INTERNATIONAL COUNCIL FOR
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Demersal Fish Committee

GROWTH OF EUROPEAN FLOUNDER (PLATICHTHYS FLESUS) AND COMMON DAB (LIMANDA LIMANDA) IN DUTCH COASTAL WATERS WITH REFERENCE TO HEALTHY AND DISEASED FISH.

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by

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ABSTRACT

This paper presents data on the growth of flounder (*Platichthys flesus*) in marine, brackish and freshwater areas and dab (*Limanda limanda*) in the coastal and offshore waters of the Netherlands. The growth of these species was studied by the backcalculation of otoliths which were broken and burned to clarify the pattern of the annuli. The study was based on the examination of otoliths from 2015 flounders and 931 dabs which were collected during a special fish disease survey between August and September 1987.
Sexual dimorphism in growth was observed in flounder but not in dab. For flounder the backcalculated overall mean lengths at ages I-VI were 110, 198, 250, 290, 314, 337 mm and for dab these values were 84, 156, 198, 227, 244, 255. For both species length for age data differed among areas. Growth rates of flounder are generally higher for brackish and freshwater populations than for marine populations. For dab highest growth rates were found for an offshore population. The available data do not indicate a reduced growth in flounders affected with skin lesions (lymphocystis disease and ulcers); the same was true for dab with *Glugea stephani* infection in the intestine.

INTRODUCTION

Flounder (*Platichthys flesus*) and dab (*Limanda limanda*) have recently aroused an increasing interest from scientists as they appear to be useful species for monitoring chemical pollutants and disease. Flounder is a euryhaline species frequently used as a local indicator for coastal/estuarine areas, whereas dab is a true marine species more suitable as a general indicator for the entire North Sea. However, in order to be able to efficiently employ flounder and dab as target species in monitoring studies, more basic biological aspects such as population structure, growth and migratory behaviour of these species must be more thoroughly investigated and made available.
In this paper the first results of a study into the growth of dab and flounder in estuarine, coastal and offshore areas in the Dutch part of the North Sea and of flounder in a freshwater environment will be presented. A comparison is made between the growth of diseased and healthy fish.

MATERIALS AND METHODS

Otolith sampling

Otoliths from 2015 flounders and 931 dabs were sampled in the context of a special fish disease survey in August and September 1987 at 15 locations in the southern North Sea and the Dutch coastal waters and estuaries (fig. 1). The dab and a number of the flounder were caught with a 6-meter beam trawl with a standard "sole trawl", a mesh of 7 cm and a cod-end mesh of 4 cm (localities 3 ,6, 7, 8, 9, 11, 13, 14, and 15). At other sites flounder were caught with standing nets with a mesh size of 9 cm. A length stratified sample was used for age determinations and a record was made of the presence of diseases.

Backcalculation from otoliths

The backcalculation method adopted was similar to the one used for turbot and brill (Van Leeuwen and Rijnsdorp 1986, Lucio, 1986). The otoliths were broken through the nucleus and burned on a brass plate above a gas flame. The burned otoliths were mounted in plasticine and were read with a binocular. The pattern of light and dark rings was drawn using a drawing mirror at a magnification strength of 15. The dark band was assumed to represent the annulus. Only the outer tips of the annuli were drawn so the maximum length of each annulus (OL_x) could be measured from the drawing with a ruler with a precision of 0.5 mm. Assuming direct proportionality between otolith size (OL_{tot}) and fish size (L_{tot}) the length at age (L_x) was calculated accordingly:

$$L_x = \frac{(OL_x - 0.5\ OL_1)}{(OL_{tot} - 0.5\ OL_1)} \cdot L_{tot}$$

RESULTS AND DISCUSSION

Comparison of the results with those of general fish surveys

In figure 2 the backcalculated length distributions of 1 and 2 year old flounder and dab are compared with actual length distributions as obtained from a routine Demersal Young Fish Survey (DYFS) in the Wadden Sea in April and May 1983 (RV Stern; 3 m shrimp trawl) and along the continental coast of the Netherlands and the Federal Republic of Germany (chartered commercial beam trawler GO29; 6 m shrimp trawl). During the DYFS about 250 15-minute hauls were made. Details are given in Van Beek et al. 1980. For both species it was shown that the peaks in the length distributions generally coincide, although the exact position of the peaks differ by 1 or 2 cm. This discrepancy is due to the fact that the assumption that a linear relationship exists between otolith size and fish length which passes through the origin may be wrong (for plaice and turbot is has been shown that this assumption does not hold; Van Leeuwen and Rijnsdorp, 1986)

Overall growth and regional differences

Overall growth curves for flounder and dab are given in figure 3. The growth rates for 1 and 2 year old male and female flounder are about equal, but compared to the females the males showed a marked retarded growth after their third year. No significant differences in growth rates between males and females were found for dab. Compared to females the male dabs showed a slightly retarded growth in their third year, but the mean lengths for 5 and 6 year old males were not notably different from those of the females cohorts. The absence of sexual dimorphism in the growth of dab is probably due to the low number of older fish. A number of studies have reported a marked differentiation in the growth rates of male and female dabs (e.g. Ortega-Salas, 1980).

