COMMONWEALTH OF AUSTRALIA

Commonwealth Scientific and Industrial Research Organization

Division of Fisheries and Oceanography

REPORT 43

# DATA COLLECTED BY AUSTRALIAN PARTICIPANTS DURING THE MAY, 1968 SEA TRIALS OF SCOR/UNESCO WORKING GROUP 15 ON "PHOTOSYNTHETIC RADIATION IN THE SEA"

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CONTENTS




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# I. INTRODUCTION

This report gives all data collected by Australian participants on the cruise of the Ellen B. Scripps in May 1968 in the Gulf of California for the SCOR/UNESCO Working Group 15 (W.G. 15) on "Photosynthetic Radiant Energy in the Sea". Members of W.G. 15 took part in this cruise to test, demonstrate, and intercalibrate various devices for measuring radiant energy in the sea. The Australian role was to measure primary production and to demonstrate to the physicist members of the Group the methods and needs of the biologist.

The measurements were made by H.R. Jitts and D.R. Lockwood.

The positions of the stations are given on page 4 (Table 1). Primary production was measured at 8 stations, the submarine percentage transmission of light at 10 stations, the irradiance under the blue glass filters used in primary production measurments at 2 stations, and the variation of incident sunlight from 1248 h to 1432 h at Station 7. The methods and equipment used are described below and in the references.

# II. PRIMARY PRODUCTION

Primary production was measured using $^{14}C$ with the simulated in situ technique (Jitts 1963). Samples were taken at 1100 h with a 6 l. plastic sampler (Jitts 1964) from 6 light depths determined by balance by depth submarine photometry (Section III). Ten μc of $^{14}C$ were added to 60 ml aliquots of each sample in round-bottomed Pyrex flasks which were then incubated from local noon to sunset in a gymballed water bath under the appropriate blue glass filter exposed to sunlight, and cooled with a flow of surface sea-water. After incubation, the samples were filtered under $\frac{1}{2}$ atmosphere vacuum through membrane filters (Millipore HA), fumed with conc. HCl for 10 min, dried overnight over silica gel and soda-lime, and counted with a windowless Geiger counter. All samples were corrected for dark uptake of $^{14}C$ by measurements made on duplicate samples. Further details of the techniques and methods of calculation are as given in Dyson, Jitts and Scott (1965) except that for the calculation of column production under 1 $m^2$ the integration was extended to the depth of penetration of 1% surface light where production was assumed to be zero. The results are given in Figures 1 to 8.

# III. SUBMARINE PHOTOMETRY

Deck and submarine photometry were measured with selenium photocell detectors (Megatron Type B) with a 25 ohm load, under frosted glass, flat plate collectors and blue filters of 50 nm half-band width with peak transmission at 480 nm (Schott BG 12, 2mm and GG 5, 2mm).

The outputs of the photocells were recorded on the two X channels of an $X_1X_2Y$ recorder with an input impedance of 100,000 ohm. Before each station the outputs of the two photometers were matched by varying the scale factors on the recorder with the photometers exposed to a fluorescent lamp. The deck photometer was placed under a clear glass filter under water in the deck incubator described in Section II. The submarine photometer was lowered into the sea together with a strain gauge depth-measuring instrument whose output was recorded on the Y channel of the $X_1X_2Y$ recorder. From this trace of deck and submarine light as a function of depth, the percentage transmission of light was calculated at approximately 3 m intervals and plotted on log graph-paper as shown in pages 15 to 24 (Figs. 9-18).

To determine the light depths for productivity measurements, the deck photometer was then placed successively under each of the varying blue glass filters in the incubator and the submarine photometer raised until the outputs of the two photometers matched.

## IV. SPECTRAL IRRADIANCE UNDER BLUE FILTERS

The spectral irradiance under the blue glass filters used in the productivity measurements was measured by placing the remote fibre optics probe of a spectro-radiometer under each of the filters in turn at the same position as the centre of each sample flask would have been. The spectro-radiometer was an ISCO Model SR with a half band width of approximately 15 nm. Readings were corrected to a calibration made by ISCO in March 1967 against a standard lamp.

At Station 4 the irradiance under each filter was measured in $\mu W\ cm^{-2}\ nm^{-1}$ and the results are given on page 5 (Table 2). At Station 7 incident sunlight was monitored throughout the period during which the irradiance under the filters was measured and all the results given on page 6 (Table 3) have been corrected to the incident light at the start of the measurements at 1248 h.

Irradiance from 400 nm to 700 nm under the filters was calculated by integration of the curves of irradiance vs. wavelength.

Incident light was monitored at Station 7 by placing the deck photometer described in Section III under about 2 cm of water in a glass tank on deck and recording its output as a function of time at 20 sec/cm. The graph given on page 25 (Fig. 19) is condensed from the seven periods during which incident light was recorded.

## V. REFERENCES

DYSON, N., JITTS, H.R., and SCOTT, B.D. (1965).- Techniques for measuring oceanic primary production using radioactive carbon. CSIRO Aust. Div. Fish. Oceanogr. Tech. Pap. No. 18.

JITTS, H.R. (1963).- The simulated *in situ* measurement of oceanic primary production. Aust. J. mar. Freshwat. Res. 14, 139-47.

JITTS, H.R. (1964).- A twin six litre plastic sampler. Limnol. Oceanogr. 9, 452.

TABLE 1

STATION POSITIONS AND WORK DONE

| Station No. | Date | Latitude | Longitude | Primary Production | Submarine Photometry | Spectral Irradiance |
|---|---|---|---|---|---|---|
| 1 | 5 MAY 1968 | 24°25.5'N | 110°10.8'W | + | + | |
| 3 | 6 MAY 1968 | 24°34.1'N | 110°20.3'W | + | + | |
| 4 | 7 MAY 1968 | 24°33.3'N | 110°19.5'W | | + | + |
| 5 | 8 MAY 1968 | 24°33.3'N | 110°15.7'W | + | + | |
| 6 | 9 MAY 1968 | 26°02.5'N | 110°18.0'W | + | + | |
| 7 | 10 MAY 1968 | 25°51.3'N | 111°02.6'W | | + | + |
| 8 | 11 MAY 1968 | 25°57.0'N | 111°08.6'W | + | + | |
| 9 | 12 MAY 1968 | 25°56.3'N | 110°58.2'W | + | + | |
| 10 | 13 MAY 1968 | 24°33.5'N | 110°19.6'W | + | + | |
| 13 | 16 MAY 1968 | 23°07.1'N | 109°17.0'W | + | + | |

TABLE 2

IRRADIANCE MEASUREMENTS

STATION: 4 DATE: 7 MAY 1968 TIME: 1000 h

| Wavelength (nm) | Spectral Irradiance Under Filters ($\mu W\ cm^{-2}\ nm^{-1}$) | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| 400 | 6.65 | 2.6 | 0.8 | 0.2 | 0.1 |
| 425 | 16.8 | 8.0 | 2.4 | 1.0 | 0.42 |
| 450 | 21.6 | 14.4 | 5.6 | 3.0 | 1.47 |
| 475 | 32.6 | 19.4 | 9.0 | 4.7 | 2.67 |
| 500 | 31.9 | 17.5 | 7.7 | 3.8 | 2.12 |
| 525 | 23.9 | 9.9 | 3.3 | 1.3 | 0.59 |
| 550 | 10.8 | 2.7 | 0.4 | 0.1 | 0.03 |
| 575 | 4.3 | 0.5 | 0 | 0 | 0 |
| 600 | 1.0 | 0 | 0 | 0 | 0 |
| 625 | 0.3 | 0 | 0 | 0 | 0 |
| 650 | 0.1 | 0 | 0 | 0 | 0 |
| 675 | 0.1 | 0 | 0 | 0 | 0 |
| 700 | 0 | 0 | 0 | 0 | 0 |
| Irradiance 400-700 nm ($mW\ cm^{-2}$) | 3.67 | 1.84 | 0.72 | 0.35 | 0.18 |

TABLE 3

IRRADIANCE MEASUREMENTS

STATION 7 DATE 10 MAY 1968

| Wavelength (nm) | Spectral Irradiance ($\mu W\ cm^{-2}\ nm^{-1}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Direct Sunlight | | Filters Under Water | | | | | |
| | | | 0 | 1 | 2 | 3 | 4 | 5 |
| 400 | 79.5 | | 55.0 | 12.5 | 4.29 | 1.20 | 0.48 | 0.13 |
| 425 | 116.1 | | 70.6 | 25.0 | 11.4 | 4.56 | 1.75 | 0.99 |
| 450 | 140.6 | | 88.0 | 39.7 | 22.6 | 10.8 | 5.21 | 2.35 |
| 475 | 151.3 | | 93.3 | 45.7 | 27.2 | 14.0 | 7.78 | 3.81 |
| 500 | 154.2 | | 92.8 | 43.8 | 25.1 | 12.1 | 6.56 | 2.83 |
| 525 | 157.8 | | 99.2 | 34.1 | 14.9 | 5.39 | 2.38 | 0.78 |
| 550 | 148.0 | | 92.8 | 17.05 | 3.75 | 0.83 | 0.20 | 0.04 |
| 575 | 149.4 | | 97.6 | 7.18 | 0.75 | 0.06 | 0 | 0 |
| 600 | 141.7 | | 92.8 | 1.88 | 0.06 | 0 | 0 | 0 |
| 625 | 140.4 | | 86.1 | 0.44 | 0.22 | 0 | 0 | 0 |
| 650 | 133.0 | | 80.5 | 0.14 | 0.02 | 0 | 0 | 0 |
| 675 | 127.8 | | 79.5 | 0.06 | 0.02 | 0 | 0 | 0 |
| 700 | 114.1 | | 68.2 | 0.06 | 0.02 | 0 | 0 | 0 |
| 725 | 97.9 | | 54.8 | 0.06 | 0.02 | 0 | 0 | 0 |
| 750 | 100.1 | 94.2 | 52.5 | 0.07 | 0.02 | 0 | 0 | 0 |
| 800 | | 88.9 | | | | | | |
| 850 | | 82.9 | | | | | | |
| 900 | | 73.4 | | | | | | |
| 950 | | 33.0 | | | | | | |
| 1000 | | 60.0 | | | | | | |
| 1050 | | 52.6 | | | | | | |
| 1100 | | 41.0 | | | | | | |
| Time | 1248 | | 1308 | 1314 | 1330 | 1400 | 1425 | 1406 |
| Irradiance 400-700 nm ($mW\ cm^{-2}$) | 41.4 | | 25.9 | 5.53 | 2.70 | 1.21 | 0.60 | 0.27 |

