



C.M. 1971/L:16
Plankton Committee
Hydrography Committee

"On primary production in the Baltic".

by

Stig H. Fonselius

Fishery Board of Sweden, Hydrographic Department, Gothenburg.



The most important biological production in the Baltic is the production of phytoplankton, the primary production. The primary production has been measured at two Swedish lightships in the Baltic during a period of several years. The work was carried out at the lightships "Finngrundet" in the Bothnian Sea and at "Hävringe" in the Baltic proper. At the "Finngrundet" the series extends from November 1961 to November 1968 and at the "Hävringe" from November 1963 to November 1967. The C-14 technique of Steeman-Nielsen was used and applied "in situ" as described by Michanek (1970). The measurements were carried out twice a month by crew members of the lightships. If one assumes that these series are representative for the Gulf of Bothnia and for the Baltic proper including the Gulf of Finland respectively, it is possible to get an idea of the total yearly production of the Baltic as a rough average. This is of course a very doubtful assumption, but there are hardly any other methods to estimate the primary production. Most probably we will, however, get the right order of magnitude for the primary production.

Unfortunately the measurements could not be carried out through the whole year due to the ice conditions during the winter, when the lightships had to leave their stations. There has also occurred some breaks in the series due to other difficulties. It has, however, been possible to obtain at least one value for every month of the year during the measuring period at the "Hävringe" and for all months except April at the "Finngrundet". The measurements were carried out at the following depths: 0 m, 5 m, 10 m and 15 m. Additionally the 2.5 m level has on most occasions been measured and some times also the 20 m level. In order to obtain an even distribution of the measured levels, I have interpolated values for each 2.5 m interval and extrapolated down to a fictional zero point at 25 m. Of course the production often will

stop before 25 m but the values below 15 m are anyhow very low and will not influence the final results more than some few per cent. The measured values have been computed as mg C/m^3 and day. Through addition of all levels and multiplication with 2.5, the total production on each occasion is obtained in mg C/m^2 and day. The values reported had been computed according to the older method (Michanek 1970), which gives too low values. According to instructions from the International C-14 laboratory in Charlottenlund, Denmark, these values were corrected through multiplication with the factor 1.45. The "dark fixation" was included by multiplying with the factor 1.1. Fig. 1 and Fig. 2 show the separate results from each measurement on the two lightships expressed as $\text{mg C/m}^2/\text{day}$. From these results monthly mean values have been computed when several measurement series have been carried out during the month. When only a single measurement series has been available, this has been used as mean value for the month. Fig. 3 and Fig. 4 show the monthly mean values during the measurement periods in $\text{g C/m}^2/\text{month}$. The values at the "Finngrundet" show a clear increase of the primary production during the period, but the values at the "Hävringe" are too few to give any trend. At the "Hävringe" the measurement series were broken several times during the period and the period is also shorter at this lightship. In order to get the monthly mean production during the whole period, all values for every month has been used to compute the mean values. For some months only few or a single value have been used. Especially during the spring months February, March and April very few values exist. Tab. I shows these monthly means for the two lightships in g C/m^2 . Through addition of the monthly means the yearly mean productivity has been obtained and is also given in Table I. By multiplying with the surface areas of the sea areas covered by the measurements, the total yearly primary production of the Baltic may be computed. Table II shows the areas of the Gulf of Bothnia and of the Baltic proper including the Gulf of Finland in km^2 and the total primary production of the areas in tons/year. The total yearly mean production of the Baltic will then amount to about 26 million tons of carbon per year.

In order to check these results, the production at the two lightships are compared with the primary production values obtained at some Danish lightships on which the same C-14 method has been used during several years. Table III shows the Danish results. It can be seen

that the primary production is lower in the Baltic and especially in the Gulf of Bothnia than in the Danish waters. The values seem to be somewhat high compared to the production in the oceans given by Ryther (1969). He gives the yearly mean production in the open sea as 50 g C/year and in coastal areas as around 100 g C/year. A sea with an oligotrophic surface layer, as the Baltic, should have a low primary productivity. It is, however, possible that the primary production of the Baltic has increased considerably during the last decades due to "fertilization" through sewage and industrial waste water or maybe due to natural fertilization. The Baltic may therefore now have a relatively high productivity. This has also been suggested by Kaiser and Schulz (1970). They observed extremely high productivity values during cruises in the Baltic when participating in the Baltic Year programme. These values are from different areas of the Baltic during 1969-1970 and they support the theory that the primary production of the Baltic is increasing continuously from year to year.

References.

