

TRAWL BAG SELECTIVITY IN THE *CHAMPSOCEPHALUS GUNNARI* FISHERY

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Abstract

Experiments on trawl bag selectivity during fishing on pre-spawning concentrations of *Champscephalus gunnari* were carried out in June 1990 in the South Georgia area concurrently with trawl surveys as part of the main biological and oceanic research program. The results presented here are based on 29 hauls and, due to the limited time available for experiments, should be considered as preliminary. $L_{50\%}$ was 24.8 cm and the selectivity factor was 3.10 for a mesh size of 80 mm. Comparison of these results with results from previous years demonstrates close similarity. A significant increase in modal length (up to 34-35 cm) as well as earlier sexual maturation of fish were noted. It was suggested that the use of Polish type chafers and a reinforced outer cover on trawl bags reduces the stress on the mesh threads and increases mesh openings therefore enhancing their selectivity properties. Further experiments are recommended in order to fully understand the mechanism involved.

Résumé

Des expériences sur la sélectivité des poches de chalut au cours de la pêche effectuée sur des concentrations de *Champscephalus gunnari* en état de préonte furent tentées en juin 1990 dans la région de la Géorgie du Sud, ainsi que des campagnes d'évaluation par chalutage, dans le cadre du programme principal de recherche biologique et océanique. Les résultats présentés dans cette communication sont basés sur 29 traits et, étant donné le peu de temps disponible pour les expériences, devraient être considérés comme préliminaires. $L_{50\%}$ était de 24,8 cm et le facteur de sélectivité de 3,10 pour un maillage de 80 mm. La comparaison de ces résultats avec ceux des années précédentes révèle une étroite similarité. L'augmentation importante de la longueur modale (atteignant 34 - 35 cm) a été notée, de même que la maturation sexuelle plus précoce des poissons. Il a été avancé que l'utilisation de tabliers de type polonais et d'une couverture renforcée à l'extérieur des poches de chalut réduit la pression sur les fils du maillage et augmente l'ouverture de la maille, améliorant ainsi les propriétés de sélectivité. Des expériences complémentaires sont préconisées afin de mieux saisir le mécanisme en jeu.

Резюме

В июне 1990 г. одновременно с траловыми съемками, являющимися частью основной программы биологических и океанических исследований, были выполнены экспери-

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менты по селективности мешков тралов при облове преднерестовых концентраций *Champocephalus gunnari* в районе Южной Георгии. Представленные результаты были основаны на данных, полученных по 29 тралениям. В связи с тем, что время, предоставленное для проведения экспериментов, было ограничено, данные результаты следует рассматривать как предварительные. Для ячеи размером в 80 мм величина $L_{50\%}$ равнялась 24,8 см и фактор селективности - 3,10. Сравнение этих результатов с полученными за предыдущие годы указывает на их близкое сходство. Было отмечено значительное увеличение модальной длины (до 34-35 см), а также более раннее наступление половозрелости рыб. Высказывается предположение о том, что использование фартуков, применявшихся при промысле Польшей, и силовых внешних покрытий траловых мешков снижает нагрузку на волокна ячеи и увеличивает их открытие, улучшая таким образом селективность трала. Для полного понимания данного механизма рекомендуется провести дополнительные эксперименты.

Resumen

Dentro del programa principal de investigación biológica y oceánica, se realizaron experimentos de selectividad con redes de saco, los cuales se compaginaron con prospecciones de arrastre. Estos estudios se llevaron a cabo en junio 1990, en la zona de Georgia del Sur y se centraron en las concentraciones de *Champocephalus gunnari* durante la época previa al desove. Los resultados presentados en este trabajo se basan en 29 lances, pero debido a las limitaciones de tiempo dedicadas a los experimentos, deberán considerarse como preliminares. Para una luz de malla de 80 mm. se obtuvo un $L_{50\%}$ de 24.8 cm y un factor de selección de 3.10. Cuando se comparan dichos resultados con los de años anteriores, se ve que existen ciertas similitudes entre ellos. Se ha constatado un incremento importante de la talla modal (hasta 34 o 35 cm), así como una madurez sexual más temprana de los peces. Se indica que, el uso de protectores del copo polacos y de un forro reforzado en el exterior de la red de saco, disminuyen la tensión soportada por los hilos de la red y aumentan la abertura de las mallas, con lo que se obtiene una mejora de las propiedades de selección. Se recomienda la realización de nuevos experimentos con el fin de comprender mejor los mecanismos de este proceso.

1. INTRODUCTION

Results of experiments on trawl bag selectivity in the *Champocephalus gunnari* fishery are presented in this work. Experiments were carried out on board BMRT *Anchar* in June 1990 in the South Georgia area concurrently with trawl surveys within the main biological and oceanic research. Due to the limited time that was available, the following material should be viewed as preliminary. Extensive theoretical and experimental research on trawl bag selectivity

in the *C. gunnari* fishery should be conducted in the near future on the basis of this material. The paucity of data obtained from experimental work has made it necessary to include the results of previous studies.

