Northwest Atlantic Fisheries Organization

Serial No. N750

NAFO SCR Doc. 83/IX/84

FIFTH ANNUAL MEETING - SEPTEMBER 1983

Some Parameters of Bottom-trawl Selective Characteristics from Data of Instrumental Observations Carried Out Relative to Beaked Redfish, Greenland Halibut, American Plaice, Yellowtail Flounder and Roundnose Grenadier in the Fishing Areas of the Northwest Atlantic

by

K. N. Nikeshin, V. G. Kovalenko and A. S. Gorshkova

Polar Research Institute of Marine Fisheries & Oceanography (PINRO)
6 Knipovich Street, Murmansk, USSR

Introduction

To secure rational fisheries a great attention is paid to the mesh size regulation in fishing gears. Thus, the minimum 130 mm mesh size was chosen instead of 120 mm, used earlier in the groundfish fishery in the economic zone of Canada from July 1, 1981. In 1982 at the IV-th NAFO Session the introduction of the minimum 130 mm mesh size in the whole NAFO zone was proposed by Canada.

The optimum mesh size is scientifically substantiated on the basis of experimental determination of trawl bag selective characteristics, and estimation of instantaneous and long-term losses and profits of catch in connection with changing of one mesh size for another. It is also necessary to take into account the relative number of small-sized fish in the catch and their retention coefficient.

It is known that the escapement of each fish species changes with the mesh size variations and their length-age composition, depends on biological condition of fish caught, technique and tactics of fishing.

A type of chafers and cover codends influences the fishes escapement through the bag. The dependence of fish escapement on numerous different factors results in considerable variations of the selective parameters.

As a result, the retention by trawl bags with larger mesh size may be higher than that with smaller ones, which presents certain difficulties in substantiation of the optimum mesh size. The mate-

rials presented on the basis of determinations of the trawl bag selectivity with different mesh relative to beaked redfish, Greenland halibut, American plaice, yellowtail flounder and roundnose grenadier were obtained in the PINRO laboratory of commercial fishery.

The substantiation of the optimum mesh size is considered in the paper on the basis of retention and escapement of small-sized fish through trawl bags with different mesh.

Material and methods

The results of the trawl bags selectivity determination obtained on the research vessels of PINRO in the fishing areas of the Northwest Atlantic were used as materials for the paper. The investigation was carried out from 1979 to 1981. The trawl bags with 100 - 155 mm mesh size made of double-polyamid yarn (3,1 mm diameter) were tested. Selective characteristics of trawl bags were determined according to standard methods using the ICES type covers. An inner mesh size was measured by a wedge-shaped plate 2 mm thick under pressure of 5 kg load. A set with the identical mesh size included 7 - 10 valid hauls. The maximum catch did not exceed 5 tons per haul. The results of the experimental works were presented in Tables and analysed in the form of selectivity curves.

Results

The retention by trawl bags is usually presented by the curves of selectivity which in the segment of small-sized fish gradually show a decreasing of retention with their length reduction. In this case, the selectivity curves would show the growth of small-sized fish escapement with mesh size increase in trawl bags and decrease of the relative amount in the catch. This conclusion is used in substantiation of mesh size increasing in trawls , as the measure directed to rational exploitation of fish stocks.

However, for the most fish species the curves of selectivity plotted according to experimental data in the range of small lengths show, as a rule, a considerable increase of retention with the

fish length reduction (Fig.I).

Analysing the reasons of fish retention increase in the length range below 1° (Fig.I) it may be concluded that for the fish in this length the correlation between maximum girth of the fish body cross section and mesh perimeter contributes much more to their escapement through the trawl bag than for fish in the length above 1°.

Thus, it may be considered, that the increase of small-sized fish retention is, apparently, related to essential influence upon these fish escapement of such factors , as small energetic capacities of small-sized fish, prevention of escapement by fish of larger size etc.

The mentioned pattern of selectivity curves in the small length range influences upon the retention of small-sized fish and their amount of trawl bag catches using different mesh. We shall consider the results of determination of trawl bag selectivity. The curves of trawl bag selectivity with different mesh relative to beaked redfish, Greenland halibut, American plaice and yellowtail flounder are presented in Figs. 2,3,4.

