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International Council for the  
Exploration of the Sea

ICES CM 2000/W:04

Theme Session:  
On Cooperative Research  
with the Fishing Industry:  
Lessons learned.

RESULTS OF A DEEP-WATER EXPERIMENTAL FISHING  
IN THE NORTH ATLANTIC: AN EXAMPLE OF COOPERATIVE  
RESEARCH WITH THE FISHING INDUSTRY

by

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**ABSTRACT**

This Experimental fishing was conducted by the freezer trawler *M/V Puente Sabaris*, in international waters of the North Atlantic in February-April 1999. One scientific was on board to collect data and biological material. Seamounts and banks near Azores was explored (Antialtair, Altair, Faraday, Olympus and Minle) and also Reikjanes Ridge and Hatton Bank. Fishing effort was more intense at Reikjanes and Hatton with deepwater trawling.

Most of the catch was obtained at Reikjanes and Hatton. Blue ling (*Molva dypterygia*) was the most caught species, with high catches at Reikjanes (3652 kg/hr.). Roundnose grenadier (*Coryphaenoides rupestris*) was the second species in importance, catch mainly at Hatton and Faraday. Other caught species were Boreal shark (*Somniosus microcephalus*), Atlantic halibut (*Hippoglossus hippoglossus*), Smoothhead (*Alepocephalus bairdii*), Black scabbardfish (*Aphanopus carbo*) and Orange roughy (*Hoplostethus atlanticus*). All catches were taken at depths of below 600 m.

The length range of Blue ling was 59-137 cm, with predominance of males. This was also evident in orange roughy, with individuals between 48-69 cm. The length range of Roundnose grenadier was 4.5-23 cm. The length-weight ratio was estimated for the main species. Observations of maturity at length was made, most of the individuals of Blue ling were mature.

**KEY WORDS:** North Atlantic, experimental fishing, deep-water, trawl, blue ling, roundnose grenadier, orange roughy.

## INTRODUCTION

In recent years, the Spanish fishing fleet has intensified the search for alternative resources and grounds, counting on scientific assessment. Since 1997, the Distant Water Fisheries Research Programme for at the Spanish Institute of Oceanography (IEO) in Vigo have been developed several Pilot Action Experimental Fishing on the Atlantic Ocean, funded by the European Union. These Experimental Fishings are cooperative research initiatives between fisheries scientists and the commercial fishing industry. In these experiences a biologist observer is on board of each participant vessel to collect data and biological material, for subsequent analysis at the IEO laboratory.

Three Experimental fishings were conducted on the Mid Atlantic Ridge, on the adjacent underwater seamounts (Iglesias and Durán, 1997) and Lorien Knoll (Durán and Paz, 1998) by freezer trawlers belonging to the shipowners' association ANAMER. Valuable information has been obtained on distribution, biology and exploitation possibilities of new resources, particularly in the case of several deepwater species such as Grenadiers, Smoothhead, Orange roughy, Alfonsinos, Black scabbardfish, Blue ling and deepwater sharks, besides pelagic species such as Mackerel and Oceanic horse mackerel.

Based on these previous experiences, the vessel *M/V Puente Sabaris* conducted a Pilot Action to explore the possibilities of fishing on several banks and underwater elevations in the North Atlantic (Durán, 1999). Exploration took place during the first half of 1999, supplementing the information collected in previous campaigns performed in summer. As on other occasions, a biologist observer was on board to collect data and biological material. This article describes the main results (ICES, 2000) of this exploratory fishery as an example of a Cooperative research with the fishing industry.

## MATERIAL AND METHODS

The experimental campaign was conducted by the commercial vessel *M/V PUENTE SABARIS*. The technical characteristics of this freezer trawler are outlined in Table 1.

**Table 1.-** Technical specifications of the *B/C Puente Sabarís*

Main engine: 1950 CV	Beam: 11 m	Year built: 1986
Tonnage: 813	Fish hold capacity: 1692 m <sup>3</sup>	Hull: Steel
Length : 67.7 m	Freezing capacity: 42 Tm/day	Port: Vigo (Spain)

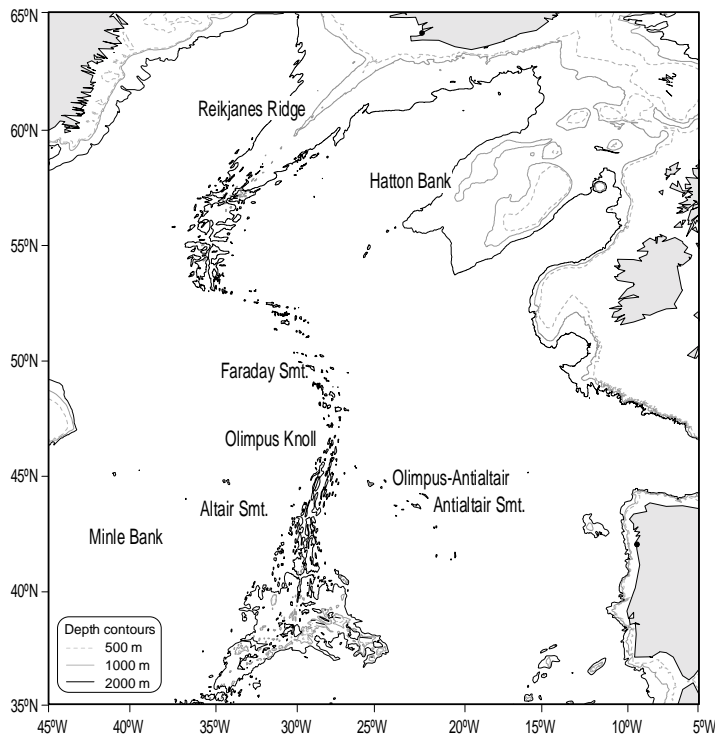
Practically all the fish were caught by bottom trawl of the type *PEDREIRA*, which is the type normally used by the Spanish freezer fleet in deep waters. This is especially designed for rough terrain. Also, highly restricted tests were conducted with a *GLORIA* midwater trawl. Fish were detected and gear was monitored with various electronic equipment, such as echo-sounder (SIMRAD ES-500), sonar (SIMRAD FS-925), a rope measuring system (MARELEC SM-D), etc.