Experiments were conducted on board the *Anchar* by Dr V.G. Bidenko (AtlantNIRO) and engineer I.G. Istomin (VNIRO) who were greatly assisted by the scientific team and the crew.

2. SCHEDULE AND AREA

Selectivity hauls were made from 17 to 20 June 1990 in an area having the mean coordinates of 54°25'S, 38°10'W at depths of 230 to 250 m. The four-mile-long fishing site extended in a north-south direction and had a sand-silt bottom.

Mean swell was approximately five on the Beaufort scale, atmospheric temperature from -1° to +2° and surface water temperature about 1.3°. No strong currents were registered.

Trawling was carried out 24 hours per day in both directions (wind permitting). The target species comprised from 80 to 100% of catches.

3. MATERIALS AND METHODS

BMRT *Anchar* is a stern freezer trawler with a displacement of 2 120 tonnes and a main engine of 2 000 hp.

Fishing gear was a standard soviet-made four-panel kapron¹ trawl "Khek-4M", used for fishing for bottom and off-bottom species (Figures 1 and 2). The triple-cable rigged (cable length - 100 m) trawl was equipped with a ground rope having 300 and 400 mm diameter bobbins and metal triple-slitted 5.5 m² trawl-boards with a dry weight of 1 780 kg (Figure 3).

Trawling speed during the study was from 3.0 to 3.4 knots. The trawl had a vertical opening of 7.5 m; the distance between the boards was 68 m when 550 m long wires were used.

A standard four-panel trawl bag type 7173 used in the *C. gunnari* fishery was used in the selectivity study. The double twine of the single-layer trawl bag was made of spun kapron fibres 3.1 mm in diameter. The nominal mesh size was 80 mm.

Investigations followed a methodology which incorporates the basic principles generally adopted for selectivity experiments (Treschev, 1974; VNIRO, 1983, AtlantNIRO, 1989 a, b) with a few modifications. These changes made it possible to consider more fully the nature of the fishery and the specific problems to be addressed.

The trawl bag was equipped with nine 5.8 m long bands of 35 mm kapron rope which were evenly spaced along the codend part of the trawl bag at 1.3 m intervals. The bag was then placed in a fine-meshed outer cover (fish retaining bag) larger than the bag itself and enveloping the entire trawl bag. To prevent damage caused by contact with the bottom and during hauling, it was also covered with 8.6 m long bands of rope. The rear 9 m of the outer cover was sheathed with heavy duty webbing. The lengthwise edges of the outer cover were reinforced by four kapron side ropes. The front part of the outer cover was attached to the front of the

¹ a USSR-made polyamide-6 fibre

trawl bag along its external perimeter while the back part of the outer cover, which is 2 m longer than the trawl bag, was equipped with its own codend rope. The nominal mesh size of the outer cover was 35 mm, which ensured the retention of all fish passing through the trawl bag.

In order to prevent damage and undue wear and tear to the outer cover, trawling ceased when a catch of 5 to 6 tonnes had been taken.

The weight of fish retained in the trawl bag, as well as the weight of the fish passing into the outer cover, was determined by direct weighing using fish baskets of known volume, and by weight of frozen fish produce. Samples from the trawl bag and the outer cover were processed in the usual way for this type of experiment. After each haul, size composition and rate of escapement were determined and a full biological analysis of samples was conducted once daily to determine fish biometry.

The inner mesh size of the trawl bag was measured after every 10 hauls with the help of a wedge-shaped gauge used in ICNAF. Measurements were taken in three cross-sections, both along the trawl bag and around its perimeter. The mesh size of the trawl bag when filled with fish was measured on deck by means of dividers when catches exceeded three tonnes.

4. RESULTS

Data obtained from the 29 hauls made using the trawl bag described above are given in Table 1. Trawling duration was from 10 to 70 minutes with the average being 44 minutes. Mean catch-per-haul was approximately 1.5 tonnes (approximately 2.0 tonnes/hour). Data on fish length frequency distribution and biometric characteristics for the period being studied are given in Table 2. Details of the sex composition of the exploited population and maturity stages of individual fish are given in Table 3 (data from V.P. Shopova, AtlantNIRO).

Preliminary data on fish retention by the trawl bag aggregated over all hauls made during the experiment are presented in Table 4 on ICSEAF SELDAT Form 1.

A trawl-bag selectivity curve was constructed from these data (Figure 4). The method of sliding means (Treschev, 1974) was used to calculate experimental values.

In this instance, the length of fish retained in the trawl bag at 50% equals:

$$l_{50} = 24.8 \text{ cm}$$

and the selectivity factor equals:

$$K_s = \frac{l_{50}}{B} = \frac{24.8}{8.01} = 3.10$$

where K_s = selectivity factor;
 l_{50} = overall length of fish retained at a 50% retention rate;
 B = mesh size.

