JDE

NATIONAL INSTITUTE OF OCEANOGRAPHY

WORMLEY, GODALMING, SURREY

Waves at Morecambe Bay Light Vessel Irish Sea

by

L. DRAPER

N.I.O. Internal Report No. A.32

SEPTEMBER 1968

NATIONAL INSTITUTE OF OCEANOGRAPHY

Wormley, Godalming, Surrey.

Waves at Morecambe Bay Light Vessel, Irish Sea.

by

L. Draper

N.I.O. Internal Report No. A.32

September 1968

CONTENTS

Figures:

Waves have been recorded by a Shipborne Wave Recorder (Tucker, 1956) on the Morecambe Bay Light Vessel (about fifteen miles west of Fleetwood). The vessel was stationed in 12 fathoms of water. The records from the first year of operation, from November 1956, were analyzed by M. Darbyshire and used by J. Darbyshire in the development of his wave forecasting technique. However, the method of abstraction of the data from the records did not follow the methods now used (Draper, 1966), which have been based on subsequently-developed theoretical studies (Tucker, 1961, 1963) and (Cartwright and Longuet-Higgins, 1956). Also, it is not easy to compare the data given in the original publication (M. Darbyshire, 1958) with more recent publications of wave data for other areas, as the presentation has also evolved appreciably in recent years. Because of these differences, the data from Mrs. Darbyshire's original sheets has been re-processed to bring it into line with current practice; for example, the values of H_{max} originally obtained have been converted to the appropriate parameter in current nomenclature, H_1, and the significant periods originally obtained have been converted to zero-crossing periods using average relationships between the two parameters.

The original purpose of this installation was not that of routine data collection, and records were taken hourly from 0900 to 1800 hours. However, for long-term statistical purposes this is not important, and eight of the records, mostly of 15 minutes' duration, taken each day have been analyzed; the results presented here are based on the records from the first year of operation.

The parameters calculated from Mollie Darbyshire's original data are:

(a) H_s The significant height (mean height of the highest one-third of the waves); this is derived from $H_1 = f(H_s)$ where f is a factor related to the number of zero-crossings in the record (Tucker, 1963). The numerical value of f for a record containing 100 waves is 1·60, and for 50 waves f = 1·49.

These values of f are theoretical ones for a narrow-band spectrum (Cartwright and Longuet-Higgins, 1956) and have been shown to be substantially correct for typical wide-band spectra of sea waves (Tucker, 1963).

(b) $H_{max(3\ hours)}$
The most probable value of the height of the highest wave which occurred in the recording interval (Draper, 1963).

(c) T_z The mean zero-crossing period.

The results of these measurements are expressed graphically, divided into seasons thus:

Winter:	January	February	March
Spring:	April	May	June
Summer:	July	August	September
Autumn:	October	November	December

For each season, a graph (Figures 1 - 4) show the cumulative distribution of significant wave height H_s, and the most probable value of the height of the highest wave in a three-hour interval, $H_{max(3\ hours)}$. The distribution of zero-crossing period is given for each season (Figures 5 - 8).

Figure 9 is a scatter diagram relating significant wave height to zero-crossing period.

Discussion of results

From Figures 1 - 4 may be determined the proportion of time for which H_s or $H_{max(3\ hours)}$ exceeded any given height for each season. For example, in the winter, the significant height exceeded 5 feet for 21 per cent of the time. Figures 5 - 8 give the distribution of zero-crossing period for each season.

The scatter diagram (Figure 9) relates significant height to zero-crossing period. The numbers of occurrences are expressed in parts per thousand. For example, the most common wave conditions were those with a significant height of between 1 and 2 feet with a zero-crossing period of between 4 and 5 seconds, which occurred for 68 thousandths, i.e. 6·8 per cent, of the time. The rapid attenuation of the shorter waves with depth means that the pressure units, which are necessarily situated 6 feet below mean water level, do not record waves which have a period of less than about 3 seconds; this is the cause of the cut off below about that period.

A parameter which is sometimes of interest is the wave steepness, defined as wave height : wave length: it may also be expressed as a decimal number. It should be noted that the steepness of a wave is not the same as the maximum slope of the water surface during the passage of a wave. Lines of constant steepness of 1 : 20 and 1 : 40 are drawn on Figure 9. (In this case, steepness relates to significant wave height : wave length calculated from the zero-crossing period). A fairly well-defined limit of steepness is observed at approximately 1 : 16 (0·06). There is a theoretical limit for an individual progressive wave of 1 : 7 (0·14). It is not possible to present persistence information because of the absence of night-time records.

The highest wave recorded during the year was 28 feet in height with a zero-crossing period of 7·6 seconds.