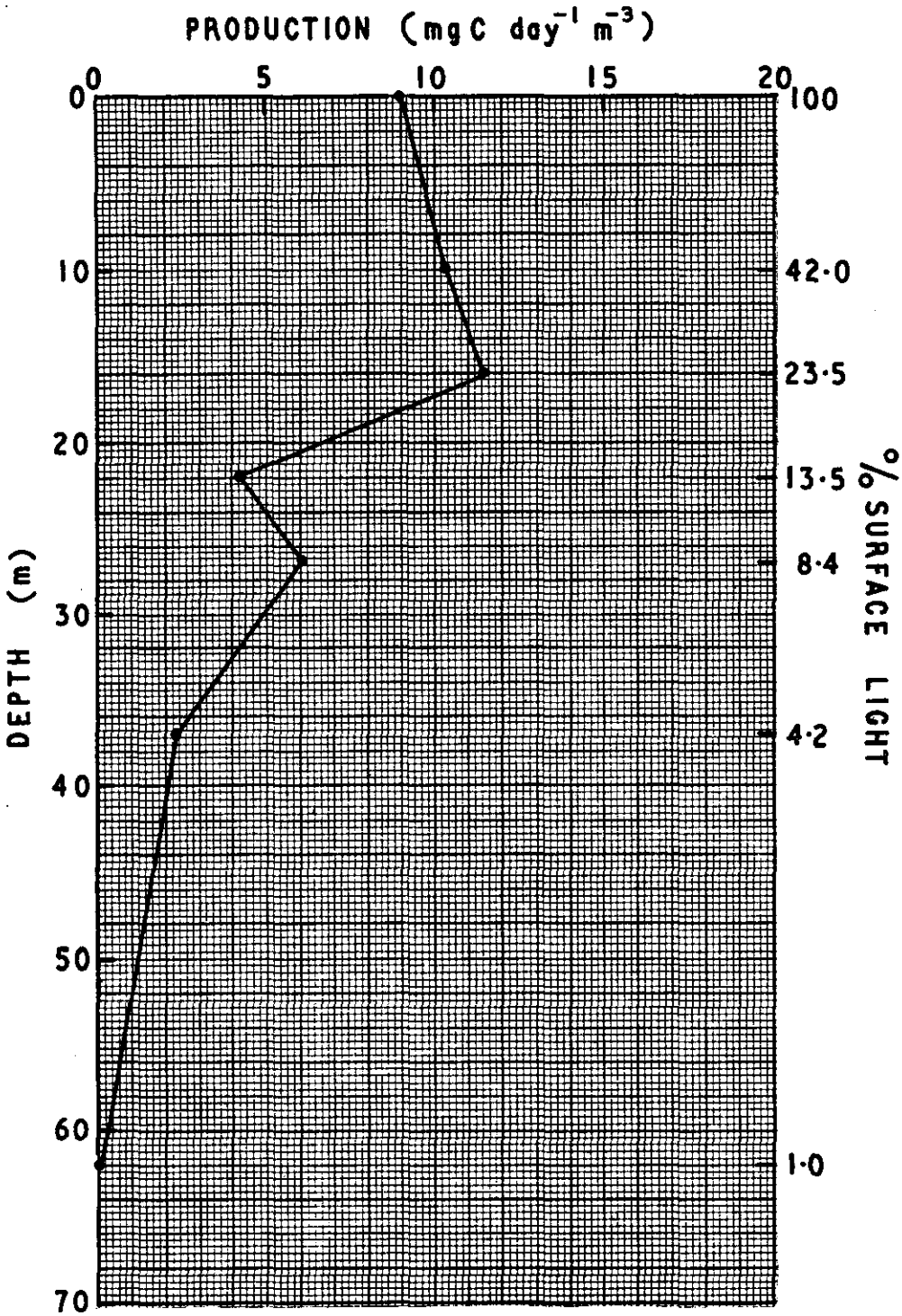


Fig. 1. Primary production. Station: 1. Date: May 5, 1968. Time: 1100 h. Column production under 1 $m^2$: 0.30 g C $day^{-1}$ $m^{-2}$.

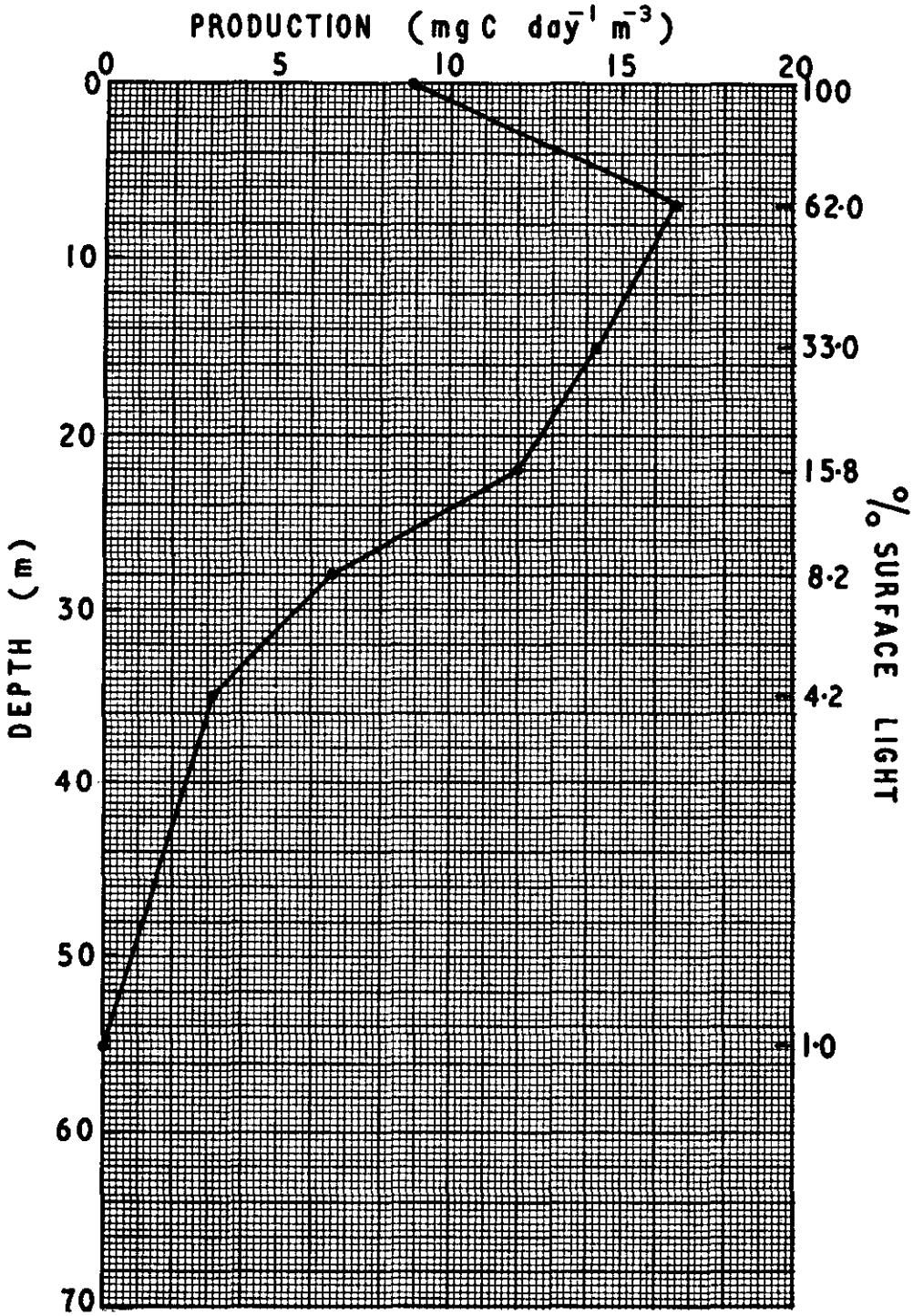


Fig. 2. Primary production. Station: 3. Date: May 6, 1968. Time: 1100 h. Column production under 1 $m^2$: 0.43 g C $day^{-1}$ $m^{-2}$.

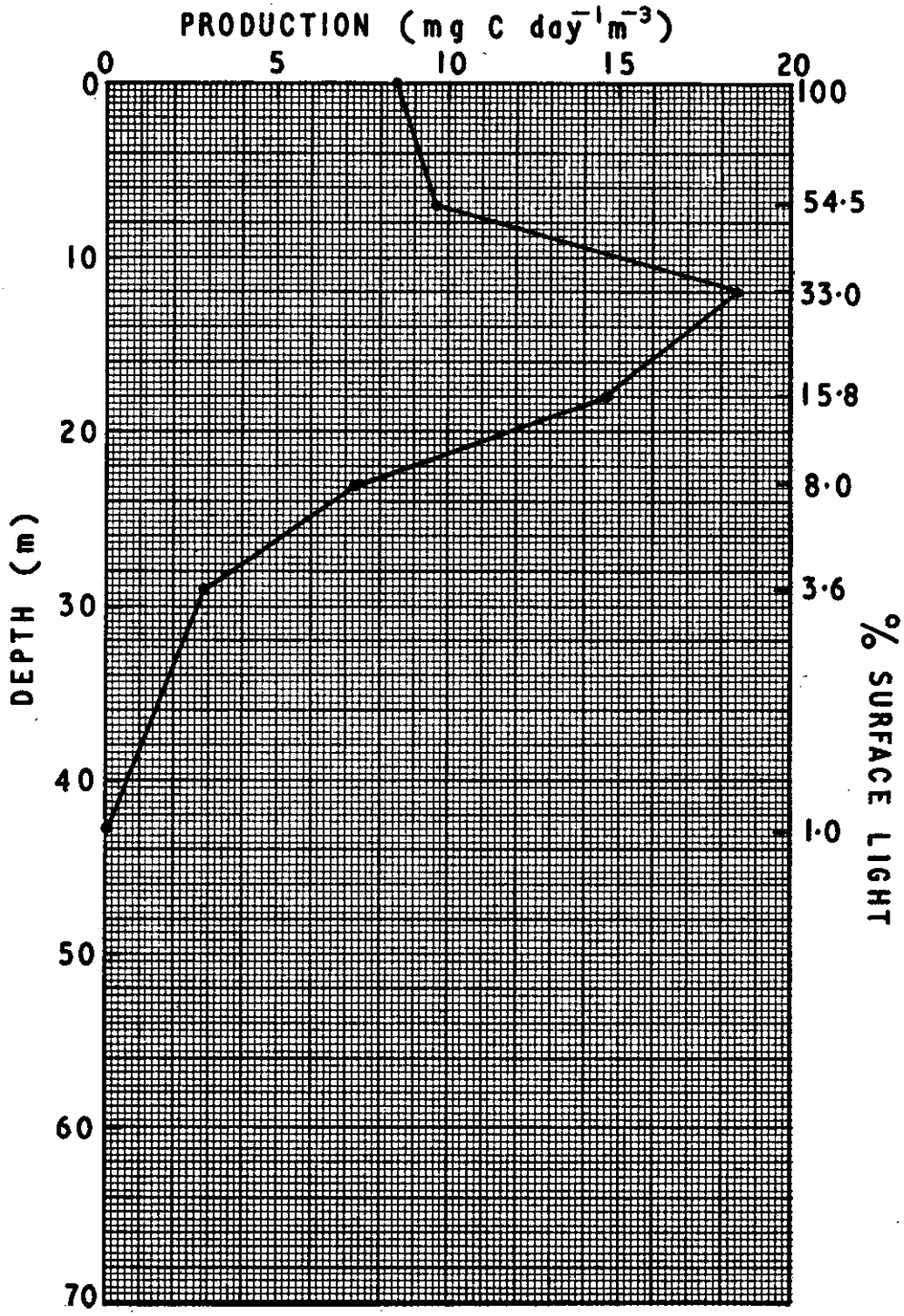


Fig. 3. Primary production. Station: 5. Date: May 8, 1968. Time: 1100 h. Column production under 1 $m^2$: 0.34 g C $day^{-1}$ $m^{-2}$.