A summary of the back-calculated mean length for different age groups of flounder and dab in the different localities is presented in table 1 and 2. The data indicate that a considerable regional variation exists in the rate of growth in length for both species.The rate of growth of flounder was generally higher in brackish and freshwater environments than in marine habitats, with the exception of the Eastern Scheldt marine sea arm where the rate equaled that of the brackish Western Scheldt (fig 4).

In the case of dab the data do not show a consistent difference in the growth rate found between shallow coastal and deeper offshore populations, although the highest rates were found in one of the offshore populations (fig. 5).

The backcalculated growth rates for flounder from this study were higher than those reported by Summers (1979) who studied the growth of the flounder population in the Ythan estuary in Scotland, and also of Beaumont and Mann (1984) who studied flounders from a freshwater population (Frome River) in southern England. Summers (1979) also found higher growth rates for freshwater populations than for marine populations.

An explanation for differences in the observed patterns in growth is likely to involve a number of factors such food availability, temperature, and migration. At present, there is insufficient information on the food availability for the fish species and the areas concerned. Flounder is known to adapt to higher temperatures in relation to other flatfish, which might contribute to a higher growth rate in brackish and freshwater areas as compared to the marine coastal areas. Another factor that may influence the differences in the observed length for age of populations from freshwater and marine waters is the migration. It is known that fast-growing flatfish become sexually mature at a younger age than slow-growing fish (Rijnsdorp and Van Leeuwen 1985). The fast-growing flounder therefore leave their nursery areas at a younger age. As the freshwater areas are characterized by relatively young populations it is likely that only a part of the flounders return to these waters after spawning. The older age-groups in the freshwater areas may therefore be dominated by the slower-growing immature fish. Also in the case of dab a differential migration of slow- and fast-growing fish may cause differences in length for age between populations from coastal and offshore areas.

Comparison of healthy and diseased fish

In the light of the possible influence of disease to growth, the mean length for age data for healthy and diseased fish was calculated and compared (see table 3 and 4 for dab and flounder respectively).

The available data did not indicate a lower growth rate in flounders affected with lymphocystis (a viral skin disease) or skin ulcers (skin lesions associated with bacteria). A slightly enhanced growth rate was observed for 3 and 4 year old flounder affected with lymphocystis disease compared to their healthy cohorts. Also there was no indication that the presence of *Glugea stephani* (a protozoan infection mainly in intestine) affected the growth of dab. The above comparisons are based, however, on a rather limited number of diseased fish and more research must therefore be done before final conclusions can be made.

