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# INVESTIGATIONS OF THE *FURCELLARIA LUMBRICALIS* DISTRIBUTION AND ABUNDANCE AT THE EASTERN COAST OF THE BALTIC SEA.

by

Korolev, A., Kuznetsova, T., Drozdetsky, V.

Latvian Fisheries Research Institute
6 Daugavgrivas Str., Riga, Latvia, LV-1007

Abstract

Aerial photography of shallow waters and monitoring of *Furcellaria* lumbricalis distribution and state using underwater TV-system and sampling by SCUBA divers were done on 280 stations in Kaliningrad area, Lithuania, Latvia and Estonia from 1980 to 1990. The maps of grounds and distribution of dominant species were made, trends in changes of abundance of *Furcellaria lumbricalis* were determined and investigated. During the period from 1978 to 1990 total stock of *Furcellaria* in the region Klaipeda - Ventspils decreased from 86,000 to 13,000 tons. Thus spawning grounds along Lithuanian coasts have almost lost their natural substratum. The main decrease of the *Furcellaria* amount was determined after the accident with oil tanker "Globe Asime" near Klaipeda. The most valuable coastal *Furcellaria* biocenoses with high reproductive capacity and biodiversity and natural spawning grounds have remained in Pape - Liepaja area in Latvia. Since 1982 on the underwater research sites Pape experiments on restoration of algal areas by means of artificial substrata have been conducted.

## 1. INTRODUCTION

Investigations show that in the coastal area in percentage value predominates sand grounds that may be characterized with small specific biodiversity of hydrobionts and comparatively low level of bioproductivity.

On the contrary the stone bottom structures play a significant role in the forming of coastal ecosystems. All main species of macrobenthos are concentrated in these areas. The main biocenose of Eastern Baltic Coastal Area: *Mytilus edulis -- Furcellaria lumbricalis*, that characterizes the intensity of self-purification processes and bioproductivity in the coastal waters the special value has.

*Furcellaria lumbricalis* being the dominant species (by biomass) in such a biocenoses serves as a spawning substratum for Baltic herring (*Clupea horengus membras*) and raw material for the manufacturing of agar-agar in Latvia and Lithuania.

Examination of *Furcellaria*'s stock near the Lithuanian and Latvian coast using the drag was started by M. Kireeva in 1955. (Kireeva, 1960). In 1956 the works were continued in the area of Karklininkai - Shventoi by using scuba divers. The works were done on 5 sections and 14 stations. The average biomass and stock of *Furcellaria* in that region wasn't determined. In the publications of that time approximate figure of the total stock of *Furcellaria* in the open part of the Baltic Coast was 80 - 90 thousand tons.

The expedition works for the purpose of investigations of the *Furcellaria*'s stock near the Lithuanian coast and small parts of Latvian coast (up to Pape area) were carried out in 1968 - 1969 years by E. Blinova (Blinova, Tolstikova, 1972 ). At that time the total biomass of *Furcellaria* in that region was estimated, distribution of the projective covering was determined and biomass mapping was done.

The examination of whole stock and abundance of *Furcellaria* in the Kaliningrad area, Lithuania, Latvia, islands of Saarema and Hijuma in Estonia were executed in the period from 1973 till 1980 by E. Prytkov, A. Korolev and H. Kukk. (Korolev, Muravsky, Prytkov, 1983; Kukk, 1978).

From 1980 till 1991 À. Korolev managed the monitoring of the main stock of *Furcellaria lumbricalis* in the Klaipeda - Ventspils region.

## 2.MATERIALS AND METHODS.

The efficiency of research works and investigations of seaweed in the Baltic depends mainly on the methods and conditions under which the works are carried out.

The works of 1955 were managed by using drags that didn't permit to obtain the correct data on the stone bottoms. That is why all investigations that followed were based on the scuba diving sampling. The diving samplings were managed on the stations at 6 to 20 m depth in the coastal zone of Baltic Sea and in range 1.5 - 13 m in the Gulf of Riga. The stations were situated in the sections that were perpendicular to the shore line. The distance between sections varied from 0.5 to 2 km.

Within each station the value of projecting covering of seaweeds was determined visually. At the same moment two samples using the frames of 0.25 $m^2$ were taken there. According to the data obtained the value of average biomass of each alga species were determined. Because of the high labor-intensity of such method we couldn't examine all regions where *Furcellaria* grew during one field season. So, the borders of the algae areas weren't determined correctly.

