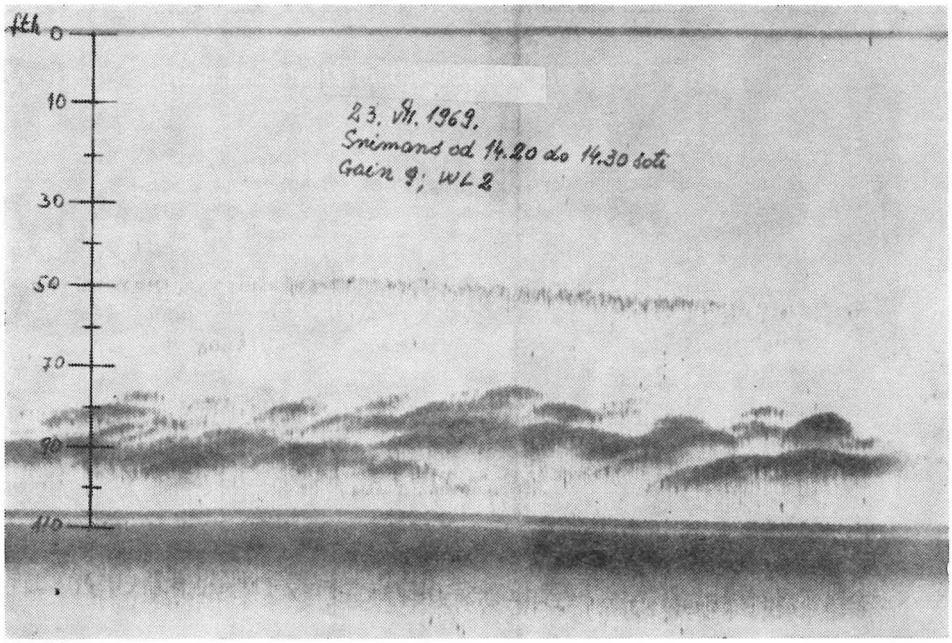

Fig. 4 — Ten minutes echo-survey fraction (from 14.20 to 14.30 hour) of the bottom layer in patchenees form. Vessel speed 3 knots, Echo-sounder 30 kHz, gain 9, WL 2

Slika 4 — Desetminutni snimak (od 14.20 do 14.30 sati) donjeg dijela difuznog sloja (DSL) u obliku manjih nepravilnih koncentracija. Brzina broda 3 Nm/sat, frekvencija aparata 30 kHz, osjetljivost 9, WL 2

DISCUSSION

A very comprehensive study of quantitative, qualitative and distribution aspects of the copepods along the eastern Adriatic coast (Gamulin, 1939) involves findings of two authors (Steuer, 1912; Leder, 1917) who on the base of plankton collections in the Jabuka pit, during »Najade« expedition, registered existence of *»Euchaeta-horizont«* during the summer of 1911—1914 year. According to their data, *»Euchaeta-horizont«* was evident on the depths from 30 to 150 metres and its formed three biological layers: first layer, characterized with presence of the small forms of copepods; second layer, from 20 to 100 metres, with *Euchaeta hebes* and *Calanus helgolandicus* species; third layer, from 100 metres to the bottom of the sea, called as »calanus layer« where dominate *»Euchaeta zone«* and *Calanus helgolandicus*. Discussing diurnal vertical migrations (Steuer, 1912) of the copepod *Euchaeta hebes* for the Jabuka pit region concluded that this species makes considerable vertical movements during a day-time was registered at a depth of 180 metres while at night-time was found in the surface sea layers. Hure (1961) studying diurnal and seasonal distribution of the zooplankton in the southern Adriatic has found that two copepods: *Euchaeta hebes, Calanus helgolandicus,* during the summer months, make a significant diurnal vertical migrations. Hoenigman (1964) analysing horizontal distribution of zooplankton

in the central and northern Adriatic concluded that appearance and distribution of the zooplankton have a seasonal character, influenced by hidrographical dynamics of the Adriatic basin, topography of the Adriatic and vertical movements of the plankton organizms from a deeper sea layers toward sea surface during the night. Vučetić (1966) studying vertical migrations of copepod *Calanus helgolandicus* in the Veliko jezero (sea lake) on the island Mljet in the central Adriatic, has found that summer thermoclina formed in the »lake« in range from 15°C to 18°C directly influenced vertical migration of the species. Same author (Vučetić, 1973) analysing relationship between distribution of the zooplankton in the central Adriatic with water circulation (ingression) from the eastern Mediterranean assumed that various batipelagial and Euphausids forms found in the central Adriatic are results of stronger water influence from the eastern Mediterranean basin.