5. ANALYSIS OF RESULTS

Analysis of the results obtained reveals the unusual composition of this particular *C. gunnari* stock:

- dominance of females (80% of all specimens recorded);
- high modal length (34 to 35 cm);
- the insignificant amount of smaller (less than 25 cm) size groups accounting for less than one percent of the population; and
- absence of immature fish.

Extensive data from previous years give a modal length of 24 to 26 cm (AtlantNIRO, 1986). Moreover, Polish and Spanish scientists have reported a mean length of 23.4 cm at 50% maturity. However, we have observed a distinctly earlier maturation and larger fish size in the population (see Table 2.). The observed pre-spawning condition of the population is enough to suggest that under any other conditions fish would be more able to pass through the mesh and the selective properties of the mesh would be greater. Therefore it would appear to be illogical to consider any increase in mesh size.

A more promising solution to the problem of increasing the selective properties of trawl bags is the introduction of a design aimed at easing the tension in the mesh threads. AtlantNIRO scientists (Ivanova *et al.*, 1989) noted that in a number of cases Polish-type chafers led to some reduction of net selectivity properties but not by any means, did they worsen them to any considerable degree.

In the above-mentioned study where South-West Atlantic hake was being taken by trawls, the inner-mesh size was 114 to 115 mm. At a 50% retention rate and without the reinforced outer cover, the modal length was 38.5 cm, whereas a modal length of 40.93 cm was achieved when using the reinforced Polish-type chafer. This demonstrates the improved selectivity of trawl bags when using a reinforced outer cover. This is caused by the decreased tension on the main part of the net webbing occasioned by the reinforced outer cover which, apparently takes most of the strain during trawling. In any case, it is attached for this reason. A more open mesh is less tense and allows fish to pass through more freely. The angle of the corner of the top mesh in the trawl bag was 44.2° when equipped with a reinforced outer cover and 36.6° without it.

This clearly confirms the results of a modelling experiment in a flume tank conducted in AtlantNIRO by engineer E.L. Baev and scientist N.M. Ivanova. Figure 5 shows the elongation of the mesh threads of a trawl bag without the Polish-type chafer. Figure 6 clearly shows that using a reinforced outer cover decreases the tension on the threads of the main net webbing and significantly widens mesh openings (in both cases, a fine-meshed bag filled with plastic balls was placed inside the trawl to simulate a catch).

Simulated trawling at a speed of 3 to 3.5 knots with a catch of 50 tonnes showed the mean values of the angle of the corner of the top mesh in the trawl bag (based on measurements of all meshes along its length) to be:

- for models with reinforced outer cover - 34.3°; and
- for models without reinforced outer covers - 26.1°.

Of course, there are other ways to decrease the tension of the mesh threads (by placing net webbing over riblines, belly lines, etc.); however, special research and *in situ* experiments are needed in relation to the *C. gunnari* fishery.

6. CONCLUSION

Experiments on trawl bag selectivity on pre-spawning concentrations of *C. gunnari* demonstrated that $l_{50\%}$ was 24.8 cm and the selectivity factor was 3.10 for a mesh size of

80 cm. Comparison of these results with those from previous years shows close similarity. A significant increase in the modal length (up to 34-35 cm) as well as earlier sexual maturation of fish were noted.

It is suggested that the use of Polish-type chafers and a reinforced outer cover on trawl bags decreases the stress on the mesh threads and increases mesh openings and therefore selective properties of the mesh. Further experiments are required to fully understand the mechanism involved.

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Table 1: Results of trawl selectivity experiments.

Number	Trawl Number	Date	Start Time	Trawl Duration (mins)	Weight (kg)	
					Catch	Escapement
1	2	3	4	5	6	7
1	312	17.06	12.05	11	3000	25
2	313	"	13.55	10	2000	10
3	314	"	15.37	20	4500	51
4	315	"	19.03	17	2000	32
5	316	"	20.41	23	1000	48
6	317	"	22.26	52	1500	30
7	319	18.06	06.35	40	000	32
8	320	"	08.25	52	1900	96
9	321	"	10.35	37	2200	63
10	322	"	12.42	38	900	46
11	323	"	15.00	50	1700	60
12	324	"	17.35	50	1300	50
13	325	"	20.10	40	1100	35
14	326	"	22.25	50	900	70
15	327	19.06	00.45	40	740	35
16	328	"	02.35	45	600	32
17	329	"	04.50	46	500	67
18	330	"	07.32	61	1300	140
19	331	"	09.55	53	1000	55
20	332	"	12.25	55	2100	106
21	333	"	14.55	50	2300	60
22	334	"	17.00	55	950	97
23	335	"	19.25	36	750	40
24	336	"	21.43	54	800	70
25	337	20.06	00.37	51	800	66
26	338	"	03.20	55	530	50
27	339	"	06.00	60	1500	62
28	340	"	09.00	60	900	75
29	341	"	11.30	58	1300	77
Total:	29			1269	41070	1 680

Table 2: Biometry of *C. gunnari* around South Georgia.