The combination of these two methods with the aerial photography of shallow waters followed by the scuba diving sampling on the test stations turned out to be the most effective.

The monitoring of the main stock of the abundance of *Furcellaria* based on using the underwater TV system, supplemented with the diving sampling. The areas and kinds of works, that had been done during the period from 1973 to 1986 are shown in Fig. 1.

Aerial-visual observations were done from the helicopter Mi-2 and aircraft Il-14. Aerial photography from the board of Il-14 airplane showed that the most favourable time for doing such work in the Eastern Baltic is the period from 10 May to 20 June, when high transparency of water before the beginning of intensive development of phyto- and zooplancton combines with the propitious meteorological conditions -

insignificant clouding, (driving away) winds of the low power, and the minimum of rough sea.

Aerial methods allowed us to determine all places where both alga and mussels areas were situated, to point out their borders, and to truss them with the shore marks in the short time. Photographies allowed to point out a straight grid of stations for the further underwater investigation. The level of transparency on the pictures allowed to determine the high and middle border of the areas. The lower borders of seaweed growing were defined by the underwater television and divers.

Sampling and mapping of coastal water ( 0 - 30 depth) benthos and macrophytes communities were carried out using underwater TV system IBAK UF-9 and scuba diving. The basic monitoring stations were situated at the depth of 7, 10, 13, 15 and 20 m of the sections that were perpendicular to the shore and 2 - 5 km apart. Location of the stations was defined using ship radio-locator navigation system with the appropriate for this equipment precision. While the boat was drifting within the station area the video signal of bottom image was recorded so, 200 x 1.2 m section of surface was described for analyzing later. About ten percent total stations (situated mainly among 5 and 20 m depth) where the visual projective covering of macrophytes was maximal were the test sampling stations. The samples of periphyton and macrophytes had been taken by scuba divers from the 0.25 m x 0.25 m site. Some control sites on the surface of the artificial reefs, which were applied in the underwater polygon near Pape were used as the permanent sampling stations, but the data, obtained from them can't be representative for general ecological situation evaluation in Latvian coast, because those stations mainly were devoted to evaluate our attempts of ecological rehabilitation and restoration of *Furcellaria* stock in Pape area.

The identification and analytical treatment of samples were done according to the standard techniques. The result was calibrated biomass of *Furcellaria lumbricalis* and other species, that provide calculation of the multiplier for transformation of the coefficient of the macrophytes projective covering (visually determined from the video records) into the biomass value in order to map spatial distribution of dominant species biomass (kg/sq.m).

## 3. RESULTS.

In the Eastern Baltic *Furcellaria* grows in two forms – attached to the stone bottoms and floating one. The attached form is concentrated in the shallow waters of Kaliningrad area, Lithuanian and Latvian coast, but the floating form exists only in the Kassary Bay of Estonia. Total stock of that kind of algae was estimated since 1976 as 130,000 tons (Table 1.)(Muravsky, Korolev, Kuznetsova, 1988).

Table 1.Distribution of the total stock of *Furcellaria lumbricalis* (tons of wet weight) being estimated since 1976.

| REGION | 1976 | 1986 |
|---|---|---|
| ESTONIA | | |
| Kassary Bay | 30,000 | 20,000 |
| Saaremaa and Hijuma islands | 12,000 | 12,000* |
| LATVIA | | |
| Gulf of Riga | 2,500 | 2,000* |
| Ventspils – Pape | 60,000 | 29,700 |
| LITHUANIA | | |
| Shventoi – Klaipeda | 25,000 | 0,300 |
| KALININGRAD AREA | | |
| Zelenogradsk – Baltijsk | 500 | 0,000 |

* - Expert value

The maximal biomass of *Furcellaria* in the area of Girulai - Liepaja reaches 3 kg/$m^2$, with the projective covering up to 100 %. This species is dominant one (about 90 % of mass) On the stone grounds of the Eastern Baltic. Gulf of Riga was found, to be an exclusion, where the dominant is *Fucus vesiculosus* (up to 80 %) and in Saarema island (up to 60 - 70 % of total mass of algae in that region).

