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" On the Hake population dynamics from Galicia (NW Spain) with a preliminary assessment "

by

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Summary

In the present work, first we have computed the fishing mortalities vectors exerted on the hake (Merluccius merluccius L.), that inhabit in the Galician shelf. To do that we have used the Jones's cohort analisys, with which we also obtain a estimation of the recruitement. This fishing mortality vector was subdivided by gears.

From these F actual vectors obtained on this way, we have done some simulations about mesh size and fishing effort's changes to know the potential effects of these fishing strategy changes, in the yields.

To do that we have used the Jones's model changes in mesh size and effort, and multi-gears Ricker model.

Resumé

Dans le présent travail, on fait en premier lieu un calcul des vecteurs de mortalité par pêche à la quelle est soumise le merlu (Merluccius merluccius L.) qui vit

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sur la plataforme continentale galicienne. Pour cela, nous avons utilisé le modèle d'analyse de cohortes sur une distributions de tailles avec lequel nous obtenons aussi une estimation du recrutement, ce vecteur de mortalité par pêche s'est subdivisé par engines de pêche.

On second lieu, et à partir de ces vecteurs F actuels ainsi obtenus, nous avons réalisé des simulations de changements de maille et effort de pêche pour connaitre les effets qui causeraient ces possibles changements de la stratégie de pêche, dans les rendements à la longue terme échéance.qui seraient obtenus. Pour cela, nous avons utilisé le modèle de changement de maille et effort de Jones et le modèle multi-engines de Ricker.

INTRODUCTION

Four kinds of gears work in the fishery of the continental shelf off Galicia (NW Spain): Trawling, Gillnet, Small Gillnet and Longline.

The main target for all of them is Hake (Merluccius merluccius L.), specially for the three last ones. Trawlers catch as well mainly Norway Lobster (Nephrops norvegicus L.), Horse Mackerel (Trachurus trachurus L.) and Blue Whiting (Micromesistius poutassou Risso).

Fleet charachteristics are shown in the following table:

	Nº boats	H.P.	G.R.T.	Ton.Hake/Year
Trawling	225	400	143	10700
Gillnets	100	166	36	2800
Longline	175	170	37	2400
Small Gillnets	428	25	5	1000

Trawlers use a 40 mm. cod-end mesh. Most of this fleet seasonally fishes undersize hake (less than 25 cm. in length) from October to March, taking profit of the big concentrations of recruits to this area on the shelf, between 100 and 250 m. dep.

Longlines and gillnets (these ones using a 80 mm. mesh) fish on the beginning of the continental slope, in inadequate areas for trawling.

Small gillnets, with mesh size between 50 and 60 mm., fish in the "Rias" and areas very near of the seaside. This is a very popular gear in every little port.

METHODS AND RAW DATA

Catch.- Catches by gear are controlled for the fisheries research groups of the authors, in order to obtain a good accuracy.

Sampling.- They are made in the most important ports by each gear, and on board of fishing boats. Fishes were measured to the nearest centimeter, although length distributions were adapted to the lowest centimeter. Table 1 and fig.1 show length distributions and catch by gear.

Selecting parameter values.- We have adopted the same values selected in the last ICES Hake Working Group (Nantes, 1976), that were the following ones:

Growth: the v. Bertalanffy equation

$$l_t = 134\ (1 - \exp(-.07(t + .78)))$$

Length-weight key:

$$W\ (kg.) = .0000051\ L^{3.074}$$

Natural mortality rate:

$$M = .2$$

Final explotation rate (for cohort analysis)

$$F/Z = .8$$

Selection factor (nylon)

$$S.F. = 3.6$$

The percentage of retention for each length group into the selectivity range has been made fitting the selection curve to a logistic one (Table 2).

Mortality vectors per gear in the current fishing situation.- Cohort analysis made on length compositions was used (R. Jones, 1974). It was assumed an equilibrium state in the fishery, considering the mean length distribution in the three years in which sampling has been made, and constructing a "synthetic cohort".