Exploration was carried out on North Atlantic international waters, inside the ICES area (X, XII and XIVb Divs.), and in two clearly differentiated stages (Table 2). From 26th February to 19th March, operations were in the vicinity of the Azores Islands, commencing at Antialtair Smt. and a nearby elevation. This was followed by exploration of Olympus Knoll, Altair Smt. and Minle Bank, finishing at Faraday Smt. and area, totalling 22 campaign days. From 21st March to 11th April, activity was developed on the Reikjanes Ridge and Hatton Bank, totalling a further 22 work days.

**Table 2.-** Investigated areas and total depth range explored.

Stage	Investigated area	Depth range
First stage (22 days): Near Azores	Antialtair Seamount	889-1080 m
	Eminence between Olympus Knoll and Antialtair Smt.	630-1850 m
	Olimpus Knoll	710-1050 m
	Faraday Seamount	550-1142 m
	Altair Seamount	975-1382 m
	Minle Bank	as depth as 1600 m
Second stage (22 days): North to 56°N	Hatton Bank	762-1200 m
	Reikjanes Ridge	630-1250 m

The geographic location of the investigated areas are shown in the figure 1.



**Figure 1.-** Map showing the eighth investigated areas.

Data were collected by the observer biologist on board, under instructions from the IEO laboratory in Vigo. Location (latitude and longitude), time (UTC), depth (m.), catch and discards (kg of live weight, estimated or weighted) of the total of 110 hauls conducted were noted, 8 of these hauls being declared null due to breakages and other serious incidents. All the information was recorded on board by the observer on a laptop computer, using specific software. Measurements were taken at random, of the total length to the nearest lower cm., except in the case of grenadier, where preanal fin length to the 0.5 nearest lower cm. was measured. Biological samplings were made (stratified by length), recording size (cm), weight (g.), sex, maturity stage and stomach content of each individual, according with methods of IEO. The biological data collected is in table 3.

**Table 3 .-** Number of samples, individuals and otoliths collect.

Specie	Length samples	Individ.	Length range (cm)	Biological samples	Individ.	Otoliths
Blue ling ( <i>Molva dypterygia</i> )	19	2011	59-137	19	1493	116
Roundnose grenadier ( <i>Coryphaenoides rupestris</i> )	7	998	4.5-23	4	368	-
North atlantic codling ( <i>Lepidion eques</i> )	6	760	19-39	4	116	-
Mora ( <i>Mora moro</i> )	4	23	38-65	1	9	-
Black scabbardfish ( <i>Aphanopus carbo</i> )	3	146	78-126	11	264	183
Greater lantern shark ( <i>Etmopterus princeps</i> )	3	350	20-78	1	100	-
Slender codling ( <i>Halargyreus johnsonii</i> )	3	53	30-44	-	-	-
Oceanic redfish ( <i>Sebastes mentella</i> )	3	343	25-50	3	44	-
Longnose velvet dogfish ( <i>Centroscymnus crepidater</i> )	3	92	27-87	1	36	-
Birdbeak dogfish ( <i>Deania calceus</i> )	2	190	68-114	-	-	-
Orange roughy ( <i>Hoplostethus atlanticus</i> )	1	197	48-69	10	248	153
Cardinal fish ( <i>Epigonus telescopus</i> )	1	8	52-74	-	-	-
Smoothhead ( <i>Alepocephalus bairdii</i> )	1	112	37-86	1	3	-
Black dogfish ( <i>Centroscyllium fabricii</i> )	1	33	58-82	-	-	-
Roughead Grenadier ( <i>Macrourus berglax</i> )	-	-	-	2	14	-
Golden redfish ( <i>Sebastes marinus</i> )	-	-	-	1	2	-
Atlantic halibut ( <i>Hippoglossus hippoglossus</i> )	-	-	-	1	4	-
Blackfish ( <i>Centrolophus niger</i> )	-	-	-	1	17	-
<b>TOTAL</b>	57	5316		60	2718	452

## RESULTS

### Surveys: nature of the sea bottoms

The first stage of the campaign involved an intense search for fish and for bottoms suitable for trawling, in the area adjacent to the Azores Islands (Olimpus Knoll, Minle Bank, Altair Smt. and Faraday Smt), with a total of 123.13 hours of surveying distributed over 12 days (table 4). Exploration revealed a very steep topography, peaks, needles and, generally, very steep bottoms and small trawlable surfaces. Olimpus Knoll was inaccessible to trawling and, on the Minle Bank the depths detected were greater than 1600 m, meaning that it was not possible to perform valid hauls.

**Table 4.-** Sounding near Azores.

Area	Mín. depth	Type of ground
Milne Bank	>1600 m	No detected
Altair Smt.	975 m	Very hard
Olimpus Knoll	710 m	Inaccessible, peaks, needles
Faraday Smt.	550 m	Abrupt, with deepest surfaces good to bottom trawl

In the areas explored during the second stage of the campaign, Reikjanes also presented a very abrupt topography (Magnusson et al 1995), whereas on Hatton Bank, the bottoms were less steep.

## Fishing effort

Most of the fishing effort was made with deepwater trawling on the Reikjanes Ridge and on Hatton Bank (table 5). Average trawling times were far higher on Hatton due to the fact that in the other areas explored, trawlable surface was negligible and steep, fishing gear frequently running aground or breaking, making it necessary to use a fishing method characterised by short duration hauls. The underwater topography of Olympus and Minle made fishing impossible. Pelagic trawling effort was highly restricted, since only 2 valid catches out of the 100 made with deepwater gear was achieved.