The monitoring of *Furcellaria* stock that has been carried out by LatFRI in the Klaipeda - Ventspils area since 1980 shows that we have the stable tendency of decrease of *Furcellaria*'s stock. The dramatic decrease was determined after the accident with oil tanker "Antonio Gramshi" near Ventspils in 1979 and "Globe Asime" near Klaipeda in 1981 (Fig. 2.). Thus, during the period from 1981 to 1986 general stock of *Furcellaria* in the region Klaipeda - Ventspils decreased more than 2.5 times ( from 80,000 to 30,000 tons). Spawning grounds along Lithuanian coasts have almost lost

their natural substratum that is followed by their complete deterioration. In the recent time the *Furcellaria* stock is estimated about 13,600 tons, Akmenrags - Liepaja - 3,000 tons, Liepaja - Pape - 10,000 tons, Palanga - 600 tons.(Korolev, Kuznetsova, Drozdetsky, 1992). The floral structure of different region of Eastern Baltic discribed in table 2.(Kuznetsova, Drozdetsky, Korolev, 1989). On one hand that decrease took place because of the decline of the area of growth, and, on the other hand because of the decline in the average and maximal projective coverings and biomass of seaweeds. Other tendencies that have been observed for the last decade are the following: 1) seaweeds disappear from the northern parts of the area, i.e. in the Ventspils - Akmenrags area and on the southern part — Girulai - Palanga; 2) the maximal biomass was declined from 1000 to 400 g/$m^2$, and projective covering — from 100 to 30%; 3) the stock in Kassary Bay decreased to 20,000 tons; 4). Baltijsk - Zelenogradsk algal area has absolutely disappeared; 5) decrease of Fucus amount in Riga's Bay has been determined; 6) the estimated stock of floating form of *Furcellaria* near the Estonian islands - Saaremaa a remains on the same level; 7) the only one comparatively stable stock of *Furcellaria lumbricalis* in Eastern Baltic in recent time is left within the Pape - Perkone area in Latvia. (Fig 1,3./

From 1982 to 1990 we dealt with the problem of recovery of abundance of *Furcellaria lumbricalis* and its cultivation in the Eastern Baltic.

The investigations have been done in two directions:

- cultivation of the alga fragments on the flexible collectors /Fig.4 a,b/ (Korolev, Kadnikov, Kuznetsova etc. 1990).

- introduction and cultivation of alga on the surface of artificial reefs (mostly because of the natural sedimentation and catching on of alga fragments torn of by storms).(Korolev, Kuznetsova, Kadnikov, etc,1989).

For realization of the first direction the special technique and arrangement for the attachment of the algae fragments were elaborated. When fragments of alga were attached they were growing on the flexible collectors of the permanent type in the coastal zone for 3 years. The collectors (height - 5m) was arranged at the depth of 12.5m on the underwater research sites Pape. Increase in mass and lenght of Furcellaria on the collectors for 1 year were 64.9 and 54.6 per cent respectively. The speed of grow of algal fragments

depended on the collector height. At the depth 5m the growth of mass and lenght was lower, than at the bigger depth. It was connected with intensive overgrowth of collector upper parts. They were occupied by blue mussels which biomass reached 4.5 kg per $m^2$ after 3 year of exposition.(Fig 5). As a result, collectors were lowered on the bottom. (Korolev,1991).

The second mode of settling – by using of artificial reefs was the most effective.

For the realization of that idea the various types of artificial reefs were elaborated,designed, made and installed in the coastal zone (Fig 6). In order to provide complete information about the process of natural fragmentation of furcellaria during the autumn storms we did research on the subject of storm landing of furcellaria on the plagues of Lithuania and Latvia, that provides the main source of red algae for agar-agar production in the Eastern Baltic.

The reefs for the alga settling were made of the reinforced concrete and used net including the fluffing up ends of the kapron rope - the most effective catchers (was found experimentally) for free *Furcellaria* fragments(Fig.7). Those constructions were installed along the direction of water drift. The secondary succession taking place there some month later began with the *furcellaria* fragments being caught by the fluffing up ends of the kapron rope of the reef surface and after three years of exposition the new rich biocenose of *Furcellaria lumbricalis*, *Mytilus edulis*, *Balanus balanus*, various *Gamaridae* and *Polychaeta(Fig 8)*, *table 3* species was formed not only on the surface of the reef but also all over the place near the experimental reef.(Korolev, Kuznetsova, Kadnikov, 1991).

In comparison with the surrounding natural biocenoses the biomass of main biological objects in the reef area was two times larger. The special biodiversity also exceeds such parameter for the natural biocenoses.