The actual fishing mortality vector so obtained ($F \cdot \Delta t$) was partitioned proportionally to catches by gear in each length group, obtainning a first estimate of the actual vectors $F \cdot \Delta t$ by gear (Table 3 and fig. 2).

Long-term effects of possible changes in trawlers mesh-size and effort of all gears.- We have considered the fishery divided in two parts: Trawling and "other gears" (gillnet, longline and small gillnet) together. From these two actual fishing mortality vectors, different pairs of new vectors were obtained changing mesh size in the trawl gear and effort so in trawling as in "another gears".

Long-term changes were obtained introducing these possible couples of vectors in two models which have been used in an alternative form: change in mesh-size and fishing effort by R. Jones (1961), and multigear by Ricker.

Tables 4 and 5 show the computations such they have been made for each model. Long-term changes in Yield so obtained are expressed as percentual change from the current situation.

RESULTS

Table 6 shows results obtained with Ricker method. Trials made are corresponding to the following cases:

a) Four mesh-sizes in the cod-end of the trawling gear (40, 60, 80 and 100 mm.).
b) Five levels of effort for trawlers (current situation, ±25 % and ±50 %).
c) Five levels of effort in "other gears" (current situation, ±25 % and ±50 %),

totalling 100 fishing strategies.

Table 7 shows results obtained with Jones model for ten specially interesting trials. Long-term changes are written separately for trawling and "other gears", so as the fishery as a whole. These long-term possible changes are compared with those obtained by Ricker method.

Total inmediate losses were also evaluated for each change in trawlers mesh-size, with the following results:

Mesh-size	60 mm.	80 mm.	100 mm.
Inmediate loss	26 %	40 %	54 %

CONCLUSIONS

1. The actual F.Δt vector from trawlers shows a dramatically high fishing mortality on lenth groups between 5 and 25 cm. (age classes 0 and I).

   These high fishing mortalities on the two first age classes are caused to the above cited seasonal catches by trawlers on the concentrations of under-size hake, and the mesh-size used. This fact is the main responsible of the overfishing situation of hake in this area.

2. With the actual trawler mesh-size, the result of any increase in fishing effort should always be a decrease in yield.

3. Growth overfishing is so heavy that an increase the mesh-size in the cod-end of trawlers to 60 mm. or more, should cause long-term increases in yield more than 100 %, although fishing effort of trawling and "other gears" permits to change in a ±50 % range.

4. Maintaining the current effort level for each gear, an increase in the trawlers mesh-size should cause inmediate total losses of 25 %, and long-term total gains evaluated in 150 %.

5. Maintaining the actual mesh-size and level of effort of trawlers, a change in the level of effort of the other gears would not provoke significative changes of total yield.

References

CIEM	1977	. Rapport du groupe de travail sur la Merlu. Nantes, 30 Nov.-3 Déc. 1976 (in press).
Jones, R	1961	The Assessment of the long term effects of changes in gear selectivity and fishing effort. Mar. Res. Scot. No 2, 17 pp.
Jones, R	1974	Assessing the long term effects of changes in fishing effort and mesh size from length composition data.ICES CM F:33,13pp.
Ricker, W.E.	1975	Computation and Interpretation of Biological Statistics of Fish Populations. Bull. Fish. Res. Board of Canada,No191.

LENGTH GROUP	Catch in Number of individuals x 1000				
	Trawl	Small Gillnet	Long-line	Gillnet	All gears
5 - 9	2514				2514
10 - 14	64523				64523
15 - 19	92310				92310
20 - 24	28596	231			28827
25 - 29	8407	1140			9547
30 - 34	2904	1865			4769
35 - 39	1079	680	3		1762
40 - 44	1014	198	32	10	1254
45 - 49	614	101	79	33	827
50 - 54	371		174	100	645
55 - 59	220		411	232	863
60 - 64	188		425	368	981
65 - 69	126		228	370	724
70 - 74	37		102	221	360
75 - 79	21		31	78	130
79	26		10	23	59
Total (N x 1000)	202950	4215	1495	1435	210095
% N	96.6	2.01	.71	.68	100
Total weight (Ton.)	10700	1000	2400	2800	16900
% weight	63.31	5.92	14.20	16.57	100

TABLE 1 . Total number of fishes in the catch by length group and gear.