ACKNOWLEDGEMENTS

The author wishes to thank Trinity House for permission to install the equipment on their vessel, the Masters and Crew for operating it, Mrs. Mollie Darbyshire for her kindness in allowing him to use her original data sheets, Miss Eileen Squire for writing the computer program used in handling the data, putting the data through the computer and collating the results, and Mr. R. Graves for preparing the diagrams.

REFERENCES

TUCKER, M.J. 1956 A Shipborne Wave Recorder.
Trans. Instn. nav. Archit. Lond. 98, 236-250.

DRAPER, L. 1966 The analysis and presentation of wave data - a plea for uniformity.
Proc. 10 Conf. on Coastal Engineering, Tokyo, Chapters 1 and 2.

TUCKER, M.J. 1961 Simple measurement of wave records.
Proc. Conf. Wave Recording for civ. Engrs. (N.I.O.) 22-3.

TUCKER, M.J. 1963 Analysis of records of sea waves.
Proc. Instn. civ. Engrs. 26, 304-316.

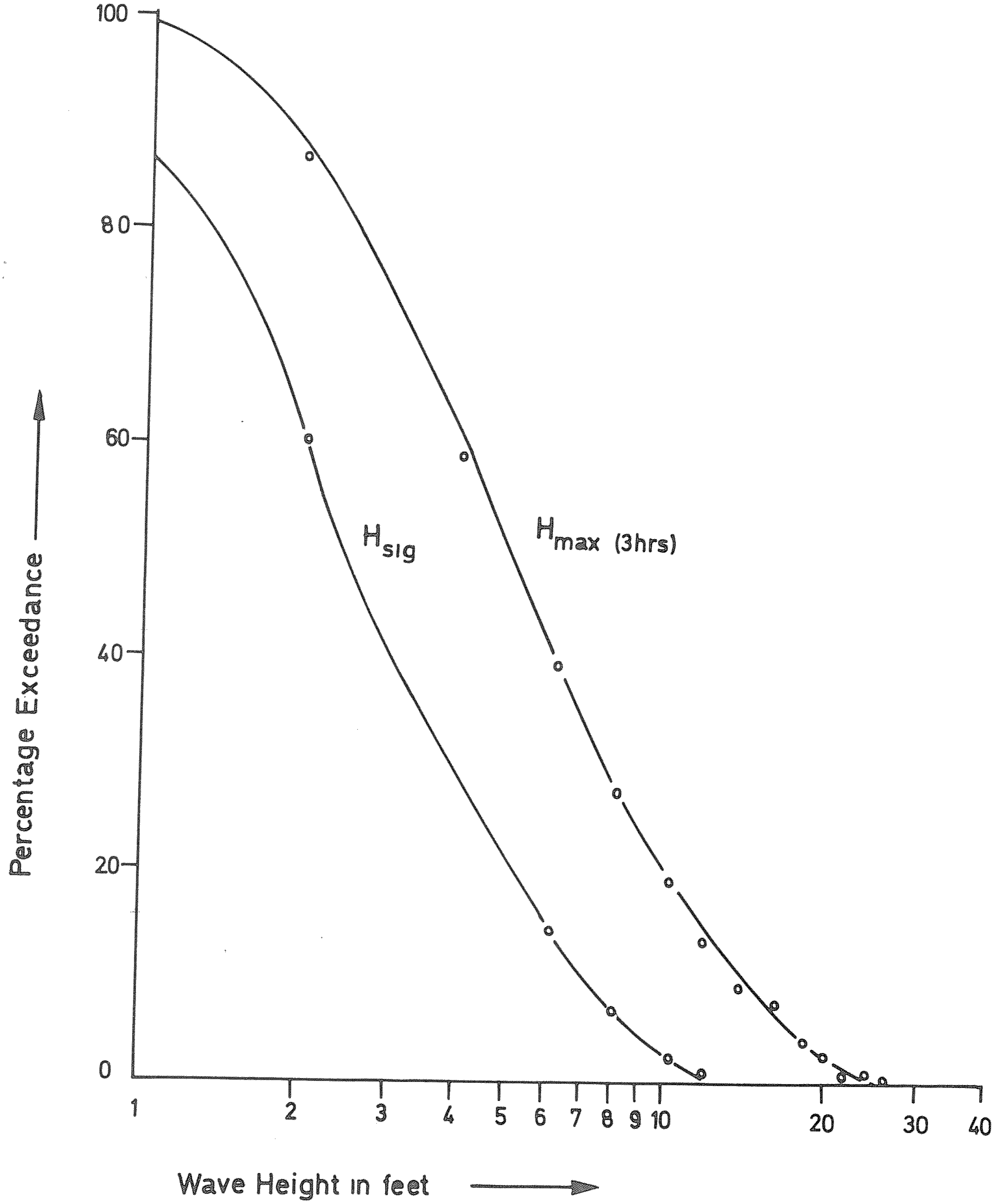
CARTWRIGHT, D.E. and LONGUET-HIGGINS, M.S. 1956
The statistical distribution of the maxima of a random function.
Proc. roy. Soc. A 237, 212-232.

