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Growth of the sea scallop (*Placopecten magellanicus*) on the Tormentine Bed, Northumberland Strait

By

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ABSTRACT

Von Bertalanffy growth equations for two samples of sea scallop (*Placopecten magellanicus* Gmelin) collected on the Tormentine Bed (Northumberland Strait) in 1983, were fitted by least squares using data on size at age and size increments within known time intervals. Evidence of Lee's phenomenon of apparent change in growth rate for the sea scallop is presented. Growth rates were found to be similar between sexes and samples and were the slowest reported to date in the distribution range of the species. It is suggested that the unusual water temperature regime of Northumberland Strait could be responsible for such low growth rates.

RESUME

Les équations de croissance de von Bertalanffy ont été calculées a partir de deux échantillons de pétoncle géant (*Placopecten magellanicus* Gmelin) provenants du banc Tormentine (Détroit de Northumberland) en utilisant la méthode des moindres carrés pour des données de longeur en fonction de l'âge et d'accroissement par intervalle de temps. Il semble que le phénomène de Lee (changement apparent dans le taux de croissance) soit présent chez le pétoncle du banc Tormentine. Les taux de croissance des deux sexes et pour les deux échantillons étaient semblables. Les taux calculés sont inférieurs à tout ceux calculés sur l'aire de distribution du pétoncle géant à date. Le régime unique de température de l'eau du Détroit de Northumberland est suggéré comme cause possible.

INTRODUCTION

Although several growth studies on the sea scallop, Placopecten magellanicus (Gmelin) have been done in the past , only a few have been conducted in the Gulf of St. Lawrence: some work by Chiasson (1949), a detailed work by Naidu (1969) in Port au Port Bay, Newfoundland and a brief study by Jamieson (1979) in Northumberland Strait. This lack of knowledge has hampered recent efforts to provide management advice on scallop stocks of the southern portion of the Gulf. In an attempt to fill the gaps, it was suggested that growth studies be conducted on various beds in the Southern Gulf.

This paper describes the results of a growth study conducted on the Tormentine Bed in Northumberland Strait and compares them with those of previous studies.

MATERIALS AND METHODS

The Tormentine Bed is located in the central portion of Northumberland Strait (Figure 1). In the spring of 1983, a sampling area was chosen on the main fishing ground of the bed. This area was sampled twice during the year; on July 7 and on November 10. On each occasion, 6 tows of approximately 10 minutes were done using a 5-gang Digby drag including 2 buckets lined with shrimp net (38 mm stretched mesh size). In July, the sexes were determined but in November visual determination of the sexes was impossible since most of the scallops were in spent condition.

The shells were brought back to the laboratory, cleaned of sediments and epibionts with a brush and allowed to dry. Using the method described by Merrill et al. (1966), the annual rings were located. The first ring was more difficult to identify. In some cases, it was faint or appeared non-existent however shells with well-marked rings had a pronounced first ring at approximately 10 mm. Other rings were easy to read. The distance between the umbo and the middle of each annulus as well as the total height of the shells were measured to the nearest millimeter. The total number of annual rings was also recorded.

In order to determine the real age of the scallops, several factors had to be taken in consideration. In the Southern Gulf, scallops spawn during the summer and early fall (Jamieson, 1979). During the July sampling approximately 10% of scallops were partially spent. Considering a 40 to 50 days larval period (Naidu,1969) , scallops would be settling from August to the late fall. Consequently, September 1 , which was chosen as settling date by Naidu (1969), was also arbitrarly chosen as settling date in this study. In this study, March 1 was considered as the time of formation of the annual ring. Consequently scallops would be approximately 6 months old at the time of formation of the first ring, 1 1/2 years at the second ring and so on.

Von Bertalanffy growth curves were then fitted to the data by the method of least squares using the program BGC2 for equally spaced age groups (Tomlinson and Abramson, 1961) and using Tomlinson's least squares method for observations of size increments within known time intervals (Program BGC4 in Abramson, 1971). With the last method annual rings were used as "tags"; since the rings are formed every year at the end of winter (Stevenson and Dickie, 1954), the elapsed time between two rings is one year. All computations were done on the Hewlett-Packard 9845B desk computer of the Marine Biology Research Centre using the programs cited above which were previously adapted to HP Basic by Dr. G. Conan of the Centre.

RESULTS

One hundred and seventy five animals were collected in July and 202 in November. Size frequency distributions for the two samples are shown in Figure 2 and 3. Few animals below 70 mm were caught and the largest individual was 113 mm. The mean size of scallops caught in July was 87.67 mm (s.d. 10.65) and 90.42 mm (s.d. 8.84) in November. The two size frequency distributions were found to be significantly different at P=.05 using a Wilcoxon two-sample test (Sokal and Rohlf, 1981).