Analysing the curves of selectivity mentioned it is seen, that their main part tends, as presented in Fig.1 by line I, to show the increase of retention in the range of small-sized fish. The optimum mesh size was substantiated on the basis of their escapement and retention. In this case, the groups of younger fish, the weight of one specimen being considerably smaller than that of middle-aged and older fish , may be related to this category.

According to this, while analysing the data on selectivity, the following maximum fish length was considered in characteristics of escapement and retention:

- 35 cm for Greenland halibut;
- 48 cm for grenadier;
- 30 cm for American plaice and yellowtail flounder;
- 25 cm for beaked redfish from 3 ML and 2H Divisions.

Table data are analysed for each species separately. Tables 1, 2 and 3 present the data for beaked redfish. As is seen, mesh size variation from 120 to 155 mm does not, practically, cause the decrease of total number of beaked redfish below 25, 27 and 29 cm

in trawl bag catches (in %).

No marked increase of small sized fish escapement through the trawl bags is either observed. When using the 100 mm mesh the beaked redfish amount is about 10 - 12%. The mean minimum length of retained fish and the mean maximum length of escaped fish with the mesh increase from 100 to 155 mm vary slightly. Tables 4, 5 and 6 present the data for Greenland halibut. It follows from Tables that under the Greenland halibut fishery conducted on the shelf , where the small-sized fish below 35 cm dwell, their total number is 26% in catches of trawl bags with the 117 mm mesh, 11% with the 127 mm mesh, i.e. it decreases by 15%. In this case the 50% retention is observed. In the area of a continental slope where fish concentrations are presented by large maturan individuals , the mesh size variation from 124 to 133 mm does not, practically, change the percentage of fish below 35 cm in the catches. In this case the number of small-sized fish in catches does not exceed 4,5%, though the retention is rather significant ranging from 71,6 to 59,4%. It may be considered, that under the Greenland halibut fishery on the continental slope, where the main part of fish are of commercial length at minimum-allowable mesh size of 120-125 mm, the number of fish in catches will not exceed 10-15%. The minimum length of retained fish grows with the increase of mesh size by 1-2 cm (from 117 to 127 mm and from 124 to 134 mm). Tables 7-12 present the data for American plaice and yellowtail flounder. It follows from the tables, that the total number of American plaice (in %) 25,27 and 31 cm long in catches taken with 127 and 134 mm mesh trawl varies slightly (by 2-3%). The amount of small-sized fish in trawl bags will be:

- about 9% for all fish below 25 cm long and about 55% for those 31 cm long at the 31 cm mode of size frequency of caught fish;

- about 4% for all fish below 25 cm long at the 34-37 cm mode and about 16% for those 31 cm long.

With the mesh size increase from 127 to 134 mm the fish retention may decrease , approximately, by 15%.

The number of small-sized yellowtail flounder in trawl catches and the retention of all fish 31 cm long with the mesh size chan-

ged from 127 to 134 mm decreases by some 9%. The maximum escaped fish length and minimum retained fish length do not vary with the mesh increase from 127 to 134 mm. Tables 13-15 present the data for roundnose grenadier. The retention of all roundnose grenadier 50 cm long with the 117-134 mm mesh size varies slightly from 74% to 68%, i.e. by 6%.

The total amount of small-sized fish in catches ranges from 33 to 16% for different size compositions of caught fish. The minimum length of retained roundnose grenadier increases, approximately, by 2 cm with mesh size variation from 117 to 134 mm; the maximum length of escaped fish ranges from 78 to 80 cm with mesh size variation.

Conclusions

1. The data on experimental determination of selective properties of trawl bags with different meshes relative to small-sized beaked redfish, Greenland halibut, American plaice, yellowtail flounder and roundnose grenadier are summarized in the paper.
2. The optimum mesh size for the above fish species is substantiated basing on escapement and retention of small-sized fish by trawl bags with different meshes. The results of researches carried out by the PINRO commercial fishery laboratory presented at the NAFO Session (Chumakov et al., MS 1981; Nikeshin et al.,MS 1982; Nikeshin et al., MS 1981a; Nikeshin et al., MS 1981b) were taken into consideration.
3. It is noted that under the substantiation of optimum mesh size in trawls it is necessary to provide the minimum retention of small-sized fish and their amount decrease in the catch as one of the most important conditions.
4. As the curves of selectivity for the above fishery objects show, the increase of fish retention occurs in the length range of small-sized fish. The increase of small-sized fish retention can be explained by such factors as fish low powers, hindrance of escapement by larger fish resulting from shading of the net and keeping small-sized fish away from it, etc. The increase of reten-

tion of small-sized fish leads to low dependence of regular variations of escapement and retention of fish from these size groups on the mesh size , i.e. the mesh size increase in certain limits does not, practically, change retention and escapement of small-sized fish by trawl bags.