References

Blinova E.I., Tolstikova N.E.,1972.
Zapasi promislovoy agaronosnoy vodorosly Furcellaria Fastigiata (Huds) Lamouz i Beregov Litvy. Rastitelnye resursy - 8. Akademija Nauk.M. p.380-388.

Kireeva M.S. 1960.
Raspredelenije i biomassa vodoroslej Baltijskogo morja. Trudy WNIRO. Tom 42. p.195-205.

Korolev A.P.,Muravsky V.I., Prytkov E.I. 1983.
Shtormovye vybrosy furceljarii na poberezhje Baltijskogo morja i ih osnovnye kharakteristiki. Riga. V kn. "Rybokhozjaistvennye issledovanija v basseine Baltijskogo morja" vypusk N18. p.95-102.

Korolev A.P., Kuznetsova T.A., Kadnikov V.B., Nazarenko A.N. 1989.
The use of the artificial reefs for the melioration of the Baltic Sea. Moscow.WNIRO. In: Proceeding of Intern. Conf. "To-days problems of marine culture". p.58-60.

Korolev A.P., Kadnikov V.B., Kuznetsova T.A., Muravsky V.I., Nazarenko A.N., Zake A., Drozdetsky V.G. 1990.
Investigation of the application of the artifical constructions in the coastal region of the Baltic Sea. Moscow. WNIRO. In: Artificial relfs for the fisherij farms. p.166-176.

Korolev A.P., Kuznetsova T.A., Drozdetsky V.G. 1991.
Monitoring of stock of agar-rich sea weed in the coastal region of the Baltic Sea.
Riga. University of Latvia. In: Proceedings of Intern. Conf. "Methods of investigation and the use of hydrosystems". p.64-65.

Korolev A.P. 1991.
Peculiarities of the application of artificial reefs and substrates in coastal region of the Baltic Sea. Riga. University of Latvia. In: Proceeding of Intern. Conf. "Methods of investigation and the use of hydrosystems". p.173.

Korolev A.P., Kuznetsova T.A., Kadnikov V.B., Drozdetsky V.G. 1991.
Artificial reefs in the coastal zone of the Baltic Sea. Rostock. Fischerei-Forschung. 2.p.57-60.

Kukk H. 1978.
Bottom vegetation in the southern coastal waters of the Gulf of Finland. Botanicheskij zhurnal. Tom 63. N6. p.844-852.

Kuznetsova T.A., Drozdetsky V.G., Korolev A.P. 1989.
Izuchenie sostojanija, raspredelenija i izmenenija zapasa furceljarii v pribrezhnoj zone Baltijskogo morja. Sevastopol. Tez. dokladov IV Vsesojuznoj nauchno-tekhnicheskoj konferencii "Vklad molodyh uchenyh i specialistov v reshenie sovremennyh problem okeanologii i gidrobiologii".p.6.

Muravsky V.I. Korolev A.P., Kuznetsova T.A. 1988.
Sostojanie zapasa furceljarii v Baltijskom morje i vozmozhnosti ejo vosstanovlenija.
Moscow. Rybnoe khozjaistvo. N3. p.13-14.

Table 2

**Floral structure of different regions of Eastern Baltic**

| N | Region | Number of species | Number of common species | Coefficient of community of species (per cent) |
|---|---|---|---|---|
| 1. | Klaipeda<br>a) s.Klaipeda<br>b) t.Palanga | F. lumbricalis | 0 | |
| 2. | Pape | F. lumbricalis<br>Phyllophora truncata<br>Enteromorpha intestinales<br>Ceramium rumbrum<br>Ceramium tenuicorne<br>Ectocarpus confervoides<br>Hildenbrandtia prototypus | 1 | 14.3 |
| 3. | Bernati | F.lumbricalis<br>Phyllophora truncata<br>Enteromorpha intestinales<br>Ceramium rumbrum<br>Ceramium tenuicorne<br>Ectocarpus confervoides<br>Polisiphonia nigrescens<br>Hildenbrandtia prototypis | 7 | 87.5 |
| 4. | Liepaja | F.lumbricalis<br>Phyllophora truncata<br>Enteromorpha intestinales<br>Cladophora glomerata<br>Pilayella litoralis<br>Ceramium rumbrum<br>Ceramium tenuicorne<br>Ectocarpus confervoides | 8 | 60 |

