International Council for the Exploration of the Sea

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Plankton Committee

On Primary Production in the Southern Baltic (1966-1967).
II. From the Arkona Deep to the Bay of Gdańsk

by
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Introduction

Investigations on the photosynthetic activity in the southern Baltic were started in 1964. The results of the experiments carried out until the end of 1965 in the Bay of Gdańsk only were reported previously (1966).

The investigations were continued in 1966, the area, however, was extended into the open sea. The present contribution deals with the preliminary examination of the data obtained by the experiments during the last two years.

Methods

The rate of photosynthesis was measured by the ^{14}C technique "in situ" according to Steemann Nielsen (1952, 1958), at standard depths of 0,5m, 5m, 10m, 20m and 30m during half a day-time. The details of the adapted procedure were reported in 1966. The ampoules with the radioactive carbonate solution were prepared in our laboratory. Their exact specific activity was standardized by the General Agency for ^{14}C Determination in Charlottenlund, Denmark. The radioactivity of plankton on filters was counted in our laboratory with a thin-window Geiger-Müller counter tube. The rates of photosynthesis in particular layers were computed according to Strickland(1960) as follows:

$$\text{mg C/m}^3\text{/day} = \frac{\text{net activity of plankton} \times \Sigma\, CO_2 \times 1{,}05 \times 2}{\text{total added activity}}$$

and represented graphically as the function of depth. $\Sigma\, CO_2$ was calculated according to K. Buch (1945); the penetration of light under the sea-surface was determined by means of underwater photometer. For determination of photosynthetic pigments, particularly chlorophyll a content, 1 to 2 litres of sea-water were filtered under vacuum through Millipore AA filter; the further processing being in accordance with the recommendation of SCOR/UNESCO Working Group 17 (1964).

Results

Measurements of the primary production were made in 1966 to 1967 during some short cruises at our routine hydrographical stations:-

A_1	(55°02'N - 14°01'E)	bottom depth about 50 m in the Arkona Deep
B_1	(55°20'N - 15°45'E)	bottom depth about 98 m in the Bornholm Deep
U	(54°46'N - 16°44'E)	bottom depth about 34 m in the vicinity of Ustka town
B_3	(55°20'N - 18°00'E)	bottom depth about 78 m in the eastern outlet of the Słupsk Furrow.
G_2	(54°50'N - 19°20'E)	bottom depth about 110 m in the southern part of the Gdańsk Deep.

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0	(54°36'N - 19°09'E)	bottom depth about 84 m in the Bay of Gdańsk.
J	(54°35'N - 18°46'E)	" " " 54 m in the Bay of Gdańsk.
ZP	(54°37'N - 18°37'E)	" " " 26 m south-west of the Hela Cap in the Bay of Puck.

All these stations are shown on the map attached to this contribution.

The rates of production in the whole column of the euphotic zone under 1 m^2 of sea-surface were calculated by integration and are shown in Table 1.. From the graphical presentation (Figure 1), it is easy to observe some differences in the vertical distribution of the production. A common characteristic is noticeable at three stations (ZP, J and 0 in 1966), situated in the coastal zone of the Bay of Gdańsk, which are directly influenced by the land and by the discharge waters of the Vistula. Here the organic production was highest at the surface even during summer, and with increasing depth it decreased rapidly in all cases. At 10 m depth the production was already small and pratically stopped at 20 m depth. The maximum values of production were similar to what was found in the previous year, viz. in March-April 50 to 60 mg C/m^3/day at the surface, and 293 to 395 mg C/m^3/day in the photosynthetic layer; and in September 73,2 mg C/m^3/day at the surface and 274 mg C/m^2/day in the whole water column. In the open sea the primary production was measured at four stations (A_1, B_1, B_3 and U). For this area the shapes of the curves representing the production as function of depth are showing some characteristic differences. The productivity at the surface was often smaller than in the deeper parts of the euphotic zone, with the maximum at about 5 m depth. Sometimes (Station B_1 in July) the carbon assimilation at the 10 m depth was even higher than at the surface. With further increase in depth, the productivity decreased quickly in all cases. The lower boundary of the photosynthetic zone was determined by the season and the actual light intensity, and was lying at a depth of 20 to 30 m. The highest rates per surface unit were found in April (Stations U and B_1) amounting to 252 to 266 mg C/m^2/day, where at the same time the rates per volume at the surface were comparatively low (15,5 mg C/m^3/day).

The lowest values of organic production were found at the darkest time of investigations, namely in October-November at Stations B_1 and 0 (57,7 to 60,6 mg C/m^2/day).