- 1969,
Bertelsen, E. and Hansen, P.M.; Fiskeriundersøgelser i 1969 ved Danmark, Färöarne og Grönland. H.Plankton. Skrifter fra Danmarks Fiskeri-og Havundersøgelser Nr 30.
- Kaiser, W. and Schulz, S.1970:Preliminary Results on Biological Investigations 1969/70 in Connection to Earlier Observations and to the Pollution of the Baltic. 7th Conference of the Baltic Oceanographers, Helsinki May 11th to 15th 1970. Abstracts.
- Michanek, G., 1970: Data of Primary Production Measured by the C-14 Method at two Lightships in the Baltic. Medd. Havsfiskelab. Lysekil, nr 86.
- Ryther, J.H., 1970: Photosynthesis and Fish Production in the Sea. Science Vol. 166, No 3901.

Table I.

Monthly mean production of organic carbon (g C/m^2) at the lightships "Finngrundet" and "Hävringe" measured with the C-14 method.

Month	"Finngrundet"	"Hävringe"
January	0.47	0.97
February	0.40	1.42
March	1.01	4.05
April	---	17.69
May	13.70	7.22
June	8.45	9.81
July	7.92	12.94
August	8.64	8.30
September	7.30	9.73
October	6.15	3.72
November	1.95	1.52
December	0.57	0.64
Yearly meanprod.	56.6 $\text{g C/m}^2/\text{year}$	78.0 $\text{g C/m}^2/\text{year}$

Table II.

The areas of the Gulf of Bothnia and the Baltic proper including the Gulf of Finland, and the yearly meanproduction of the Baltic (tons C/area).

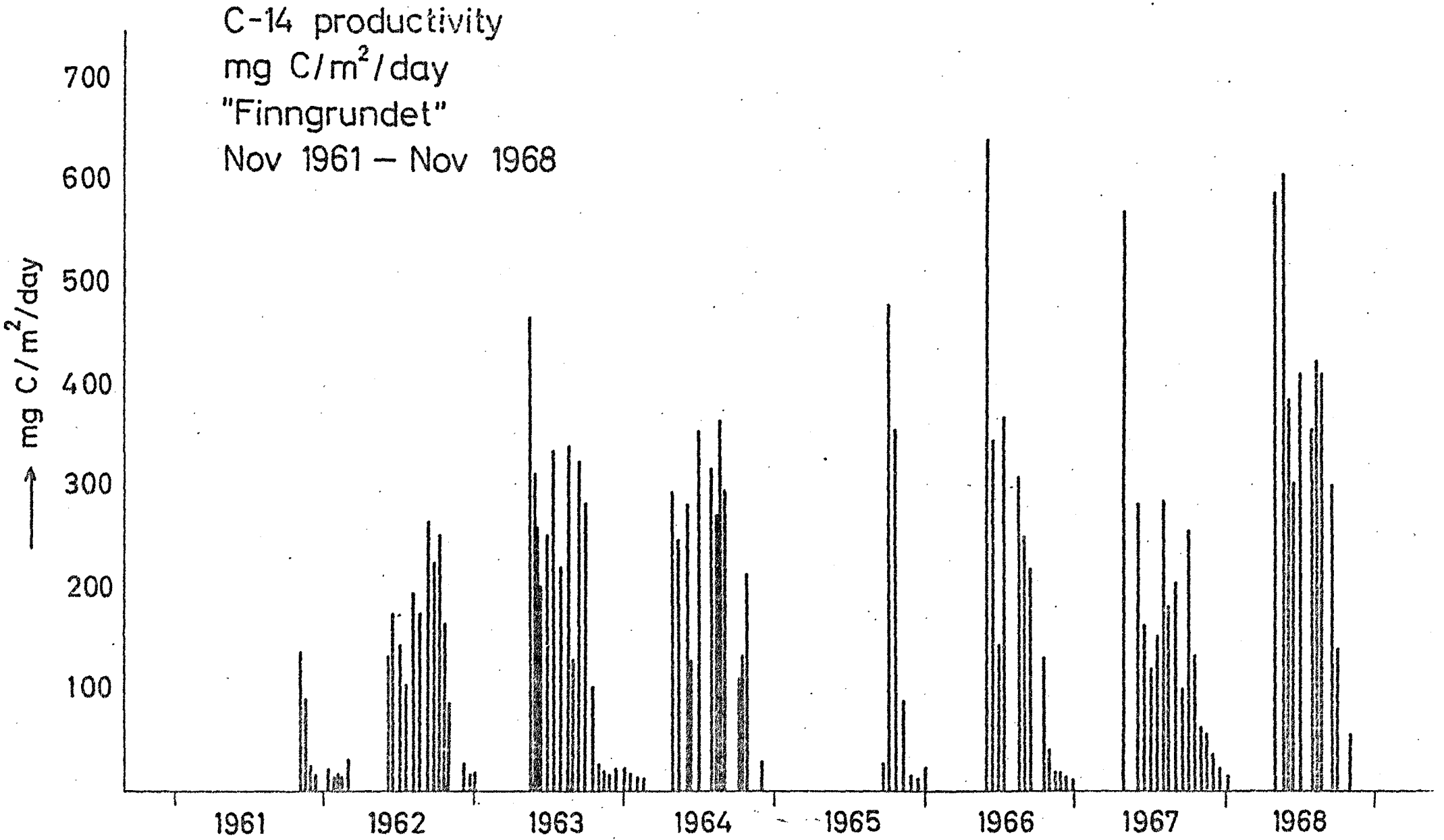
Area	Surface km^2	tons C/year
Gulf of Bothnia	103 600	5.864×10^6
Baltic proper + Gulf of Finland	262 400	20.467×10^6
Total production of	366 000 km^2 is	26×10^6 tons C/year