Table 3

Overgrowth of artificial reef in coastal zone of Baltic Sea on the depth 12m.after 1 year exposition

| Site of reef | | Species | Number per m | Biomass kg per m |
|---|---|---|---|---|
| Float | | Balanus | 30.000 | 2,800 |
| | | Mussel | 480 | 0,250 |
| Collectors from net | | Balanus | 7.000 | 1,300 |
| | | Mussel | 390 | 0,210 |
| | | Seaweed | 21 | 0,120 |
| The top of reef | Inside of reef | Balanus | 2.000 | 2,000 |
| | | Mussel | 6.300 | 0,600 |
| | Outside net | Balanus | 1.500 | 1,500 |
| | | Mussel | 1.000 | 0,450 |
| Bottom part | Inside of reef | Balanus | 18.000 | 1,900 |
| | | Mussel | 400 | 0,250 |
| | Outside of reef | Balanus | 10.000 | 1,200 |
| | Outside net | Balanus | 9.500 | 1,000 |
| | | Balanus | 3.900 | 0,550 |
| | | Mussel | 4.000 | 0,600 |
| | Inside net | Furcellaria | 40 | 0,400 |
| Surface of ballast | | Balanus | 2.500 | 0,700 |
| | | Mussel | 340 | 0,210 |

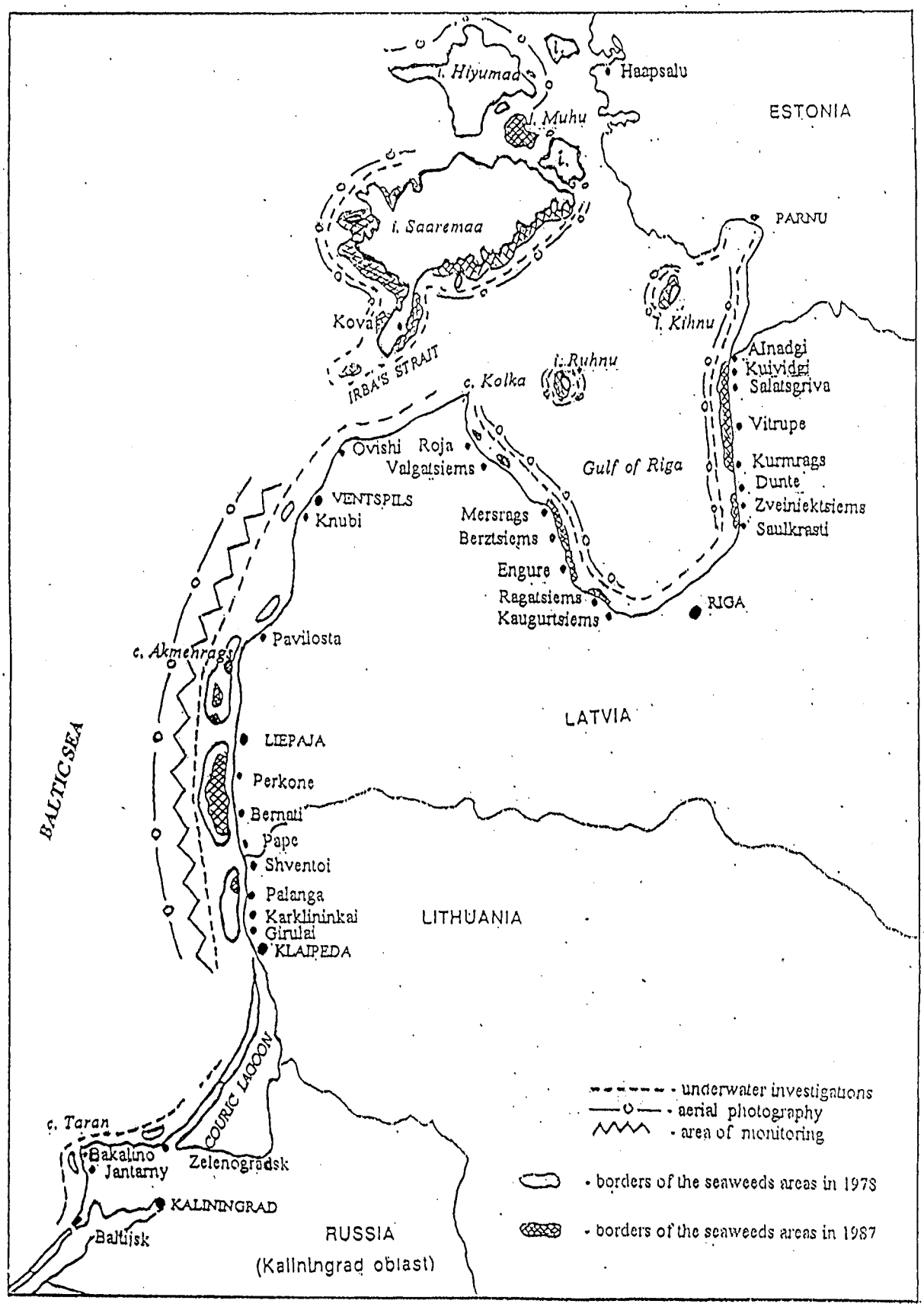


Figure 1 Works of LatFRI in coastal zone of Eastern Baltic and distribution of the seaweeds areas

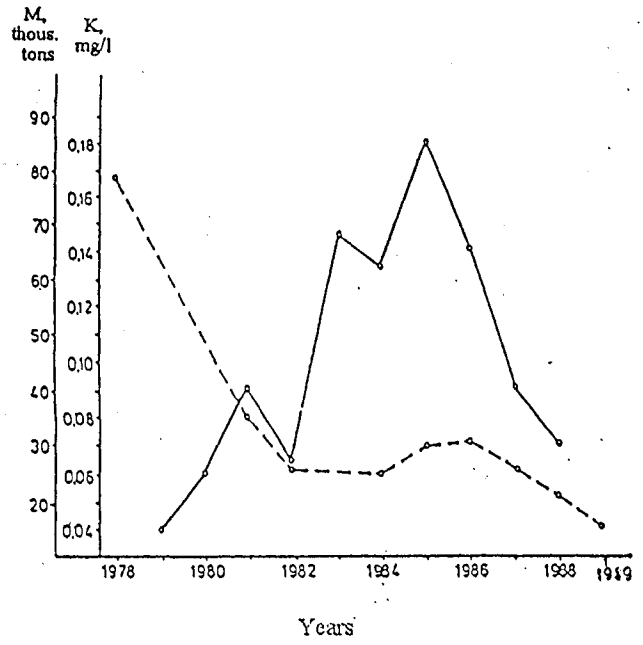


Figure 2 Dynamic of the stock Furcellaria lumbricalis and concentration of petroleum hydrocarbons in Klaipeda-Ventspils region of Eastern Baltic

_____ concentration of petroleum hydrocarbons (K), mg per liter

---------- stock of Furcellaria lumricalis (M), thous. tons.

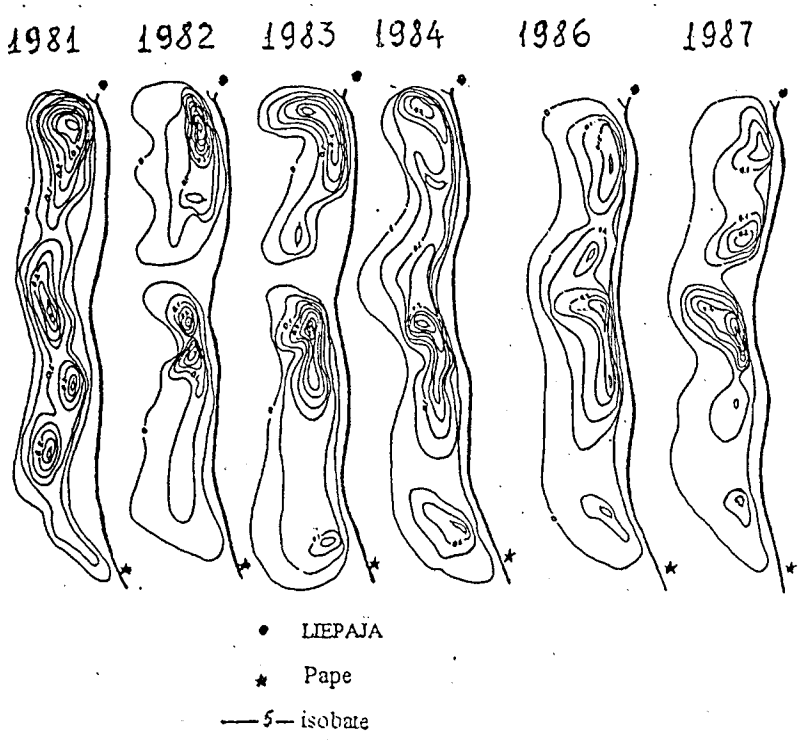


Figure 3 Dynamics of the distribution of the *Furcellaria lumbricalis* (kg per $m^2$).