Growth curves for the two samples using both methods (size at age and size increments over time intervals) are relatively close up to approximately 95 mm size. (Figure 4). The parameters K, L infinity and t_0 are given in Table 1. Since it is impossible to estimate t_0 , using the size increments method, it was arbitrarly set at 0. Conan and Shafee (1978) used a similar approach to calculate the growth of _Chlamys varia_ (L.) in Lanveoc Bay. The growth curves for males and females in the July sample are given in Figure 5 and appear similar. Growth curves were generated for the 1978 to 1982 growth seasons (using BGC4) for scallops of the July sample and show progressively faster growth rates (Figure 6). Mean size at age for scallops in the July sample (Table 2) indicates that scallops would be recruited in the fishery at approximately 4 years of age (70 mm.).

DISCUSSION

The size distribution of scallops on the Tormentine Bed from this study (Figure 2 and 3) appears to be quite similar to the one reported by Worms and Chouinard (1983). Probably due to growth and the absence of a commercial fishery in this period, a mode observed at 85 mm in July is shifted to 88-89 mm in November. The mean sizes obtained from the two samples (87.67 in July and 90.42 mm in November) compare well with the one obtained by Worms and Chouinard (1983) during an experimental survey of the entire bed in 1982 using similar gear (89.73mm). This would indicate that the sampling area chosen was representative of the total bed.

The growth curves obtained by the size at age method closely match for both samples as do the growth curves obtained by the size increments method (Figure 4). The two sets of curves may appear different, especially in older age classes but the difference in predicted length up to the age of 7 years is never more than 5 mm. At the age of 6 years, the two sets of curves start to diverge. This and the fact that the curves obtained by the size increments method present a slower growth rate can be explained by Lee's phenomenon as described in Ricker (1975). Estimates of L infinity using the size increments method are much superior (Table 1) to the largest scallop collected in both samples (113 mm). In this case, this causes the curve generated by this method to be unreliable for older age classes. Therefore, the growth curve obtained by the size at age appears to describe better the growth rates.

Lee's phenomenon stipulates that slower-growing animals often tend to mature later and also become senile and die later (Ricker,1975). In the case of the Tormentine Bed, which supports a large inshore scallop fishery, these slower-growing animals will become available to the fishery at an older age due to size selectivity of the gear. Consequently, an animal of a given age that has been in the fishery for, let us say, two years has had less chance of being caugth than an animal of the same age that has been in the fishery for three years because of a faster growth rate. This phenomenon is demonstrated in Figure 6 where growth curves were generated for each growing season from 1978 to 1982 using the program BGC4 with the corresponding growth increments. The results show that animals that have been present at least since 1978 have a slower growth rate.

For the purpose of comparison with other studies, only the curves obtained by the size at age method will be compared since it is the method used in most if not all other studies. Growth rates obtained in this study are slower than the one obtained by Jamieson (1979) for the central Strait (Figure 7). For example, an individual one year old in this study would have a predicted height of approximately 20 mm. while it would be over 34 mm using Jamieson's growth equation (L infinity= 114.82, k=0.276, t_0=-0.276). An individual would be recruited in the fishery (70 mm) at around 3.8 years of age in this study compared to 3.2 years in Jamieson's study

Jamieson's data covers the area called Central Strait which includes part of the Egmont Bay Bed where growth could be different. Another explanation could be that recruitment may have been greatly reduced since the end of the seventies (Worms and Chouinard, 1983), the individuals collected in this study would be mainly slow-growing animals. Yet another explanation could lie in the interpretation of the annual rings, however, no comparison can be made since Jamieson did not describe his method.

In this study, the mean height of the first ring was 10.94 mm (Table 2) and it was considered to be formed at 6 months of age, at the end of the first winter. After examining a large number of scallops, Naidu (1969) found that the first visible ring, in Port au Port Bay, was not formed during the first winter of life but only in the second. In his study, scallops with one growth ring were therefore considered as being 1 1/2 years old. In this study, even if I assume that the first ring counted is not a true annual ring and not count it, the first ring counted would be formed at 1 1/2 years of age at approximately 30-35 mm which agrees with Naidu's interpretation.

The growth rates found in this study are the lowest reported to date for the sea scallop except for the rate calculated for the inshore waters of the Bay of Fundy by Naidu (1969) from data published by Stevenson and Dickie (1954). However Naidu (1969) noted that the data did not appear to fit well the von Bertalanffy growth curve . From previous observations, it appears that the shells of sea scallops in the southern Gulf have well-marked growth rings and a thick shell which could be considered a sign of slower growth. As mentioned in Jamieson (1979), the temperature regime in Northumberland Strait is quite unique and is characterized by very cold (-2°C) temperatures in the winter (Lauzier and Hull,1961) and temperatures as high as 15 to 20 degrees C in summer (Dobson and Petrie, 1982).

One would believe that these high temperatures could result in accentuated growth rates in the summer, however, Posgay (1953) showed that sea scallops grow fastest at about 10° C. Rates dropped to about 95% of the maximum at 8 C and to about 80% at 12° C. Furthermore many authors (Needler,1933; Chiasson,1949; Dickie,1951,1958) have reported mass mortalities of scallops in Northumberland Strait, most of which were suspected to be related to high summer temperatures. Consequently, high summer temperatures likely have a detrimental effect on the growth of sea scallops in Northumberland Strait. The season of optimum growth is probably reduced to a few months in late spring-early summer and a few months in the fall accounting for the lower growth rates found in this study.