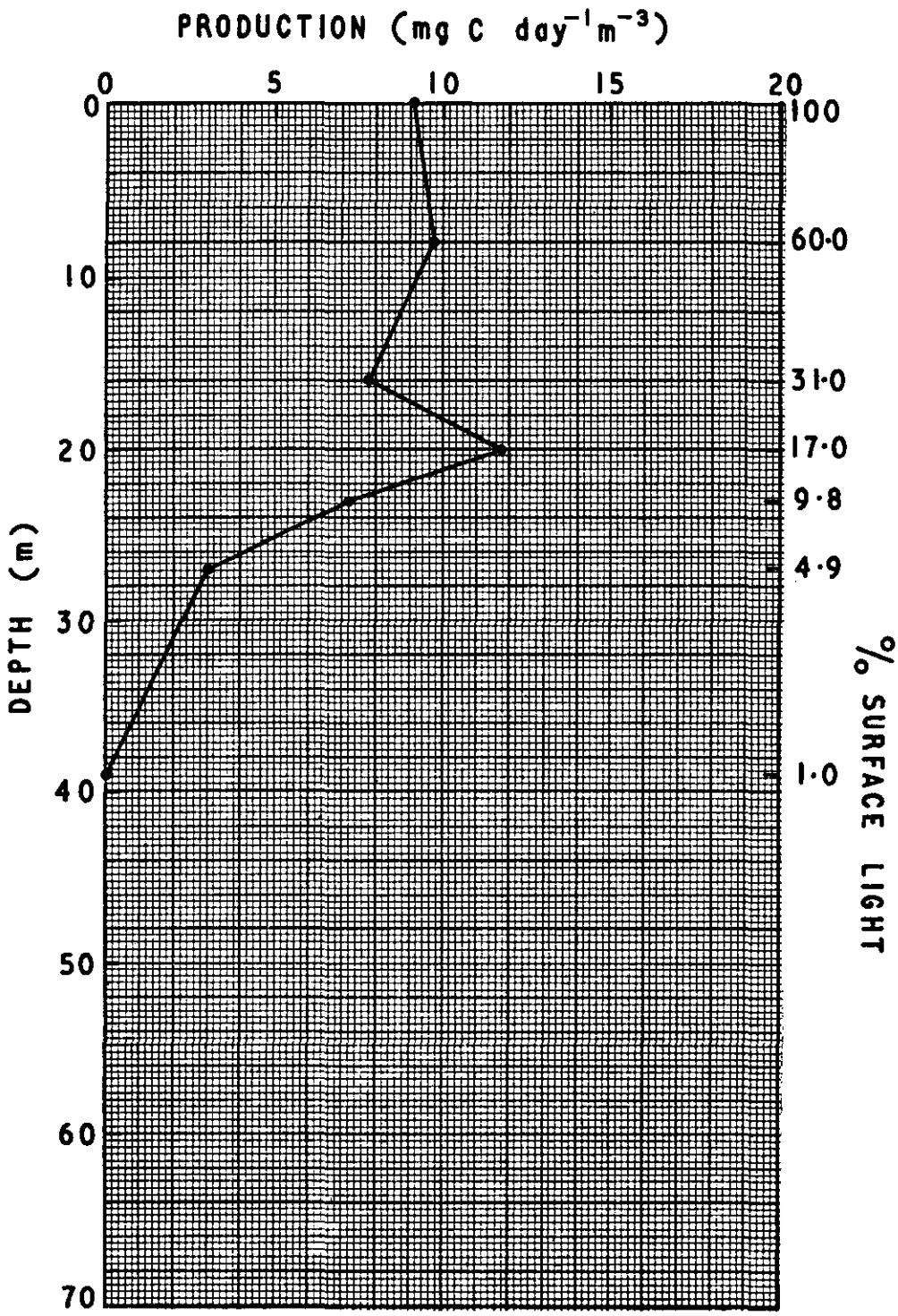


Fig. 4. Primary production. Station: 6. Date: May 9, 1968. Time: 1100 h. Column production under 1 $m^2$: 0.25 g C $day^{-1}$ $m^{-2}$.

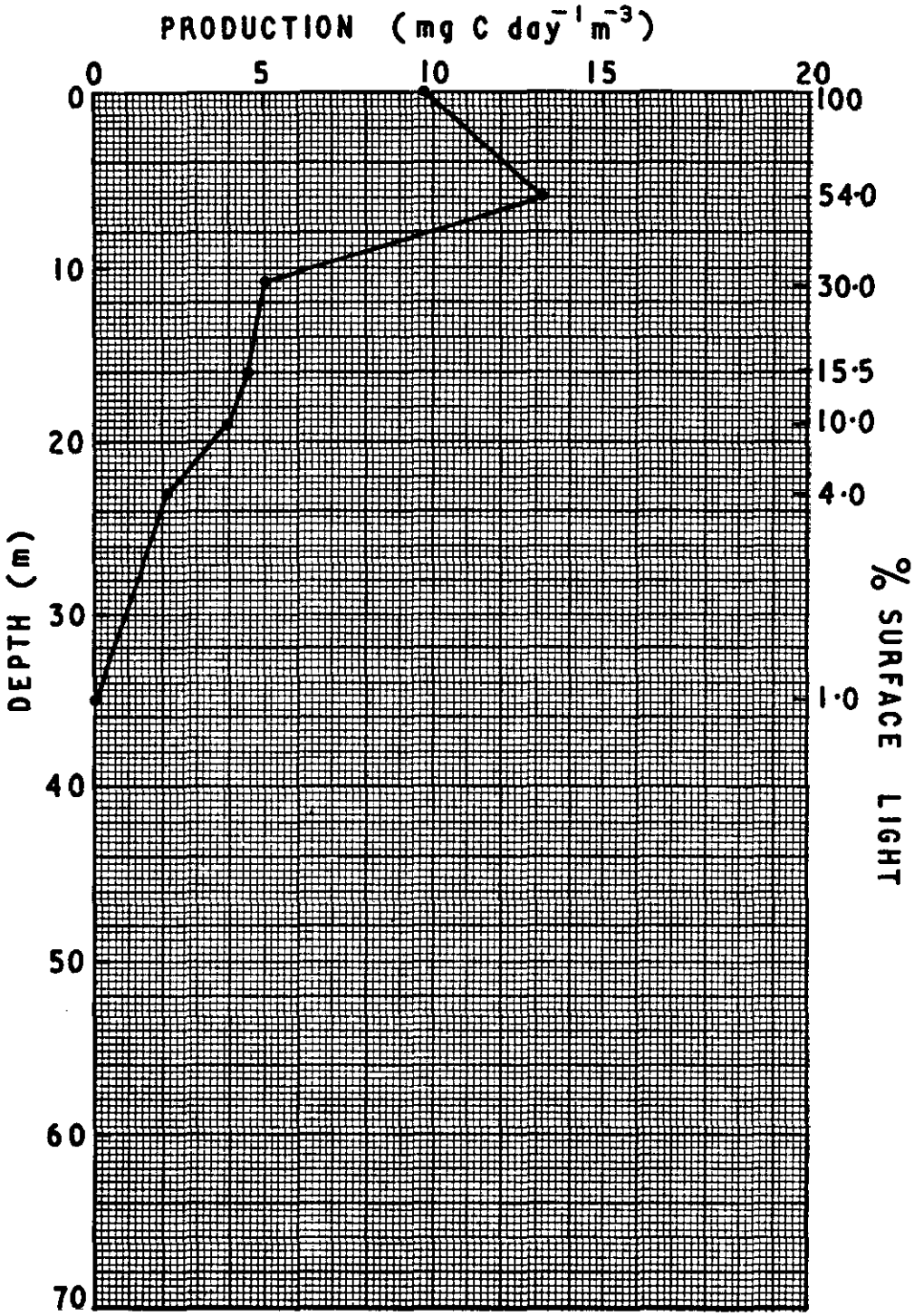


Fig. 5. Primary production. Station: 8. Date: May 11, 1968. Time: 1100 h. Column production under 1 $m^2$: 0.17 g C $day^{-1}$ $m^{-2}$.