Length (cm)	Number of specimens	Girth (mm), ϕ		Height (mm), H		Breadth (mm), B		Eccentricity of Fish Body $E = \frac{H^2 - B^2}{H^2}$	Weight (g), G	
		ϕ	σ_ϕ	H	σ_H	B	σ_B		G	σ_G
1	2	3	4	5	6	7	8	9	10	11
19	1	68.0	-	21.0	-	18	-	0.515	20	-
20	-	-	-	-	-	-	-	-	-	-
21	1	75.0	-	23.0	-	18	-	0.623	20	-
22	-	-	-	-	-	-	-	-	-	-
23	-	-	-	-	-	-	-	-	-	-
24	2	101.5	2.1	35.0	0.0	29.0	1.4	0.560	75.0	7.1
25	9	101.1	6.2	35.4	4.0	28.9	3.6	0.578	87.6	22.9
26	44	107.8	6.4	37.8	3.7	30.4	3.1	0.594	104.3	24.3
27	74	113.4	5.7	40.4	4.0	31.5	3.3	0.626	107.7	24.6
28	74	116.9	7.5	41.2	4.2	32.9	4.0	0.602	121.9	30.8
29	81	120.9	6.9	43.3	4.1	34.7	3.7	0.598	143.0	27.6
30	63	128.4	8.5	45.5	4.2	37.0	3.9	0.582	174.1	25.4
31	53	133.5	9.7	47.9	4.7	38.4	4.7	0.598	187.1	37.4
32	89	141.3	7.4	50.5	3.7	40.8	4.4	0.589	212.9	35.5
33	125	145.5	7.1	51.7	3.7	41.4	3.9	0.599	233.3	29.8
34	137	151.4	8.1	54.3	4.5	42.9	4.2	0.613	262.1	35.4
35	127	155.8	9.1	54.9	5.4	45.2	4.7	0.568	282.5	36.0
36	77	163.1	9.6	58.2	4.4	46.2	4.2	0.608	318.1	46.8
37	62	168.6	8.8	58.8	5.2	47.5	4.3	0.589	347.1	40.6
38	40	172.3	9.3	61.0	5.6	49.2	4.6	0.591	372.0	41.1
39	14	181.2	14.2	63.5	7.3	50.9	6.5	0.598	406.1	46.0
40	14	184.6	10.4	65.0	5.3	52.7	5.0	0.585	458.2	31.9
41	10	187.7	5.0	64.8	4.8	54.2	5.4	0.548	480.0	50.0
42	1	180.0	-	61.0	-	55.0	-	0.432	475.0	-
43	2	184.0	12.7	67.5	10.6	54.5	0.7	0.590	567.5	10.6

Table 3: Stages of maturity of *C. gunnari*.

Length class (cm)	Males				Females				Total
	Quantity	II	III	IV	Quantity	II	III	IV	
19	1	-	-	-	-	-	-	-	1
21	1	-	1	-	-	-	-	-	1
24	-	-	-	-	2	-	-	2	2
25	2	-	2	-	7	1	1	5	9
26	12	1	10	1	32	6	1	25	44
27	14	3	6	5	60	2	1	57	74
28	18	3	11	4	56	3	1	52	74
29	18	2	9	7	63	3	-	60	81
30	16	2	6	8	47	-	-	47	63
31	10	-	5	5	43	1	-	42	53
32	8	-	3	5	81	-	-	81	89
33	13	-	6	7	112	-	1	111	125
34	17	-	3	14	120	-	-	120	137
35	24	-	6	18	103	-	-	103	127
36	13	-	4	9	64	-	-	64	77
37	17	-	8	9	45	-	-	45	62
38	17	-	3	14	23	-	-	23	40
39	6	-	-	6	8	-	-	8	14
40	8	-	2	6	6	-	-	6	14
41	5	-	2	3	5	-	-	5	10
42	1	-	-	1	-	-	-	-	1
43	1	-	-	1	1	-	-	1	2
Total:	222	11	87	123	878	16	5	857	1100

Table 4: Mesh selectivity data for *C. gunnari*: Covered codend experiments (ICSEAF SELDAT, Form 1).

Length of Fish	Number of Fish Caught			Percentage of Fish Retained
	In Codend	In Cover	Total	
A	B	C	D	E
17	-	1	1	0
18	-	7	7	0
19	-	16	16	0
20	30	38	68	44.1
21	-	20	20	0
22	-	20	20	0
23	-	24	24	0
24	38	64	102	37.3
25	534	373	907	58.9
26	1436	866	2302	62.4
27	2984	1430	4414	67.6
28	5927	1619	7546	78.5
29	5071	1071	6142	82.6
30	5756	821	6577	87.5
31	8207	646	8853	92.7
32	14287	833	15120	94.5
33	19382	654	20036	96.7
34	21138	578	21716	97.3
35	23114	350	23464	98.5
36	13204	144	13348	98.9
37	10511	53	10564	99.5
38	6963	23	6986	99.7
39	4763	2	4765	100.0
40	2603	0	2603	100.0
41	1387	0	1387	100.0
42	344	0	344	100.0
43	237	0	237	100.0
44	59	0	59	100.0
45	-	-	-	-
46	28	0	28	100.0
Total no. of fish	148003	9653	157656	
Total weight (tonnes)	41.07	1.68	42.75	