5. Under the specialized beaked redfish fishery in the fishing areas of 3 ML and 2H the optimum mesh size in trawl bags is 100 mm (Nikeshin et al., MS 1981b). In this case the by-catch of fish with the length below 25 cm amounts to 12% by number, and the escapement of fish above 25 cm long is about 10%.

The increase of mesh size above 100 mm (from 120 to 133 mm) under the beaked redfish fishery is not reasonable in the areas mentioned , as the improvement of the length - age composition of stock structure is not provided in this case, and escapement of fish of commercial length can be above 40%.

Under the minimum-allowable mesh size of 100 mm biologically substantiated annual limitation of the total catch should be regarded the most effective measure of redfish fishery regulation in the areas of 3 ML and 2H.

6. The optimum mesh size in trawl bags under the Greenland halibut fishery is 120 mm (Chumakov et al., MS 1981). In this case the total amount of fish below 35 cm does not exceed 10% under the fishery in the continental slope area. The increase of mesh size from 124 to 133 mm, does not, practically, change the percentage of fish less than 35 cm long in catches.

7. It is reasonable to conduct the specialized fishery for American plaice and yellowtail flounder by trawls with 130 mm mesh (Nikeshin et al., MS 1982). This recommendation is based on the following: the increase of mesh size from 127 to 134 mm results in the decrease of the total catch by more than 5%. While fishing off the length size concentrations of fish , the mode of which is within the range of commercial length, the small-sized fish amount in catches taken with 127 to 134 mm meshed trawls is no more than 15% and changes not considerably (by 2-3%).

The retention and escapement parameters for yellowtail flounder, mesh size changing within the range of 127 to 134 mm, are close to the similar parameters for American plaice.

8. The optimum mesh size for the roundnose grenadier fishery is 120 mm (Nikeshin et al., MS 1981 a), as under the increase of mesh size above 120 mm, the main part of fish escaped was composed of average and large fish. The retention of the total amount of small-sized roundnose grenadier ranges from 74% to 68% under the increase of mesh from 117 to 134 mm, i.e. not considerably, by 6%.

R E F E R E N C E S

1. Chumakov A.K., K.N.Nikeshin and A.S.Gorshkova . MS 1981. Bottom trawl codend selectivity for Greenland halibut in NAFO Subarea 0 and Div. 2H,2G and 3K. NAFO SCR Doc. 81/IX/89. (mimeo).

2. Nikeshin K.N., K.G.Konstantinov, A.K.Chumakov and V.G.Kovalenko. MS 1982.On validity of trawl mesh size used in fishing areals of the Northwest Atlantic. NAFO SCR Doc. 82/VI/14.(mimeo).

3. Nikeshin K.N., V.G.Kovalenko and Yu.V.Ishchenko. MS 1981a. Trawl codend selectivity to fishing for roundnose grenadier in NAFO Division 3K. NAFO SCR Doc. 81/IX/88. (mimeo).

4. Nikeshin K.N., V.G.Kovalenko, Yu.A.Kondratyuk and A.S.Gorshkova. MS 1981b. Selectivity of bottom trawl and midwater trawl codends when fishing for deepwater redfish in the Northwest Atlantic. NAFO SCR Doc. 81/IX/87.(mimeo).

Table 1 Beaked redfish percentage in trawls with different meshes by the results of 7 sets of hauls (in areas 3M, 3L and 2H)

Inner mesh size, mm	Percentage of total fish amount below . . . cm long in trawls		
	25	27	29
120	3,63	5,74	7,54
125	6,35	16,27	25,4
133	1,31	5,62	19,06
155	0,74	4,37	11,74

Table 2 Beaked redfish retention by trawls with different meshes by the results of 7 sets of hauls

Inner mesh size, mm	% of fish retention below . . . cm long		
	25	27	29
100	75,23	77,57	80,96
120	45,80	45,0	53,0
125	45,30	51,07	52,96
127	47,77	50,17	54,06
133	35,24	39,20	46,22
155	30,25	34,29	43,00