CONCLUSION

The growth rate for sea scallops on the Tormentine Bed appears to be one of the lowest throughout the distribution range of the species. This would imply that the lucrative inshore scallop fishery now being conducted in this area and which has shown some signs of decreasing yield in recent years (Worms and Chouinard, 1983) would have difficulty recovering from stock depletion even with optimum recruitment.

Further studies on the growth of the sea scallop will be conducted on other beds in the Southern Gulf (Pictou Island Bed, Nepisiguit Bay Bed and others) in order to determine whether there are significant differences in growth between the beds. This will hopefully lead to a better understanding of scallop population dynamics in the Gulf of St. Lawrence.

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Table 1: VON BERTALANFFY GROWTH PARAMETERS FOR THE TWO SAMPLES USING SIZE AT AGE AND SIZE INCREMENTS WITHIN TIME INTERVALS METHODS

SIZE AT AGE	L Infinity	K	t0
July	103.76	0.3700	0.6734
November	108.83	0.3259	0.4636
Size Increments Within Time Intervals			
July	152.74	0.1464	--
November	178.84	0.1173	--

Table 2: MEAN SIZE AT RING OF SCALLOPS COLLECTED ON THE TORMENTINE BED ON JULY 7, 1983

Number of Rings	Age	Mean Size (mm)	Standard Deviation	n
1	0.5	10.94	2.66	175
2	1.5	25.76	5.03	175
3	2.5	44.96	6.97	173
4	3.5	63.17	7.48	171
5	4.5	76.98	6.22	153
6	5.5	85.18	5.42	101
7	6.5	90.69	4.62	59
8	7.5	94.39	4.45	41
9	8.5	99.50	4.06	18
10.	9.5	101.78	3.93	9
11	10.5	102.33	1.53	3