Length \ Mesh size	40	50	60	70	80	90	100	110
5 - 9	.023	.003	.0005	.000	.000	.000	.000	.000
10 - 14	.264	.049	.007	.001	.000	.000	.000	.000
15 - 19	.842	.433	.098	.015	.002	.000	.000	.000
20 - 24	.988	.919	.619	.189	.032	.005	.001	.000
25 - 29	.999	.994	.960	.776	.331	.066	.010	.001
30 - 34	1.000	1.000	.997	.981	.881	.513	.131	.021
35 - 39			1.000	.999	.991	.940	.692	.243
40 - 44				1.000	.999	.996	.971	.827
45 - 49					1.000	1.000	.998	.986
50 - 54							1.000	.999
55 - 59								1.000
l_c	14,40	18,00	21,60	25,20	28,80	32,40	36,00	39,60
t_c	.84	1,28	1,73	2,20	2,68	3,17	3,69	4,22

S.F. = 3.6

Adjusted to logistic curve $R = 1 - \frac{1}{1 + e^{-a(l_c - l)}}$ $a = .54$

Von Bertalanffy equation

$$l_t = 134\left(1 - e^{-.07(t + .78)}\right)$$

TABLE 2 . Selectivity data adopted.

L_∞ = 134 K = .07 M = .2 final F/Z = .8

LENGTH GROUP	N x 1000 CAUGHT	N x 1000 IN SEA	TOTAL F·Δt	TRAWL F·Δt	%	SMALL GILLNET F·Δt	%	LONG LINE F·Δt	%	GILLNET F·Δt	%
5 – 9	2514	305920	.01	.01	100						
10 – 14	64523	270872	.29	.29	100						
15 – 19	93305	179982	.79	.79	100						
20 – 24	28827	71473	.56	.56	100						
25 – 29	9547	35821	.33	.29	88	.04	12				
30 – 34	4769	22396	.26	.16	61	.10	39				
35 – 39	1762	15010	.13	.08	61	.05	39				
40 – 44	1253	11308	.13	.10	77	.02	15	.01	8		
45 – 49	822	8514	.11	.07	64	.02	18	.01	9	.01	9
50 – 54	645	6461	.11	.06	55			.04	36	.01	9
55 – 59	862	4831	.22	.06	27			.10	46	.06	27
60 – 64	981	3223	.41	.09	22			.17	41	.15	37
65 – 69	724	1751	.69	.12	17			.21	30	.36	52
70 – 74	360	699	.85	.09	11			.24	28	.52	61
75 – 79	130	234	.94	.15	16			.23	24	.56	60
79	59		.94	.41	44			.16	17	.37	39
	211153										

TABLE 3 .- Worksheet showing cohort analysis of length composition data and fishing mortality subdivision.

