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Comparative Characteristic of Some Biological Indices of the Bottom Stages of 0-Group Cod Belonging to the 1956,1958,1959,1960 and 1961 Year-classes

by

I. Ja. Ponomarenko

In order to determine the factors influencing the variations in the amount of fish recruited to the commercial stock of the Barents Sea cod, the Polar Institute annually carries out investigations on feeding, fatness, nutritional condition and sizes of the bottom stages of 0-group cod.

In the present report the following indices of cod fry belonging to the five generations are compared:- 1. food composition (weight in %); 2. stomach fullness index in ‰o (the relation of food weight to fish weight multiplied by 10.000, i.e., in per decimille); 3. fatness (the relation of liver weight to fish weight in %); 4. nutritional condition (the relation of the weight of a fish to the long-term mean weight of fish of the same length in %); 5. mean length in cm; 6. the importance of the bottom stages of 0-group cod to the feeding of cod fry of the I-II-III age-groups in November/December. These indices are compared with the abundance of the bottom stages of 0-group cod x), belonging to the given year-classes, and with the temperature anomalies which occurred along the Kola hydrological section. The materials were collected as a result of the cruises of the PINRO research vessels made in November/ December 1956, 1958-1961, with the aim of determining the abundance of the young of the commercial fishes. The 25-meter bottom trawl with a fine-mesh net (10 mm), inserted into the cod-end, was used.

Samples were collected in the area from the Murman Coast up to the Novaya Zemlya Bank (Figure 1). The length composition of the fry investigated and the whole of the fry belonging to the 0-group and taken with a trawl is given in Figure 2.

Euphausiacea (32.5% by the weight), Gammaridea (15.6%), Polychaeta (10.6%) and Pisces (17.4%) were the main food items of cod fry over the average period of five years in the near-bottom layers of the Barents Sea (Figures 3 & 4). Appendicularia (4.9%), Hyperiidea (4.5%), Decapoda (4.3%), Chaetognatha (4.1%), Mysidacea (2.0%), Cumacea (0.6%), Caprellidea (0.5%), Isopoda (0.4%), Copepoda (0.4%) and others are of secondary importance in the food of cod fry. 101 species were found in the stomachs of 0-group cod.

Local differences are traced in the feeding of the bottom stages of cod fry. On these grounds we can divide the southern part of the Barents Sea into three conventional zones as follows:- Central (designated by the letter A in Figures 1, 3, 4 and 5), the main food of fry - Euphausiacea; south-eastern (B), Gammaridea and Polychaeta prevail; and north-eastern (B_1), where the fry of Boreogadus saida and the young of Lumpenus are the dominant food objects. All the quantitative data on feeding, represented in Figures 3, 4 and 5, were calculated separately for each of these three zones as well as for the whole sea.

Food composition of cod fry in 1956, 1958-1961 is shown in Figure 4; fatness (I), nutritional condition (II), stomach fullness index (III) and the single index of Euphausiacea (relation of the weight of the eaten Euphausiacea to fish weight in ‰o) are presented in Figure 5. The percentage of feeding specimens insignificantly differed from one year to another (from 76% to 86.3%), and in the course of five years it

x) The quantitative analysis of young cod is carried out annually in the autumn/winter period in the Barents Sea. Judging from the catch of the bottom stages of 0-group cod per hour, one can determine the abundance of a year-class at the first year of life. The data on fry catches per hour's trawling are taken from the works by A.S. Baranenkova.

averaged 82.8% in the Central zone, in the south-eastern zone - 83.8% and in the north-eastern zone - 82%.