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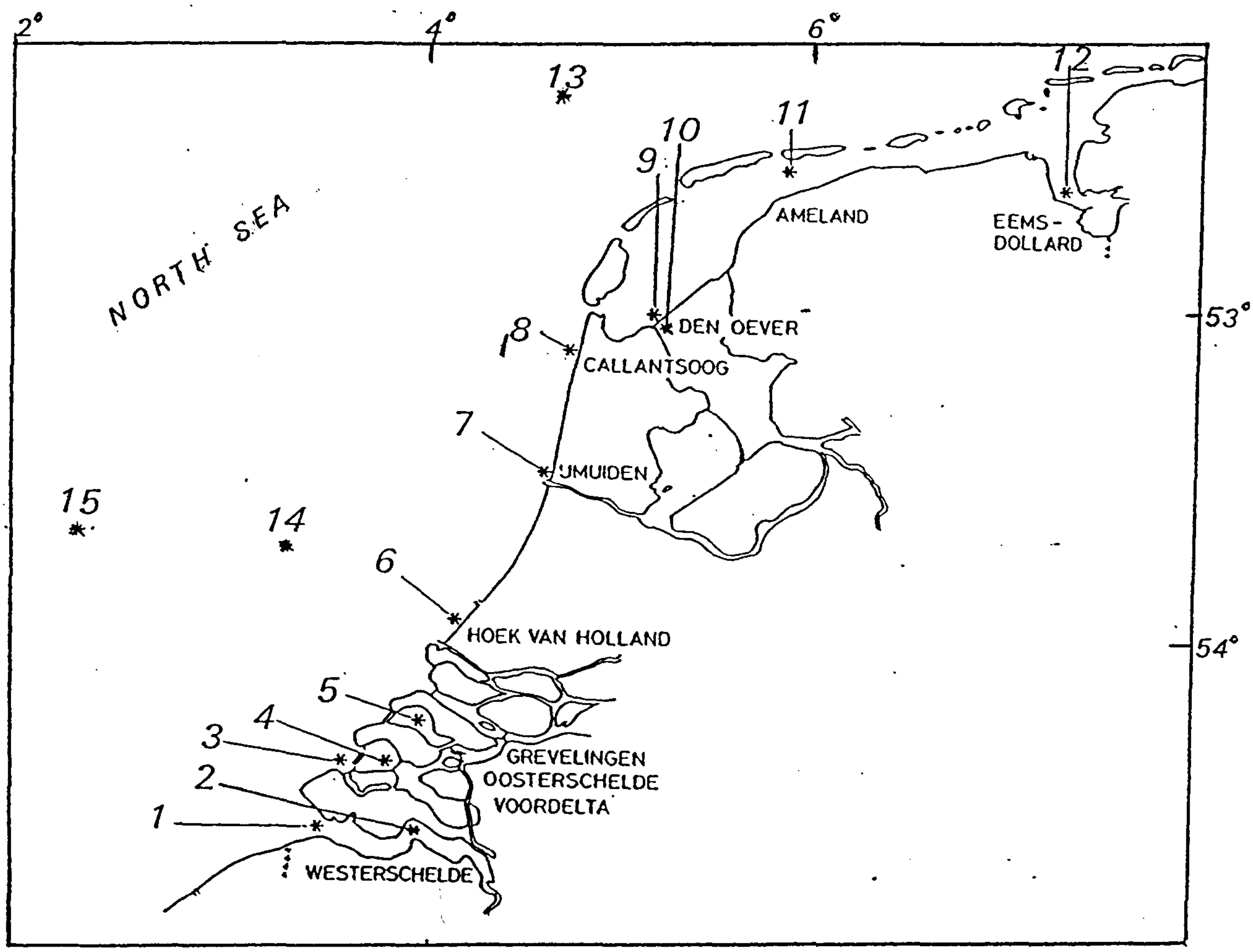