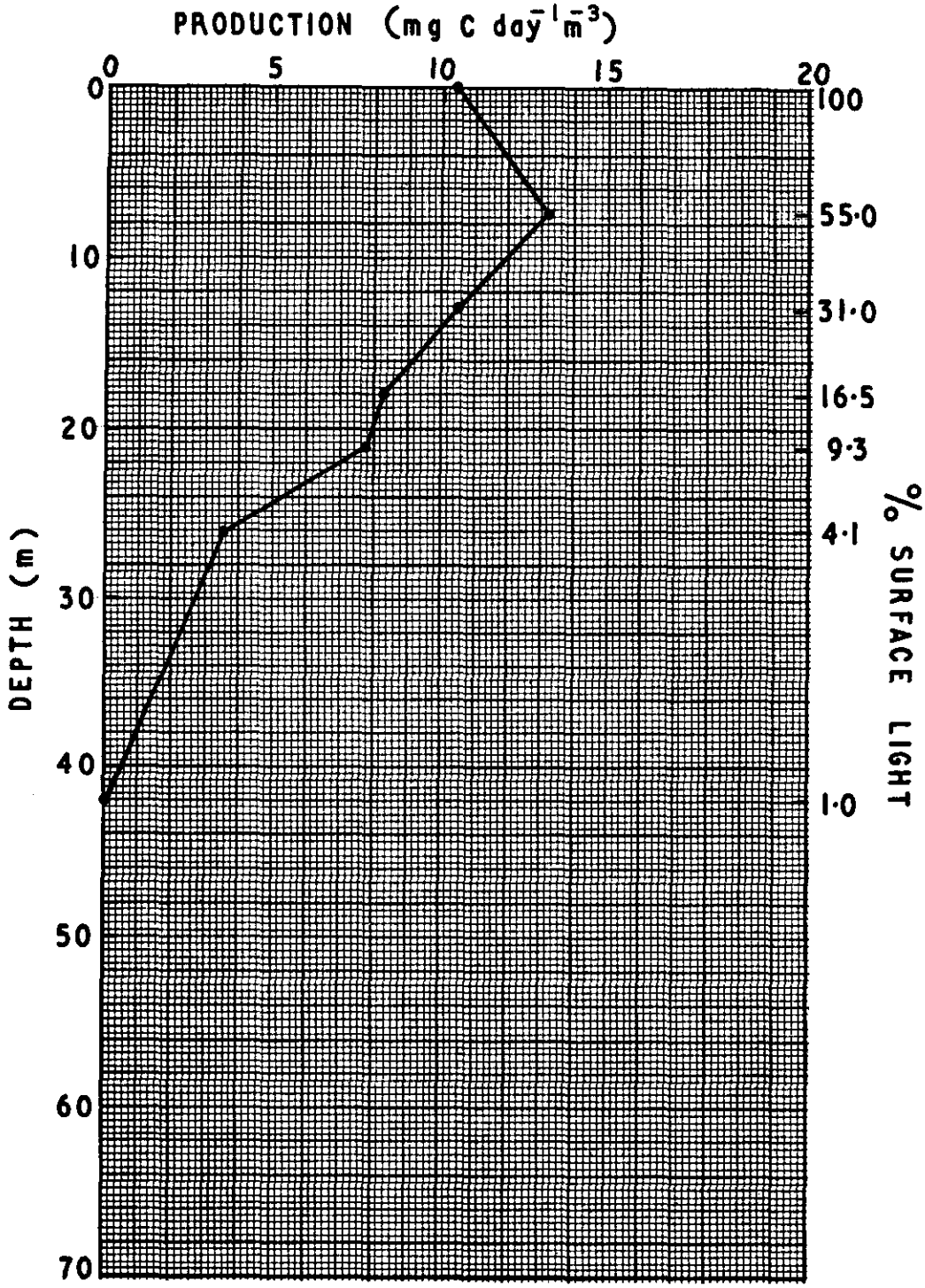


Fig. 6. Primary production. Station: 9. Date: May 12, 1968. Time: 1100 h. Column production under 1 $m^2$: 0.28 g C $day^{-1}$ $m^{-2}$.

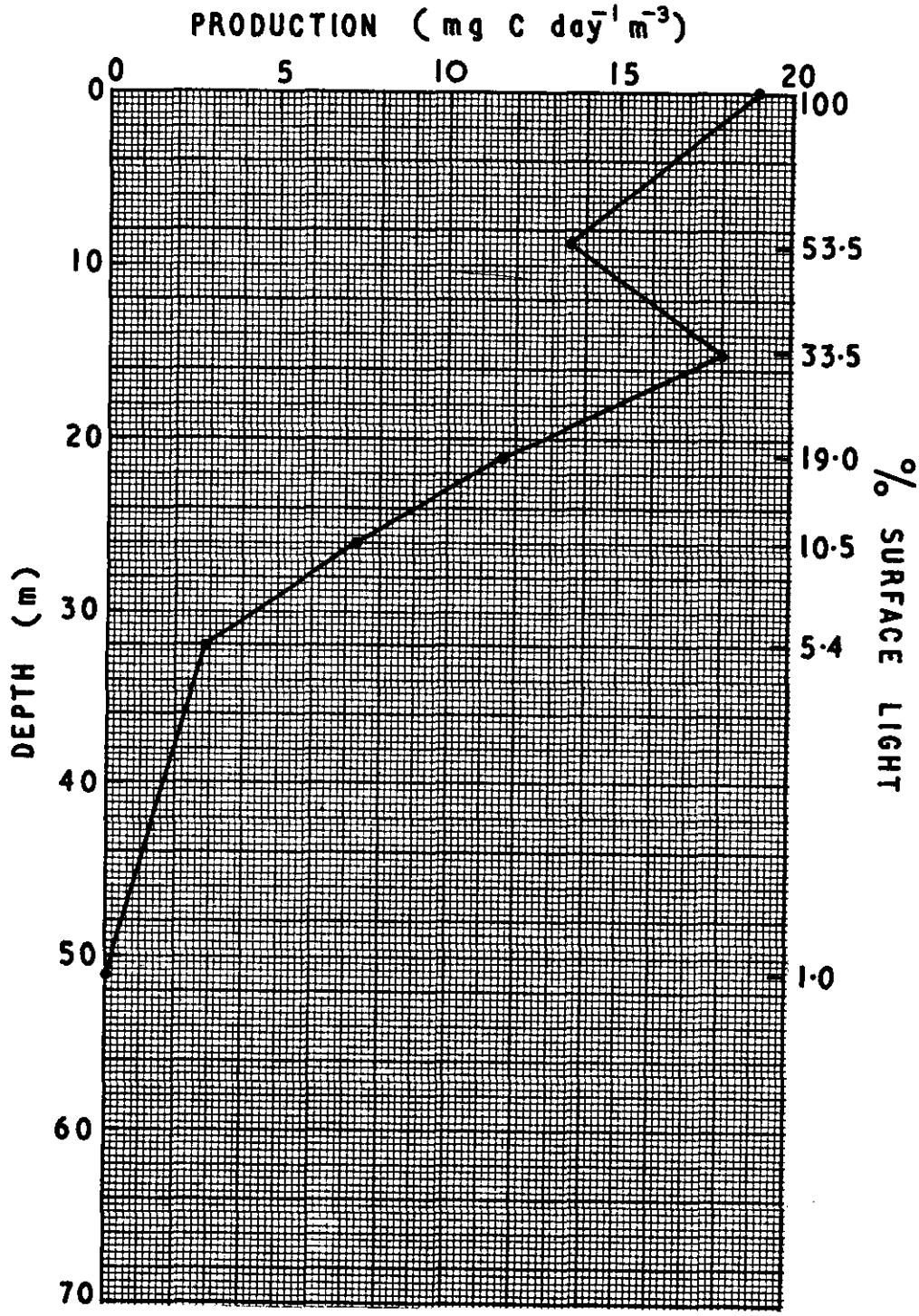


Fig. 7. Primary production. Station: 10. Date: May 13, 1968. Time: 1100 h. Column production under 1 $m^2$: 0.41 g C $day^{-1}$ $m^{-2}$.

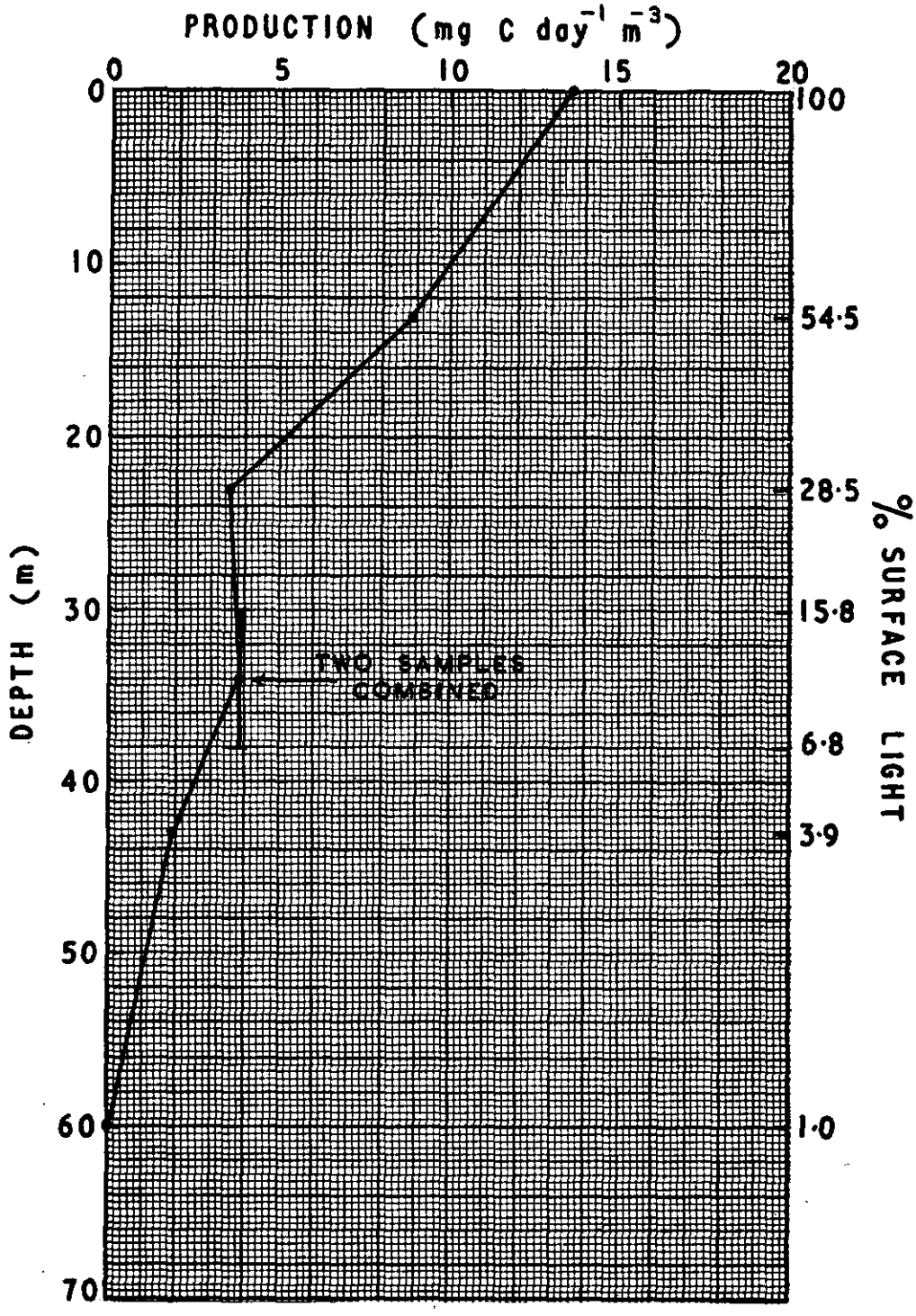


Fig. 8. Primary production. Station: 13. Date: May 16, 1968. Time: 1100 h. Column production under 1 $m^2$: 0.28 g C $day^{-1}$ $m^{-2}$.