DARBYSHIRE, M. 1958 Waves in the Irish Sea.
Dock Harb. Author. 39, 245-248.

DRAPER, L. 1963 The derivation of a 'design-wave' from instrumental measurements of sea waves.
Proc. Inst. civ. Engrs. 26, 291-304.

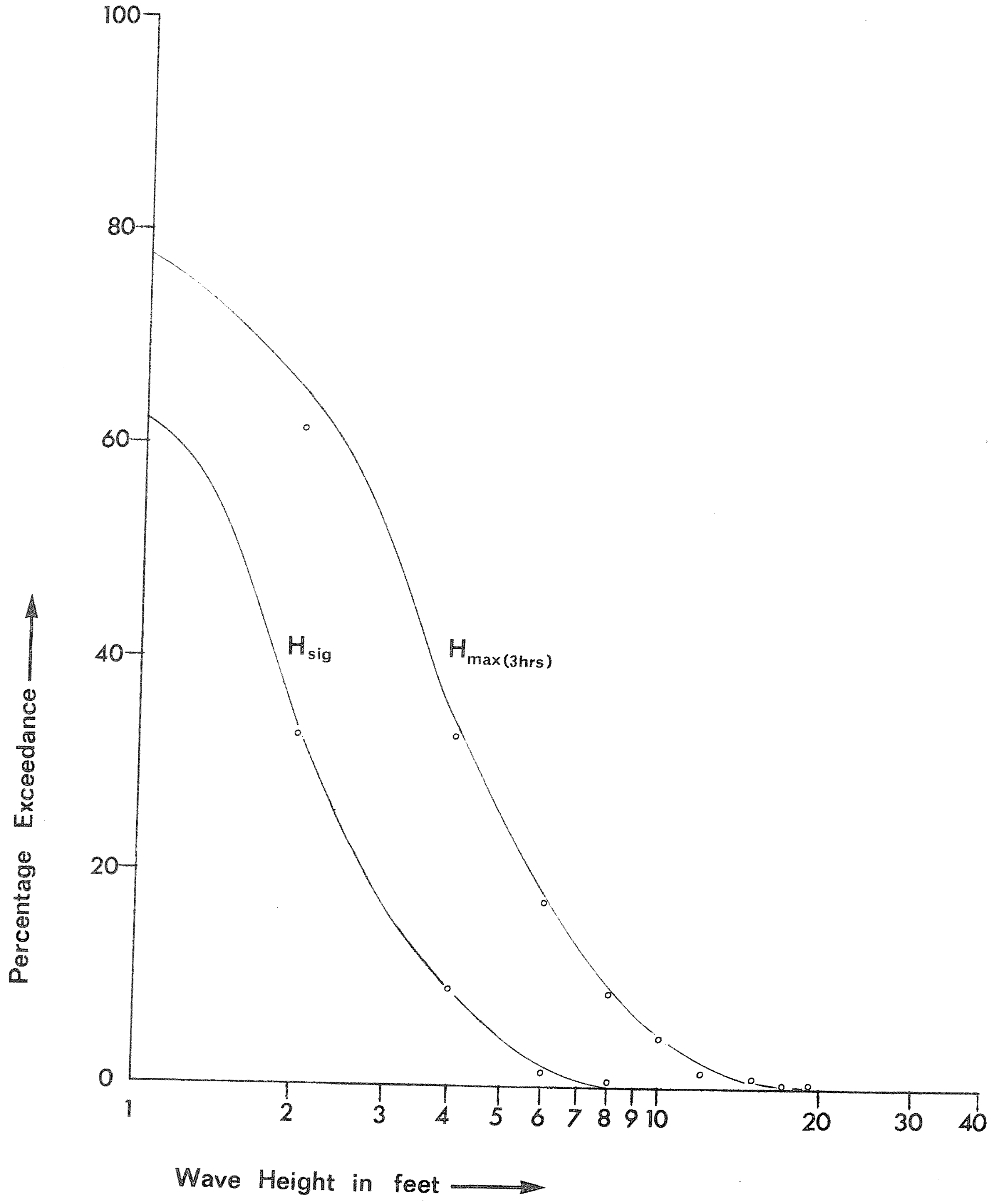
MORECAMBE BAY - Winter

FIG. 1.