Investigations in the Mediterranean that traet directly appearance of DSL in connection with biological factors were carried out by Moore (1950). Discussing DSL for the Mediterranean, author supposed that in the adjacent Mediterranean seas, should exist a higher concentrations of Euphausids and Mysisds forms, such as: *Meganyctiphanes norvegica, Nyctiphanes couchi.* Karlovac (1959), Županović (1963), Jukić (1973) investigating biology and ecology of the Hake population in the central Adriatic (Jabuka pit) have found that individuals of first year class mostly elect Euphausids: *Meganyctiphanes norvegica, Nyctiphanes couchi, Lophogaster typicus,* as a

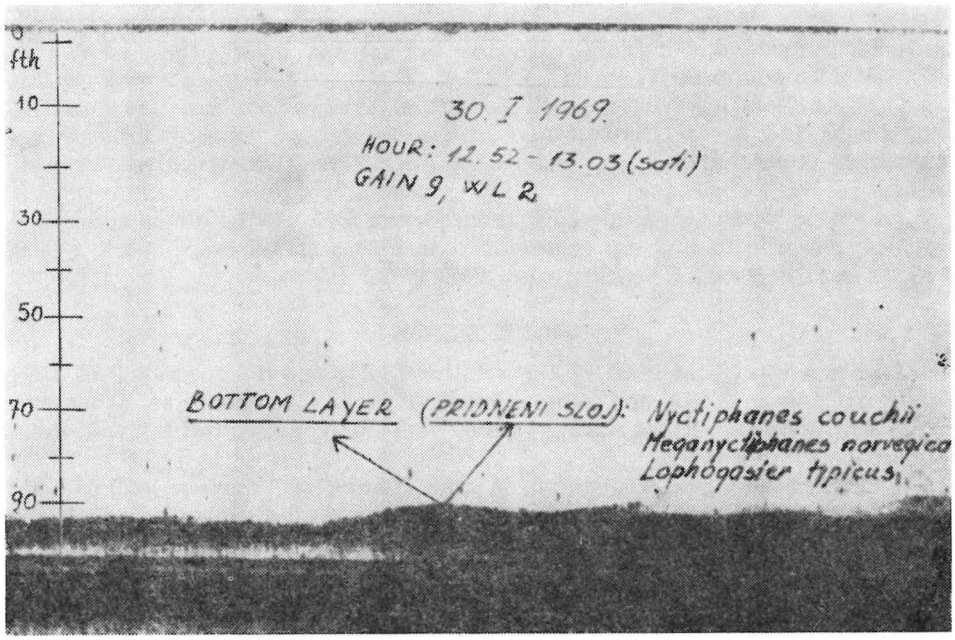

Fig. 5 — Ten minutes echo-survey fraction (from 08.05 to 08.15 hour) of the bottom layer registered. Vessel speed 3 knots, Echo-sounder 30 kHz, gain 10, WL 2

Slika 5 — Desetminutni snimak (od 08.05 do 08.15 sati) donjeg dijela difuznog sloja (DSL). Brzina broda 3 Nm/sat, frekvencija aparata 30 kHz, osjetljivost 10, WL 2

food during day-time. Jardas (1972) studying ecology and feeding habits of *Chondrichthyes* group of fishes (*Raja miraletus* L.) over the stations of clay-loamy bottom sediments in the Jabuka pit, stated that this fish consumed group of crustaceans *Schizopoda* where *Lophogaster typicus* made 25.4% of the bulk.

Our results of qualitative and quantitative plankton composition obtained by means of big stramin ring-trawl net during 1968/69 year significantly agree with earlier conclusions (Steuer, 1912; Leder, 1917) that calanoid copepods: *Euchaeta hebes* and *Calanus helgolandicus* have direct influence on formation of »Euchaeta-zone« whose phenomenon has been registered in the form of echo-traces, as upper layers on the recorder.

Food and feeding results of the Hake and Horse Mackerel populations during 1968/69 year (table 2) at day-time period pointed out evident relationship between presence and vulnerability of *Meganyctiphanes norvegica, Nyctiphanes couchi* and *Lophogaster typicus* species. In the months of dense concentration of Euphausids and Mysisds forms over the sea bottom, i. e. when formations were registered in the echo-traces shape on the recorder, examined stomachs of mentioned fishes were saturated with *Meganyctiphanes norvegica, Nyctiphanes couchi* and *Lophogaster typicus* (figures 2, 3, 4, 5). Our results have been supported Moore's (1950) hypothesis that in adjacent Mediterranean basins should exist a higher conceitrations of Euphausids and Mysids, populations prefering a lower sea temperature.