Table III.

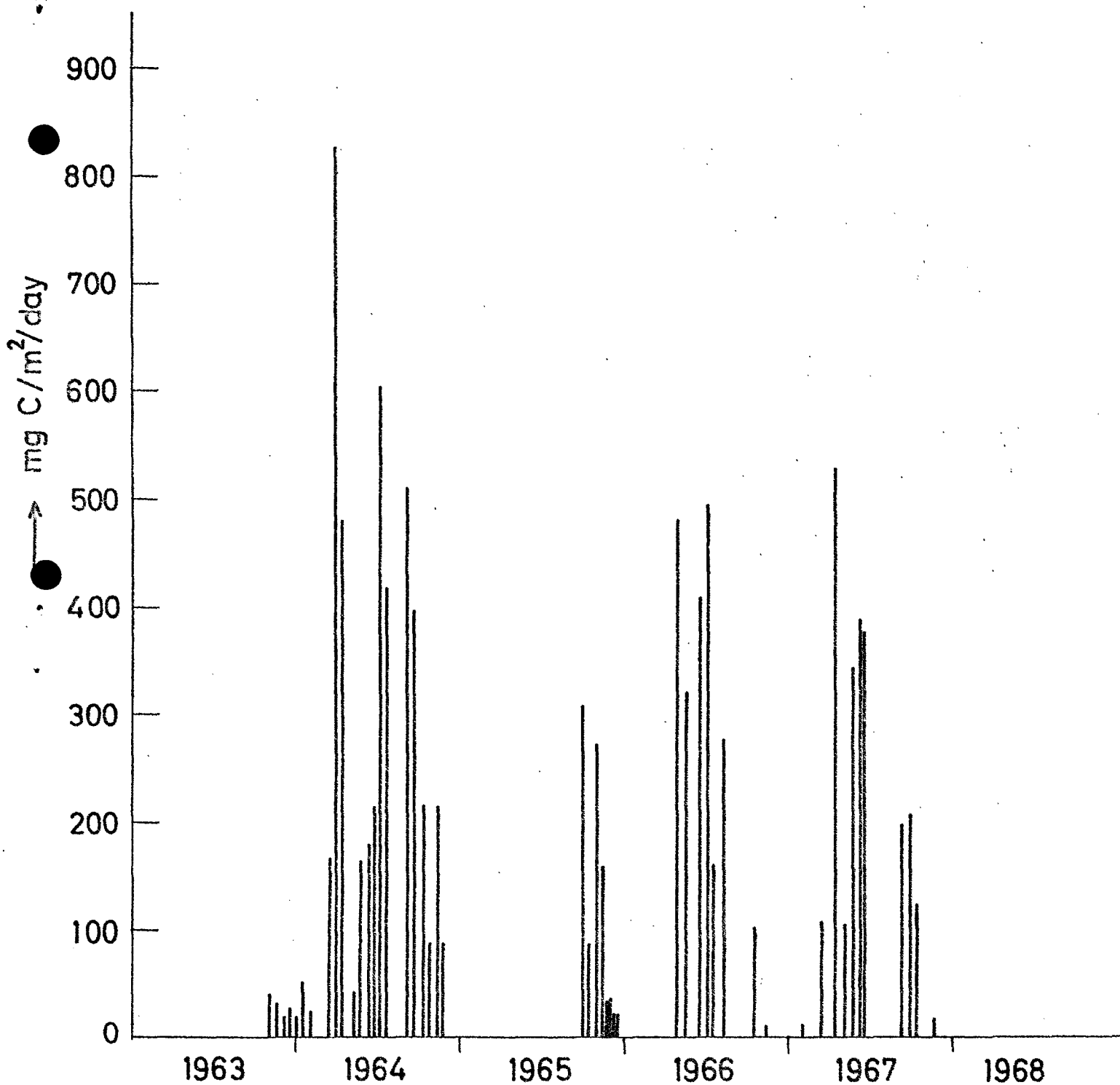
Primary production at Danish lightships measured with the C-14 method.