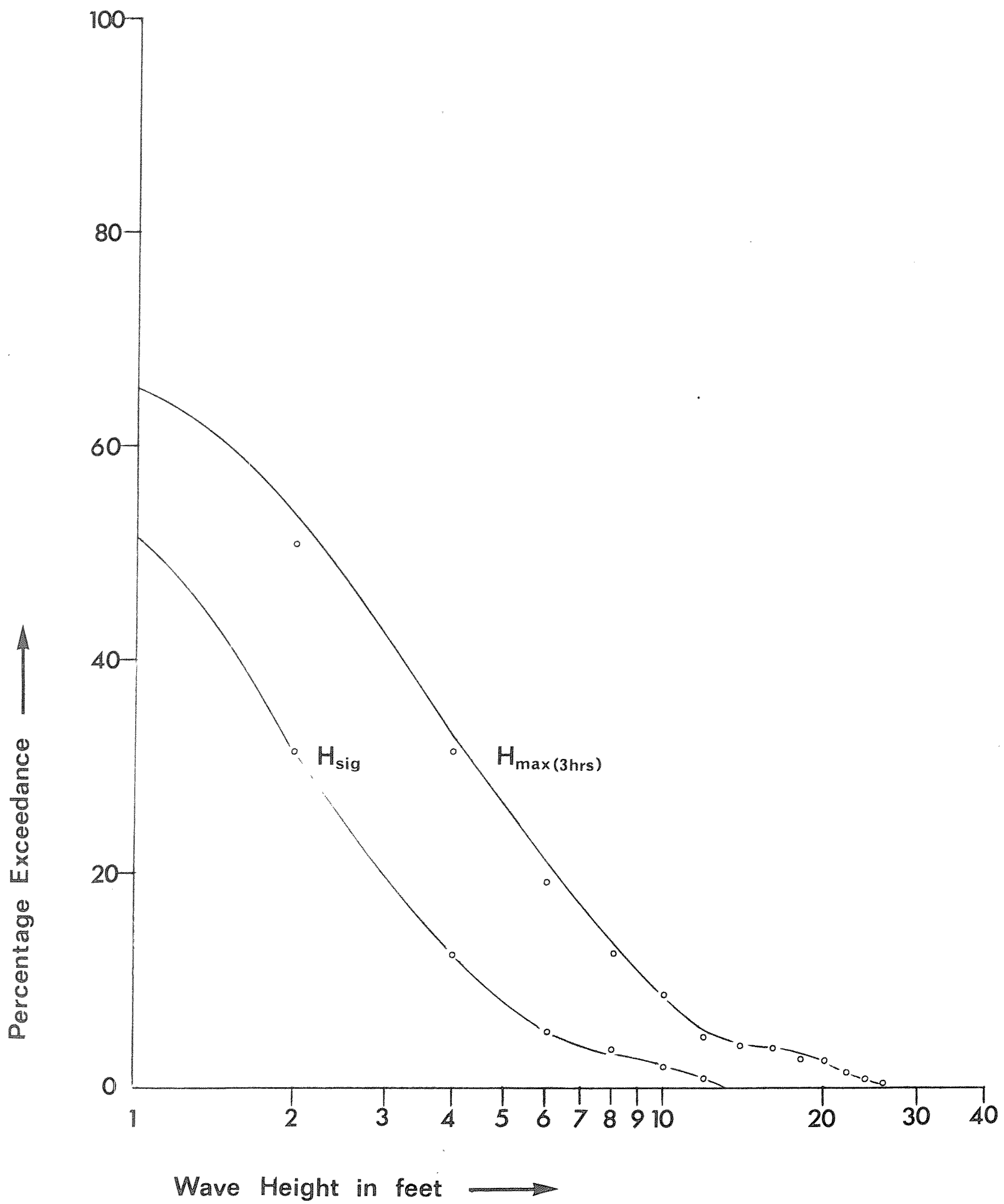
MORECAMBE BAY - Spring

FIG. 2.