T able 3 Mean minimum length of retained and mean maximum length of escaped beaked redfish through trawls with different meshes

Inner mesh size, mm	Mean minimum length of fish retained, cm	Mean maximum length of fish escaped, cm
100	18	40
120	19	40
125	20	42
127	22	43
133	19,5	43,5
155	21	42

Table 4 Greenland halibut percentage in trawls with different meshes by the results of 7 sets of hauls

Shelf			Continental slope		
Inner mesh size, mm	% of total fish amount below ... cm long in trawls		Inner mesh size, mm	% of total fish amount below ... cm long in trawls	
	28–29	34–35		28–29	34–35
117	11,3	26,37	124	0,32	4,54
127	3,73	11,05	127	0,13	1,57
			133	0,02	0,26

Table 5 Greenland halibut retention by trawls with different meshes by the results of 7 sets of hauls

Shelf			Continental slope		
Inner mesh size, mm	% of fish retention below ... cm long		Inner mesh size, mm	% of fish retention below ... cm long	
	28-29	34-35		28-29	34-35
117	48,87	50,84	124	53,57	71,64
127	49,04	47,22	127		59,35

Table 6 Mean minimum length of retained and mean maximum length of escaped Greenland halibut through trawls with different meshes

Shelf			Continental slope		
Inner mesh size, mm	Mean minimum length of fish retained, cm	Mean maximum length of fish escaped, cm	Inner mesh size, mm	Mean minimum length of fish retained, cm	Mean maximum length of fish escaped, cm
117	14-15	52-53	124	26-27	49-50
127	14-15	50-51	127	28-29	54-55
			134	28-29	66-67

Table 7 Percentage of small-sized American plaice in trawls with different meshes in Div. 3O and 3N

	Inner mesh size, mm	% of total fish amount in trawls			
		24-25	26-27	28-29	30-31
3O	127	8,01	16,95	35,06	56,28
	134	9,32	18,13	32,26	54,21
3N	127	2,7	6,2	10,4	16,6
	134	4,9	6,5	9,7	14,9

Table 8 Retention of small-sized American plaice by trawls

	Inner mesh size, mm	% of fish retention below ... cm long			
		24–25	26–27	28–29	30–31
3O	127	36,2	41,0	47,5	53,6
	134	23,8	26,0	29,2	34,6
3N	127	22,2	28,6	34,1	41,8
	134	19,4	19,5	22,5	27,6

Table 9 Percentage of small-sized yellowtail flounder in trawls with different meshes in Div. 3N

Inner mesh size, mm	% of total fish amount in trawls			
	24–25	26–27	28–29	30–31
127	3,75	11,74	23–57	31,29
134	3,40	8,97	17,69	24,20

Table 10 Retention of small-sized yellowtail flounder by trawls in Div. 3N

Inner mesh size, mm	% of fish retention below ... cm long			
	24–25	26–27	28–29	30–31
127	24,0	33,9	43,5	48,9
134	23,0	28,4	34,8	39,4

Table 11 Mean minimum length of retained and mean maximum length of escaped American plaice through trawls with different meshes

Inner mesh size, mm	Mean minimum length of fish retained, cm	Mean maximum length of fish escaped, cm
127	14–17	38–39
134	14–17	38–39

Table 12 Mean minimum length of retained and mean maximum length of escaped yellowtail flounder through trawls with different meshes

Inner mesh size, mm	Mean minimum length of fish retained, cm	Mean maximum length of fish escaped , cm
127	14–17	36–37
134	14–17	34–35

Table 13 Percentage of roundnose grenadier below fishing length in trawl with different meshes

Inner mesh size, mm	% of total fish amount below 48–50 cm in trawls
117	33,26
134	16,37

Table 14 Retention of roundnose grenadier below fishing length in trawls with different meshes

Inner mesh size, mm	% of fish retention below .... cm long
117	74,41
134	67,48

Table 15 Mean minimum length of retained and mean maximum length of escaped roundnose grenadier through trawls with different meshes

Inner mesh size, mm	Mean minimum length of fish retained, cm	Mean maximum length of fish escaped, cm
117	18–20	78–80
127	15–17	78–80
134	21–23	75–77