**Table 5.-** Fishing effort in hours trawled and number of valid hauls, by gear and explored area.

Explored area	Bottom trawl			Pelagic trawl			TOTAL	
	Hours trawled	Valid hauls	Mean tow time (hours)	Hours trawled	Valid hauls	Mean tow time (hours)	Hours trawled	Valid hauls
Hatton Bank	163.4	34	4.8	-	-	-	163.4	34
Reikjanes Ridge	20.9	40	0.5	1	1	1	21.9	41
Olimpus Knoll <sup>(1)</sup>	-	-	-	-	-	-	-	-
Faraday Smt.	5.4	14	0.4	5.3	1	5.3	10.7	15
Altair Smt.	1.8	3	0.6	-	-	-	1.8	3
Minle Bank <sup>(1)</sup>	-	-	-	-	-	-	-	-
Antialtair Smt.	0.6	1	0.6	-	-	-	0.6	1
Olimpus-Antialtair	4.2	8	0.5	-	-	-	4.2	8
<b>TOTAL</b>	<b>196.3</b>	<b>100</b>	<b>2.0</b>	<b>6.3</b>	<b>2</b>	<b>3.15</b>	<b>202.6</b>	<b>102</b>

(1) No valid hauls

For the purposes of analysing the distribution of the total effort by area and depth stratum, three ranges are established to cover all the valid catches, as shown in table 6.

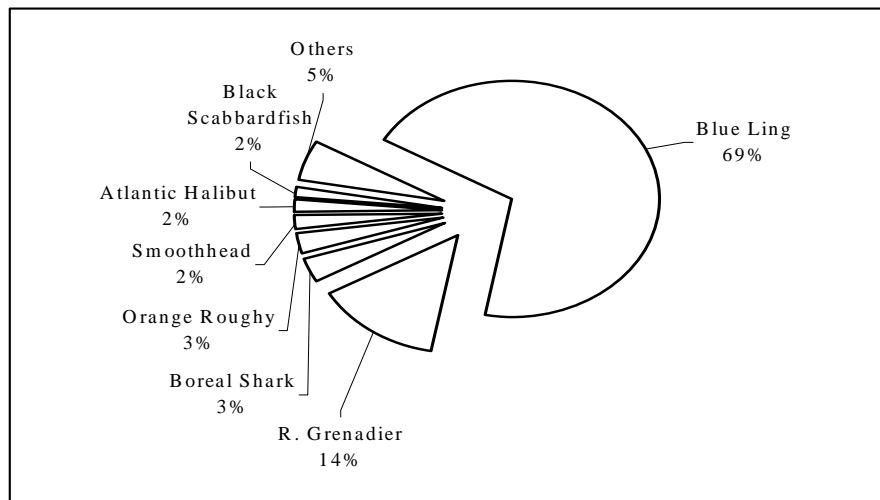
**Table 6.-** Total fishing effort in hours trawled and number of valid hauls, by area and depth stratum.

Explored area		Fishing effort by depth stratum			TOTAL
		601-800 m	801-1000 m	1001-1200 m	
Hatton	Hours	109.5	45.4	8.5	163.4
	Hauls	22	10	2	34
Reikjanes	Hours	1.5	18.2	2.2	21.9
	Hauls	2	34	5	41
Faraday	Hours	5.3	4.4	1	10.7
	Hauls	1	11	3	15
Altair	Hours	-	-	1.8	1.8
	Hauls	-	-	3	3
Antialtair	Hours	-	0.6	-	0.6
	Hauls	-	1	-	1
Olimpus-Antialtair	Hours	1.7	2.5	-	4.2
	Hauls	3	5	-	8
TOTAL	Hours	118	71.1	13.5	202.6
	Hauls	28	61	13	102

The number of trawling hours was greater in the shallower stratum, but however, the number of valid catches is higher in the intermediate stratum. This apparent contradiction is due to the different catching methods used, which depended on the characteristics of the bottom. On Hatton, where the terrain is less steep, hauls had a high average duration, and were concentrated on the 600 to 800 m stratum, on Reikjanes, where the orography is steeper, a large number of short duration catches were made on depths from 801 to 1000 m.

### Catches

Taking the campaign as a whole, most of the catch corresponded to Blue ling (*Molva dypterygia*) with 138 MT (69% of Total Catch), Roundnose grenadier (*Coryphaenoides rupestris*) with 27.7 MT (14%), Boreal shark (*Somniosus microcephalus*) with 6.5 MT (3%), Orange roughy (*Hoplostethus atlanticus*) with 5.3 MT (3%), Smoothhead (*Alepocephalus bairdii*) with 3.8 MT (2%), Atlantic halibut (*Hippoglossus hippoglossus*) with 3.3 MT (2%) and Black scabbardfish (*Aphanopus carbo*) with 3 MT (2%). North atlantic codling (*Lepidion eques*) comprised only 1% of the total. The other species, including several types of deepwater sharks, are represented by catches of less than 1% of the total. Figure 2 shows the percentages of catches from the seven most important species, with a clear predominance of Blue ling and, to a lesser extent, Roundnose grenadier.



**Figure 2.-** Percentage of the total catch of the seven main fish species.

Table 7 shows total catch in live weight per area prospected for the most important species. Most of the catch was taken on Hatton Bank and the Reikjanes Ridge, an area where the highest fishing effort was made.