Country: USSR, Date: 17 to 28 June 1990

Codend made of Kapron (type of fibre)

Mesh size in codend (mm) - 80.1. Mesh size in cover (mm) - 35.2

Duration of haul (min) - 1 269. Name of vessel - *Anchar* (AtlantNIRO)

Tonnage (GRT) - 2 120. Engine power (HP) - 2 000

Type of trawler - stern trawler

Remarks: Trawl codend with 44 mm mesh bar, without Polish-type chafer. 29 hauls, total hauling duration - 1269. Catches-per-haul from 0.5 to 4.5 tonnes.

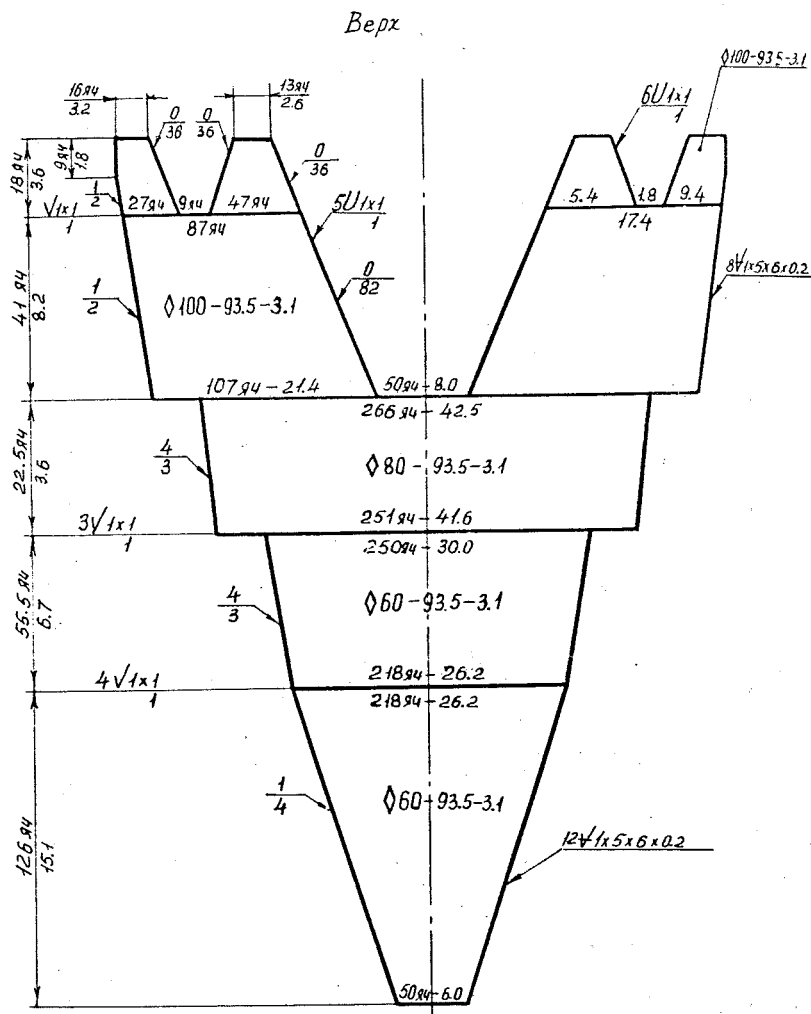


Figure 1: Top panel of trawl "Khek-4M".