LENGTH GROUP	Trawl. Catch N x 1000	Other Gears N x 1000	Total Catch N x 1000	Total $F_1 \cdot \Delta t$	Trawl $F_1 \cdot \Delta t$	Other Gears $F_1 \cdot \Delta t$	Retention mesh 40	Retention mesh 60	Trawl $F_2 \cdot \Delta t$	Other Gears $F_2 \cdot \Delta t$	Total $F_2 \cdot \Delta t$	A $\Sigma F_1 \cdot \Delta t$	B $\Sigma F_2 \cdot \Delta t$	e^{A-B}	TOTAL New Catch N x 1000	Trawl New Catch N x 1000	Other Gears New Catch N x 1000	Average weight (Kg)
5 - 9	2514	0	2514	.01	.01	0	.023	.001	0	0	0	.01	0	1.01	0	0	0	.002
10 - 14	64523	0	64523	.29	.29	0	.264	.007	.01	0	.01	.16	.01	1.16	2581	2581	0	.012
15 - 19	92310	0	92310	.79	.79	0	.842	.098	.07	0	.07	.70	.04	1.93	15786	15786	0	.034
20 - 24	28596	231	28827	.56	.56	0	.988	.619	.26	0	.26	1.38	.18	3.32	44435	44435	0	.073
25 - 29	8407	1140	9547	.33	.29	.04	.999	.960	.21	.03	.24	1.82	.43	4.01	27842	24413	3428	.136
30 - 34	2904	1865	4769	.26	.16	.10	1	.997	.12	.08	.20	2.11	.65	4.31	15811	9387	6424	.227
35 - 39	1079	683	1762	.13	.08	.05	1	1	.06	.04	.10	2.30	.80	4.48	6072	3625	2447	.352
40 - 44	1014	240	1254	.13	.11	.02	1	1	.08	.02	.10	2.43	.90	4.62	4456	3407	1049	.517
45 - 49	614	213	827	.11	.08	.03	1	1	.06	.02	.08	2.55	.99	4.76	2863	2192	671	.727
50 - 54	371	274	645	.11	.06	.05	1	1	.05	.04	.09	2.65	1.08	4.81	2538	1487	1051	.989
55 - 59	220	643	863	.22	.06	.16	1	1	.05	.12	.17	2.82	1.21	5.00	3334	917	2417	1.309
60 - 64	188	793	981	.41	.08	.33	1	1	.06	.25	.31	3.13	1.45	5.37	3983	757	3225	1.691
65 - 69	126	598	724	.69	.12	.57	1	1	.09	.43	.52	3.69	1.87	6.17	3366	583	2783	2.142
70 - 74	37	323	360	.85	.09	.76	1	1	.07	.57	.64	4.45	2.45	7.39	2003	213	1790	2.668
75 - 79	21	109	130	.94	.15	.79	1	1	.11	.59	.70	5.35	3.12	9.30	900	143	757	3.276
79	26	33	59	.94	.41	.53	1	1	.31	.40	.71	6.29	3.83	11.7	521	230	291	~ 5

TABLE 4 .: Worksheet showing long term changes calculation for a mesh size trawlers change since 40 to 60 mm. and a total fishing effort change = - 25 % .

	OLD YIELD	NEW YIELD	LONG TERM CHANGE
TRAWL	10.700	21.281	+ 99 %
OTHER GEARS	6.231	28144	+ 352 %
TOTAL	16.931	49426	+ 192 %

length (cm)	Δt (yr)	Wt (kg.)	G	M	F (trawl)	F (others)	G-M-F	exp(G-M-F)	B	$\bar{B}$	Yield
5	.56	.0007	2.15	.11	.01	.00	2.03	7.61	1.	4.31	.04
10	.59	.006	1.25	.12	.29	.00	.84	2.32	7.61	12.64	3.67
15	.61	.21	..89	.12	.79	.00	-.02	.98	17.66	17.48	13.81
20	.64	.51	.68	.13	.56	.00	-.01	.99	17.30	17.22	9.64
25	.67	.101	.56	.13	.29	.04	.10	1.11	17.13	18.07	5.96
30	.70	.177	.47	.14	.16	.10	.07	1.07	19.01	19.68	5,12
35	.74	.284	.41	.15	.08	.05	.13	1.14	20.34	21.77	2.83
40	.78	.429	.36	.16	.11	.02	.07	1.07	23.19	24.01	3.12
45	.82	.616	.32	.16	.08	.03	.05	1.05	24.82	25.44	2.80
50	.87	.852	.29	.17	.06	.05	.01	1.01	26.06	26.19	2.88
55	.93	1.141	.27	.19	.06	.16	-.14	.87	26.32	24.61	5.41
60	1.00	1.491	.25	.20	.08	.33	-.36	.70	22.90	19.47	7.98
65	1.07	1.908	.23	.21	.12	.57	-.67	.51	16.03	12.10	8.35
70	1.16	2.396	.21	.23	.09	.76	-.87	.42	8.17	5.80	4.93
75	1.26	2.961	.20	.25	.15	.79	-.99	.37	3.43	2.35	2.21
80		3.611							1.27		
										TOTAL	78.75

TABLE 5 .- Worksheet showing Ricker's model for calculation of equilibrium yield (current situation).