The main mass of materials was collected in the Central zone, where the greatest abundance of the bottom stage of O-group cod occurred in the years investigated (Figure 5). Annual variations in fatness, nutritional condition and stomach fullness index of O-group cod in the Central zone are closely connected with the annual changes of the importance of Euphausiacea in the diet of fry. Thus, the greatest in 1958 and the lowest in 196o fatness, nutritional condition and stomach fullness index correspond to the greatest in 1958 (98.o) and the lowest in 196o (7.8%o) importance of Euphausiacea in the food of fry (Figures 5,A,I,II,III). The importance of Euphausiacea in the diet of fry determines the annual variations in fatness and nutritional condition of the bottom stages of O-group cod in the southern part of the Barents Sea. The stomach fullness index, fatness and nutritional condition of cod fry belonging to the moderately abundant 1956, 1958 and 1959 year-classes (the mean catch per hour of the bottom stages of O-group cod in these years was 12, 11, 11 specimens in the southern part of the Barents Sea) were similar. The importance of Euphausiacea in the fry feeding was approximately the same during these years (special index 39.2 - 51.7 - 48.8%o). The fry of cod belonging to the 196o and 1961 year-classes occurred in low numbers in the southern part of the Barents Sea (the catch of O-group cod per hour's tow was 7-3 specimens) and were characterized by the lower fatness and nutritional condition, which corresponded to the minor importance of Euphausiacea in the food of cod (Figures 5,C,I,II,III). Probably, Euphausiacea play a great part in the diet not only of the bottom stages but also of the pelagic stages of O-group cod. This assumption is confirmed by the PINRO data on feeding of the pelagic fry of cod. The transition of cod fry to the near-bottom life is evidently closely associated with the descending of Euphausiacea to the bottom layers.

Considering the five years investigated, the three values are seen to change almost in parallels from one year to another:- 1) importance of Euphausiacea in the diet of O-group cod at the bottom stages; 2) nutritional condition of O-group cod; 3) abundance of O-group cod. Such interdependence can probably be explained by the drift of cod fry and the young of Euphausiacea from the west to the east and by the greater survival-rate of cod fry in the years rich of the young of Euphausiacea. However, it is necessary to confirm this assumption by further investigations.

No link was traced between the temperature conditions of the year and the quantitative data on the feeding of the bottom stages of O-group cod. Thus, in the cold 1956 and 1958 the annual temperature anomalies in the 0-200 m layer in the Kola section were -0.65° and -0.58° and in the relatively warm 1959 the fry of cod had the similar stomach fullness index, fatness and nutritional condition. In 1959 and 196o, when similar temperature conditions occurred (anomalies +0.18° and +0.17°C), the fatness and nutritional condition indices of fry strongly differed (Figure 5). However, a close relation between the sizes of cod fry in November/December and the temperature in February/October was found (Figure 6). The growth rate of O-group cod was somewhat lower in the cold years than in the warm years. In November/December, the average length of fry belonging to the 1956 and 1958 year-classes is 9.29 and 9.57 cm and that of fry of the 1959 and 196o year=classes 1o.79 and 1o.81 cm. The other years - 1957, 1961 and 1962 - are the average as to the temperature and the length of fry.

One of the most numerous small predators living on cod fry in the bottom layers of the Barents Sea is small cod of the I-II-III age-groups (length of 15-35 cm). The importance of fry in the diet of cod of the I-II-III groups depends upon the abundance of O-groups, and, besides, upon the length and nutritional condition of fry. Our data show that in November/December the small cod feed mainly on cod fry not exceeding 1o cm in length. As to larger fry, they are fed as a rule only if they have the low nutritional condition. The fry of the 1956 and 1958 year-classes, having the lowest length, and the fry of the 196o year-class, having the lowest nutritional condition, were fed in the greatest quantity. The large fry of the 1959 year-class with great nutritional condition were fed on in the smallest quantity (Table 1). If one should consider the comparatively small sizes and low nutritional condition of fry belonging to the 1961 year-class, these fry should have been found rather often in the stomachs of cod of the I-II-III groups. As a matter of fact, the fry of this generation were fed on in small quantities. This can be another demonstration of the low abundance of the 1961 year-class in the southern part of the Barents Sea. Thus, in the years, when the bottom stages of O-group cod have the small length or the low nutritional condition (or both), they become available to the great number of predators. The amount of predators which are able to live on the fry in the bottom layer increases in these cases.

Table 1. The importance of the bottom stages of 0-group cod in the diet of cod fry of the I-II-III age-groups[x)] in comparison with the abundance of 0-group fry, their sizes and nutritional condition.