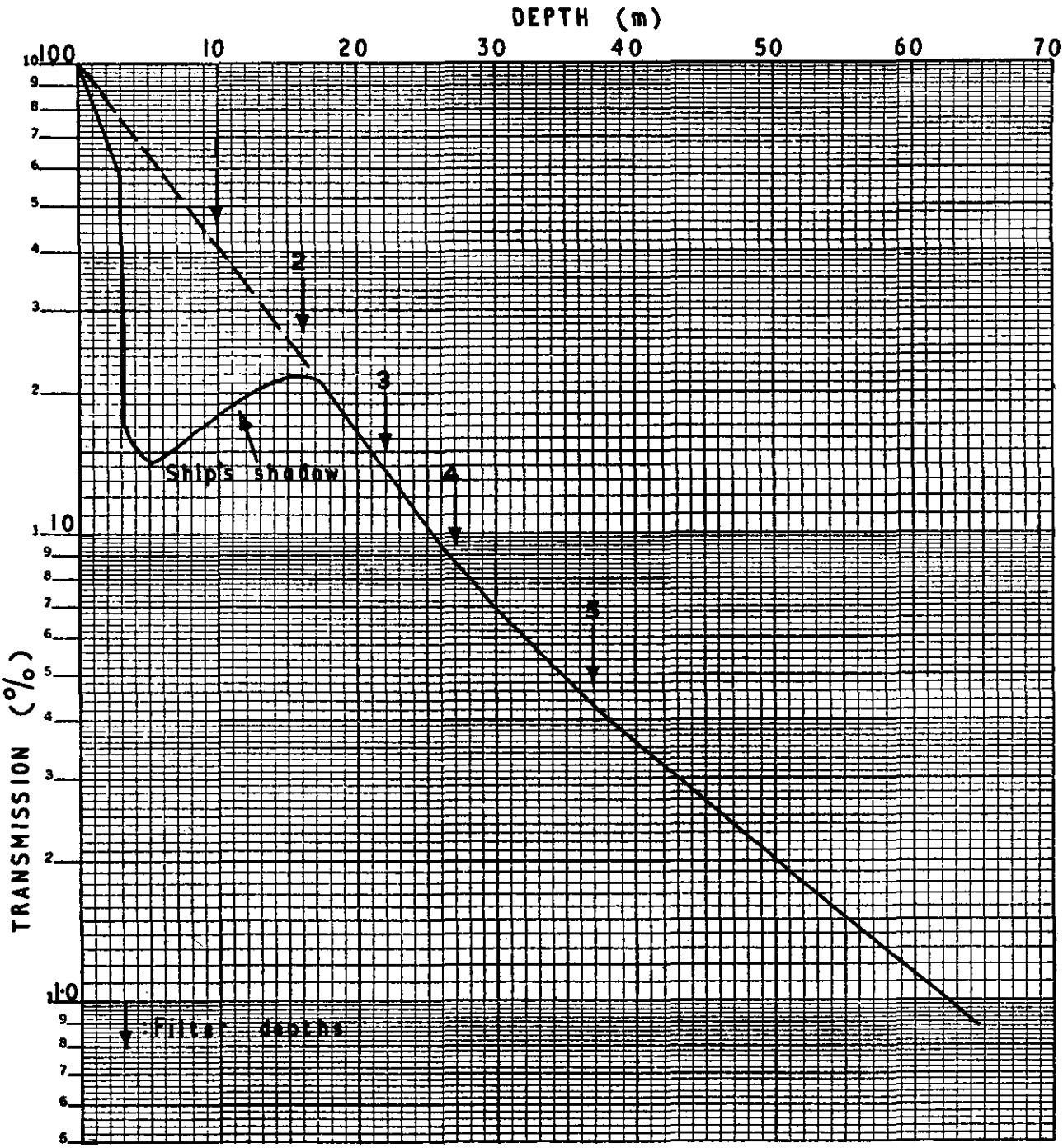


Fig. 9. Submarine photometer. Station: 1. Date: May 5, 1968. Time: 1100 h.

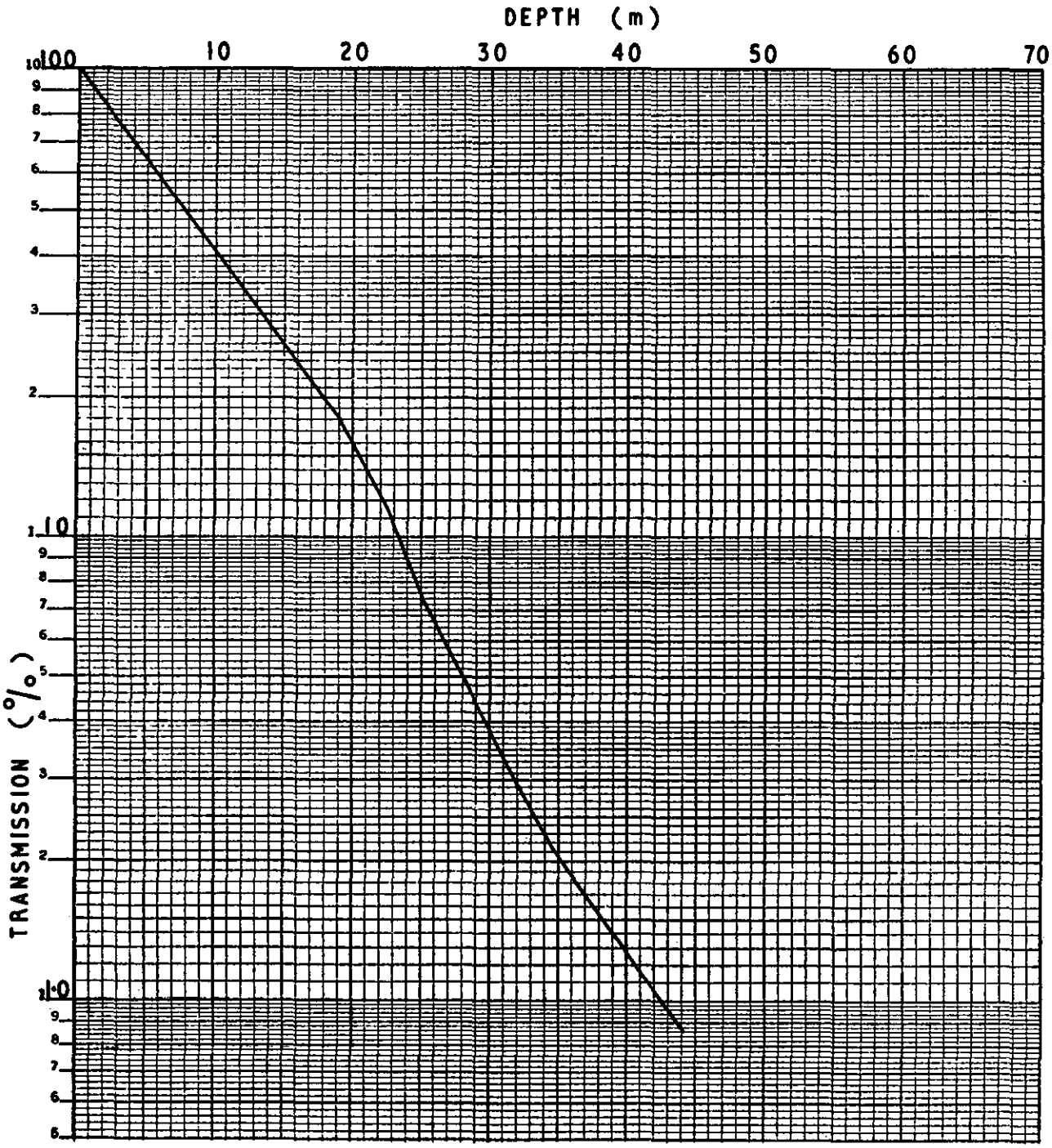


Fig. 10. Submarine photometer. Station: 3. Date: May 6, 1968. Time: 1100 h.

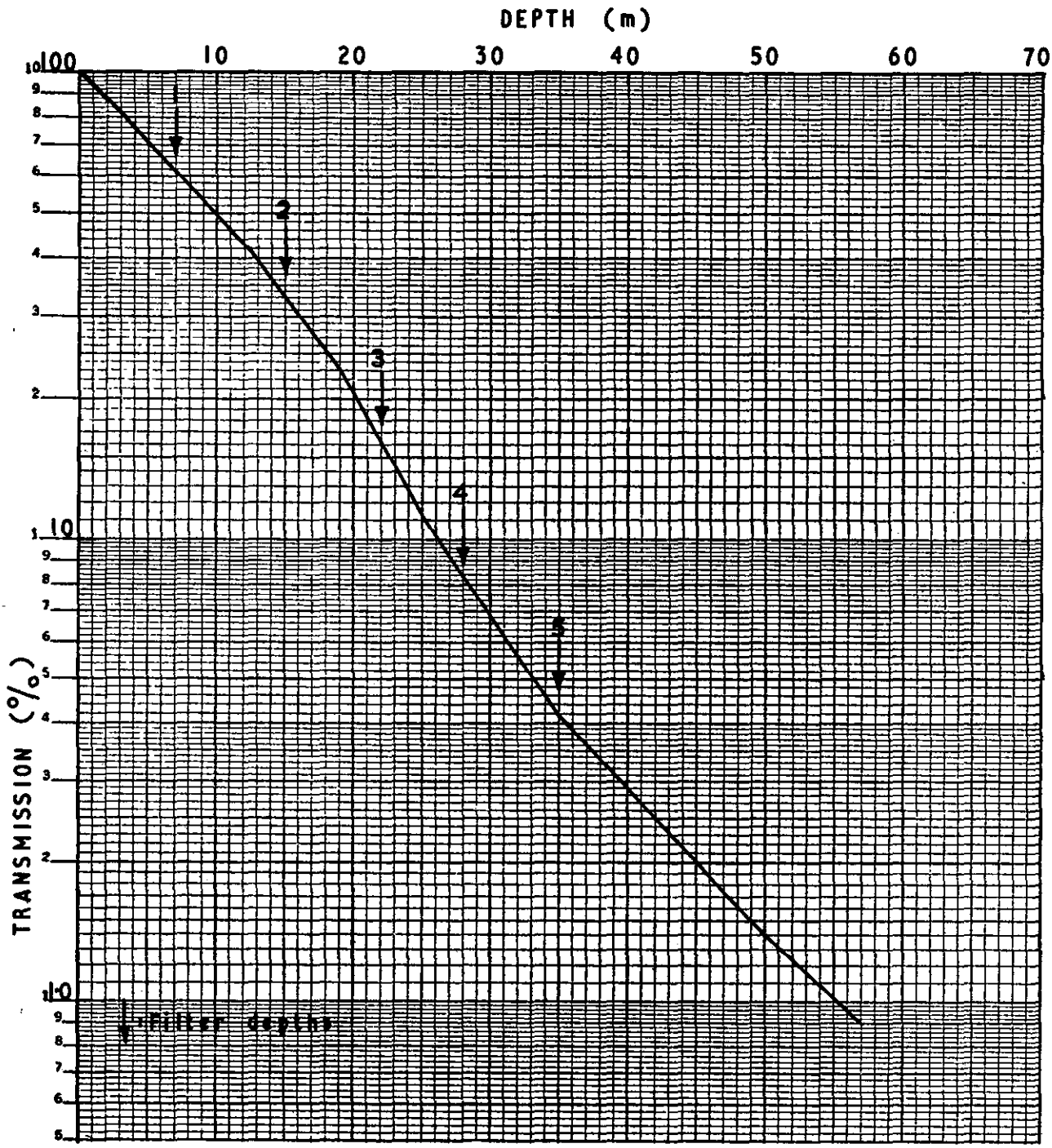


Fig. 11. Submarine photometer. Station: 4. Date: May 7, 1968. Time: 1045 h.