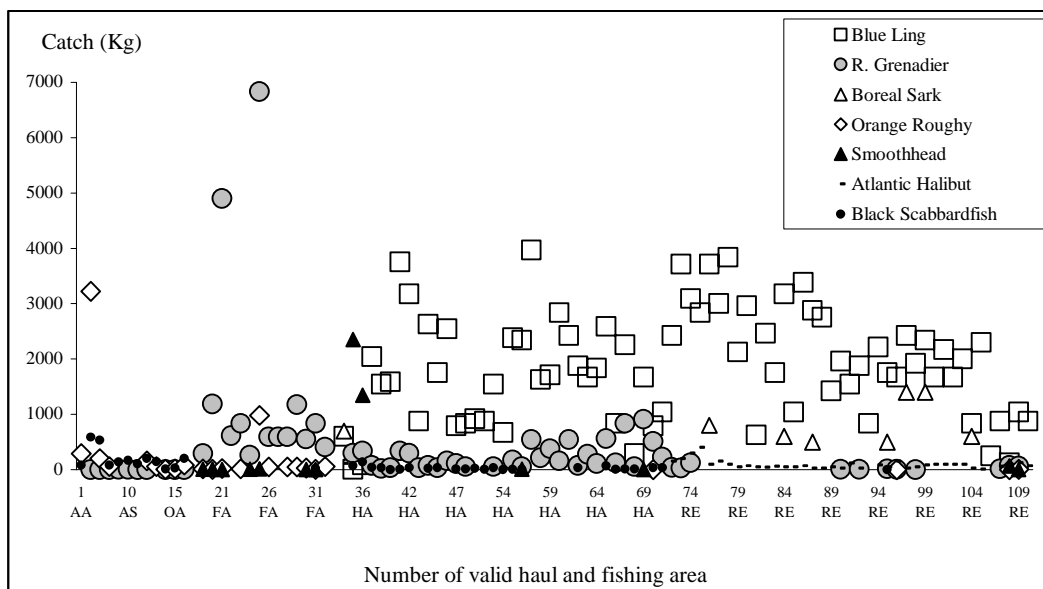
**Table 7.-** Total catch (Kg) of the main fish species, by area.

Specie	Hatton	Reikjanes	Faraday	Altair	Antialtair	Olimpus-Antialtair	TOTAL
Blue ling ( <i>Molva dypterygia</i> )	57788	80176	-	-	-	-	137964
Roundnose grenadier ( <i>C. rupestris</i> )	7692	380	19682	15	-	10	27781
Boreal shark ( <i>S. Microcephalus</i> )	-	6500	-	-	-	-	6500
Orange roughy ( <i>H. atlanticus</i> )	-	8	1268	-	292	3802	5371
Smoothhead ( <i>A. bairdii</i> )	3706	70	38	-	-	-	3816
Atlantic halibut ( <i>H. hippoglossus</i> )	-	3371	-	-	-	-	3371

**Table 7 (Cont.).-** Total catch (Kg) of the main fish species, by area.

Specie	Hatton	Reikjanes	Faraday	Altair	Antialtair	Olimpus-Antialtair	TOTAL
Black scabbardfish ( <i>A. Carbo</i> )	680	35	20	406	82	1793	3016
North atlantic codling ( <i>L. Eques</i> )	2887	45	13	1	-	5	2954
Lantern shark ( <i>E. Princeps</i> )	-	60	913	489	-	45	1508
Dogfish ( <i>C. coelolepis</i> )	1106	356	-	-	-	8	1471
Oceanic redfish ( <i>S. Mentella</i> )	6	922	-	-	-	-	928
Black dogfish ( <i>C. Fabricii</i> )	7	790	-	-	-	0	798
Birdbeak dogfish ( <i>D. Calceus</i> )	702	-	-	-	-	37	740
Mora ( <i>Mora moro</i> )	267	-	-	-	4	55	654
Leafscale gulper shark ( <i>C. Squamosus</i> )	324	143	8	10	-	50	536
Dogfish ( <i>C. crepidater</i> )	512	20	-	-	-	-	534

Figure 3 shows amounts of the main species obtained in each of the valid catches, in chronological order, indicating the area in which they were caught. The amounts of Blue ling caught, exclusively caught on Hatton and Reikjanes, were very high in most hauls, particularly on Reikjanes. Roundnose grenadier was caught in substantial amounts on Hatton Bank and on Faraday Smt., where most of the catch was concentrated in two hauls. Boreal shark and Atlantic halibut were only caught on Reikjanes, individuals being few and heavy in weight. In this area, Atlantic halibut was present in most catches. The highest catches of Smoothhead were on Hatton, with two abundant catches, with little presence in the other hauls. Black scabbardfish appeared in all areas, in discrete amounts, with frequent catches on Hatton, Antialtair and Olympus-Antialtair, where catches per haul were higher. Orange roughy appeared in the Azores area, the most important catches being on Olympus-Antialtair. Most of the catch was taken in two hauls, the rest of the catches being largely irrelevant. Generally, concentrations of this species are associated with steep terrain (underwater peaks and slopes), with a trend to migrate or disperse after trawling operations.



**Figure 3.-** Distribution of the catches (Kg) of the seven main fish species by valid haul and fishing area. AA=Antialtair, AS=Altair Smt., OA=Olimpus-Antialtair,FA=Faraday, HA=Hatton, RE= Reikjanes.

Table 8 shows the total catch (Kg) in live weight for the main species, broken down into depth strata and specifies the percentage for each of the species considered in the total campaign catch. All the catch was taken at depths of over 600 metres. Particularly, catches of Orange roughy and Black scabbardfish were very high in the 601 to 800 m depth stratum; catches of Blue ling, Roundnose grenadier, Boreal shark and Atlantic halibut were important on bottoms from 801 to 1000 m, whereas catches of Smoothhead predominated at depths from 1001 m and greater.

**Table 8.-** Total catch (Kg) of the main fish species, by depth stratum.

Specie	Total catch (Kg)			TOTAL (Kg)	% of total catch
	601-800 m	801-1000 m	1001-1200 m		
Blue ling ( <i>Molva dytergia</i> )	41290	84727	11947	137964	69%
Roundnose grenadier ( <i>C. rupestris</i> )	3563	21206	3012	27781	14%
Boreal shark ( <i>S. microcephalus</i> )	-	5100	1400	6500	3%
Orange roughy ( <i>H. atlanticus</i> )	3484	1794	93	5371	3%
Smoothhead ( <i>A. bairdii</i> )	11	109	3696	3816	2%
Atlantic halibut ( <i>H. hippoglossus</i> )	150	2861	360	3371	2%
Black scabbardfish ( <i>A. carbo</i> )	1524	884	608	3016	2%
North atlantic codling ( <i>L. Eques</i> )	2070	863	21	2954	1%
Lantern shark ( <i>E. princeps</i> )	42	839	627	1508	<1%
Dogfish ( <i>C. coelolepis</i> )	274	352	845	1471	<1%
Oceanic redfish ( <i>S. mentella</i> )	310	520	98	928	<1%
Black dogfish ( <i>C. fabricii</i> )	2	791	5	798	<1%
Birdbeak dogfish ( <i>D. calceus</i> )	680	60	-	740	<1%
Mora ( <i>Mora moro</i> )	243	84	-	327	<1%
Leafscale gulper shark ( <i>C. squamosus</i> )	158	189	190	536	<1%
Dogfish ( <i>C. crepidater</i> )	302	232	-	534	<1%