Importance in the diet	Year-classes				
	1956	1958	1959	1960	1961
% by weight	42.8	55.0	4.4	20.7	5.2
Occurrence	31.7	25.5	2.9	13.2	5.4
Average catch per hour of 0-group cod in the southern part of the Barents Sea	12	11	11	7	3
Average length of 0-group cod	9.29	9.57	10.79	10.81	9.9
Nutritional condition of 0-group in % of the long-term mean	100	100	100	93.1	94.0

The thermal regime of the sea and the feeding conditions of 0-group cod influence the sizes and nutritional condition of fry. The two last indices determine the degree of fry carnage by the small predators. Owing to the more intensive growth of 0-group cod, their survival-rate in the warm years will be better than in the cold years.

x) Samples on the feeding of cod fry of the I-II-III age-groups, 15-35 cm long, were taken in the same areas and in the same terms as the samples on the 0-group feeding. Age-composition was approximately the same during all the years. A total of 2289 stomachs were examined. The analysis of stomachs was made by the quantitative weight method.

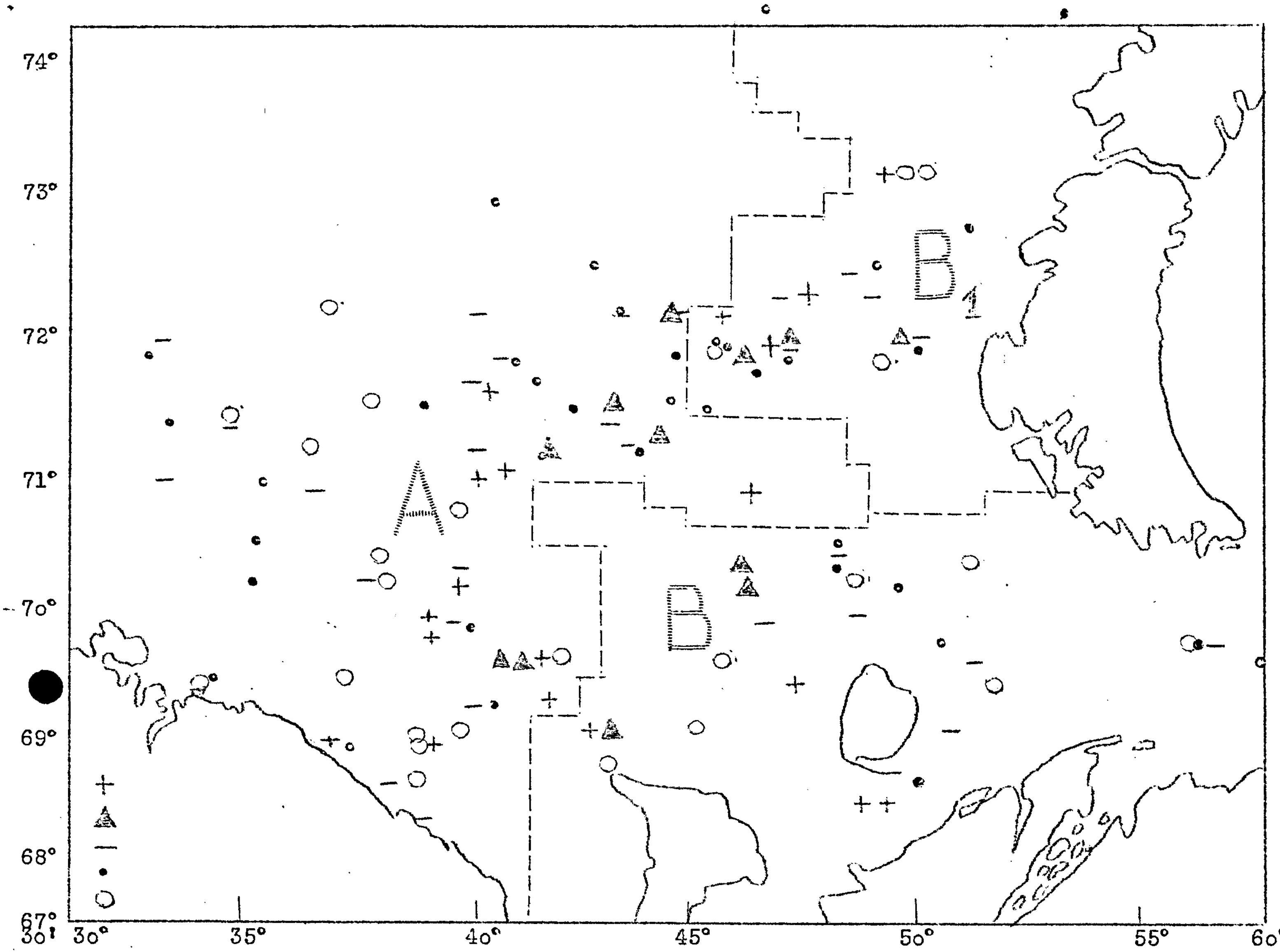

Figure 1.