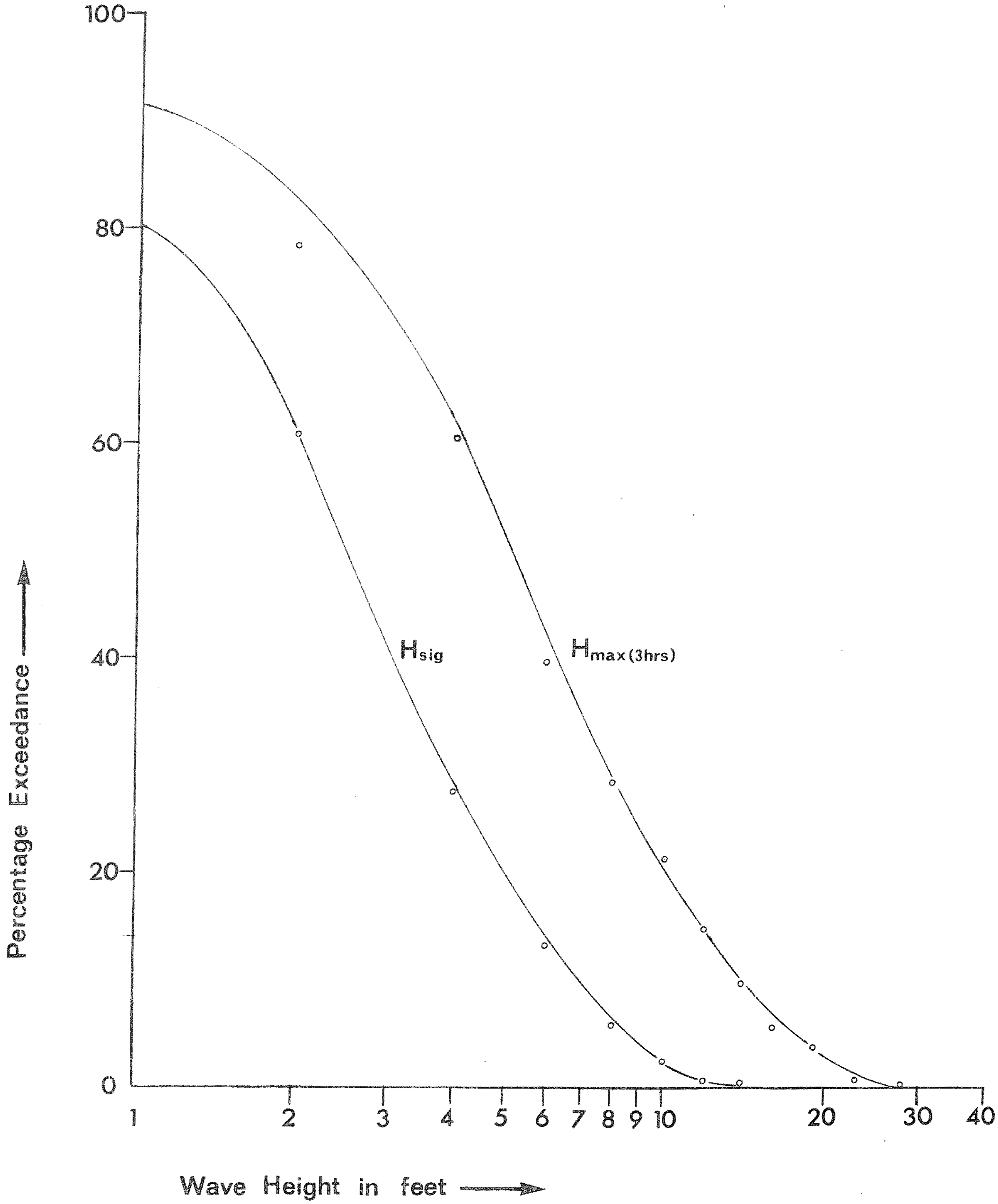
MORECAMBE BAY - Summer

FIG. 3.