## Yields

Highest yields corresponded to Blue ling on the Reikjanes Ridge (3652 kg/hr). Roundnose grenadier reached a maximum on Faraday (1834 kg/hr), but the presence of two very abundant hauls must be noted here. The highest values for Orange roughy were achieved on Olympus-Antialtair (912 kg/hr) where a very abundant haul was obtained. Atlantic halibut rose to 153 kg/hr on Reikjanes. Black scabbardfish presented the highest value (430 kg/hr) on Olympus-Antialtair (table 9). Analysis of yields for the species of most commercial interest in terms of depth shows a similar trend to that observed in the catches, except in the case of Black scabbardfish (table 10).

**Table 9-** Yield (Kg/hour) of the main fish species, by area

Specie	Hatton	Reikjanes	Faraday	Altair	Antialtair	Olimpus-Antialtair	TOTAL
Blue ling ( <i>Molva dytergia</i> )	353	3652	-	-	-	-	690
Roundnose grenadier ( <i>C. rupestris</i> )	47	17	1834	8	-	2	137
Boreal shark ( <i>S. microcephalus</i> )	-	296	-	-	-	-	32
Orange roughy ( <i>H. atlanticus</i> )	< 1	< 1	118	-	474	912	27
Smoothhead ( <i>A. bairdii</i> )	22	3	4	-	-	-	19
Atlantic halibut ( <i>H. hippoglossus</i> )	-	153	-	-	-	-	17



**Table 9 (Cont.)-** Yield (Kg/hour) of the main fish species, by area

Specie	Hatton	Reikjanes	Faraday	Altair	Antialtair	Olimpus-Antialtair	TOTAL
Black scabbardfish ( <i>A. carbo</i> )	-	1	2	223.3	133.3	430	15
North atlantic codling ( <i>L. Eques</i> )	17	2	1	< 1	< 1	1	15
Lantern shark ( <i>E. princeps</i> )	-	2	85	269.2		10	8
Dogfish ( <i>C. coelolepis</i> )	6	16	-	-	-	1	7
Oceanic redfish ( <i>S. mentella</i> )	< 1	42	-	-	-	-	5
Black dogfish ( <i>C. fabricii</i> )	< 1	36	-	-	-	-	4
Birdbeak dogfish ( <i>D. calceus</i> )	4	-	-	-	-	9	4
Mora ( <i>Mora moro</i> )	1	-	-	-	6	13	2
Leafscale gulper shark ( <i>C. squamosus</i> )	2	6	< 1	5.3	-	12	3
Dogfish ( <i>C. crepidater</i> )	3	< 1	-	-	-	-	3

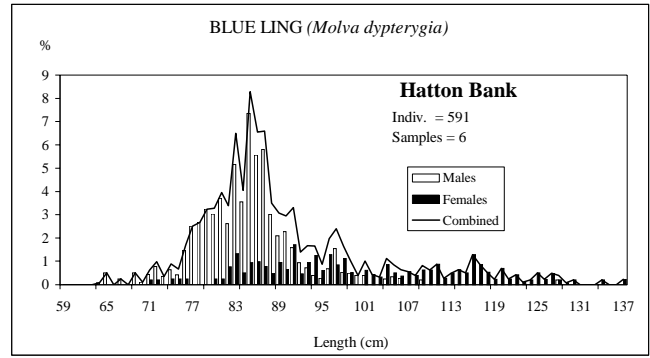
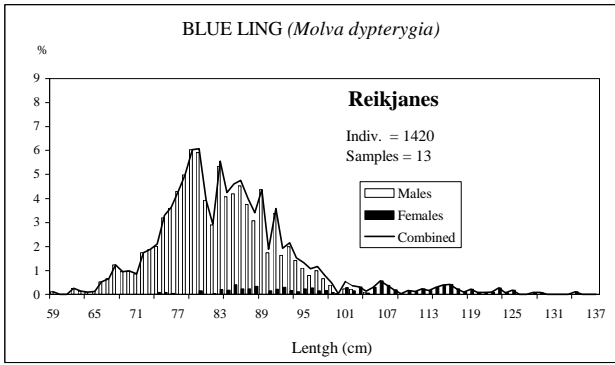
**Table 10.-** Yield (Kg/hour) of the main fish species, by depth stratum.

Specie	Yield (Kg/hora) by depth stratum			TOTAL
	601-800 m	801-1000 m	1001-1200 m	
Blue ling ( <i>Molva dytergia</i> )	354	1211	884	690
Roundnose grenadier ( <i>C. rupestris</i> )	30	298	223	137
Boreal shark ( <i>S. microcephalus</i> )	-	73	104	32
Orange roughy ( <i>H. atlanticus</i> )	30	25	7	27
Smoothhead ( <i>A. bairdii</i> )	< 1	2	273	19
Atlantic halibut ( <i>H. hippoglossus</i> )	1	41	27	17
Black scabbardfish ( <i>A. carbo</i> )	13	12	45	15
North atlantic codling ( <i>L. Eques</i> )	18	12	2	15
Lantern shark ( <i>E. princeps</i> )	0	12	46	8
Dogfish ( <i>C. coelolepis</i> )	2	5	63	7
Oceanic redfish ( <i>S. mentella</i> )	3	7	7	5
Black dogfish ( <i>C. fabricii</i> )	< 1	11	< 1	4
Birdbeak dogfish ( <i>D. calceus</i> )	6	1	-	4
Mora ( <i>Mora moro</i> )	2	-	-	2
Leafscale gulper shark ( <i>C. squamosus</i> )	1	3	14	3
Dogfish ( <i>C. crepidater</i> )	3	3	-	3