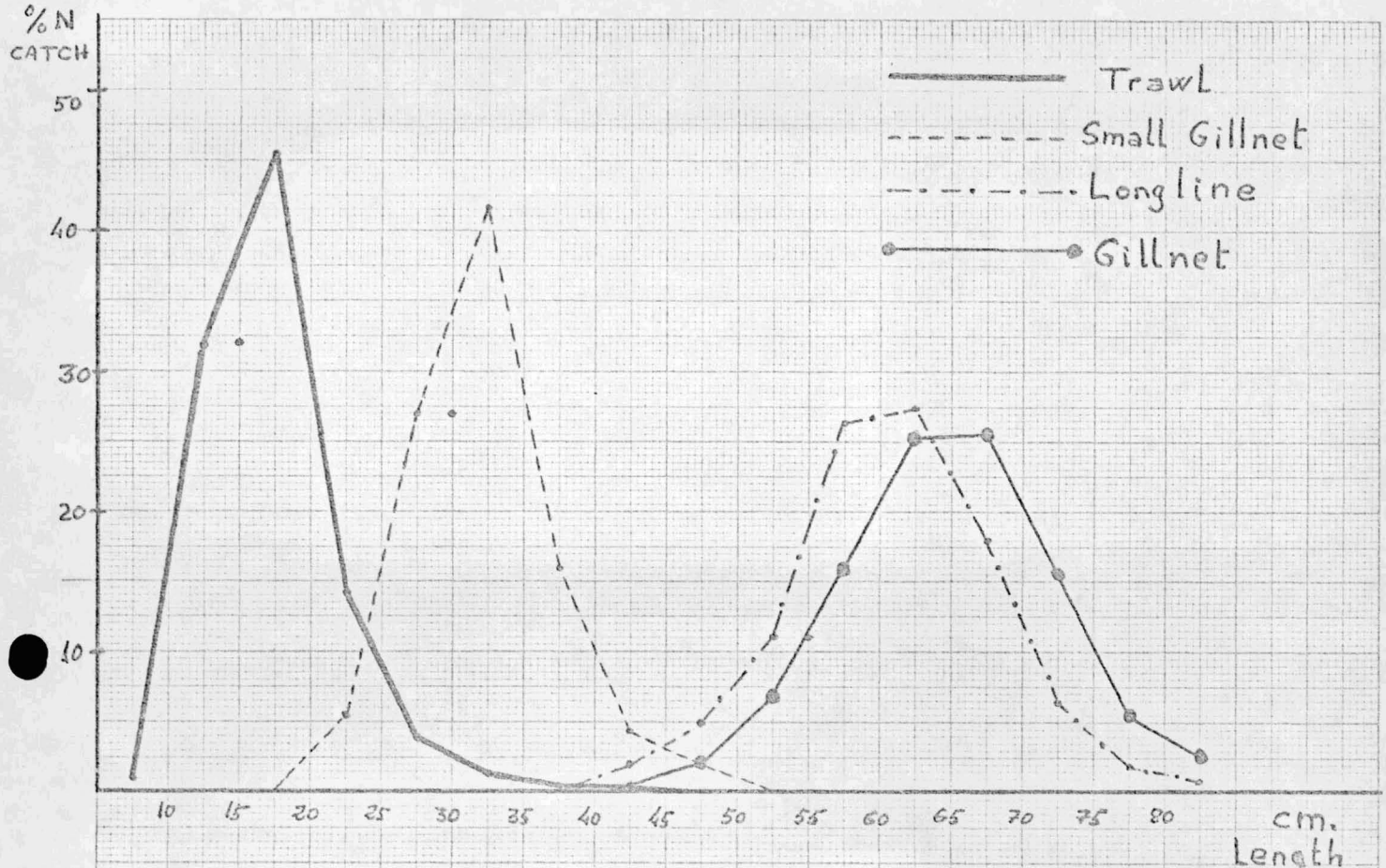
Other gears (small gillnets, longlines, gillnets)