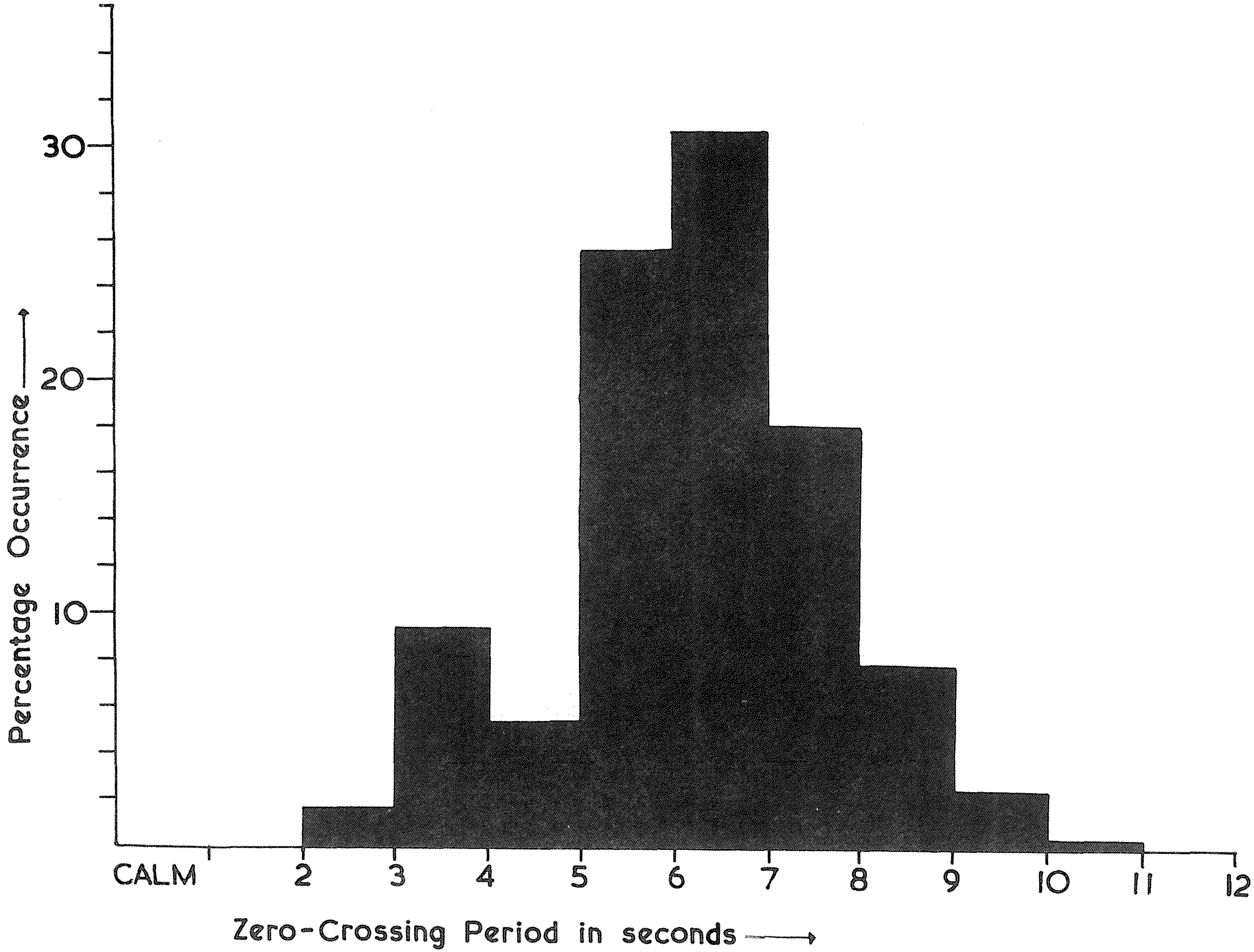
MORECAMBE BAY - Autumn

FIG. 4.



MORECAMBE BAY - Winter

FIG. 5.