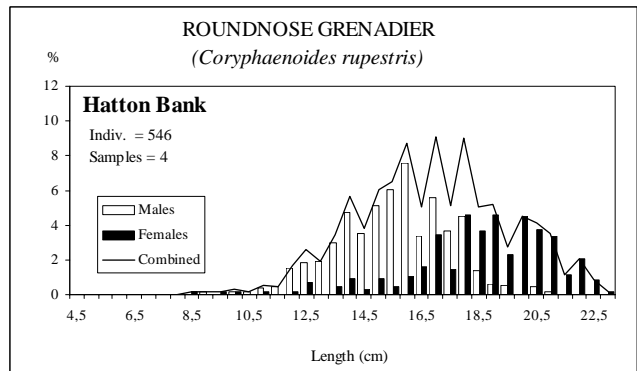
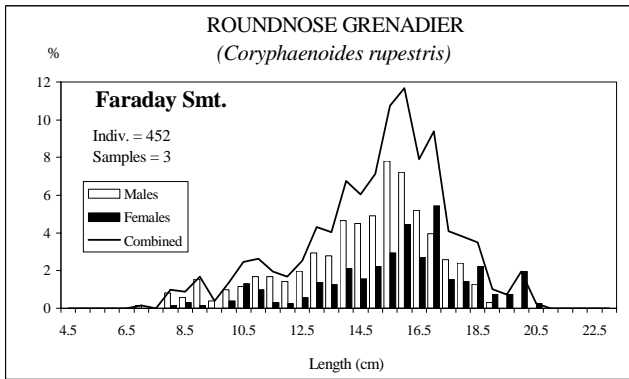
### Length distributions

On Reikjanes, Blue ling sizes ranged from 59 to 134 cm, with an almost total predominance of males (90.5%) over females (9.5%). These percentages are agreement with the observations of others autors (Magnusson et al, 1995). The males presented a range of 59 -104 cm., with a mode of 79 cm and 74-134 cm in females, with various modal classes. On Hatton Bank, sizes ranged from 64 to 137 cm, where males also predominated (67.3) over females (32.7%). The male range was 64-128 cm, with a mode of 85%, and females with sizes 71-137 cm, which also had several modal classes (figure 4).

The length of individuals of Roundnose grenadier on Faraday Smt. ranged from 4.5 to 20.5 cm. Males ranged from 7 to 19 cm, and females from 8 to 20.5 cm, with modes of 15.5 cm and 17 cm respectively. Males represent 62.8% of catches, and females 37.2%. On Hatton Bank, size ranges were from 8.5 to 23 cm, with a 16 cm mode for males and 19 cm for females. Males represented 57%, and females 43% (figure 5).

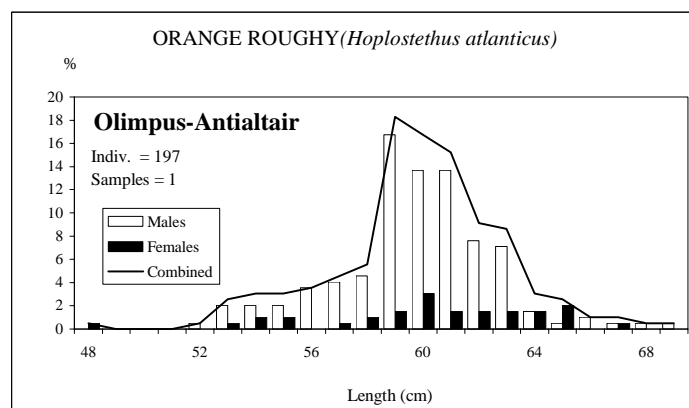


**Figure 4.-** Length distribution of Blue ling in the catches. Reikjanes Ridge and Hatton Bank.



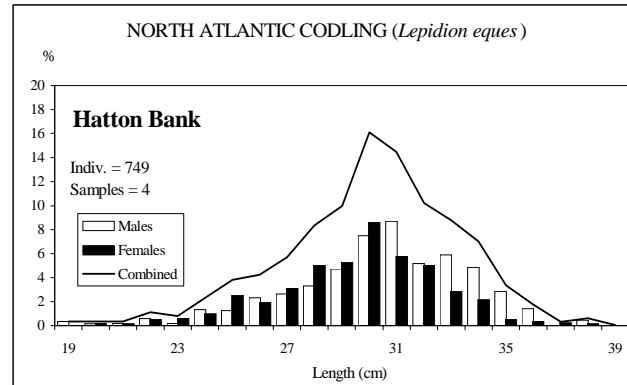
**Figure 5.-** Length distribution of Roundnose grenadier in the catches. Faraday Smt. and Hatton Bank.

Sizes of Orange roughy on Olympus-Antialtair ranged from 48 to 69 cm. 82.2% of the individuals captured were males, ranging from 52 to 69 cm, with a 59 cm mode. 17.8% were females ranging from 48 to 67 cm, with a 60 cm mode (figure 6).



**Figure 6.-** Length distribution of Orange roughy in the catches. Oimpus-Antialtair.

Size distribution of North atlantic codling (*Lepidion eques*) ranged from 19 to 39 cm on Hatton Bank, with 54% males ranging from 19 to 39 cm, and 46% females from 20 to 38 cm. Modes were 30-31 cm (figure 7). The two samplings taken on Altair and Olympus-Antair were not significant, so they were not analysed.