Fig. 1 Map showing the geographic position of the sampling localities

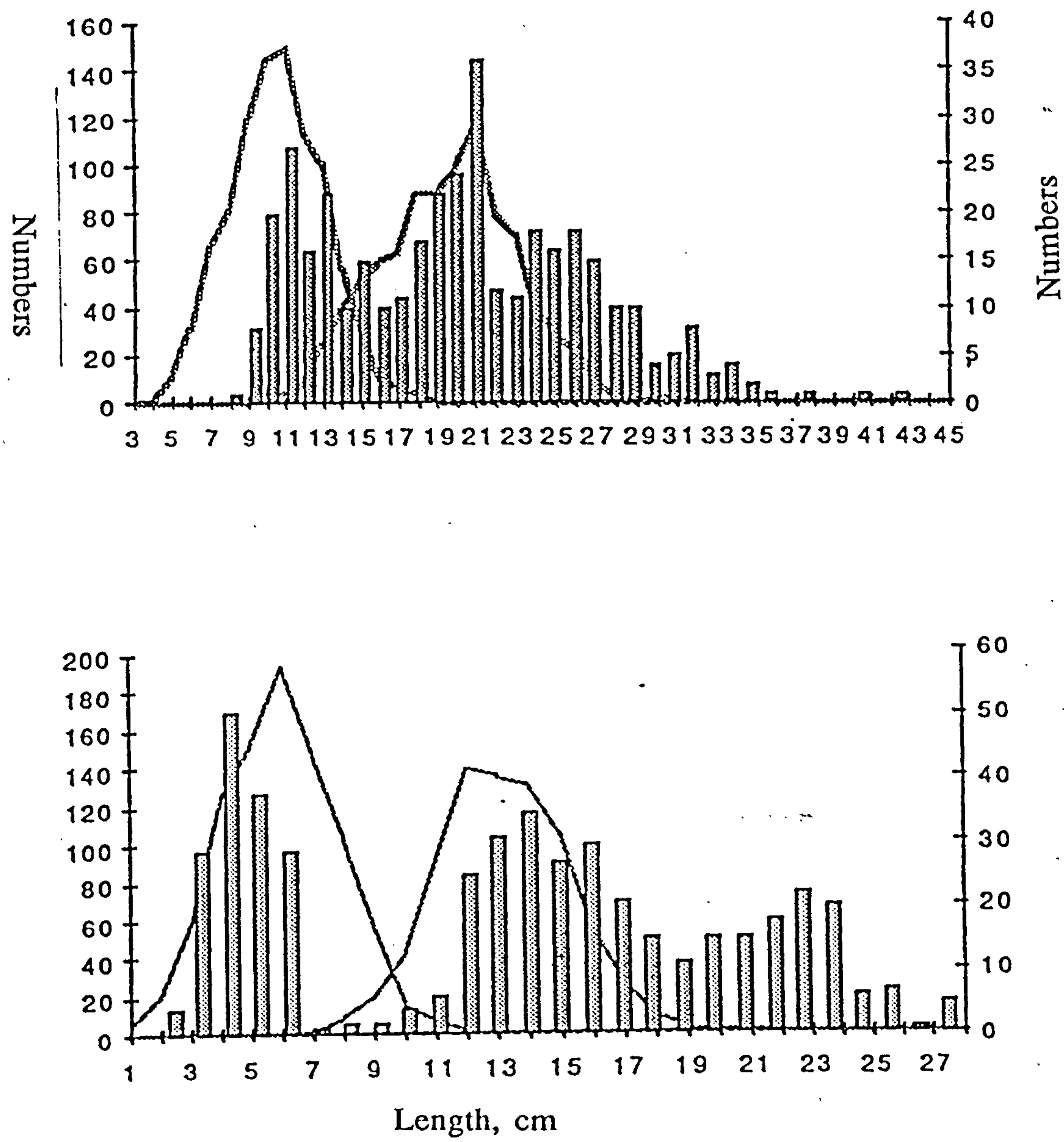
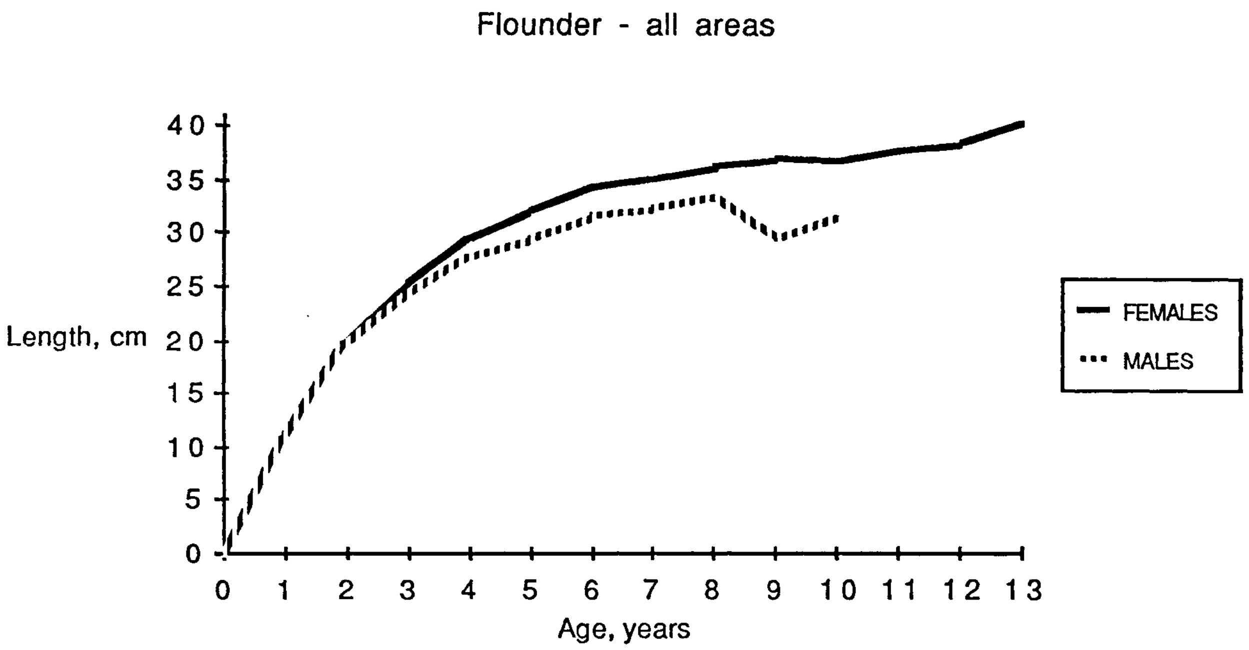


Fig. 2 Comparison of the length distribution of back-calculated lengths of 1- and 2-year old flounder (top) and dab (bottom) with the length frequencies of Demersal Young Fish Survey in April-May 1983 (shaded).