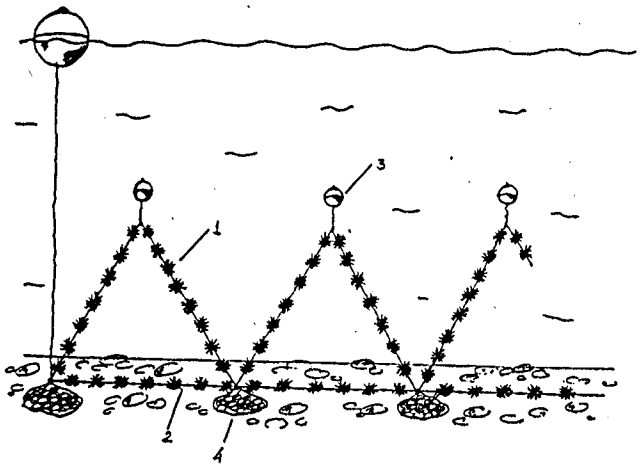


Figure 4 a) Algae cultivation collector
1 - rope with the tied-up pieces of kapron wire
2 - footrope
3 - float
4 - load

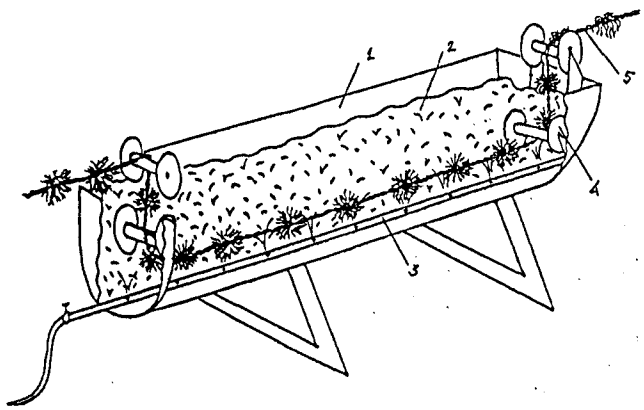


Figure 4 b) A tank for fixing of the fragmented algae.
1 - bath;
2 - algae fragments;
3 - airpumping pulp;
4 - collector pulling rollars
5 - collector

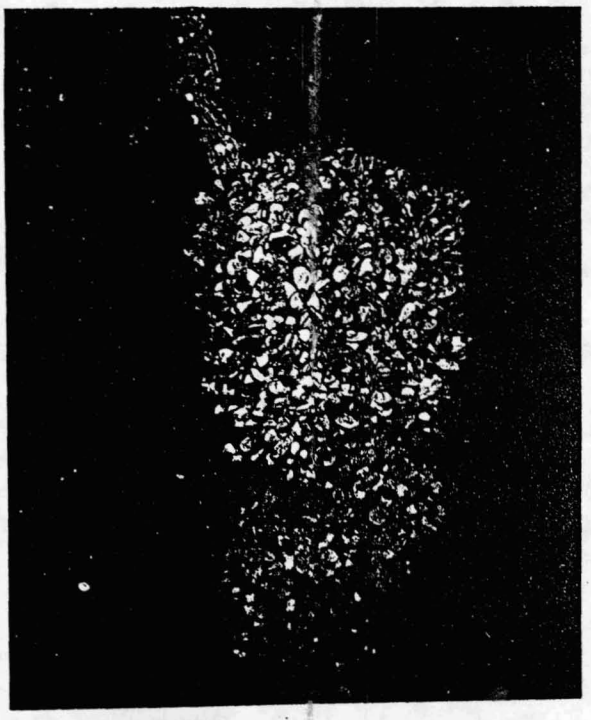

Figure 5 Blue mussels on the kapron net of the collector.