**Figure 7.-** Length distribution of North atlantic codling in the catches. Hatton Bank

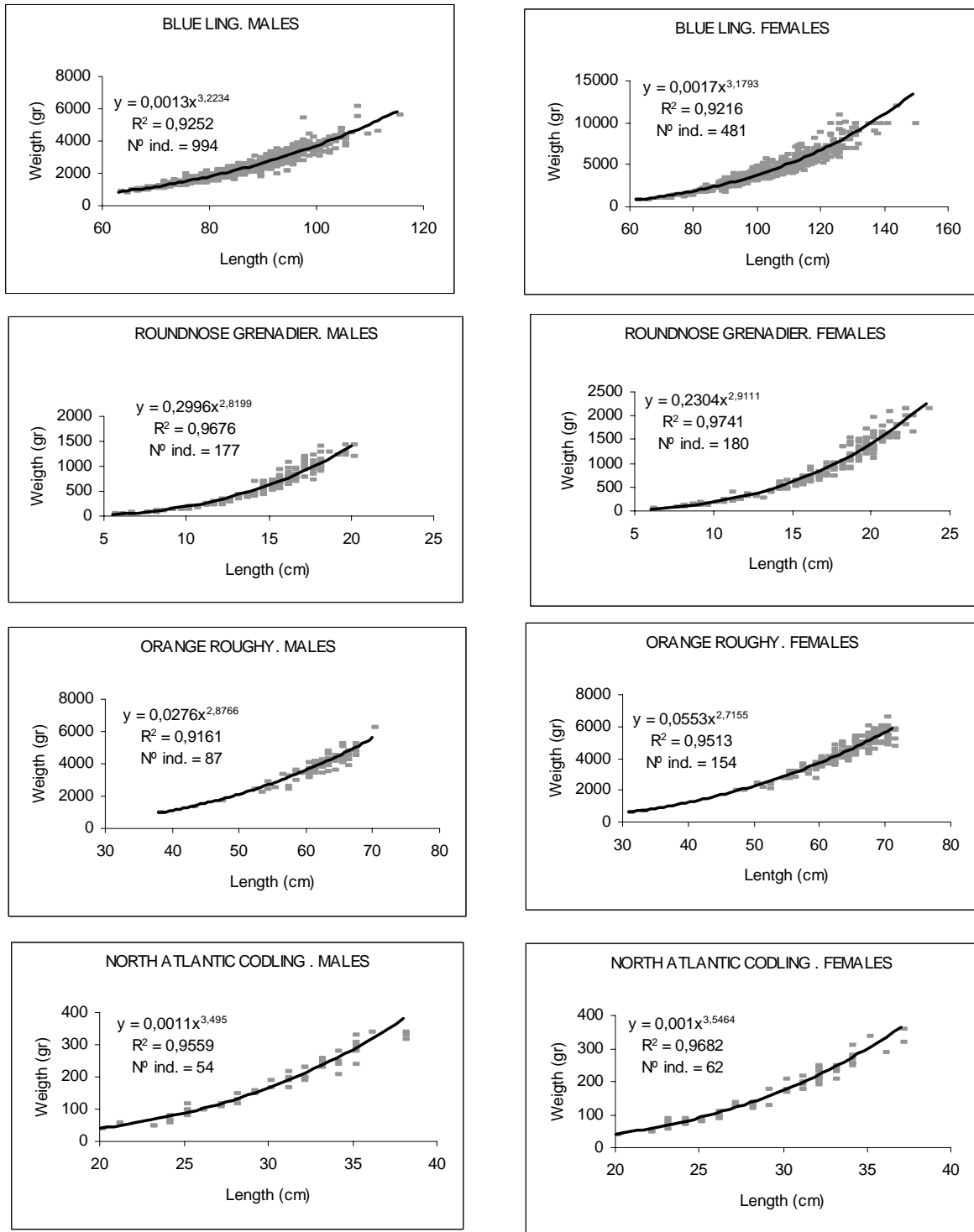
### Length-weight Relationship

Based on the biological samplings, the Size-Weight ratio parameters were estimated for the species Blue ling, Roundnose grenadier, Orange roughy, Black scabbardfish and North atlantic codling, following the model:  $Weight (g) = a Size (cm)^b$  (table 11).

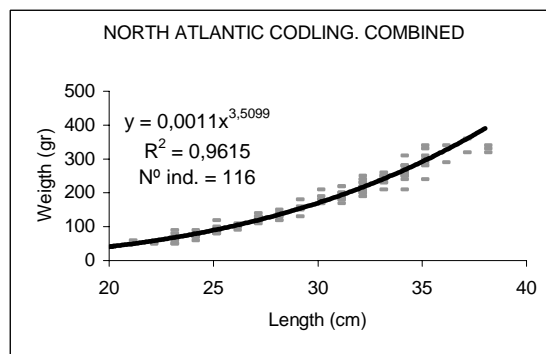
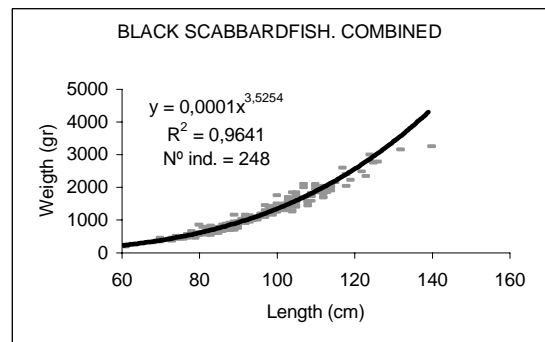
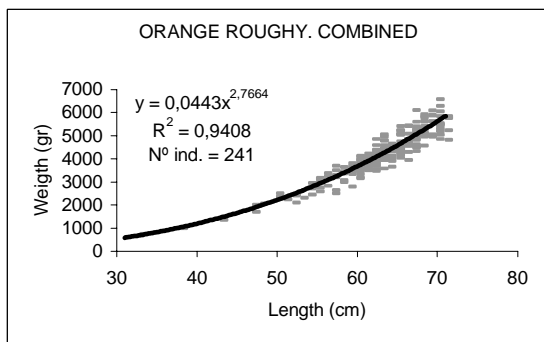
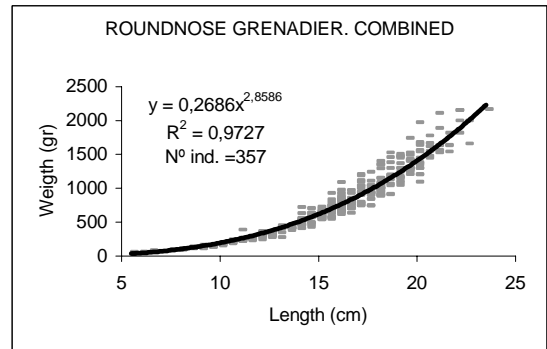
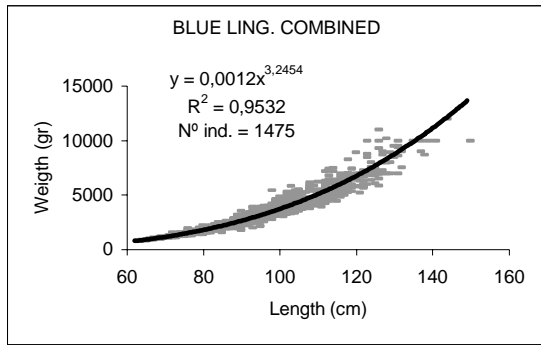
**Table 11.-** Length-weight relationship for Blue Ling, Roundnose Grenadier, Orange Roughy, Black Scabbardfish and North atlantic codling.