Trawl: Effort change	Mesh size	−50 %	−25 %	no change	+25 %	+50 %
−50 %	40 mm.	+89 %	+99 %	+102 %	+101 %	+98 %
−25 %		+33 %	+38 %	+ 39 %	+ 38 %	+36 %
no change		− 2 %	−.2 %	current situation	− 1 %	− 2 %
+25 %		−25 %	−24 %	−25 %	− 25 %	−26 %
+50 %		−40 %	−40 %	− 40 %	− 41 %	−41 %
−50 %	60 mm.	+210 %	+230 %	+235 %	+232 %	+227 %
−25 %		+172 %	+183 %	+185 %	+183 %	+178 %
no change		+139 %	+145 %	+146 %	+143 %	+140 %
+25 %		+111 %	+114 %	+114 %	+112 %	+109 %
+50 %		+ 87 %	+ 89 %	+ 88 %	+ 86 %	+ 84 %
−50 %	80 mm.	+287 %	+314 %	+321 %	+318 %	+311 %
−25 %		+277 %	+295 %	+299 %	+295 %	+288 %
no change		+264 %	+277 %	+278 %	+274 %	+267 %
+25 %		+252 %	+260 %	+259 %	+254 %	+248 %
+50 %		+239 %	+244 %	+242 %	+237 %	+231 %
−50 %	100 mm.	+317 %	+348 %	+356 %	+353 %	+344 %
−25 %		+320 %	+343 %	+348 %	+343 %	+335 %
no change		+321 %	+338 %	+340 %	+334 %	+325 %
+25 %		+321 %	+333 %	+332 %	+326 %	+317 %
+50 %		+319 %	+327 %	+324 %	+317 %	+308 %

TABLE 6 .: Long Term changes by Ricker's model obtained changing the fishing mortality vectors. (Changes in mesh size and effort trawlers and only effort in other gears).

MESH SIZE CHANGE (Trawlers)	FISHING EFFORT CHANGE		LONG TERM CHANGES			
	TRAWL	OTHER GEARS	TRAWL	OTHER GEARS	TOTAL (Jones)	TOTAL (Ricker)
no change (40 mm.)	no change	no change	10.700 Ton.	6.231 Ton.		
	+ 25 %	no change	- 11 %	- 48 %	- 25 %	- 25 %
	- 25 %	no change	+ 10 %	+ 84 %	+ 38 %	+ 39 %
	- 50 %	+ 50 %	0 %	+ 237	+ 86 %	+ 98 %
40 mm. to 60 mm.	- 25 %	- 25 %	+ 94 %	+ 341 %	+ 185 %	+ 183 %
	no change	no change	+ 86 %	+ 227 %	+ 138 %	+ 146 %
	+ 50 %	no change	+ 91 %	+ 74 %	+ 85 %	+ 88 %
	- 50 %	+ 50 %	+ 26 %	+ 523 %	+ 209 %	+ 227 %
40 mm. to 80 mm.	no change	no change	+ 118 %	+ 504 %	+ 260 %	+ 278 %
	+ 50 %	+ 50 %	+ 128 %	+ 371 %	+ 218 %	+ 231 %
	- 50 %	+ 50 %	+ 14 %	+ 756 %	+ 287 %	+ 311 %

TABLE 7 .- Effects of changes in trawlers mesh size and fishing effort by gear. Jones and Ricker methods comparison.