Generally speaking, the daily primary production under 1 m^2 surface varied during 1966 between 0,1 - 0,3 g C in the open Baltic and between 0,1 to 0,4 g C in the coastal water of the Bay of Gdańsk.

Unfortunately the investigations of the primary production in 1967 started as late as in May, when the spring maximum had passed by. The data from May indicate a great differentiation in the rate of photosynthesis depending on geographical location. The highest values were observed in the Bay of Gdańsk (Station G_2, 361 mg C/m^2/day). In the direction from east to west the primary production decreased (Station A_1, 54 mg C/m^2/day). The considerable differences found in May in the productivity at particular stations disappeared in July, however, still being twice as great as in July 1966. Nevertheless, the values in the eastern part of the sea were slightly higher than towards the west. The maximum rate of production in July 1967 is similar to that of July 1965 in the Bay of Gdańsk. In August, a rapid decline in the productivity took place, especially in the coastal zone (Station ZP, 61 mg C/m^2/day). The observations in November showed production rates being 2-3 times greater than those found at the same time a year before. The fall in the photosynthetic activity took place as late as December. When comparing the results of the investigations made in the two years under consideration, it can be said that the productivity in 1967 was considerably higher than in 1966, with a distinctly marked maximum in July and with the whole vegetation period prolonged by nearly a month.

Additional investigations on photosynthetic pigments began in 1967. The chlorophyll *a* content (Figure 2) was generally high, with small differences depending on depth, within the euphotic zone and varying with season and location. The average range was from 1 mg chlorophyll *a*/m^3 (Station A_1 in May, to 4,5 mg/m^3 at Station G_2). Sometimes maximum quantity of chlorophyll *a* was observed in the lower part of the euphotic zone, but it is possible that it had already lost its photosynthetic ability. The correlation between the photosynthetic

rate and chlorophyll a content was not quite convincing, and it is possible that in the region considered other factors such as light and nutrients play a decisive role for the production rate.

References

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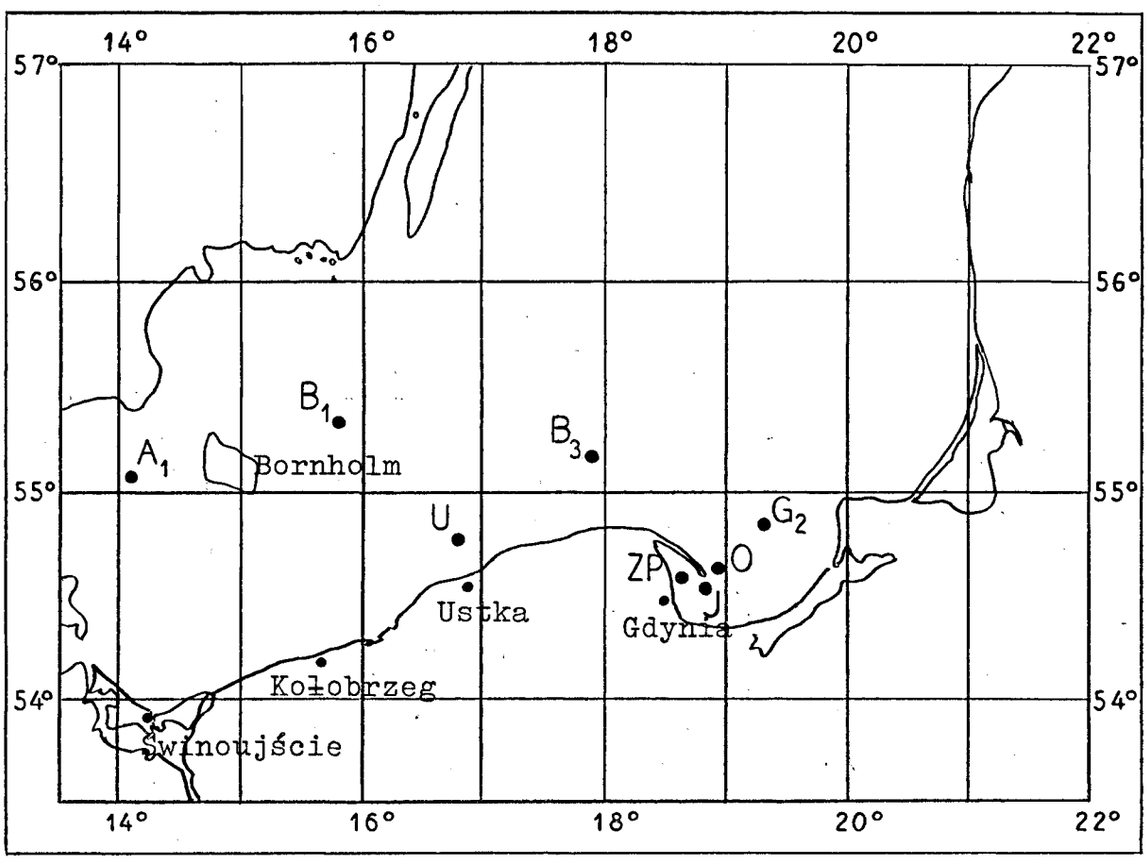
Table.