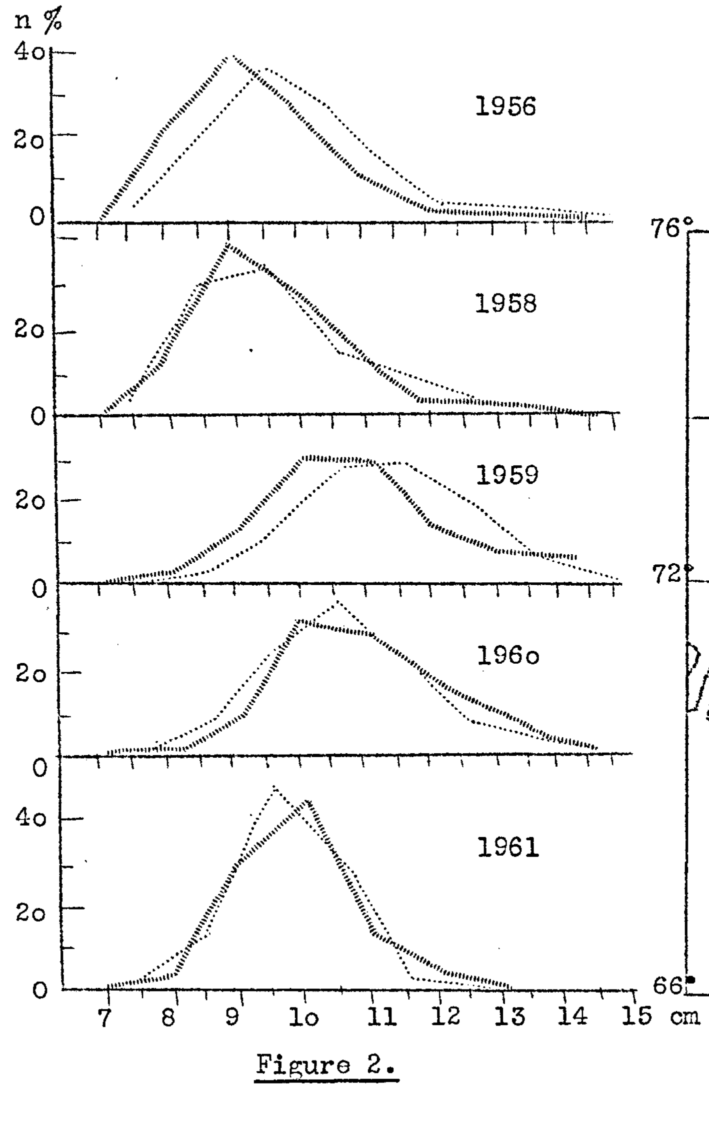

Figure 2.