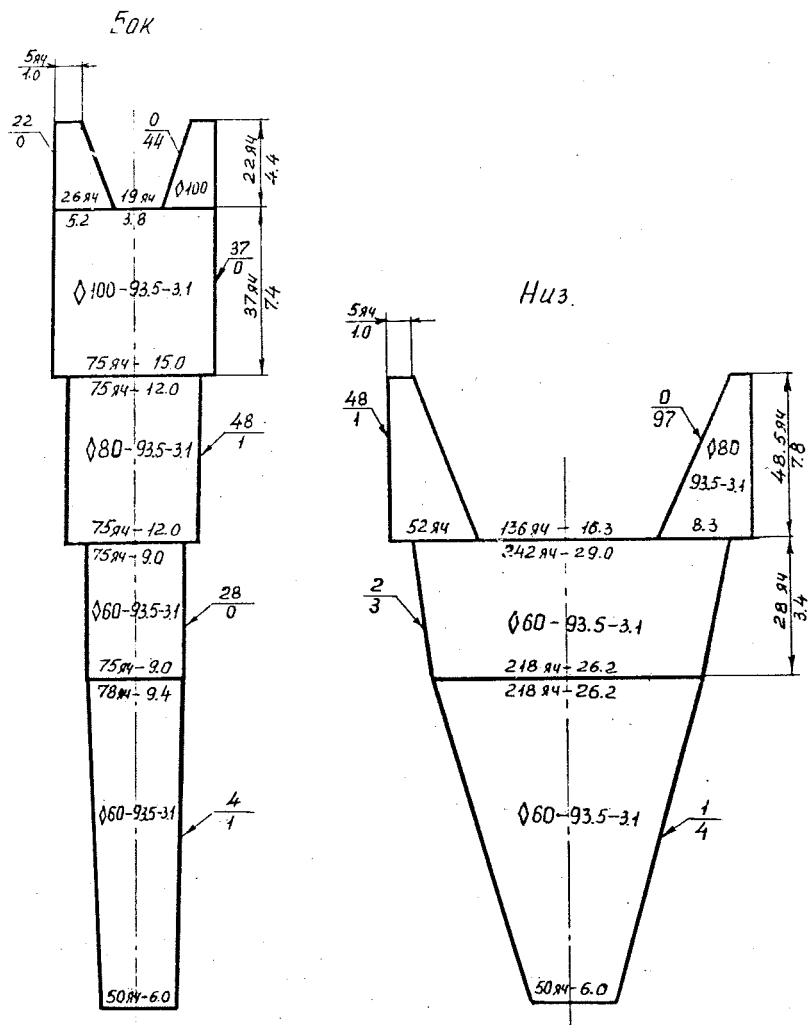


Figure 2: Side and bottom panels of trawl "Khek-4M".

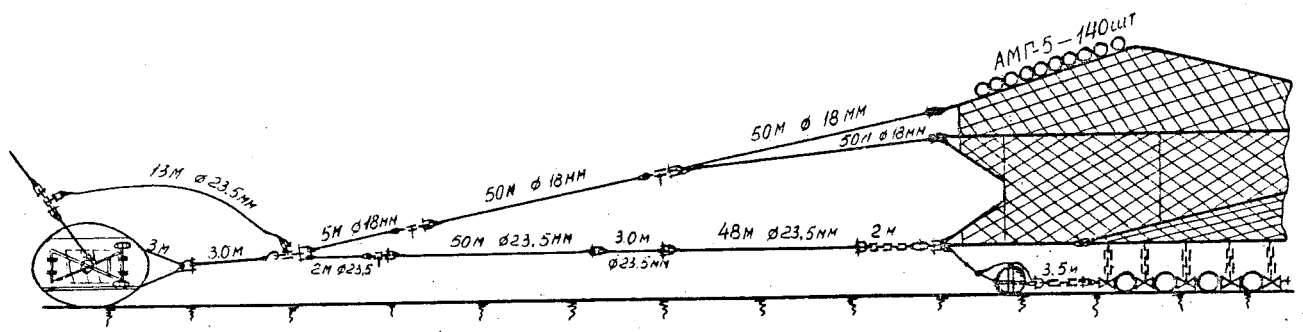


Figure 3: Rigging of trawl "Khek-4M".

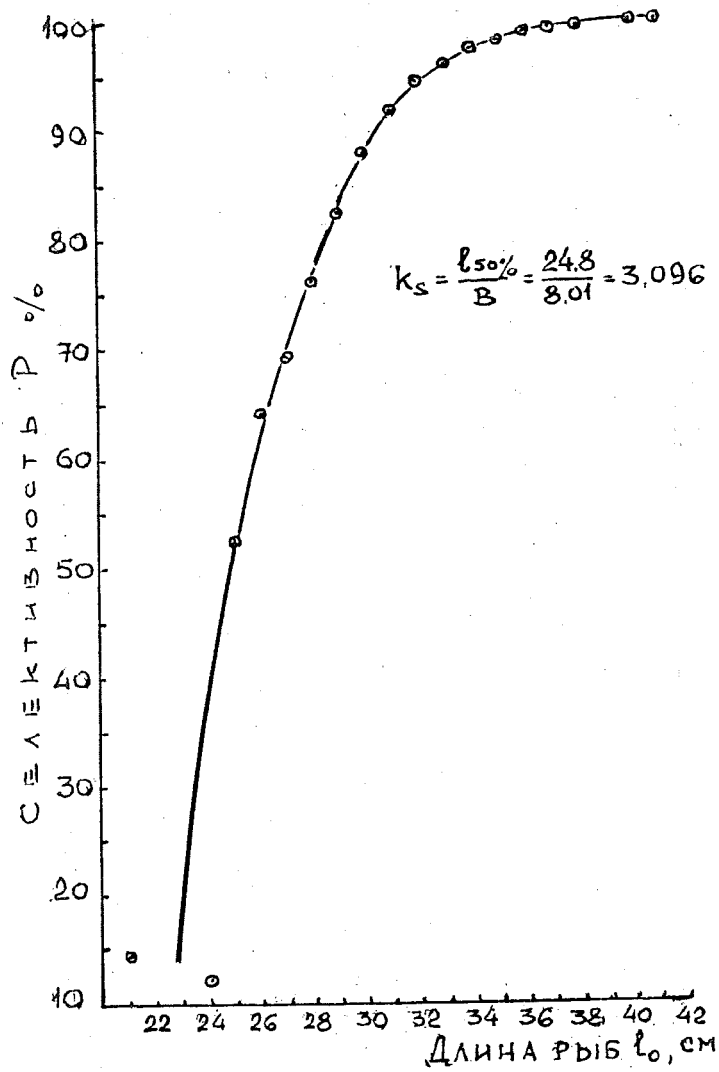


Figure 4: Selectivity curve for trawl bag with mesh size $B=80.1$ mm in respect of *C. gunnari* on the South Georgia Shelf (BMRT Anchar, June 1990. Number of hauls $N=29$. Calculations made using the method of sliding mean).