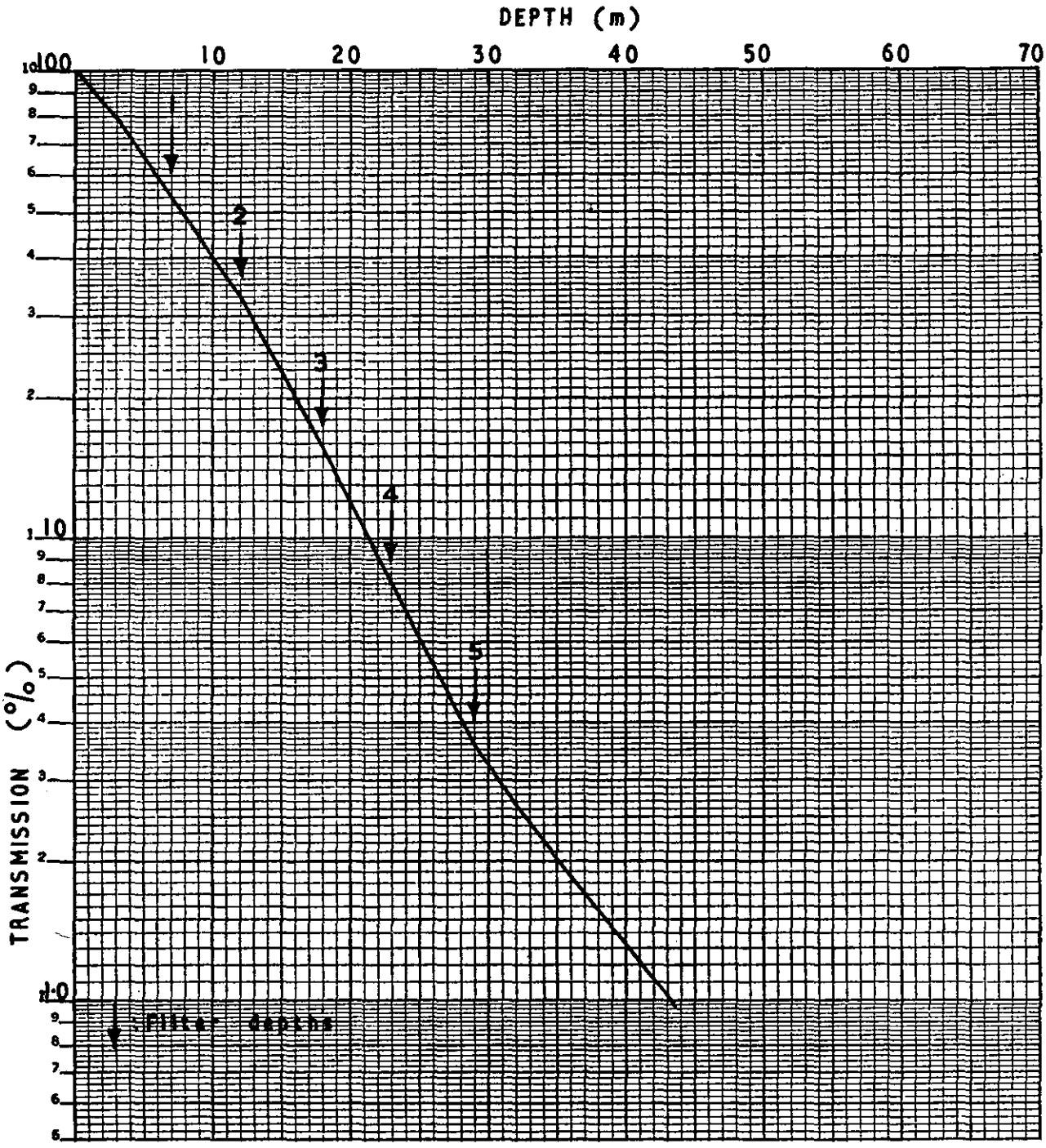


Fig. 12. Submarine photometer. Station: 5. Date: May 8, 1968. Time: 1100 h.

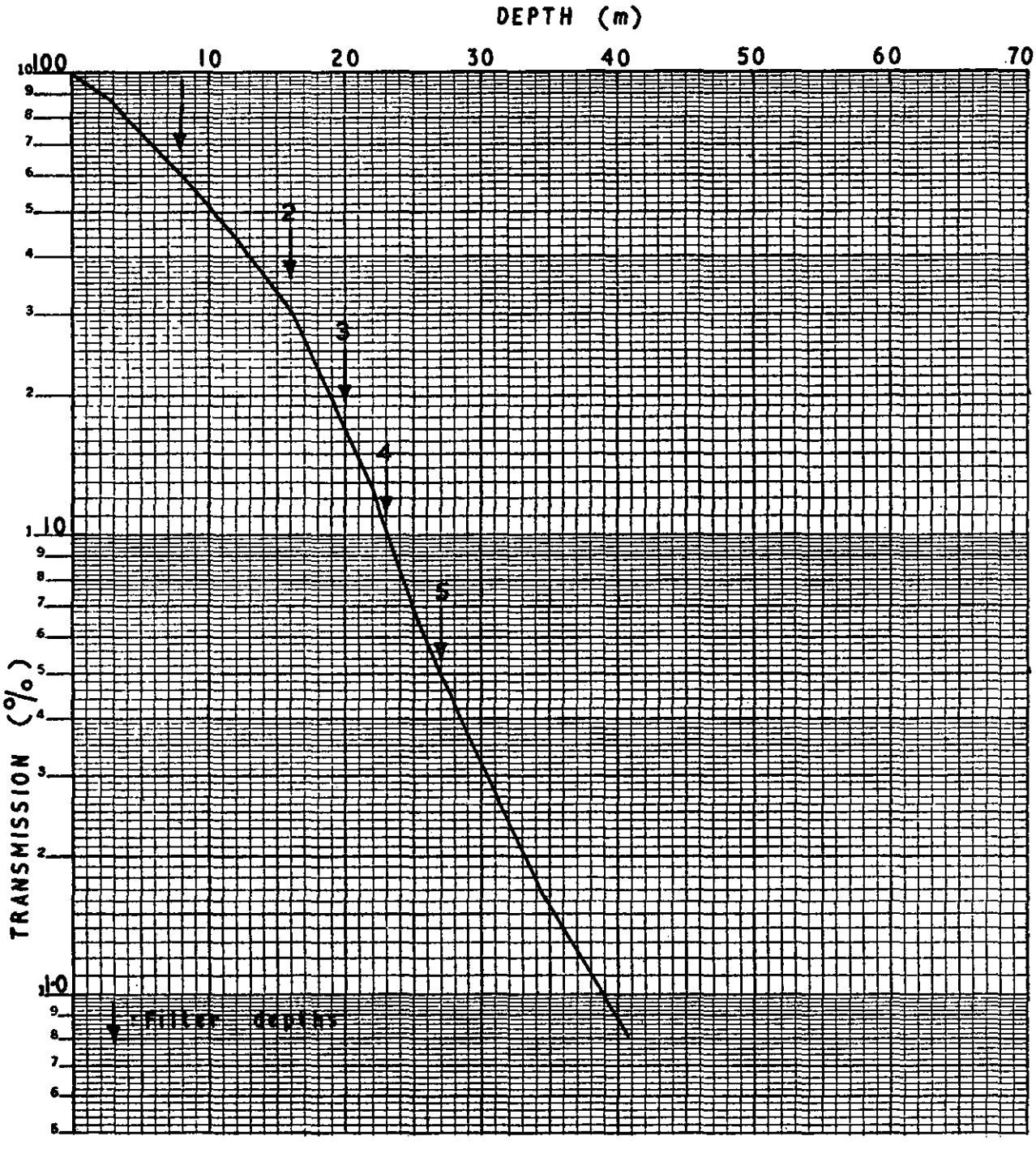


Fig. 13. Submarine photometer. Station: 6. Date: May 9, 1968. Time: 1100 h.