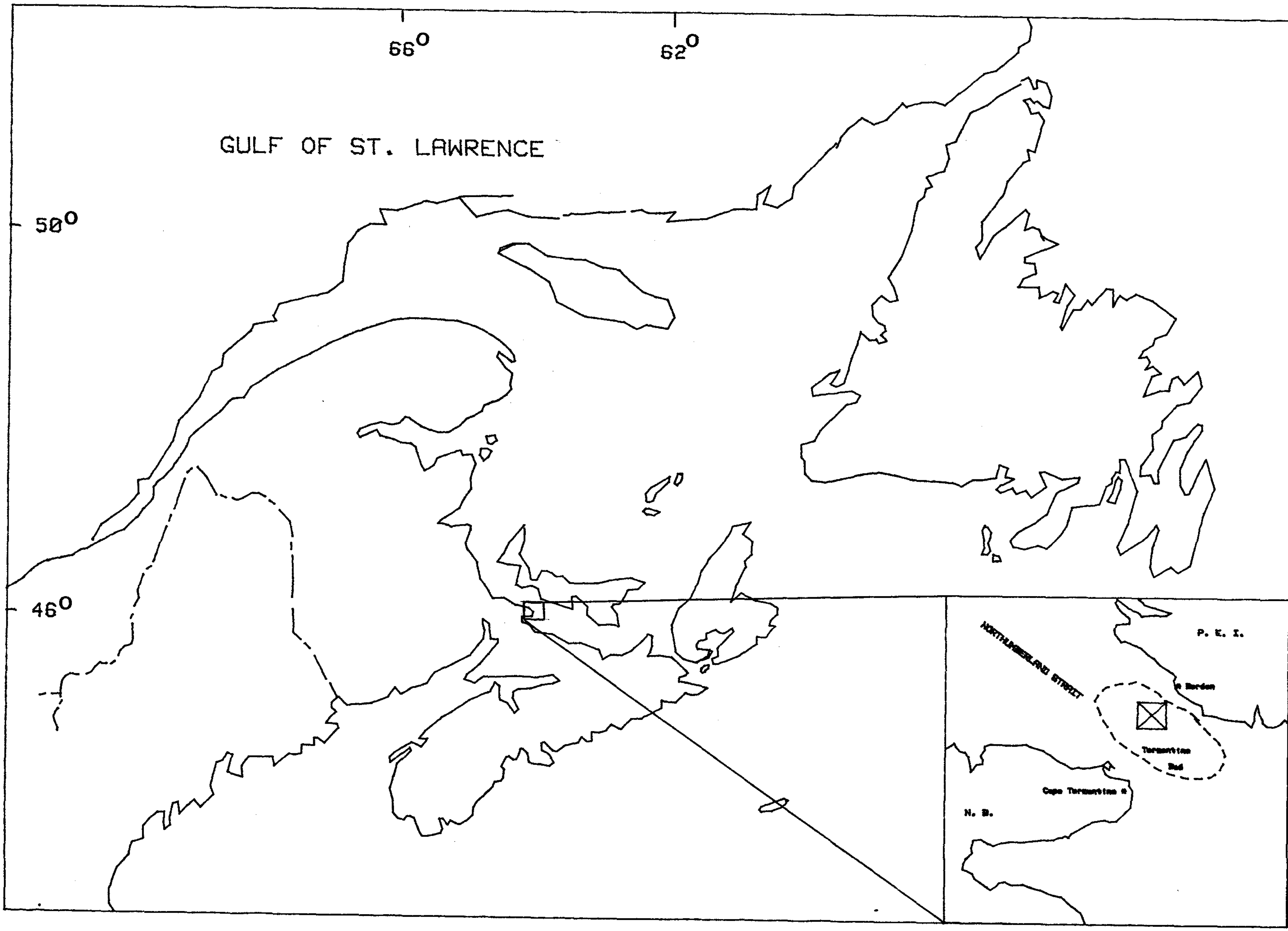

Figure 1: Map of the Gulf of St. Lawrence and the Sampling Area on the Tormentine Bed