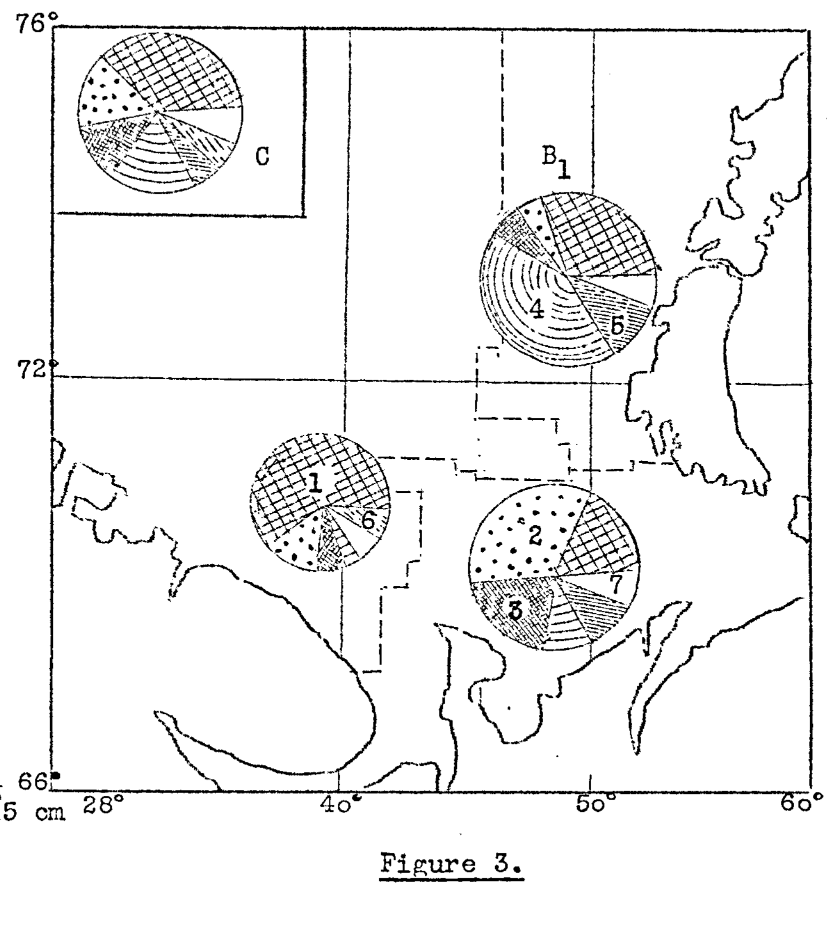

Figure 3.