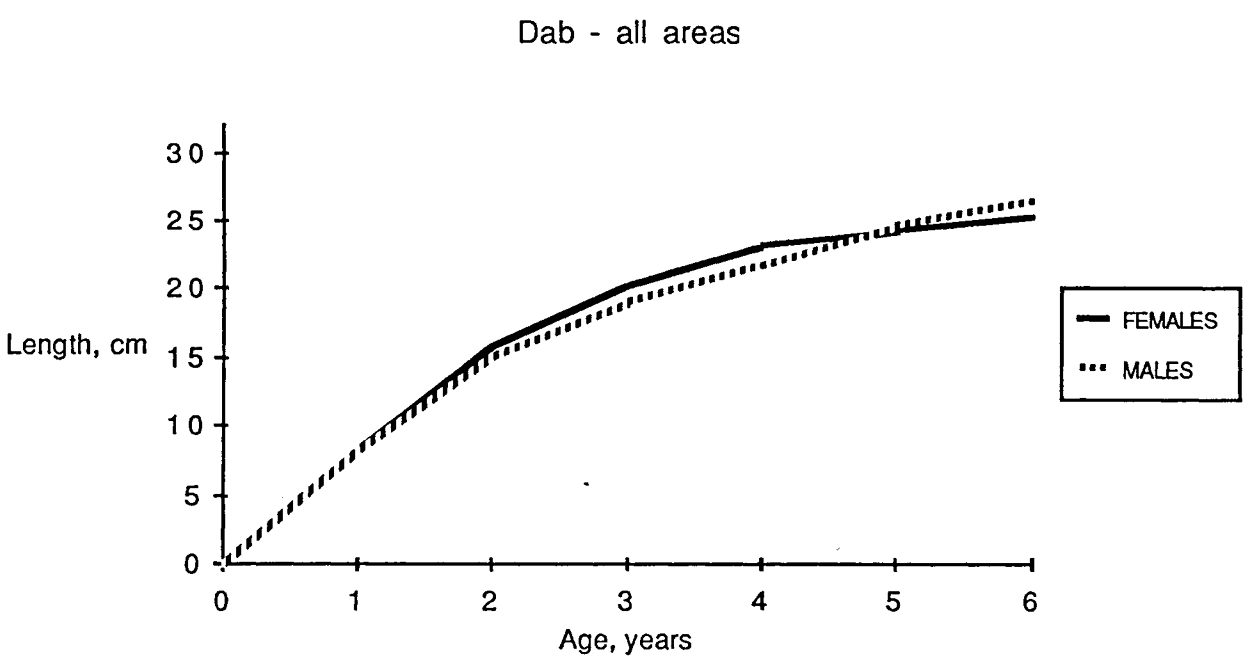


Fig. 3 Growth curves of flounder and dab as obtained by backcalculation of otoliths.