% N
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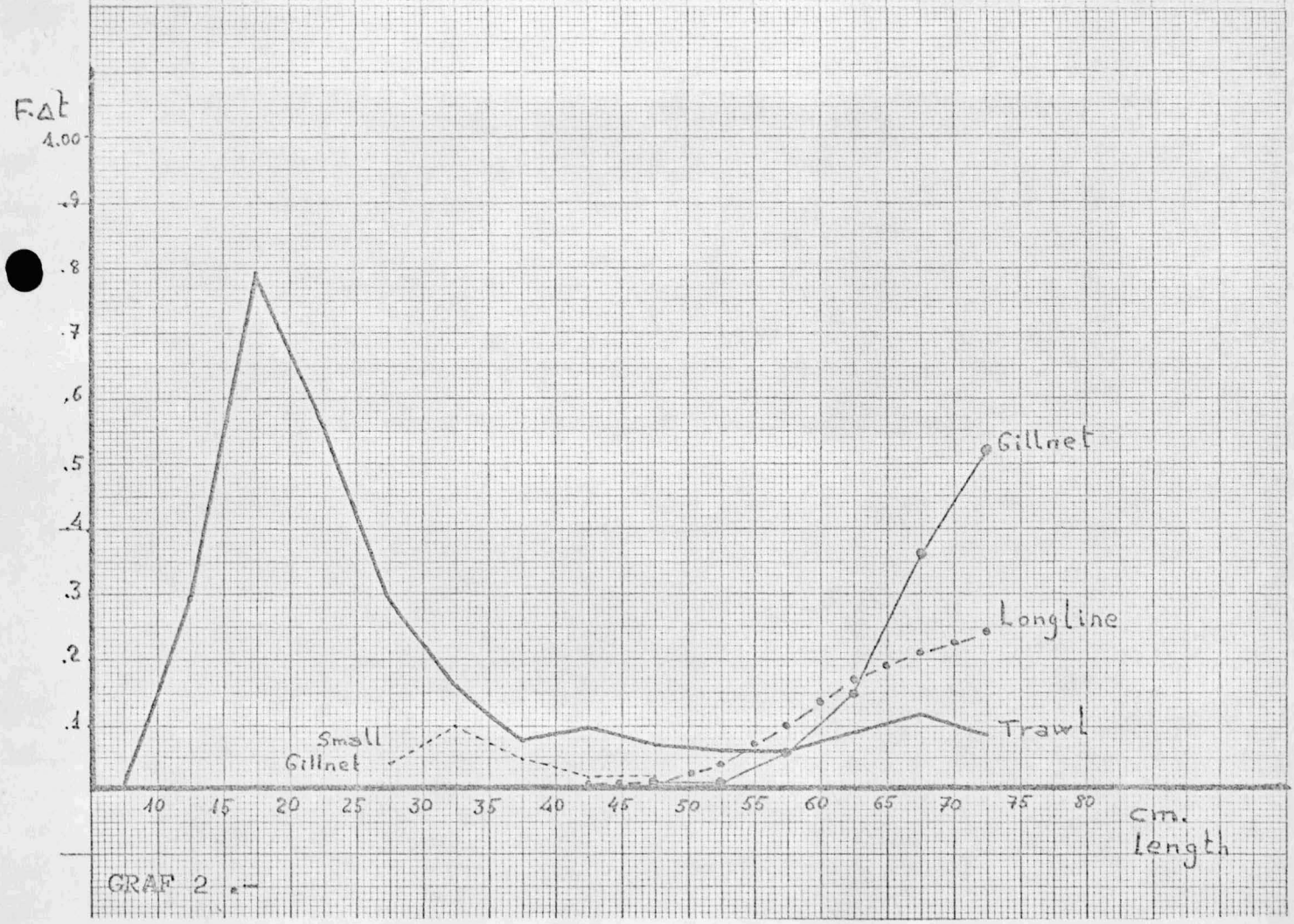
cm.
Length

GRAF. 1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cm.
length

GRAF 2