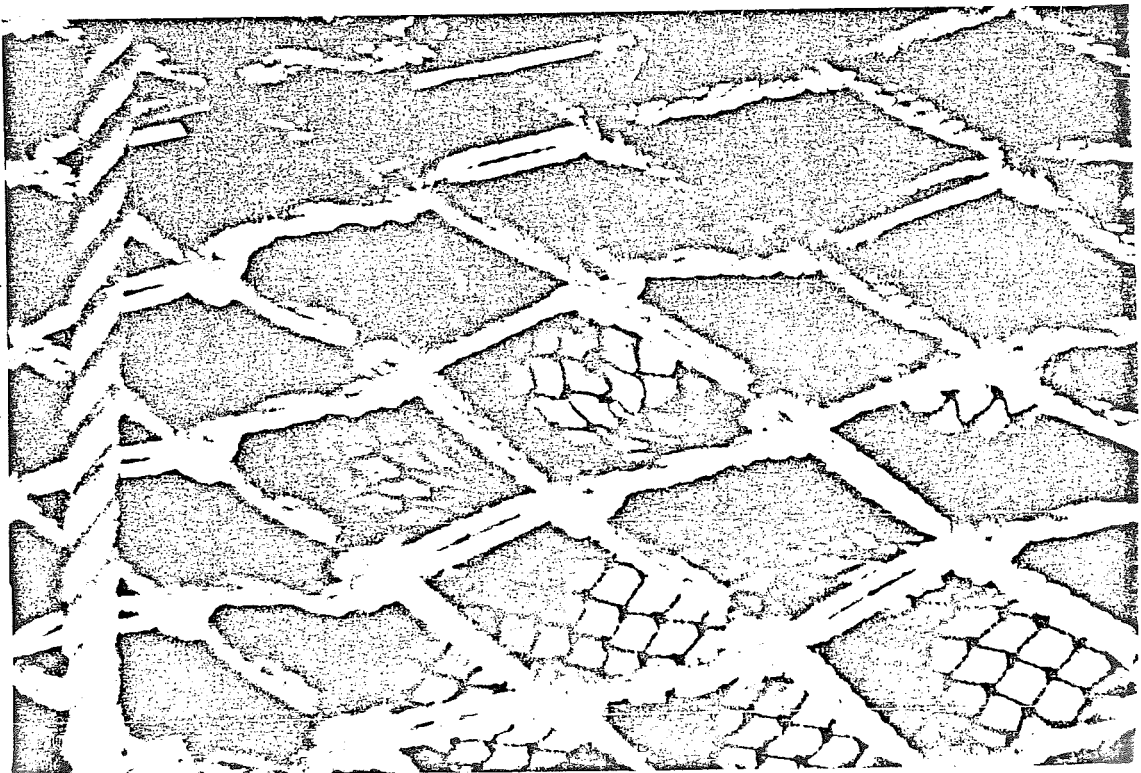


Figure 5: Mesh of trawl bag with simulated catch minus reinforced outer cover.