1966			1967		
Date	Station	mg C/m^2/day	Date	Station	mg C/m^2/day
26.III	J_1	395	-		
31.III	B_3	175	-		
1.IV	0	352	-		
28.IV	U	252	-		
29.IV	B_1	266	-		
-			17.V	B_3	233,5
-			18.V	B_1	104,4
-			21.V	U	116,7
-			24.V	A_1	53,9
-			26.V	G_2	360,9
-			27.V.	ZP	187,9
6.VII	A_1	260	-		
7.VII	B_1	214	7.VII	B_3	524,6
-			8.VII	G_2	483,1
-			12.VII	U	479,0
-			13.VII	B_1	430,6
-			5.VIII	G_2	122,0
-			8.VIII	B_3	245,4
28.VIII	0	148	16.VIII	ZP	61,3
12.IX	B_3	143	-		
23.IX	B_1	124	-		
25.IX	ZP	274	-		
21.X	ZP	77	-		
26.X	B_1	57,7	-		
4.XI	0	60,6	8.XI	G_2	204,8
-			9.XI	B_3	179,4
-			11.XI	ZP	184,5
-			24.XI	A_1	73,8
-			10.XII	B_1	16,4
-			13.XII	G_2	36,2
-			14.XII	ZP	37,7


14°
16°
18°
20°
22°
57°
56°
55°
54°
B1
B3
A1
Bornholm
U
G2
ZP
O
J
Ustka
Gdynia
Kołobrzeg
Świnoujście