Species	Sex	Individ.	a	b	R <sup>2</sup>	Length range (cm)	Weight range (gr)
Blue ling ( <i>Molva dypterygia</i> )	Males:	994	0.0013	3.2234	0.9252	63 – 115	890 – 6170
	Females:	481	0.0017	3.1793	0.9216	62 – 149	810 – 10000
	Combined:	1475	0.0012	3.2454	0.9532	62 – 149	810 – 10000
Roundnose grenadier ( <i>Coryphaenoides rupestris</i> )	Males:	177	0.2996	2.8199	0.9676	5.5 – 20	50 – 1450
	Females:	180	0.2304	2.9111	0.9741	6 – 23.5	60 – 2170
	Combined:	357	0.2686	2.8586	0.9727	5.5 – 23.5	50 – 2170
Orange roughy ( <i>Hoplostethus atlanticus</i> )	Males:	87	0.0276	2.8766	0.9161	38 – 70	1000 – 6300
	Females:	154	0.0553	2.7155	0.9513	31 – 71	600 – 6580
	Combined:	241	0.0443	2.7664	0.9408	31 – 71	600 – 6580
Black scabbardfish ( <i>Aphanopus carbo</i> )	Males:	117	0.0001	3.4964	0.9533	67 – 117	310 – 2050
	Females:	131	0.0001	3.5458	0.9692	60 – 139	190 – 3250
	Combined:	248	0.0001	3.5254	0.9641	60 – 139	190 – 3250
North atlantic codling ( <i>Lepidion eques</i> )	Males:	54	0.0011	3.495	0.9559	190 – 3250	40 – 340
	Females:	62	0.001	3.5464	0.9682	20 – 37	40 – 360
	Combined:	116	0.0011	3.5099	0.9615	190 – 3250	40 – 360

Figures 8 and 9 illustrate the corresponding graphs showing dot clouds and the curves adjusted by sex and combined total for these species.



**Figure 8.-** Length-weight relationship for Blue Ling, Roundnose grenadier, Orange roughy and North atlantic codling. Males and females.



**Figure 9.-** Length-weight relationship for Blue Ling, Roundnose Grenadier, Orange Roughy, Black Scabbardfish and North atlantic codling. Sex combined.

### Observations on maturity

Maturity data from biological samples of Blue ling and Roundnose grenadier were analyzed for its main fishing areas. The number of sampled individuals by areas, sex and maturity stage are shown in table 12. The maturity stage was determined on board by visual examination of the gonads according table 13.

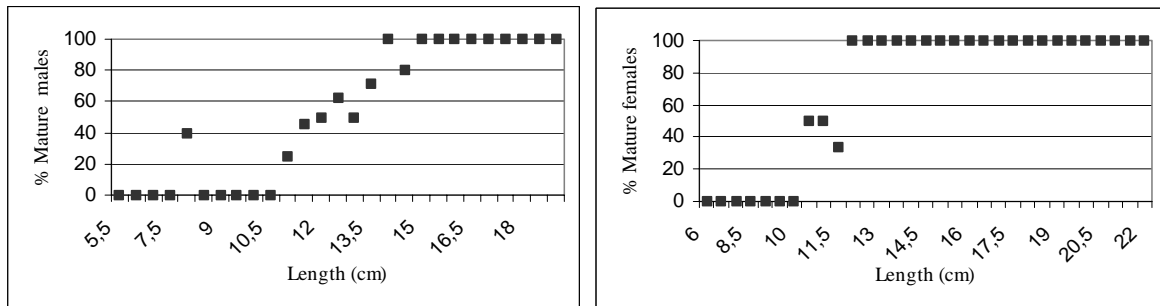
**Table 12.-** Characteristics of the maturity samples.

Maturity stage	Blue Ling						Roundnose Grenadier		
	Reikjanes Ridge			Hatton Bank			Faraday Smt.		
	Males	Females	Total	Males	Females	Total	Males	Females	Total
1	1	0	1	4	3	7	51	25	76
2	45	17	62	77	127	204	91	109	200
3	355	137	492	387	142	529	7	8	15
4	48	13	61	89	48	137	0	0	0
Total	449	167	616	557	320	877	149	142	291
Length range (cm)	64-107	78-143		63-115	62-149		5.5-20.0	6.0-22.0	

**Table 13.-** Macroscopical Maturity Scale for Blue ling and Roundnose Grenadier

Maturity stage	Description
1	Immature
2	Resting-developing
3	Spawning
4	Post-spawning

For Blue ling in Reikjanes, about 99.8% of the individuals were mature, most of the fish were mature stages 2, 3 and 4 (Magnusson et al, 1997). In the Hatton Bank, about 99.2% were mature. The percentage of mature Roundnose grenadier in Faraday Smt., are shown in figure 10.



**Figure 10.-** Percentage mature Roundnose grenadier by length in Faraday Smt. Males and females.

### ACKNOWLEDGEMENTS

This study has been conducted with the economic support of the Spanish Fisheries Administration (SGPM), the European Union, the Spanish Institute of Oceanography and the Autonomous Government of Galicia (Xunta de Galicia). Our thanks are due to the Shipowners' Association in the port of Vigo, to shipowner, captain and crew on the participating vessel and to the scientific observer on board during the Experimental Fishings.

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