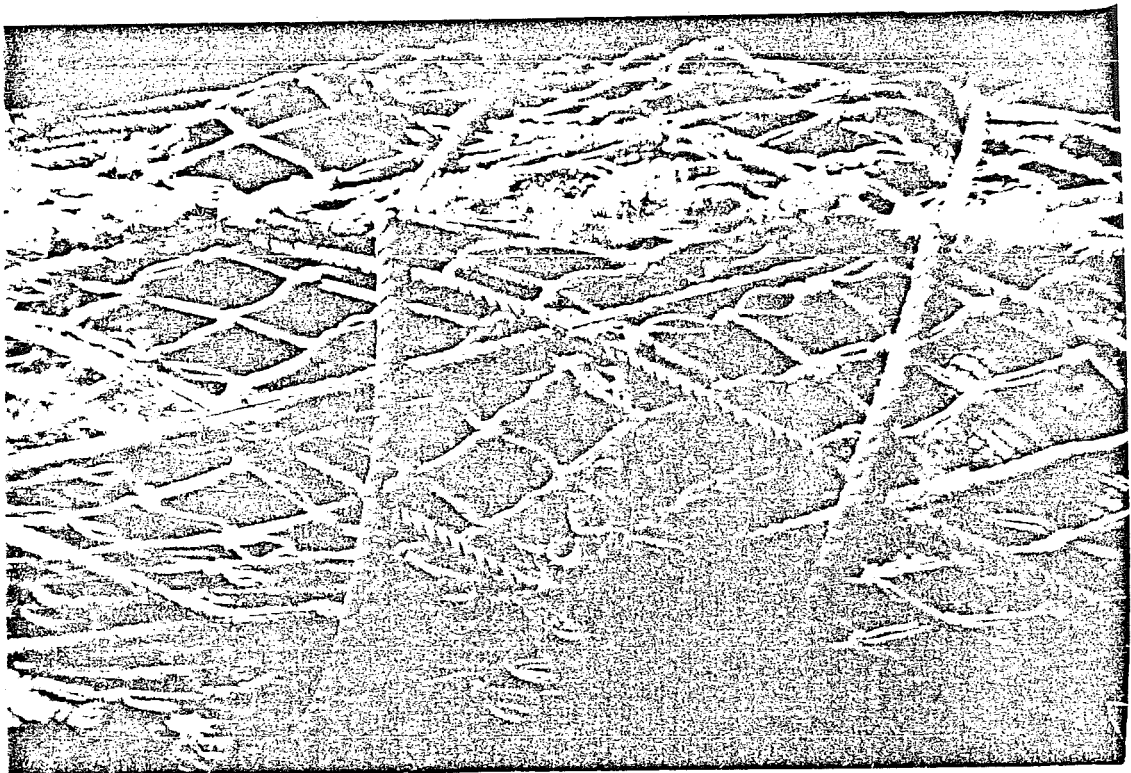


Figure 6: Mesh of trawl bag with simulated catch with reinforced outer cover.

Liste des tableaux

- Tableau 1: Résultats des expériences sur la sélectivité des chaluts.
- Tableau 2: Biométrie de *C. gunnari* autour de la Géorgie du Sud.
- Tableau 3: Stades de maturité de *C. gunnari*.
- Tableau 4: Données de sélectivité de maillage pour *C. gunnari* expériences tentées avec cul de chalut couvert (icseaf seldat, formulaire 1).

Liste des figures

- Figure 1: Face supérieure du chalut "Khek-4M".
- Figure 2: Faces latérales et inférieures du chalut "Khek-4M".
- Figure 3: Gréement du chalut "Khek-4M".
- Figure 4: Courbe de sélectivité de la poche de chalut d'un maillage B=80,1 mm en matière de *C. gunnari* sur le plateau de la Géorgie du Sud (BMRT Anchar, juin 1990. Nombre de traits N=29. Calculs effectués par la méthode de la moyenne glissante).
- Figure 5: Maillage de la poche de chalut sans couverture renforcée à l'extérieur, contenant une capture simulée.
- Figure 6: Maillage de la poche de chalut avec couverture renforcée, contenant une capture simulée.

Список таблиц

- Таблица 1: Результаты экспериментов по селективности тралов.
- Таблица 2: Биометрия *C. gunnari* в районе Южной Георгии.
- Таблица 3: Стадии половозрелости *C. gunnari*.
- Таблица 4: Данные по селективности ячеи при промысле *C. gunnari*: эксперименты с силовым покрытием мешка трала (ICSEAF SELDAT, Форма 1).

Список рисунков

- Рисунок 1: Верхняя панель трала Хек-4М.
- Рисунок 2: Боковая и нижняя панели трала Хек-4М.
- Рисунок 3: Оснастка трала Хек-4М.

- Рисунок 4: Кривая селективности мешка трала с ячейей В=80,1 мм при промысле *C. gunnari* уа шельфе Южной Георгии (БМРТ Анчар, июнь 1990 г. Количество тралений N=29. Вычисления выполнены методом скользящей средней).
- Рисунок 5: Секция содержащего имитацию улова тралового мешка без силового покрытия.
- Рисунок 6: Секция содержащего имитацию улова тралового мешка с силовым покрытием.

Lista de las tablas

- Tabla 1: Resultados de los experimentos de selectividad con arrastres.
- Tabla 2: Biometría de *C. gunnari* en las aguas de Georgia del Sur.
- Tabla 3: Fases de madurez de *C. gunnari*.
- Tabla 4: Datos de selectividad de malla de *C. gunnari*:. Experimentos realizados con el copo cubierto (ICSEAF SELDAT, Form 1).

Lista de las figuras

- Figura 1: Parte superior de la red "Khek-4M".
- Figura 2: Parte lateral e inferior de la red de arrastre "Khek-4M".
- Figura 3: Armazón del arrastre "Khek-4M".
- Figura 4: Curva de selectividad del saco del arrastre, con una luz de malla B=80.1 mm con respecto a *C. gunnari* en la plataforma de Georgia del Sur (БМРТ Анчар, junio 1990. Número de lances N=29. Se ha empleado la media móvil para los cálculos).
- Figura 5: Malla del copo de la red con captura simulada sin la cubierta exterior reforzada.
- Figura 6: Malla del copo de la red con captura simulada con la cubierta exterior reforzada.