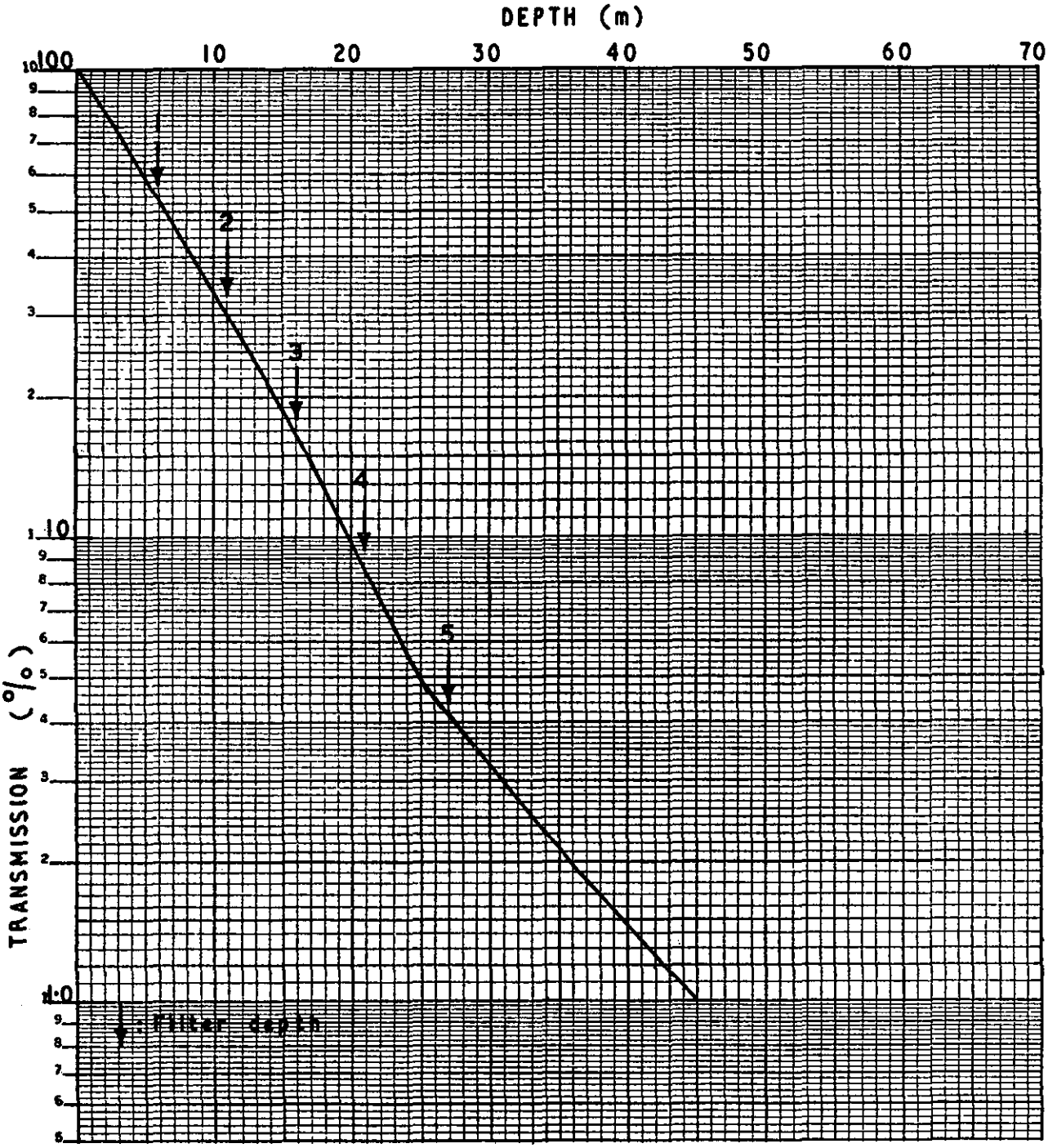


Fig. 14. Submarine photometer. Station: 7. Date: May 10, 1968. Time: 1100 h.

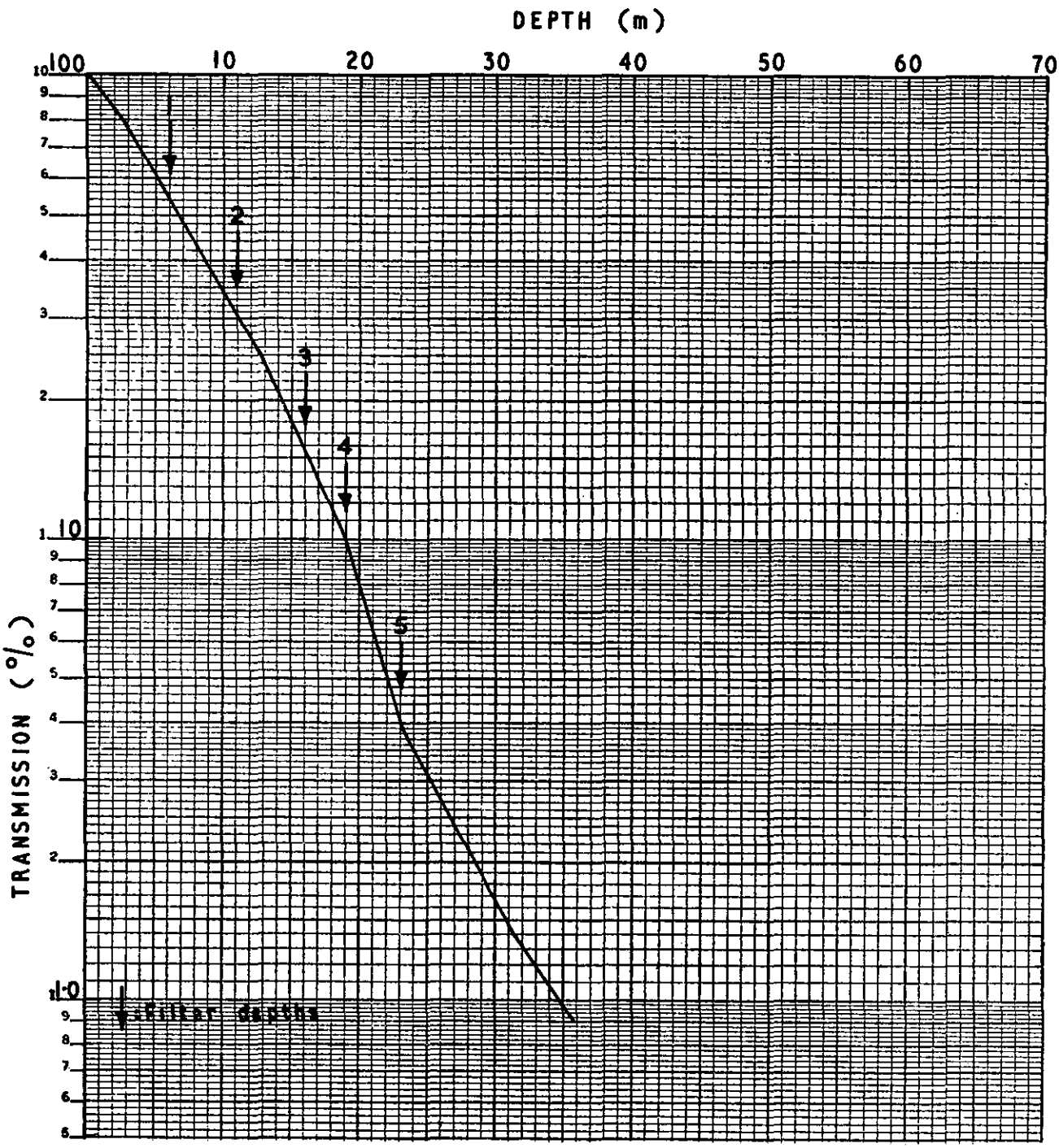


Fig. 15. Submarine photometer. Station: 8. Date: May 11, 1968. Time: 1100 h.

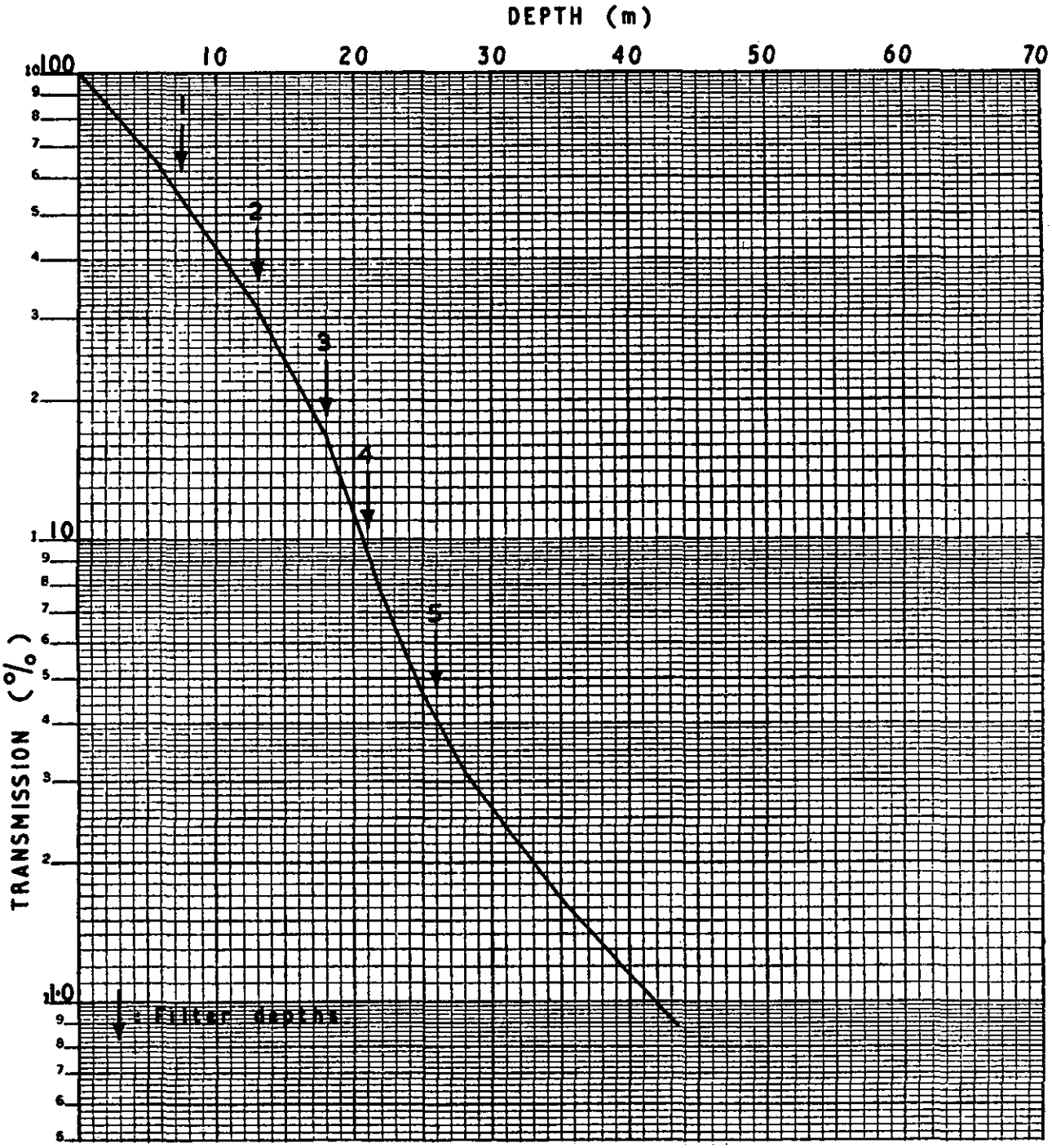


Fig. 16. Submarine photometer. Station: 9. Date: May 12, 1968. Time: 1100 h.