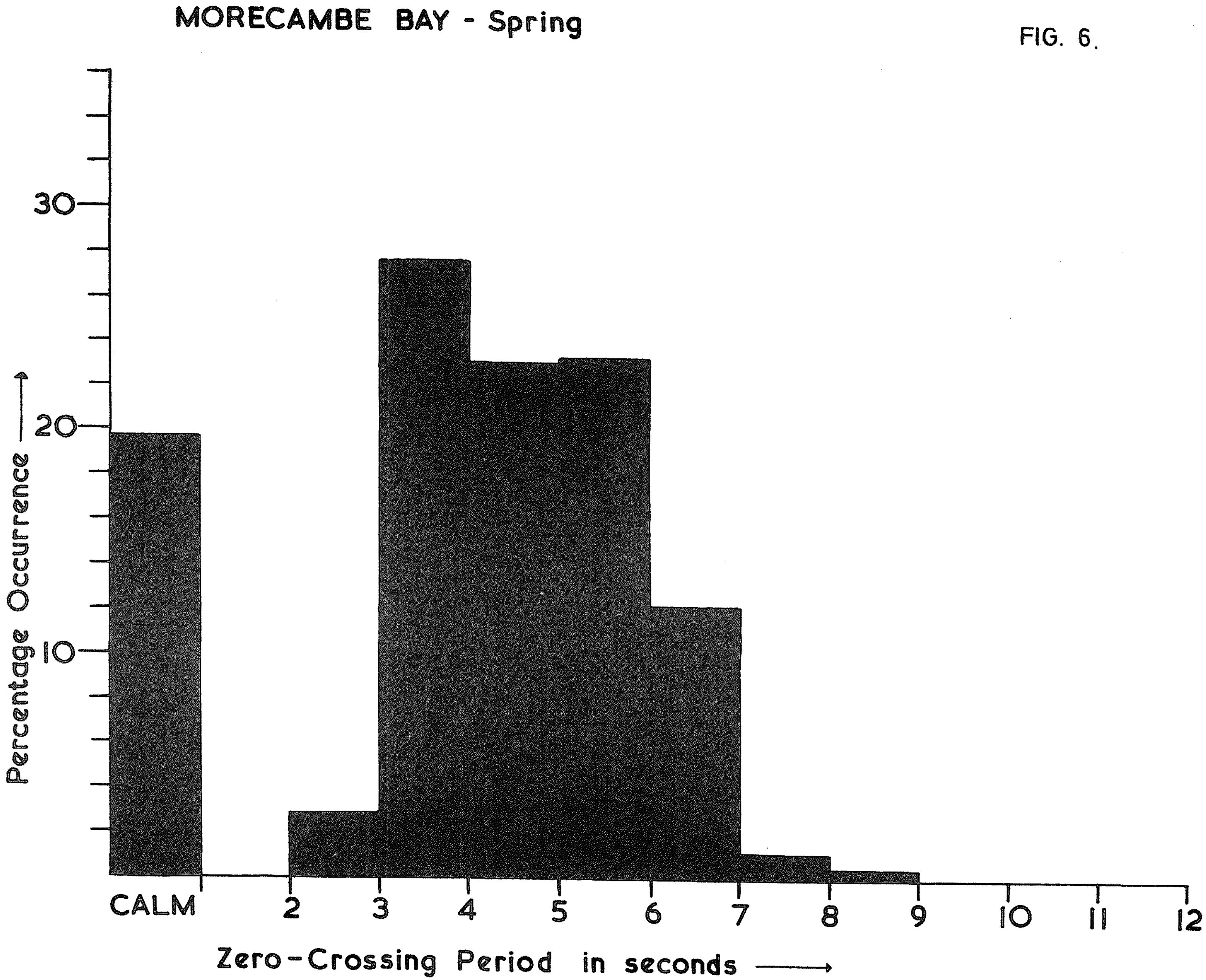
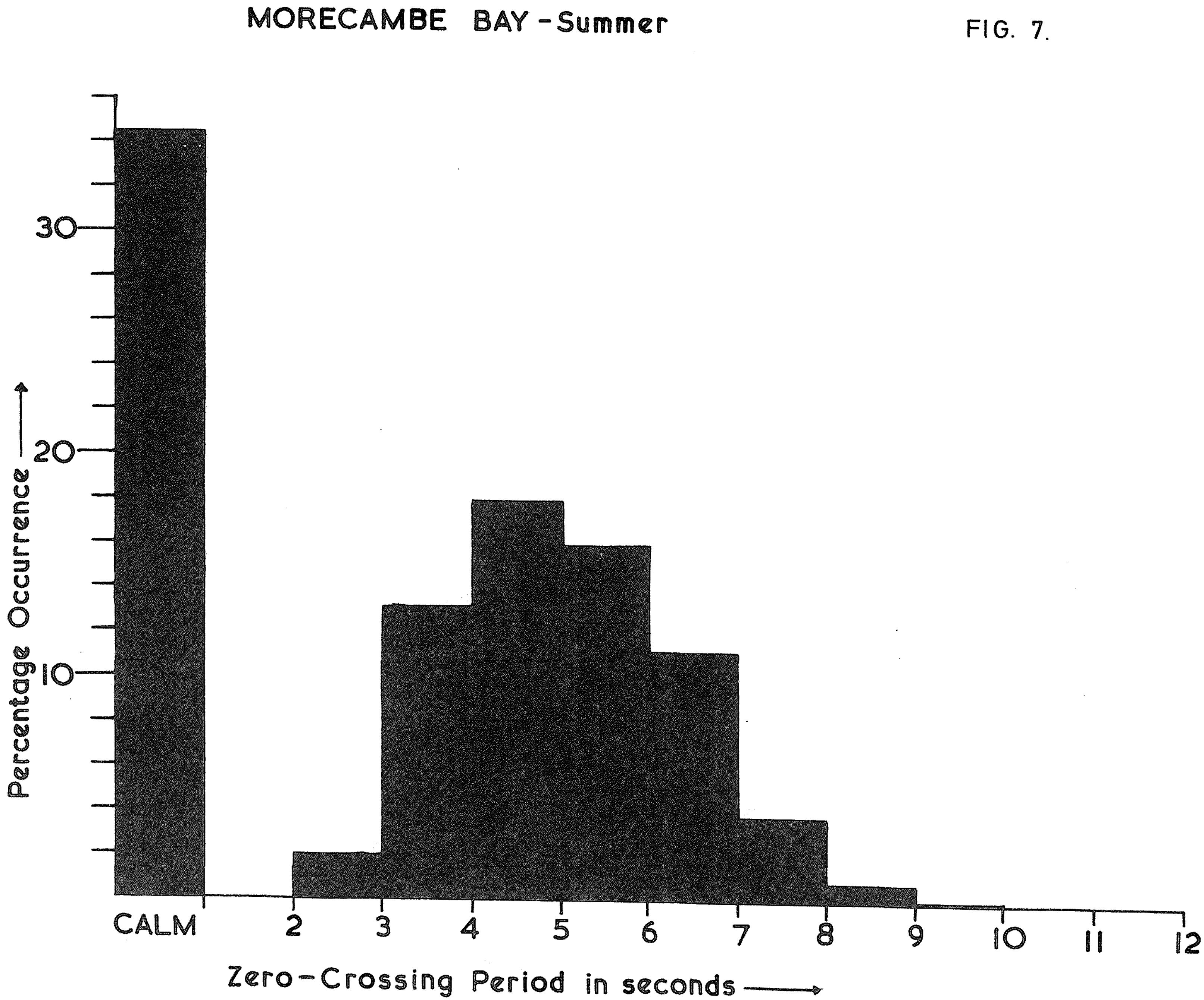

MORECAMBE BAY - Spring
30
20
10
Percentage Occurrence
CALM
2
3
4
5
6
7
8
9
10
11
12
Zero-Crossing Period in seconds

FIG. 6.