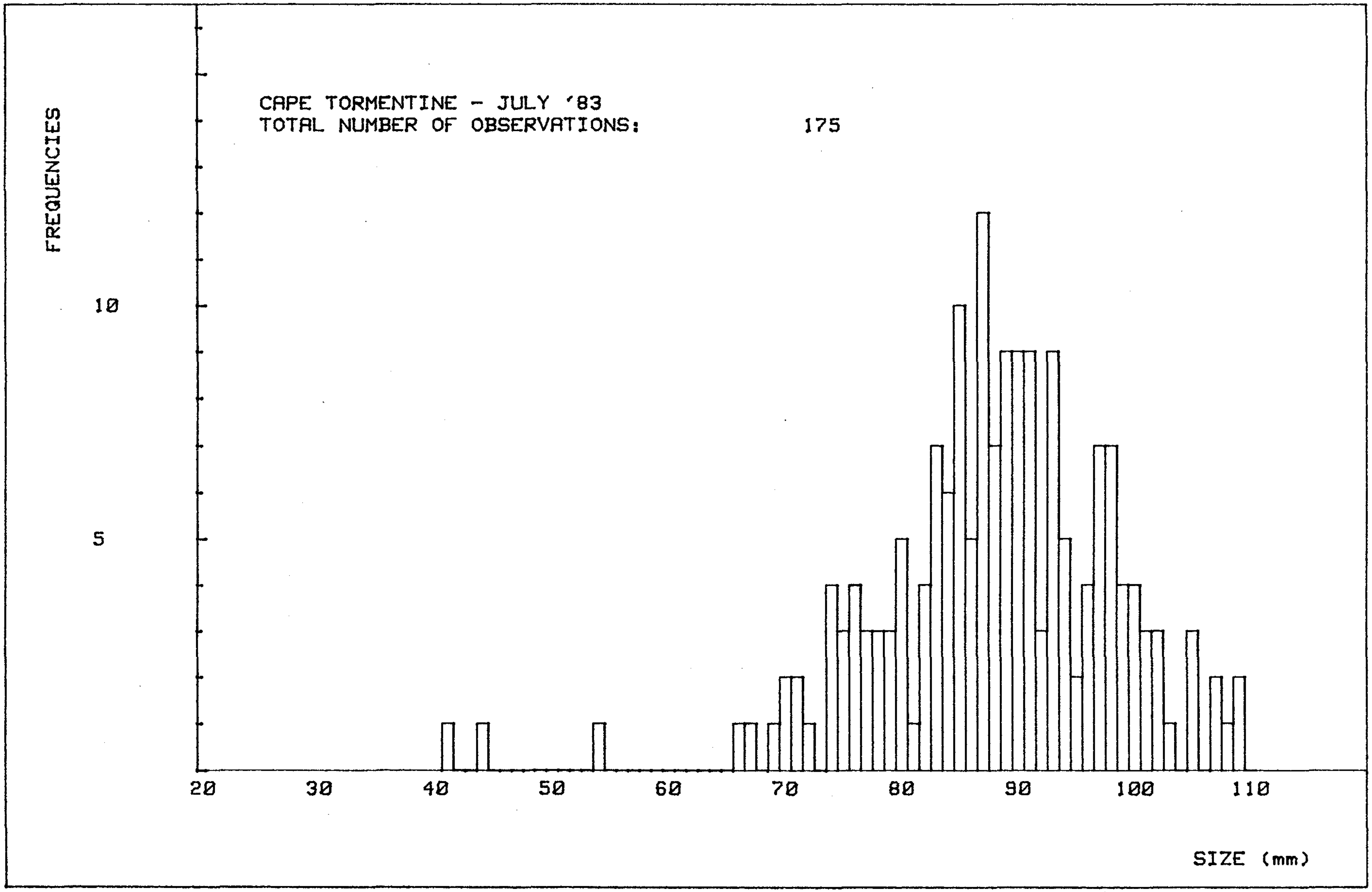

Figure 2: Size Frequency Distribution of Scallops Caught on July 7, 1983

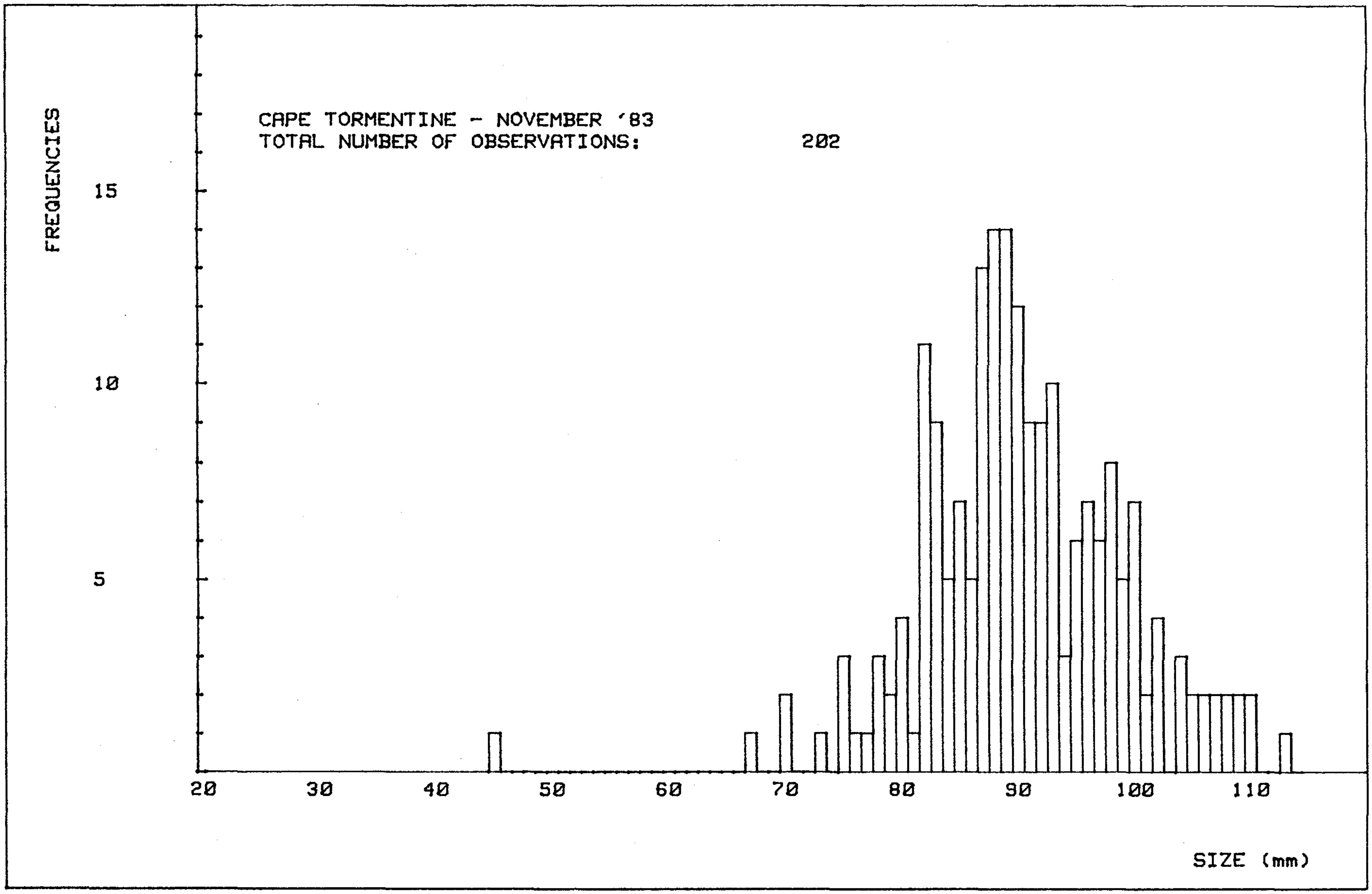

Figure 3: Size Frequency Distribution of Scallops Caught on November 10, 1983