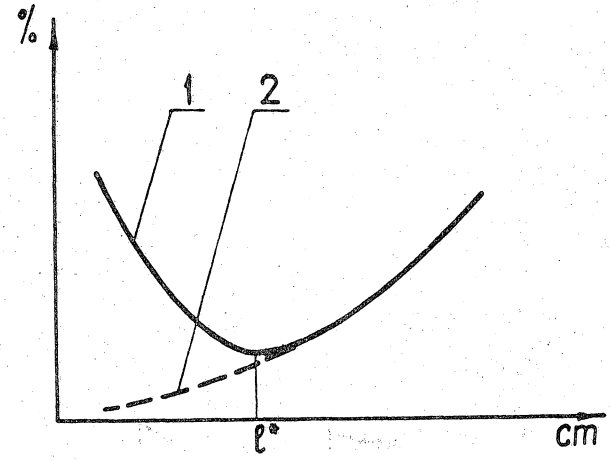

Fig. 1. Selectivity curves:
I - by experimental data;
2 - simplified form.

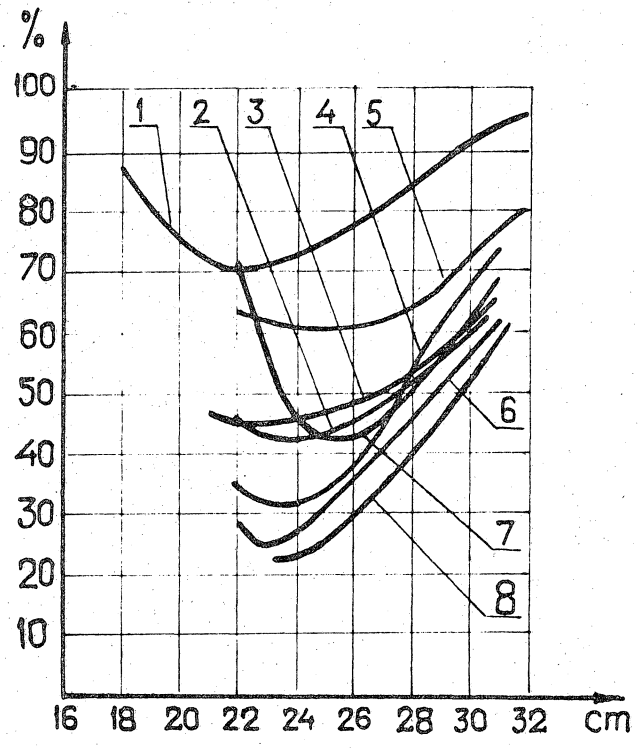

Fig. 2. Curves of beaked redfish retention for trawl bags with different meshes.
(Nos of curves correspond to the inner mesh size)
1 - 100 mm; 2 - 120 mm; 3 - 125 mm; 4 - 127 mm;
5 - 127 mm; 6 - 133 mm; 7 - 133 mm; 8 - 155 mm.