FIG. 7.


MORECAMBE BAY - Summer
30
20
10
Percentage Occurrence
CALM
2
3
4
5
6
7
8
9
10
11
12
Zero-Crossing Period in seconds

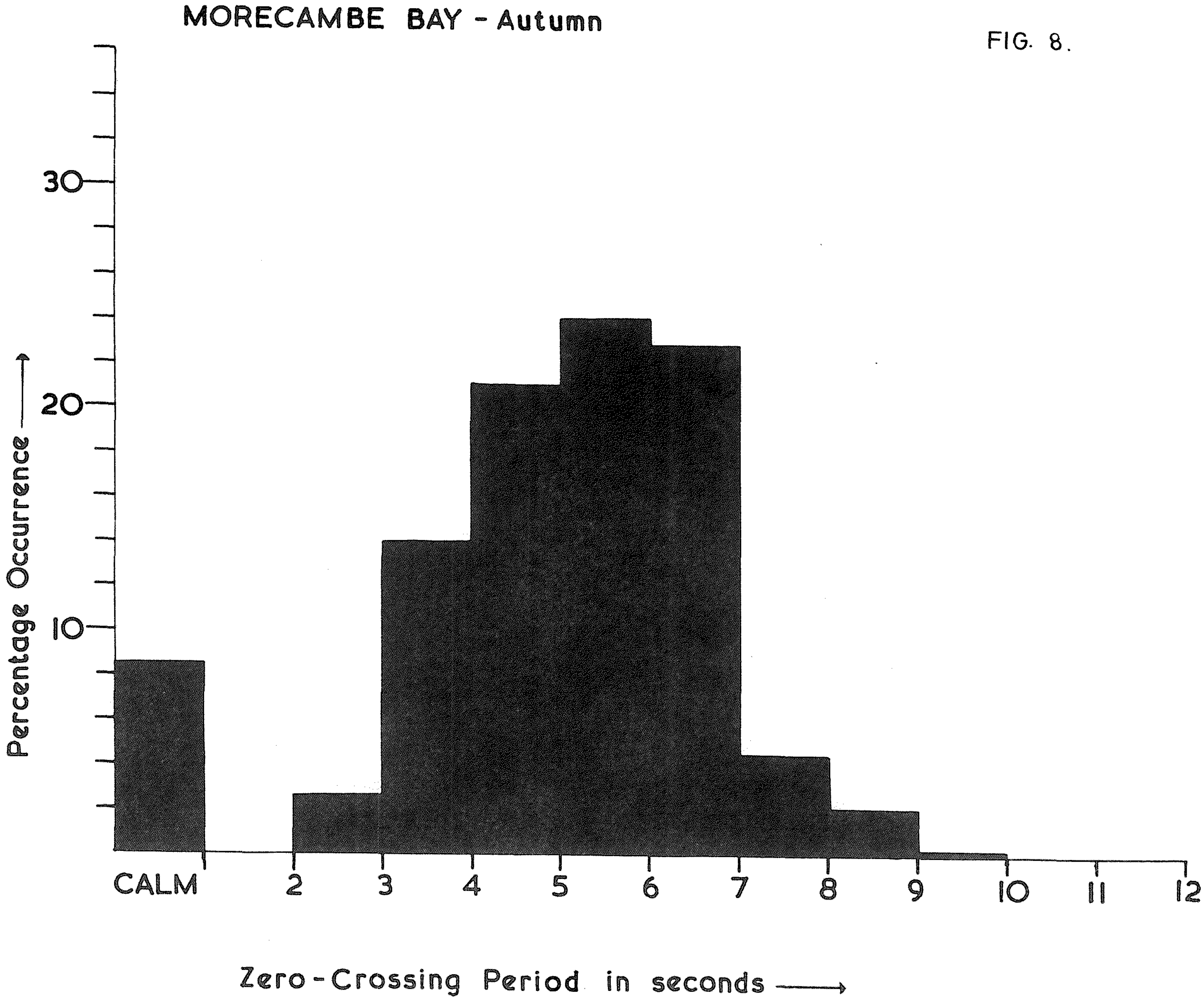

MORECAMBE BAY - Autumn
30
20
10
Percentage Occurrence
CALM
2
3
4
5
6
7
8
9
10
11
12
Zero-Crossing Period in seconds

FIG. 8.

MORECAMBE BAY–Whole year

FIG. 9.