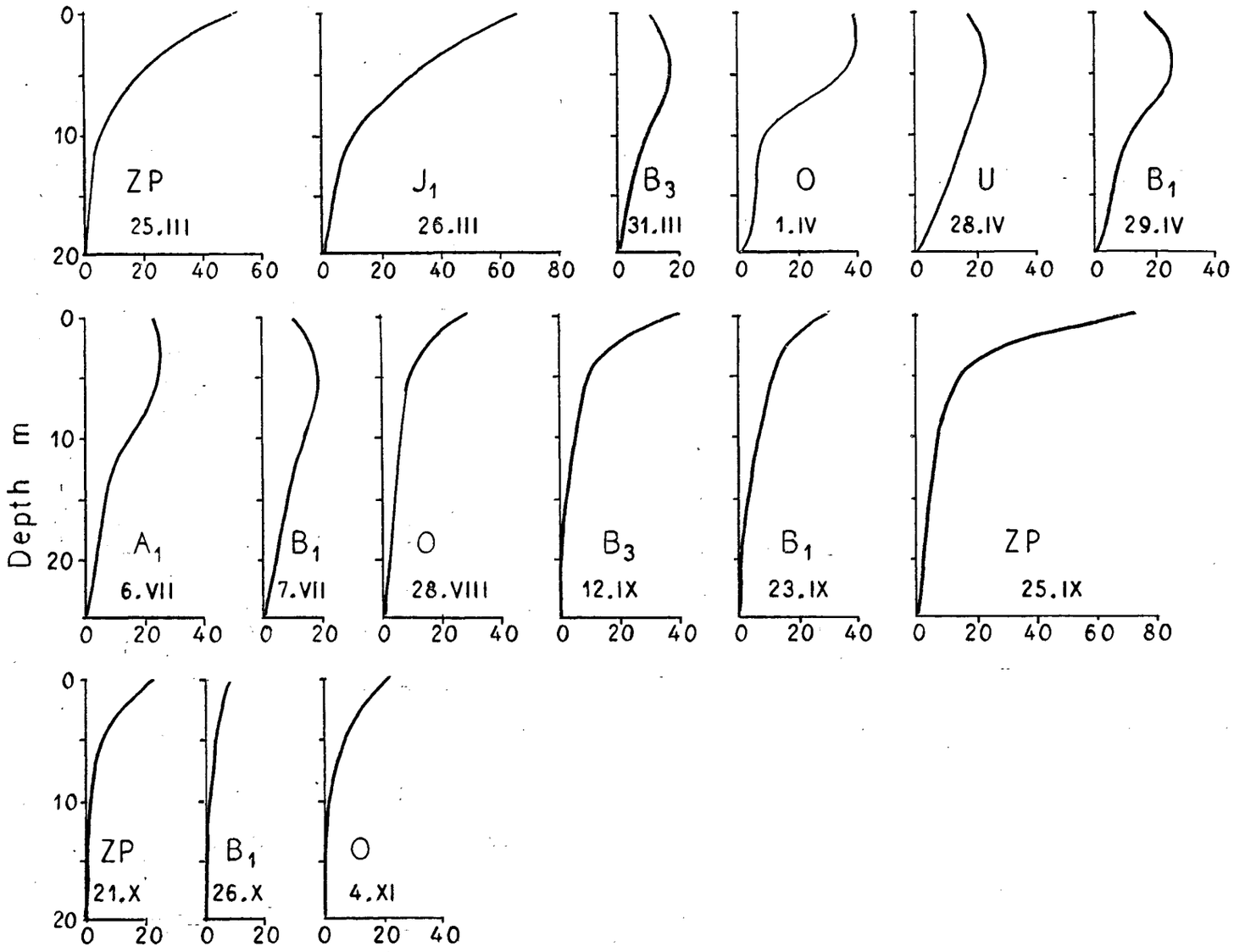


Figure 1. Vertical distribution of primary production in mg C/m^3/day in 1966.

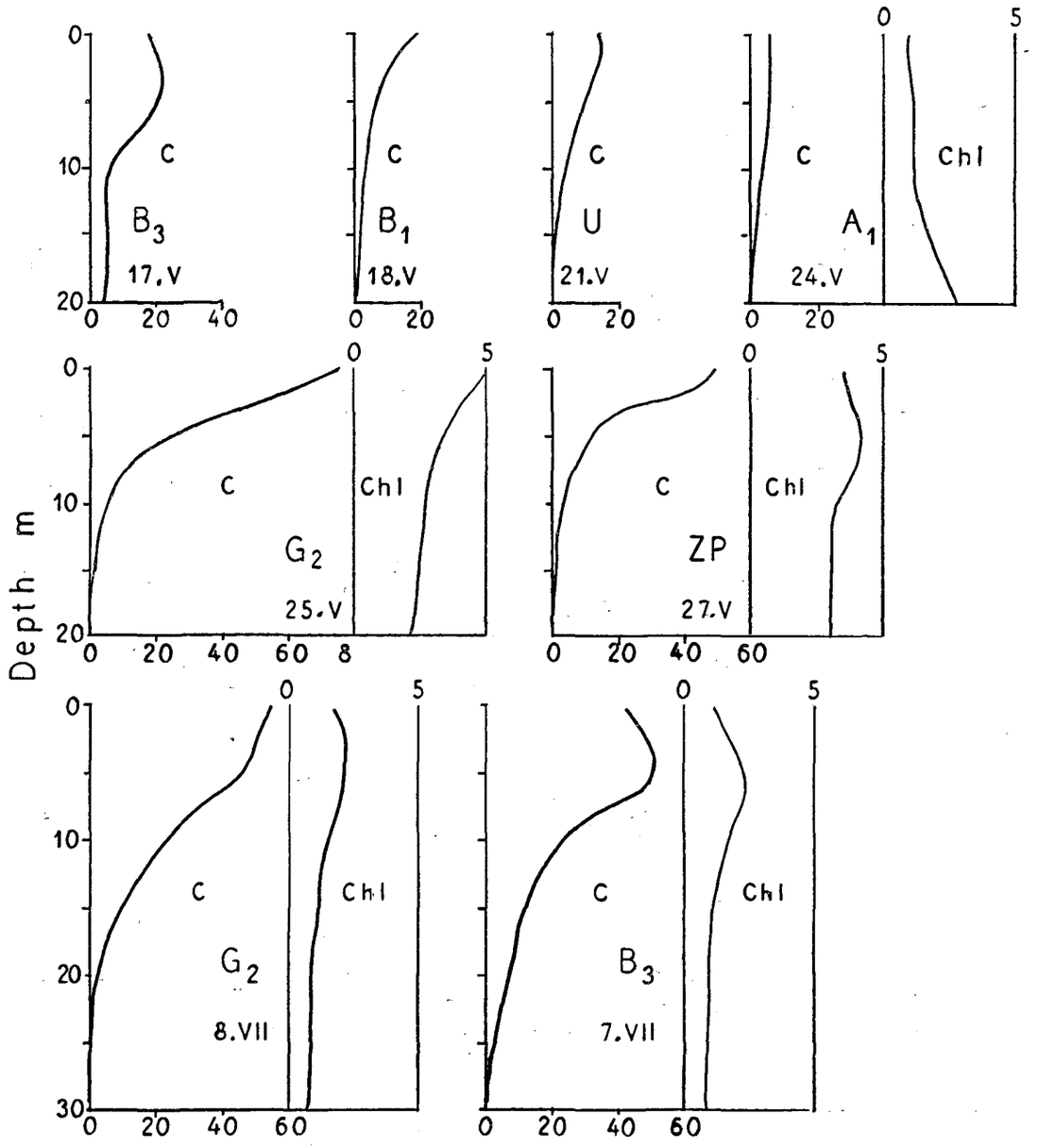


Figure 2. Vertical distribution of primary production in mg C/m^3/day /C/ compared with chlorophyll a content in mg chl/m^3 /Chl/.