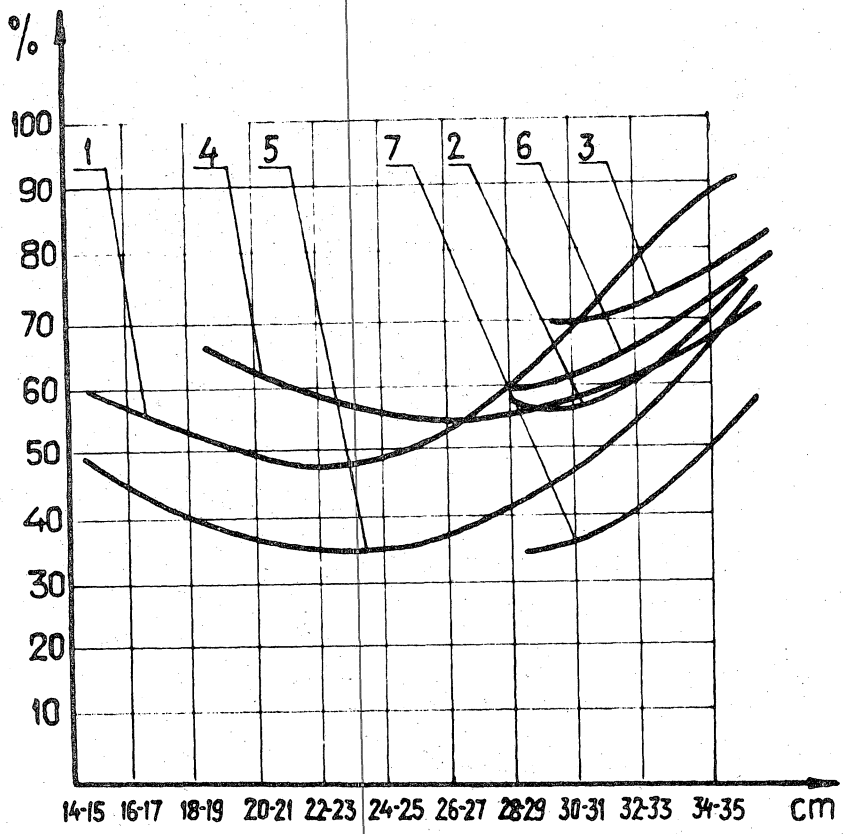

Fig. 3. Curves of Greenland halibut retention for trawl bags with different meshes.

(Nos of curves correspond to the inner mesh size)

1 - 117 mm (shelf); 2 - 124 mm (continental slope);

3 - 124 mm(continental slope); 4 - 127 mm (shelf);

5 - 127 mm (shelf); 6 - 127 mm (continental slope);

7 - 134 mm (continental slope).

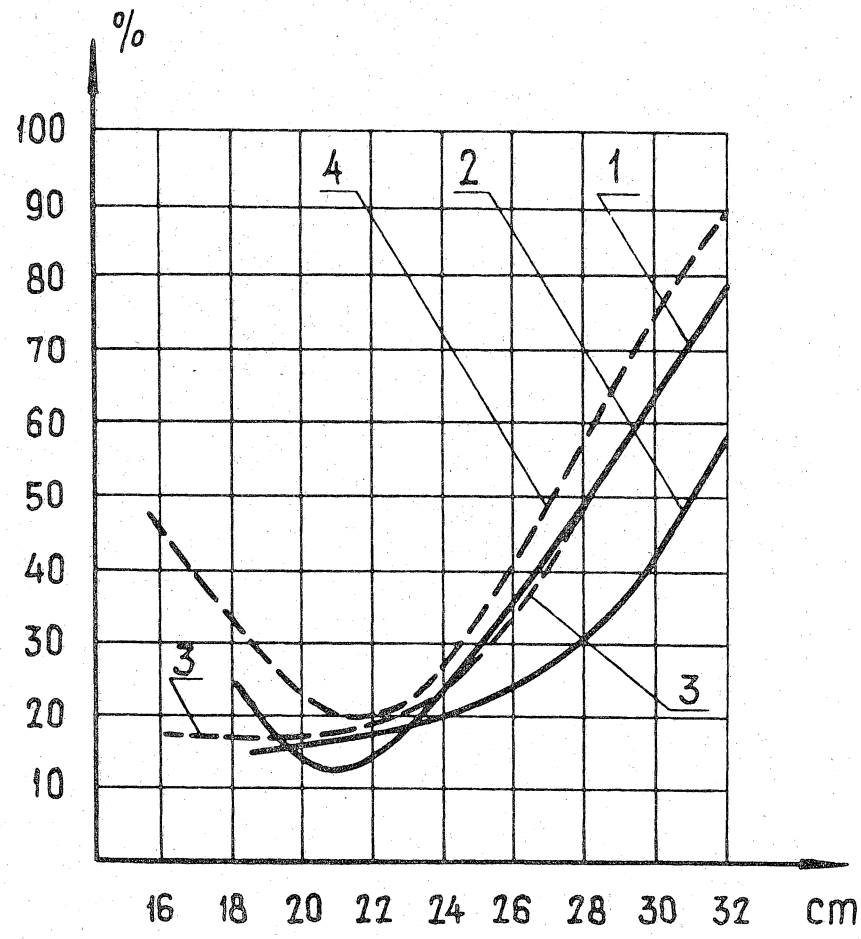

Fig. 4. Curves of American plaice and yellowtail flounder retention for trawl bags with different meshes.

———— American plaice

– – – – – yellowtail flounder

(Nos of curves correspond to the inner mesh size)

1 - 127 mm; 2 - 134 mm; 3 - 134 mm; 4 - 127 mm.