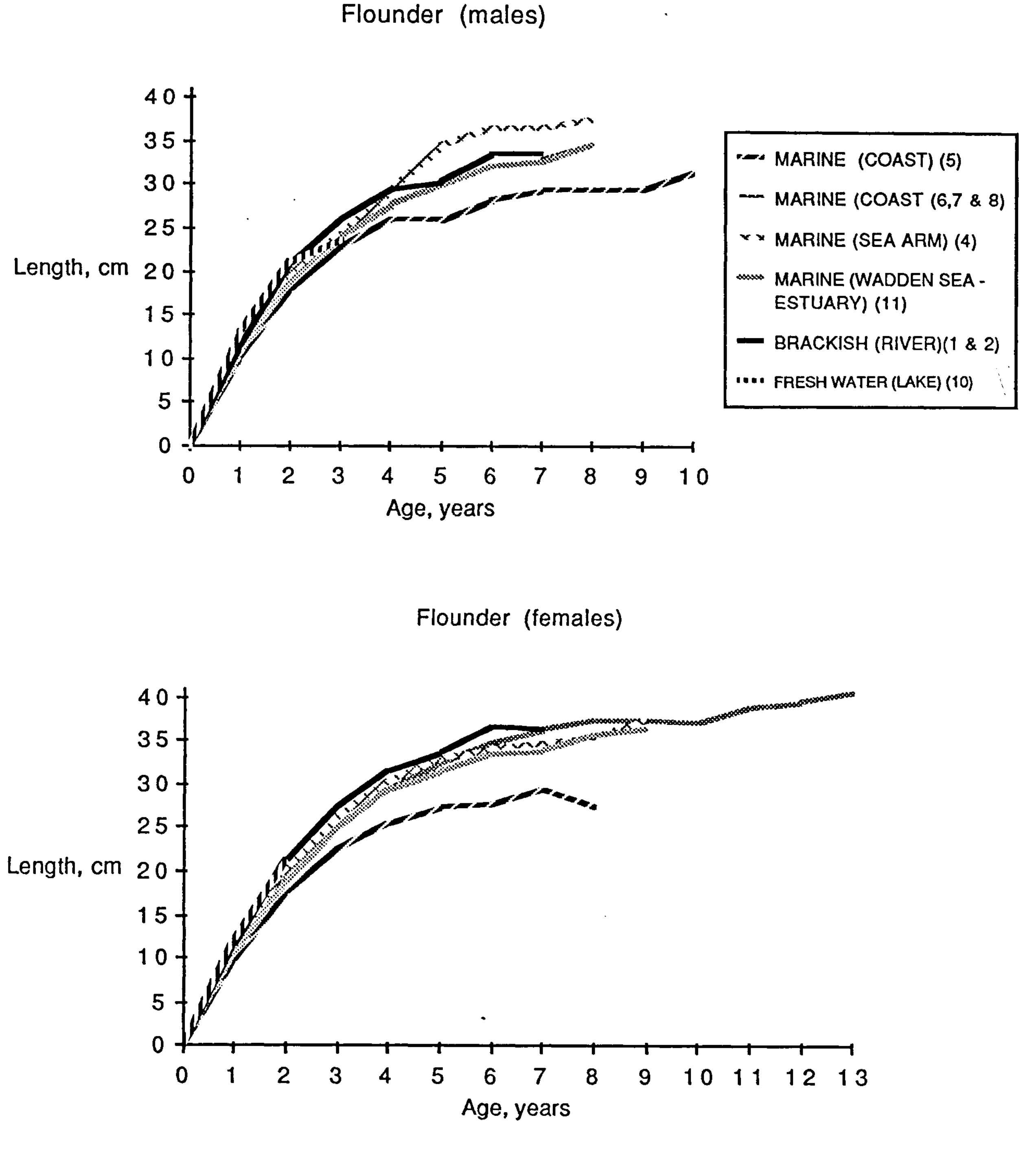


Fig 4 Growth curves of male and female flounder from different habitats as obtained by backcalculation of otoliths.

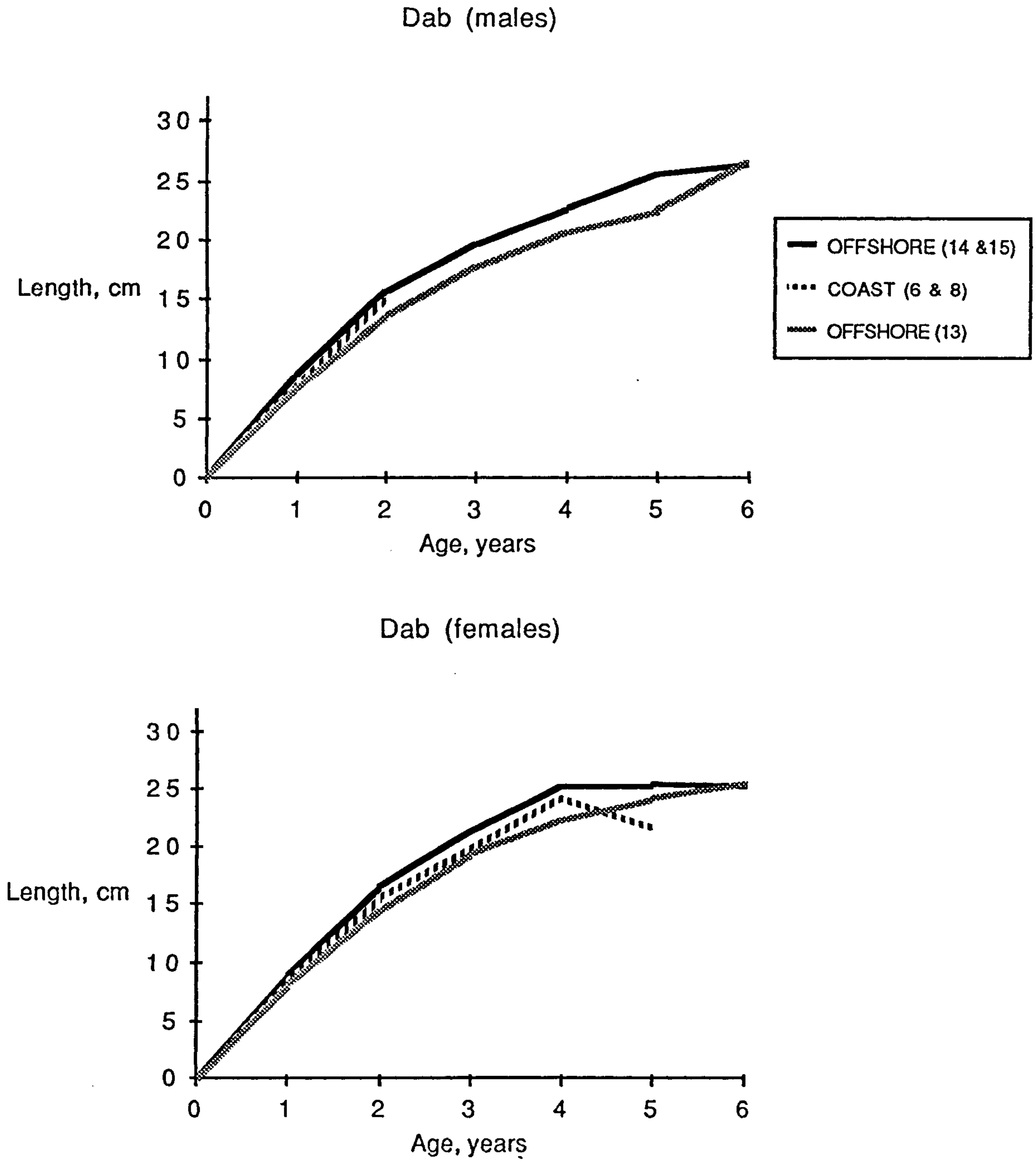


Fig 5 Growth curves of male and female dab from different habitats as obtained by backcalculation of otoliths.