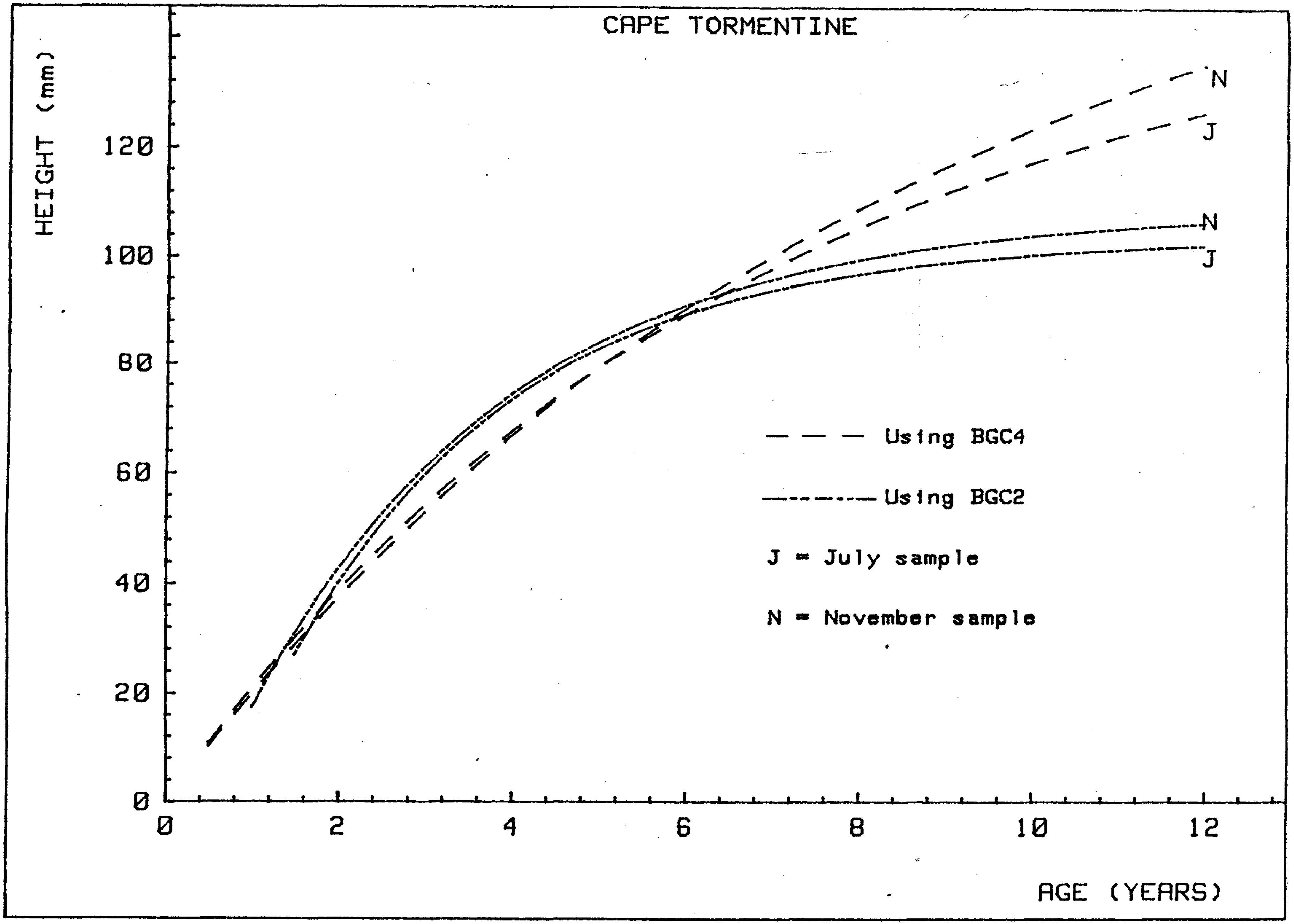

Figure 4: Comparison of Sea Scallop Growth Rates Obtained by the Method of Least Squares for Equally-spaced Age Groups (BGC2) and by the Method of Size Increments Within Time Intervals (BGC4) for the July and November Samples