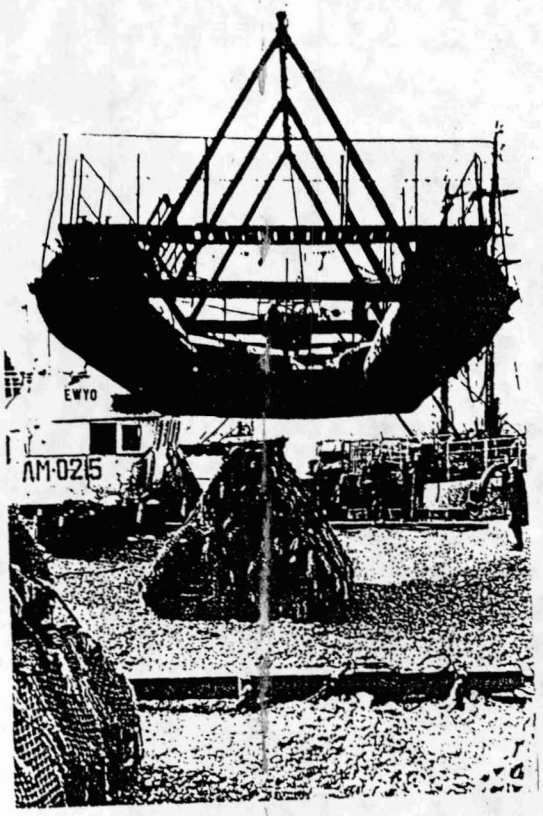


Figure 6 Artificial reef made of used tyre-covers and net with the fluffing up ends of the kapron wire for settlement of the algae. Transportation ponton on the upside.

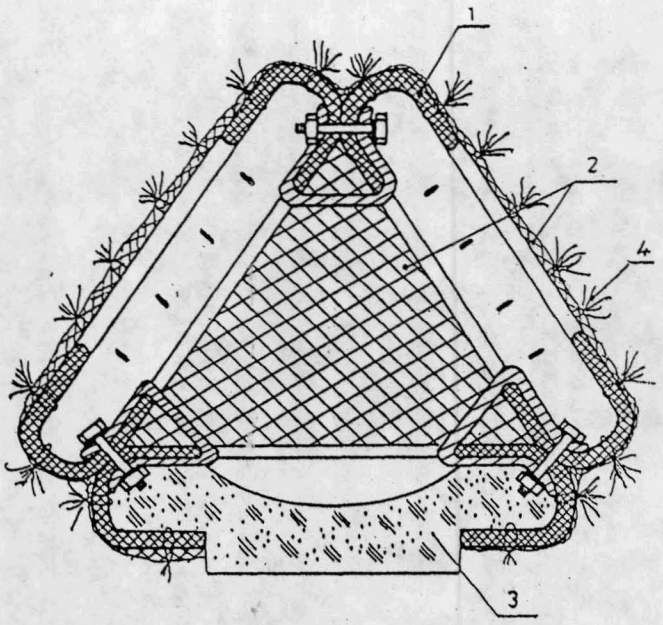


Figure 7 Section of reef
1 - framework
2 - net
3 - ballast
4 - fluffing up ends of the capron wire

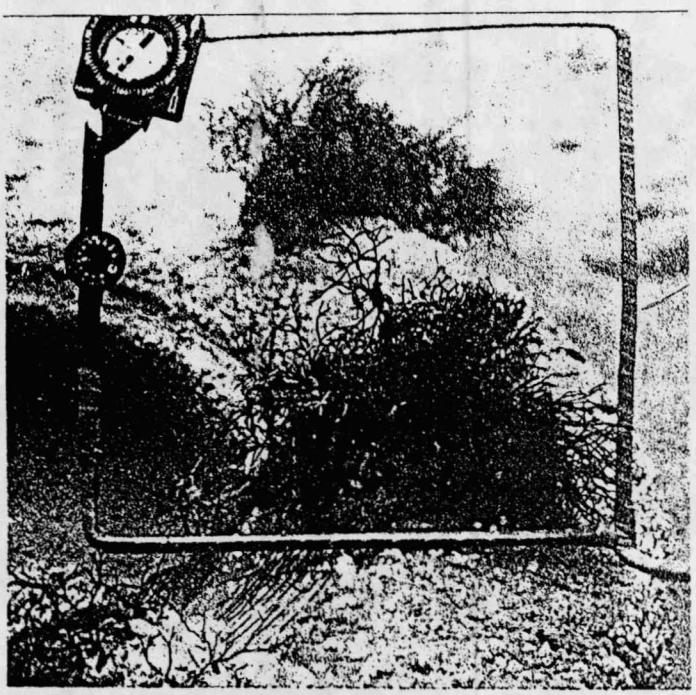

Figure 8 Biocenoses of *Mytilus edulis* and *Furcellaria lumbricalis* on the surface of the artificial reef after 3 years of exposition.