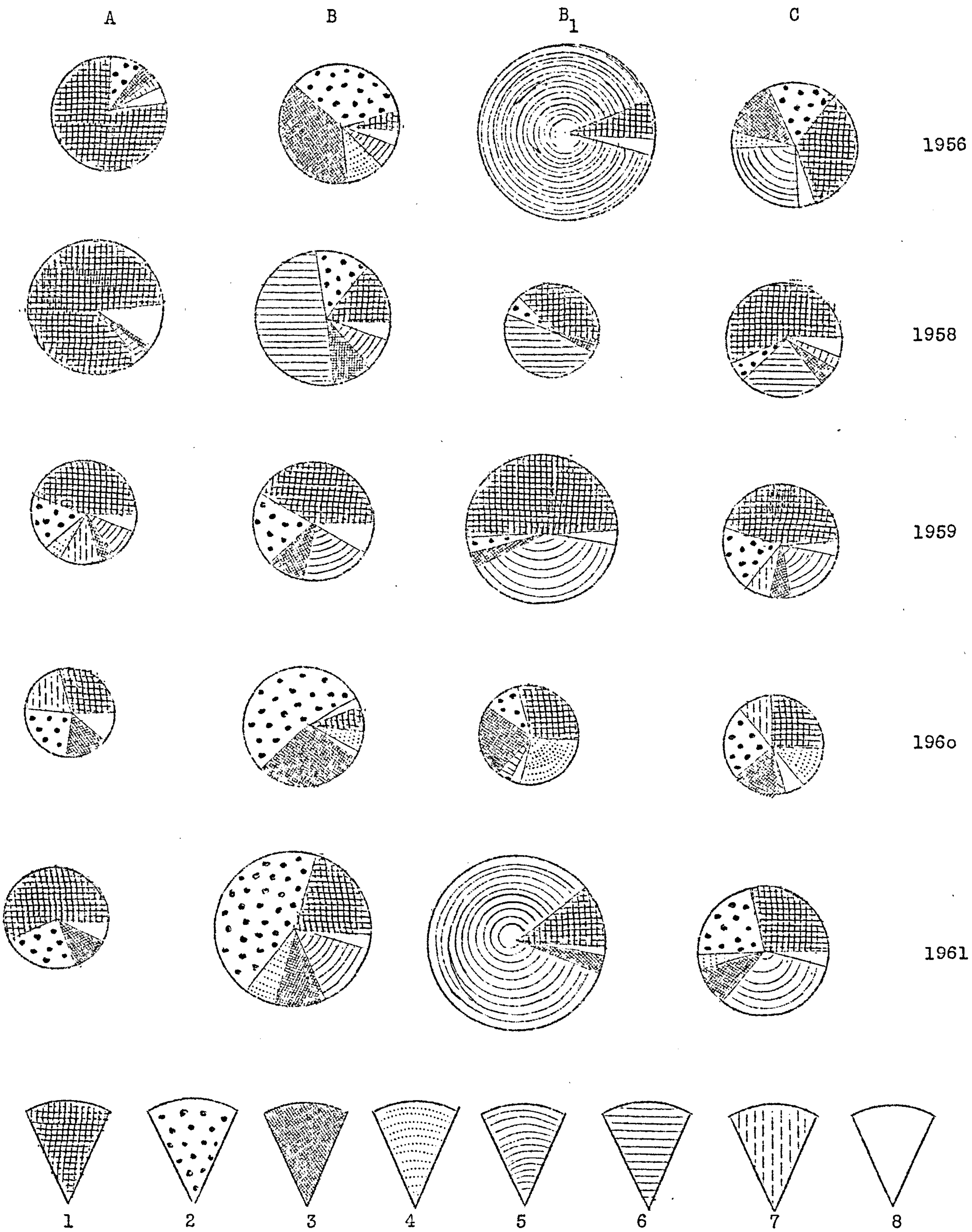

Figure 4.

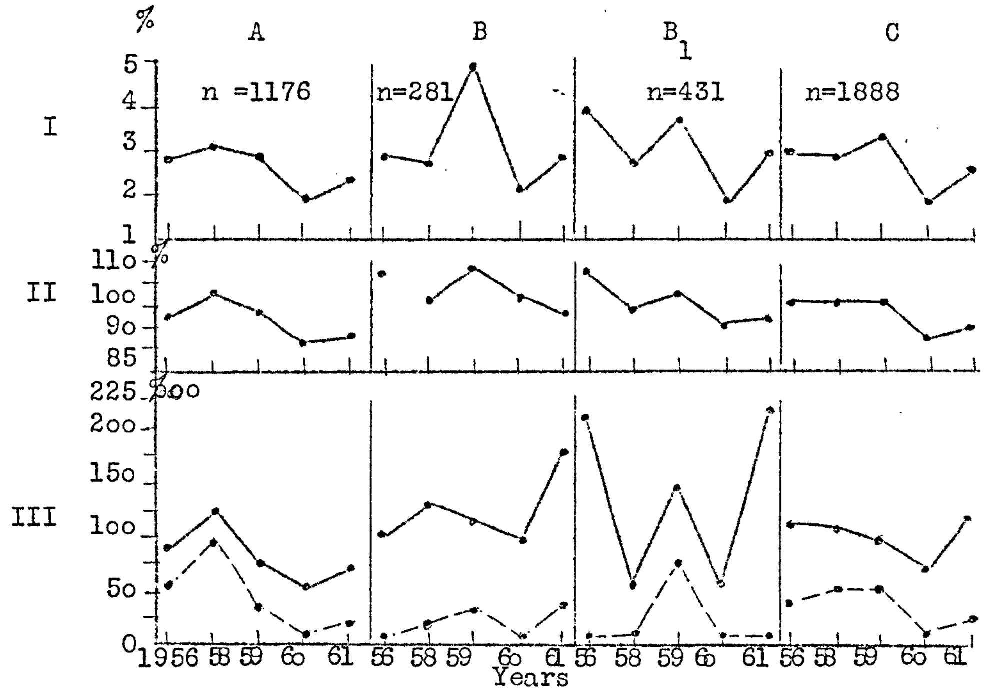

Figure 5.

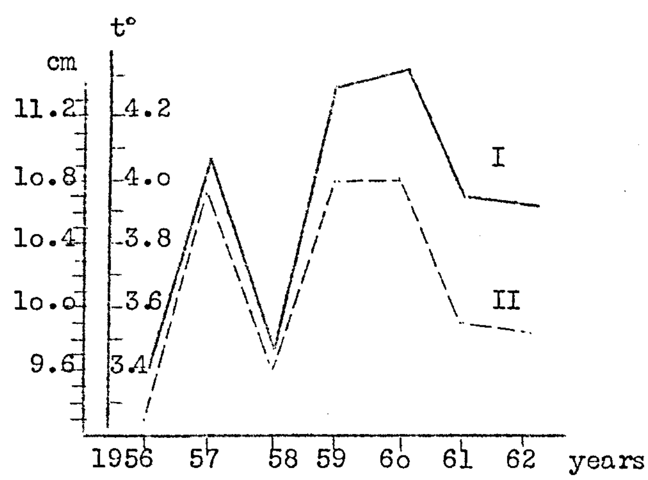

Figure 6.