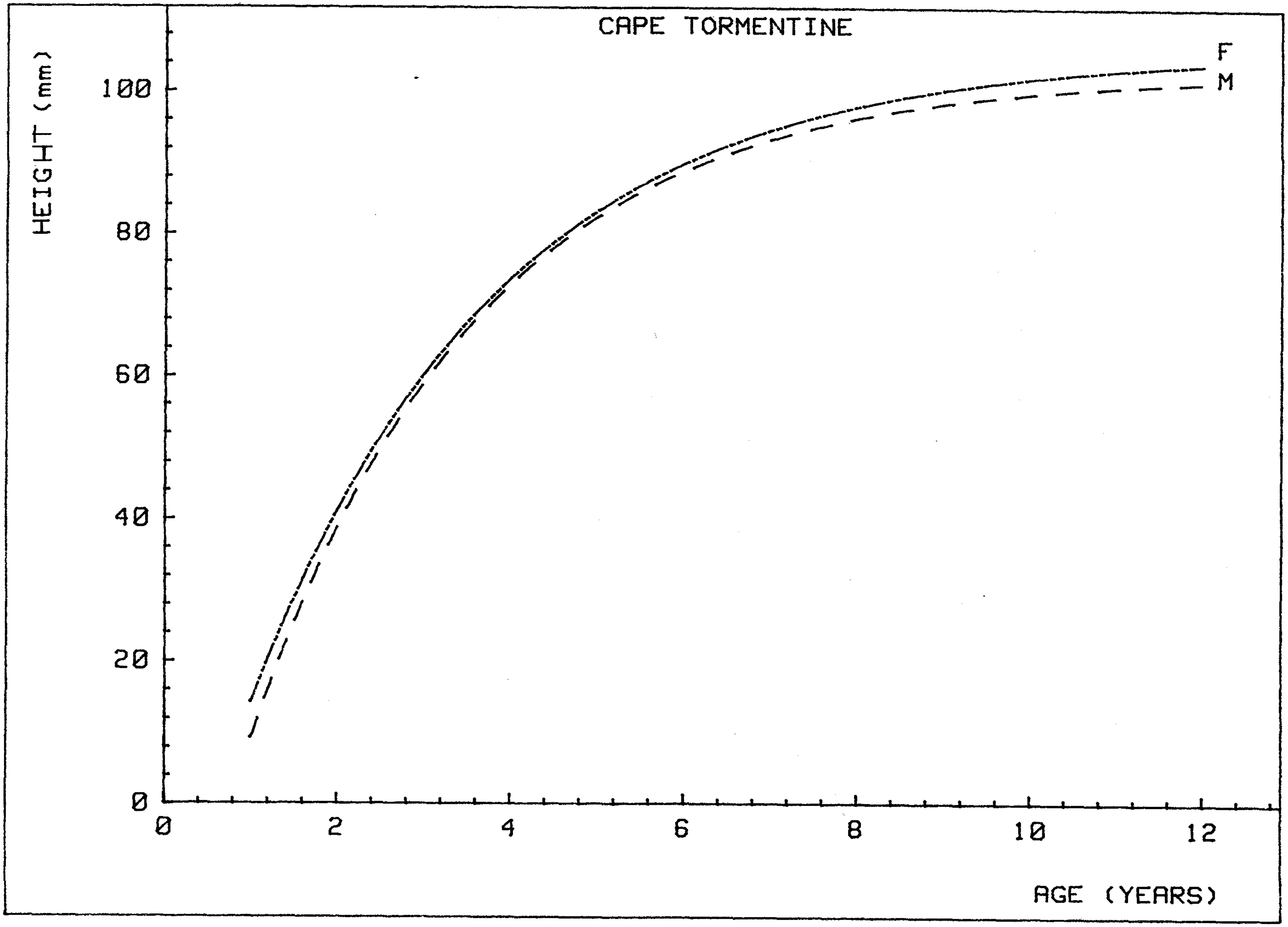

Figure 5: Growth Curves Obtained for Males and Females Calculated from the July Data by least squares (size at age method) (F = Females M = Males)