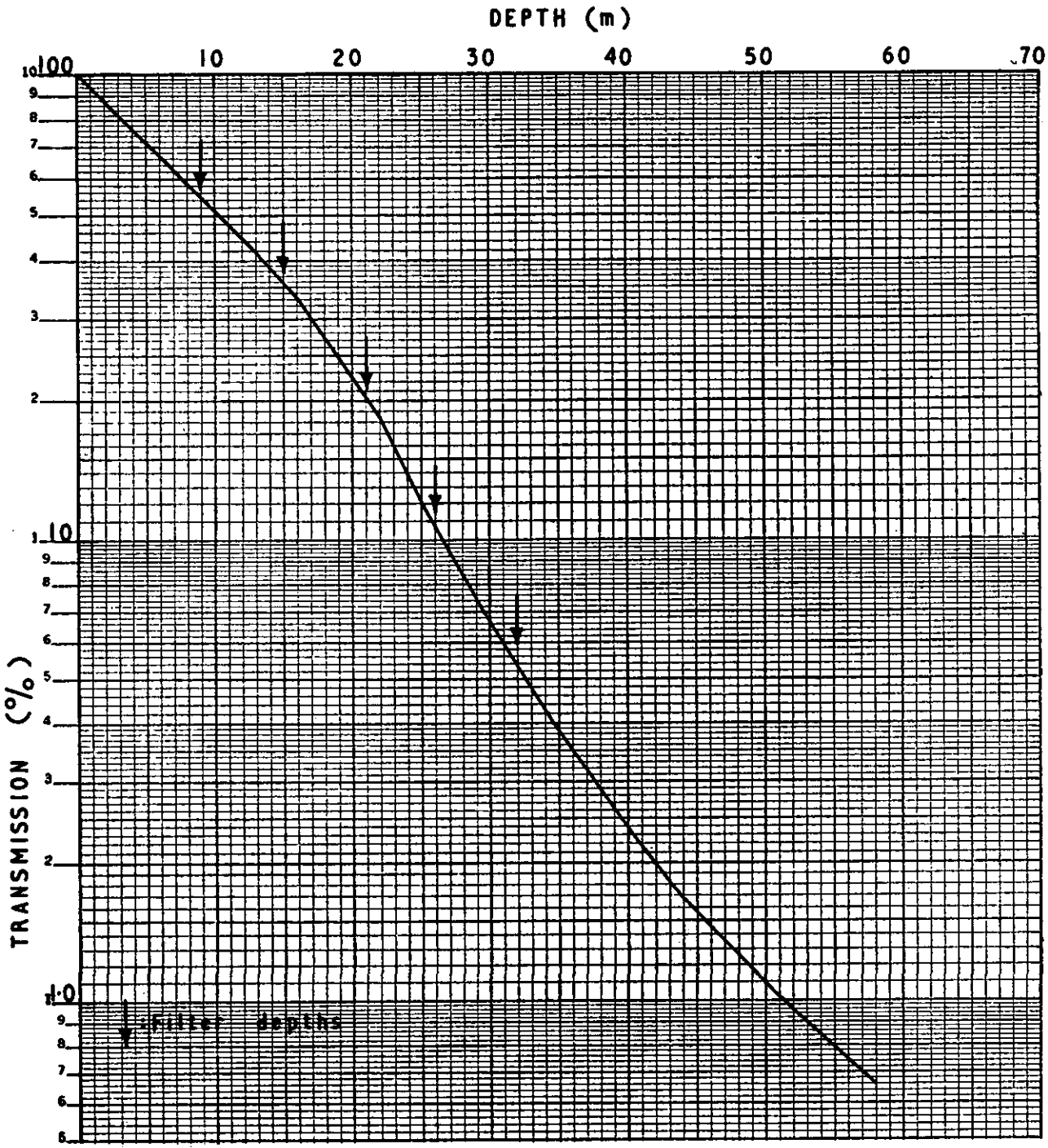


Fig. 17. Submarine photometer. Station: 10. Date: May 13, 1968. Time: 1100 h

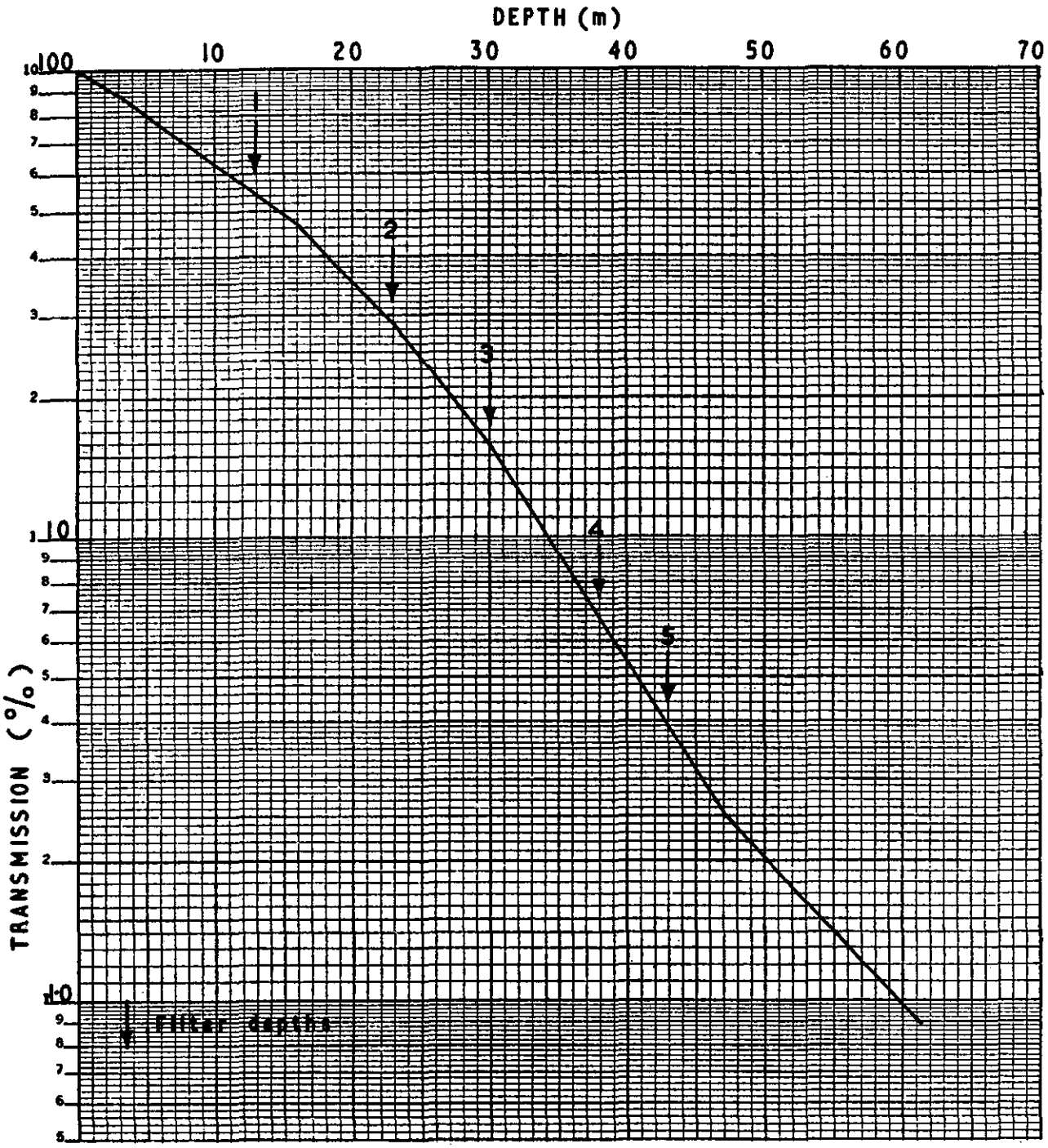


Fig. 18. Submarine photometer. Station: 13. Date: May 16, 1968. Time: 1100 h.

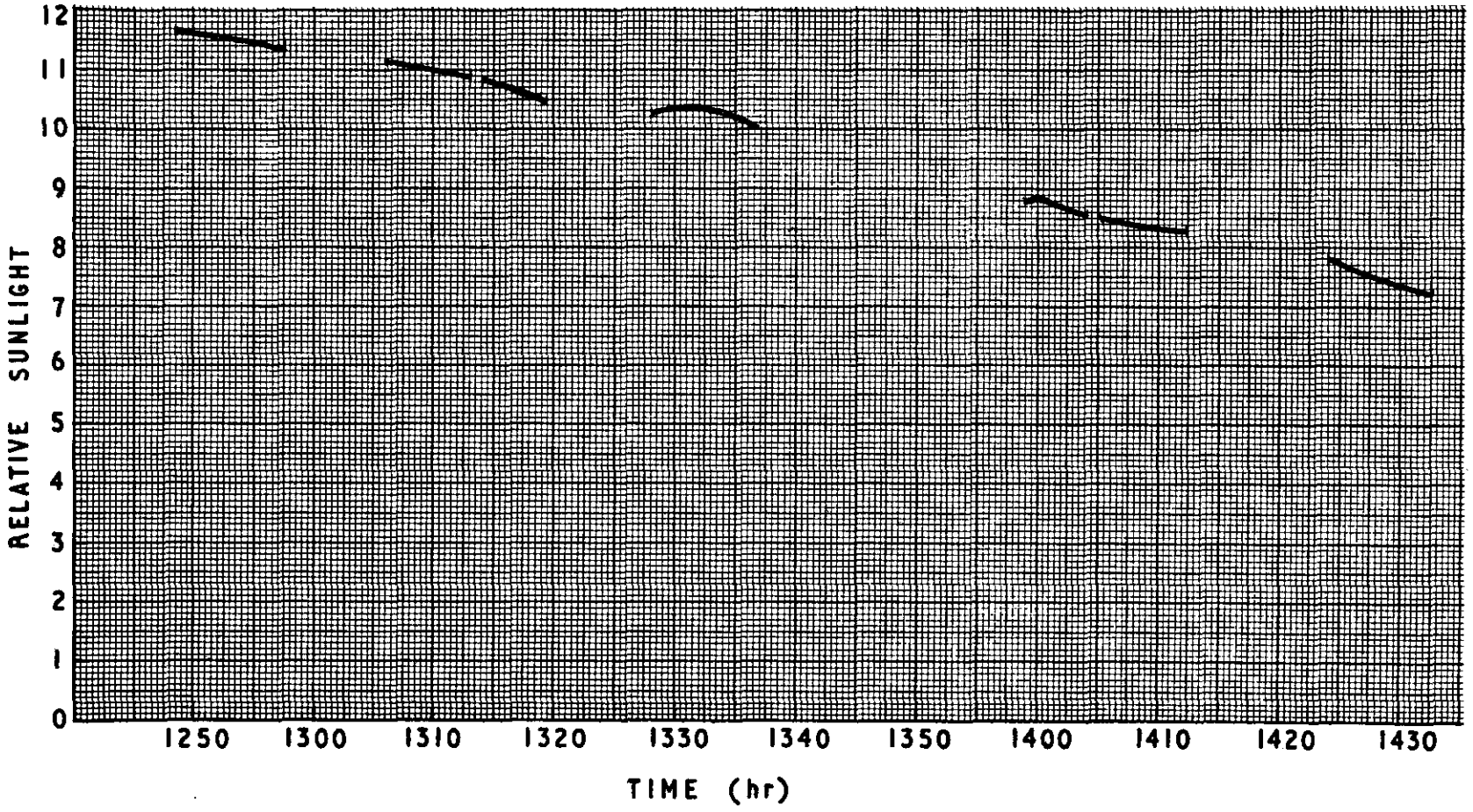


Fig. 19. Photometry measurement. Station: 7. Date: May 10, 1968. Incident sunlight.