Lightship	1966	1967	1968	1969	
Ålborg Bugt	72	73	75	86	$\text{g C/m}^2/\text{year}$
Anholt Nord	51	86	96	90	"
Halsskov Rev	60	95	134	101	"

Fig 1.



C-14 productivity
mg C/m²/day
"Hävringe"
Nov 1963 - Nov 1967



C-14 productivity
g C/m²/month
"Finngrundet"
Nov 1961 - Nov 1968

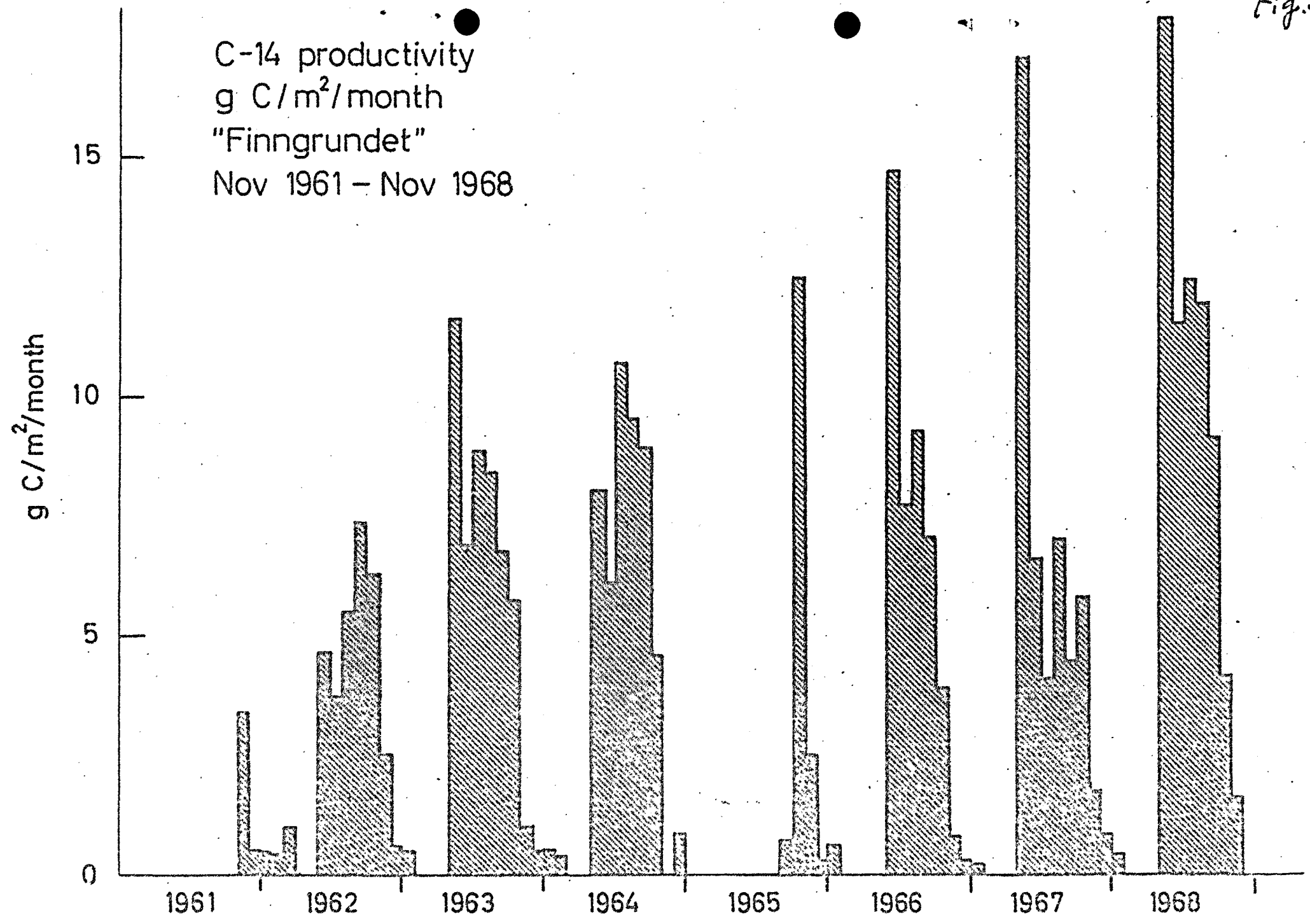


Fig 4.

C-14 productivity
g C/m²/month
"Hävringe"
Nov 1963 - Nov 1967