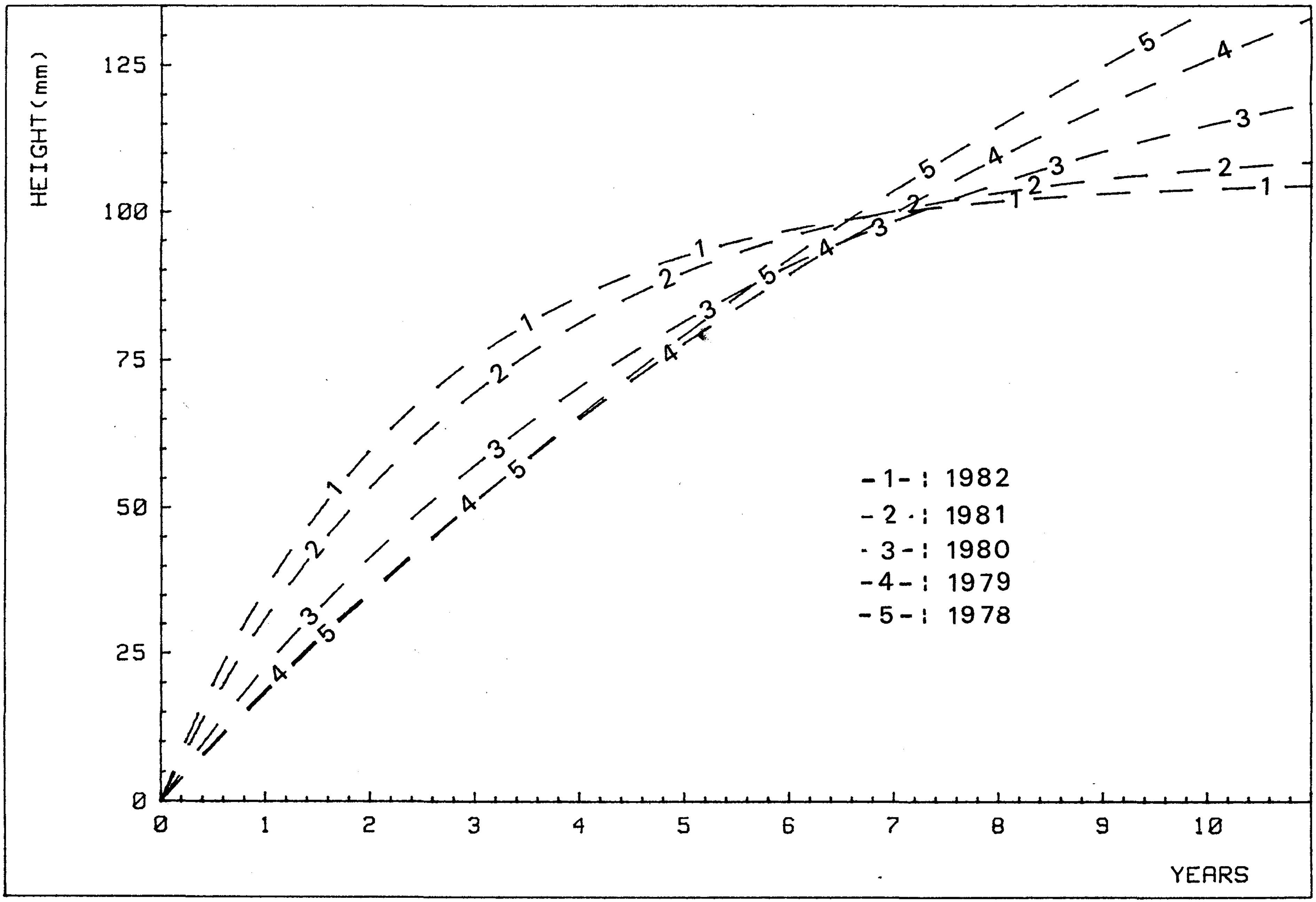

Figure 6 : Growth Curves Generated for the Last Five (1979-1982) Growing Seasons for Scallops Collected in July and Illustrating Lee's Phenomenon (Size increments within time intervals method)

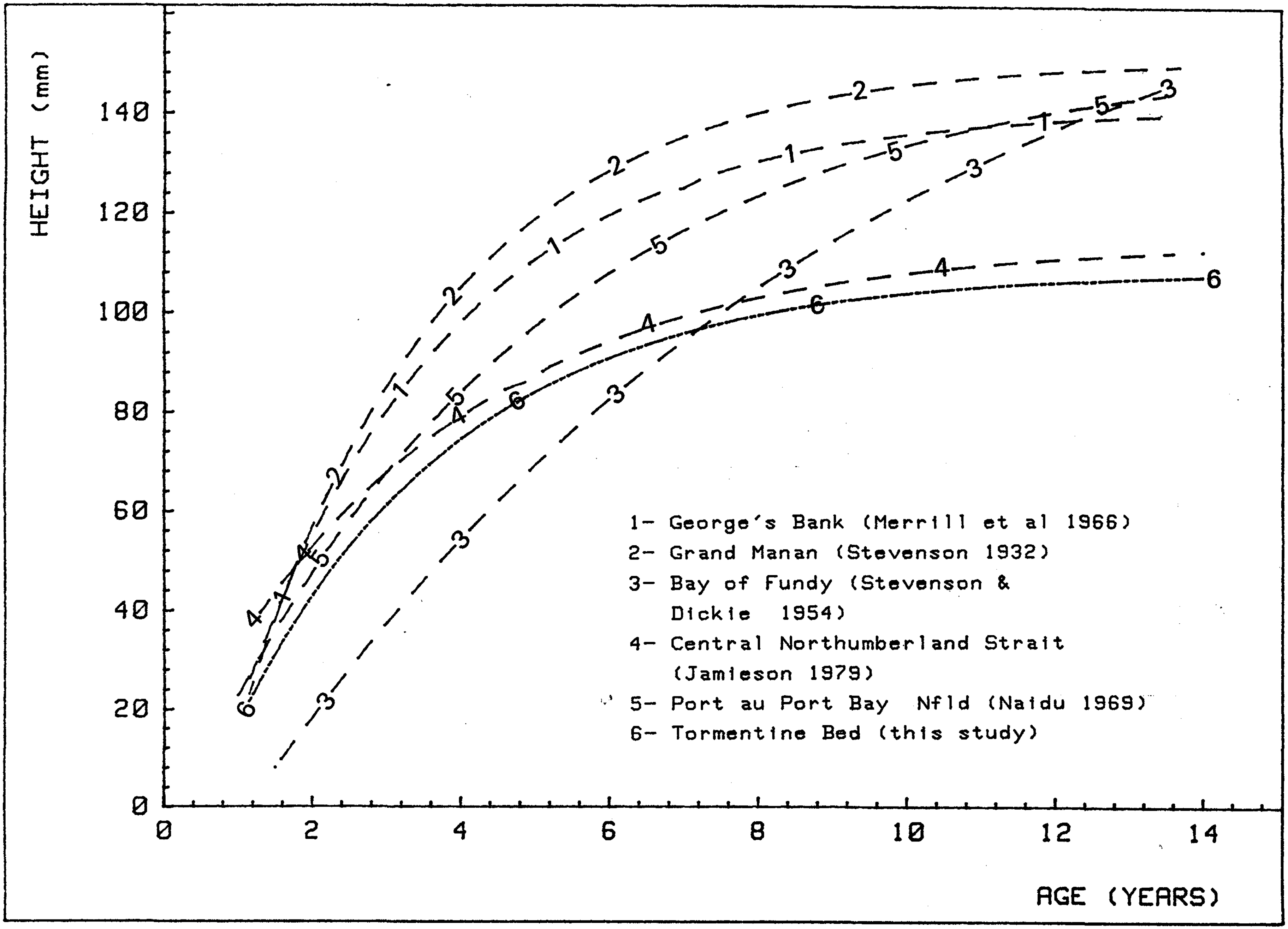

Figure 7: Comparison of Sea Scallop Growth Rates Obtained by Various Authors in the Distribution Range of the Species (Size at age method)