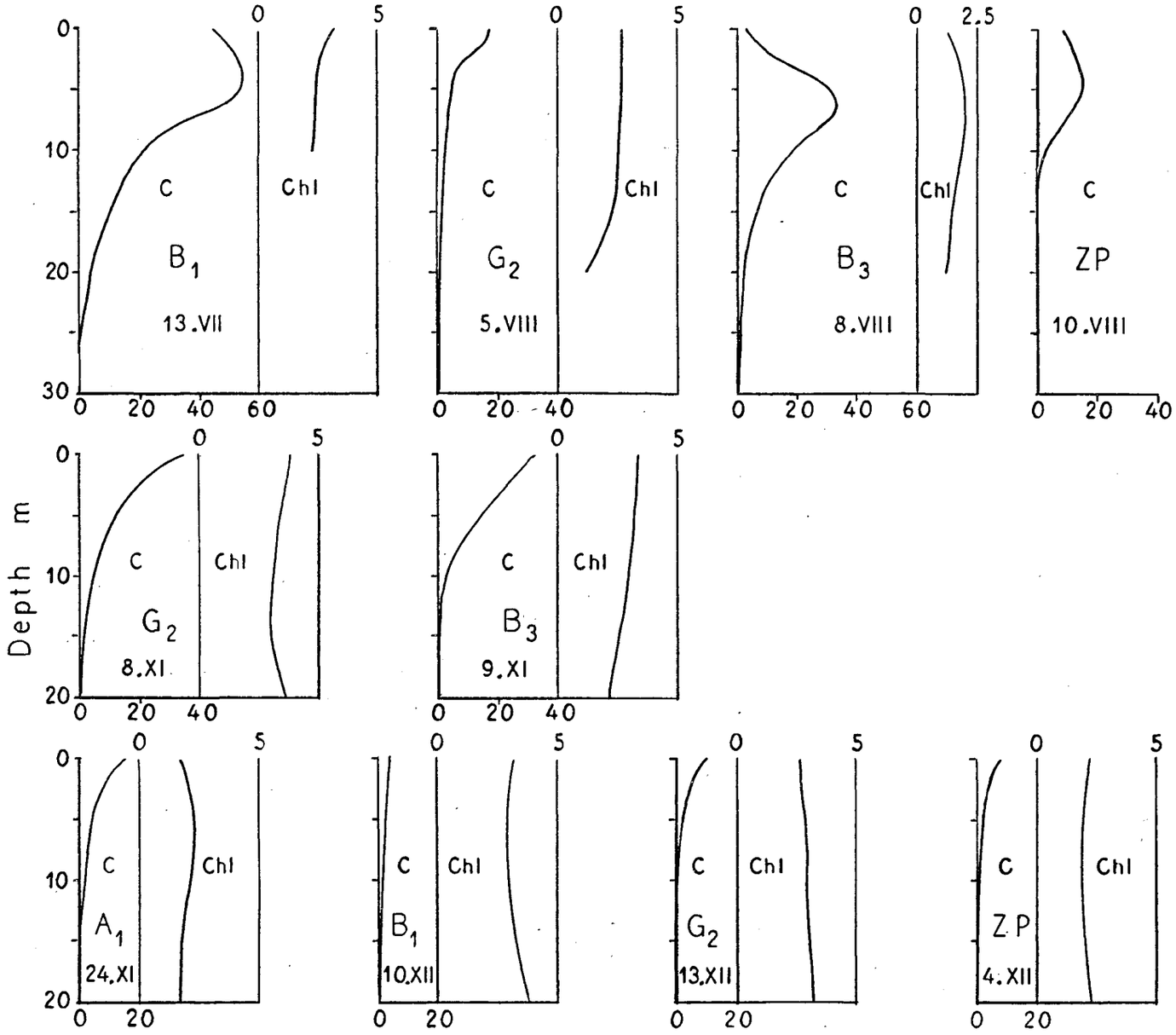


Figure 2. continued.