Measured lenghts of *Meganiyctiphanes norvegica* individuals might be related with a higher primarly production of the area, i. e. quantities of the nutrients: nitrate and phosphate in the bottom sea layers (Stojanoski, 1972; Vukadin & Stojanoski, 1974; Buljan & Stojanoski & Vukadin, 1973) in comparison with the other Adriatic regions. It seems that Euphausids and Mysiods populations of this region are zoogeographicaly isolated from those that live in the southern Adriatic and eastern Mediterranean regions.

As far as hydrographical data (table 3) and DSL formation is concerned, we were not able to find out relationship as it was stated by Clark (1933), Frassetto & Backus (1962) and Vučetić (1966).

CONCLUSION

Preliminar investigations of the relationship between appearance of Deep Scattering Layer (DSL) and some biological factors, zooplankton organizms, in the central open Adriatic during 1968/69 year have pointed out the following: following:

- DSL echo-traces registered in the Jabuka pit during 1968/69 year mostly appeared in two, in space, separated and biologicaly different layers: upper layer, dominantly formed of two copepods *Euchaeta hebes* and *Calanus helgolandicus* and bottom layer formed of *Nyctiphanes couchi, Meganyctiphanes norvegica* and *Lophogaster typicus* organizms
- formation of DSL layers was characteristic only for deeper stations, below 150 metres, of the clay-loamy bottom sediments
- it seems that hydrographical factors (temperature, salinity, density), in our case, did not directly influenced formation of DSL in the central Adriatic.

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PRILOG POZNAVANJU FORMIRANJA DIFUZNOG SLOJA (DSL) U SREDNJEM JADRANU U ODNOSU NA BIOLOŠKE FAKTORE MORSKE SREDINE

Stjepan Jukić

Institut za oceanografiju i ribarstvo, Split

KRATAK SADRŽAJ

U okviru ribarstveno-bioloških istraživanja stanja te racionalnih mjera eksploatacije demersalnih resursa srednjeg otvorenog Jadrana (Jabučka kotlina), koristeći ultra-zvučni detektor »Simrad«-580 na istraživačkom brodu m/b »Bios«, tokom 1968/69. godine registrirali smo postojanje i distribucije difuznog sloja (DSL). Difuzni se je sloj tokom godine javljao najčešće u dva, prostorno, odvojena sloja: gornji (slika 1) i donji sloj (slika 2, 4, 5). Tokom dnevne svjetlosti, gornji je sloj, veoma često, podijeljen u dva manja sloja (slika 4), a u večernjim satima vrši znatna vertikalna pomicanja prema površini mora. Za razliku od gornjeg sloja, donji sloj se tokom čitavog dana, manje-više, zadržava pri morskom dnu, te nema tendenciju vertikalnih pomicanja. Registrirani znakovi difuznog sloja, na ultra-zvučnom detektoru najčešće su formirali horizontalne znakove, izuzev u slučaju slike br. 4, širine i do 20 fth (slika 1). U studiranom području, difuzni je sloj registriran na dubljim postajama, ispod 150 metara, koje karakterizira glinasto-ilovasti facijes taloga morskog dna. Pliće postaje, koje se nalaze između izobata 100 i 150 metara (tabela 4), označene su kao negativne postaje, budući da u istraživanom periodu nijednom nije registrirano postojanje - formiranje difuznog sloja.

U studiji povezanosti formiranja difuznog sloja (DSL) u ovom dijelu Jadrana i bioloških, zooplanktonskih, komponenata morske sredine, korišteni su slijedeći izvori bioloških podataka:

1. planktonske lovine prikupljane mjesečno uz pomoć velikog stramina ∅ 2 metra;
2. kvalitativan sastav hrane u semi-pelagičnih riba: oslić *(Merluccius merluccius* L.) i sarun *(Trachurus trachurus* L.), lovljene dubinskom povlačnom mrežom (kočom).

Podaci kvantitativno-kvalitativnog sastava planktonskih lovina (tabela 1) od 150 do 0 metara, ukazuju da dvije vrste kopepoditnih račića: *Euchaeta hebes* i *Calanus helgolandicus* tokom godine dominiraju u sastavu planktona ovog područja, te na osnovu toga vjerujemo da navedeni organizmi imaju i direktan utjecaj na formiranje, distribuciju i ponašanje gornjeg dijela difuznog sloja registriranog na ultra-zvučnom detektoru.

Podaci sastava hrane u oslića i saruna (tabela 2), osobito u mjesecima jačeg formiranja donjeg dijela difuznog sloja, ukazuju da eufauzidni i mizidni rakovi: *Nyctiphanes couchi, Meganyctiphanes norvegica* i *Lophogaster typicus* formiraju donji sloj.

Na osnovu prikupljenih i obrađenih podataka moguće je konstatirati, da na formiranje, distribuciju i ponašanje difuznog sloja (DSL) u ovom dijelu Jadrana, biološke-zooplanktonske komponente morske sredine imaju dominantnu ulogu.