Table 1 - Backcalculated mean lengths (cm) (SDEV and number of observations) for flounder.

FLOUNDER (MALES)

AREA	I	II	III	IV	V	VI	VII	VIII	IX	X
	11.4	21.0	26.0	28.2	28.5	31.5				
AREA 1	2.9	3.8	3.7	3.7	1.4					
	134	*132*	*29*	*8*	*2*	*1*				
	11.2	20.9	26.3	30.2	32.5	34.5				
2	2.7	3.8	3.9	2.7	1.4	1.4				
	166	*163*	*66*	*18*	*2*	*2*				
	10.1	18.0	22.9	26.1	25.9	28.3	29.5	29.5	29.5	31.5
3	2.6	3.5	3.0	3.4	2.7	3.0	3.0	2.8		
	57	*57*	*37*	*21*	*7*	*5*	*3*	*2*	*1*	*1*
	11.6	20.1	24.5	29.5	34.5	36.5	36.5	37.5		
4	2.4	2.7	2.9	3.4						
	47	*47*	*17*	*3*	*1*	*1*	*1*	*1*		
	10.1	18.8	24.5	28.7	28.5	30.5	32.5	32.5		
5	2.5	3.1	3.7	4.0						
	32	*29*	*9*	*4*	*1*	*1*	*1*	*1*		
	9.2	17.4	26.0	26.5	28.6	31.7				
6	2.6	3.3	3.0	3.0	2.3	2.2				
	62	*62*	*48*	*2*	*8*	*5*				
	11.6	19.9	24.5	28.5	30.5	32.5	33.5			
7	2.5	2.3	2.4	2.3						
	20	*20*	*13*	*6*	*1*	*1*	*1*			
	10.9	19.4	24.7	28.2	30.3	32.5	32.7	34.8		
8	2.4	2.9	2.7	2.5	1.5	1.5	1.9	2.5		
	182	*182*	*114*	*63*	*29*	*10*	*4*	*3*		
	11.3	19.1								
9	2.6	2.4								
	6	*6*								
	13.0	21.3	23.8							
10	2.8	3.5	3.0							
	106	*106*	*30*							
	9.8	17.4	22.4	28.5	30.3	30.5	32.5			
11	2.1	3.2	4.0	2.5	2.1	1.4				
	77	*61*	*17*	*8*	*5*	*2*	*2*			
	10.7	19.8	26.5							
12	2.0	2.1	3.0							
	32	*26*	*1*							

FLOUNDER (FEMALES)

AREA	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
	11.3	20.8	26.4	30.7	33.6	36.2	36.5						
AREA 1	2.7	3.5	3.4	3.2	2.7	2.8							
	102	*100*	*27*	*15*	*9*	*4*	*1*						
	11.6	21.7	27.9	32.1	33.9	38.0							
2	2.6	3.5	4.0	3.1	3.4	2.1							
	131	*127*	*51*	*22*	*7*	*2*							
	9.9	17.6	22.5	25.6	27.4	27.8	29.5	27.5					
3	2.4	2.9	3.1	2.6	2.7	3.5	4.2						
	61	*61*	*38*	*23*	*12*	*3*	*2*	*1*					
	11.3	20.4	26.1	30.3	33.0	34.2	34.7	35.5	37.5				
4	2.5	3.4	3.9	3.7	3.2	3.0	1.2						
	98	*98*	*59*	*23*	*16*	*10*	*4*	*2*	*2*				
	10.6	19.3	28.2	31.8	39.5								
5	2.5	4.1	5.7	6.6									
	33	*31*	*8*	*6*	*1*								
	9.7	18.5	24.0	28.9	32.7	38.5	42.5						
6	2.4	2.9	3.7	4.0	3.1	4.2							
	56	*56*	*33*	*18*	*9*	*2*	*1*						
	11.7	20.8	26.8	31.4	34.5	36.2	38.2	39.5	37.5	36.5	37.5	39.5	40.5
7	2.5	2.3	2.4	2.3									
	20	*20*	*13*	*6*	*1*	*1*	*1*						
	11.1	19.5	24.8	29.1	31.7	34.2	35.0	36.5	37.5	37.5	41.0		
8	2.3	3.3	3.4	3.3	3.4	3.2	2.4	2.1	2.7	2.8			
	188	187	123	96	62	44	16	11	4	2	1		
	10.5	18.3	24.1	27.5	28.1	30.5	32.0	32.5	33.5	35.5	36.0	37.5	
9	1.7	2.2	2.5	3.7	2.0	2.8	2.1						
	42	*42*	*22*	*7*	*3*	*2*	*2*	*1*	*1*	*1*	*1*	*1*	
	12.4	21.4	25.6	29.5									
10	2.0	2.5	2.4	2.3									
	32	*32*	*15*	*1*									
	10.6	18.8	25.1	29.5	31.5	33.5	33.9	35.7	36.5				
11	2.2	3.2	3.3	2.9	3.0	2.8	2.2	2.1					
	101	*87*	*50*	*33*	*24*	*19*	*11*	*8*	*1*				
	10.1	20.4	28.5	33.5									
12	1.8	2.9	2.9										
	31	24	4	1									

Table 2 - Backcalculated mean lengths (cm) (SDEV and number of observations) for dab.

		DAB (MALES)						DAB (FEMALES)					
		AGE						AGE					
		I	II	III	IV	V	VI	I	II	III	IV	V	VI
AREA	6	8.3	15.5					8.5	15.4	20.1	23.5	21.5	
		1.4	1.9					1.7	2.0	1.5	4.2		
		34	*13*					*79*	*49*	3	2	1	
	8	6.8	12.8					8.0	15.8	19.3	25.5		
		1.3	2.0					2.1	1.6	1.5			
		24	*3*					*54*	*30*	9	1		
	13	8.5	15.4	19.1	22.8	25.2	26.5	8.8	16.3	21.3	24.7	24.5	25.0
		1.8	1.8	2.3	1.8	2.3	1.5	1.9	1.9	2.0	2.5	2.0	2.1
		120	*115*	*27*	*9*	*4*	*1*	*156*	*149*	*40*	*10*	*3*	*2*
	14	8.9	16.2	20.6	22.7	27.5		8.9	16.7	21.3	25.9	26.5	
		1.7	1.9	3.2	1.9			1.8	2.1	2.3	1.9	2.8	
		65	*64*	*18*	*5*	*1*		*126*	*125*	*25*	*7*	*2*	
	15	7.6	13.6	17.8	20.7	22.5	26.5	8.1	14.5	19.2	22.3	24.2	25.5
		1.7	1.7	1.4	1.1	2.8	1.4	1.7	1.7	1.5	1.6	1.4	0.7
		77	*70*	*28*	*14*	*2*	*1*	*130*	*123*	*65*	*42*	*25*	*10*

Table 3 - Mean length observed (cm) (SDEV and number of observations) for different age groups of healthy and diseased flounder in the coastal areas (6,7, and 8) (*significant $p < 0.05$).

		age classes					
		II	III	IV	V	VI	VII
males	healthy	25.3 2.22 *102*	28.1 * 1.97 *68*	30.3 2.63 *33*	31.9 2.08 *19*	34.2 1.15 *6*	33.8 3.54 *2*
males	lymphocystis disease	25.8 2.22 *9*	29.7 * 2.29 *26*	31.5 2.3 *28*	32.9 1.42 *4*	33.2 2.15 *8*	34.6 2.25 *3*
males	skin ulcers	25.7 2.49 *6*	27.7 1.56 *3*	30.6 1.31 *3*		33.2 1.41 *2*	
females	healthy	25.3 * 2.36 *109*	29.1 3.16 *50*	32.9 3.19 *35*	33.9 3.61 *23*	36.9 3.43 *21*	39.7 3.42 *8*
females	lymphocystis disease	27.8 * 2.53 *8*	28.6 1.99 *13*	33.2 2.72 *24*	35.6 2.69 *17*	38.1 3.18 *8*	39.2 3.22 *6*
females	skin ulcers	28.5 4.6 *3*	29 2.5 *9*	32 2.18 *5*	35.3 6.51 *2*	36.1 5.8 *2*	38.8 *1*

Table 4 - Mean length observed (cm) (SDEV and number of observations) for different age groups of healthy and diseased dab (afflicted with *Glugea stephani*) in the offshore areas (14 and 15).

		age classes		
		II	III	IV
males	healthy	19.8 1.68 *128*	22.6 3.25 *31*	24.2 1.08 *5*
males	Glugea infection	20.3 1.89 *6*		25.8 1.56 *2*
females	healthy	21.1 2.18 *204*	23.7 2.81 *43*	27.7 2.53 *10*
females	Glugea infection	21.1 2.56 *11*	23.8 1.35 *5*	28.6 *1*