AML REPORT. 3891

5 FAIRWAY DRIVE
WAREHAM
DORSET
BH20 4SG

FEBRUARY, 1983

MARINE MOLLUSCS FROM EXCAVATIONS AT LUDGERSHALL CASTLE, WILTSHIRE

Jessica Winder

PLEASE NOTE

It is not the author's intention or desire that all the tables and figures should be published but rather that they should be made available for study by anyone interested. It would be easy to select out relevant examples for printing.

J M Wonder

MARINE MOLLUSCS FROM LUDGERSHALL CASTLE

INTRODUCTION

The shell of the common European, flat or native oyster, Ostrea edulis Linnaeus, was the most common marine mollusc found at Ludgershall although a few other species did occur. The relative abundance of shells from the three sectors through time was described and some significance attached to the ratio of left to right valves and the degree of damage. A detailed analysis of measurements was undertaken to find an objective means of comparing size and shape in oyster shells on an intra and inter-site basis. The pattern of infestation occurrence has also been studied to aid comparison of samples from different contexts and to help determine the locality from which the shells originated. Shells from the kitchen area and some latrine pits in the East sector were studied more closely as these were considered to be areas of special interest.

METHOD

Initially the shells were sorted into left and right valves and counted, evidence of damage and infestation was noted, width and length of each valve measured, and presence of other marine mollusc species recorded. Most sample sizes were small and therefore grouping into phases was in some cases considered necessary although individual contexts were not ignored, especially where the sample was relatively large.

NUMBERS

The number of shells for each phase of each sector was tabulated showing the minimum number of individuals (MNI) and the number of damaged shells which was also expressed as a percentage, (Tables 1, 2 & 3). A table was also drawn to summarise this information for all three sectors (Table 4).

From the viewpoint of area excavated and period of active occupation it is not surprising that fewest shells were recovered from the South West sector, a few more from the South East sector and most from the East sector. In the South West the greatest number date from

TABLE 1

NUMBERS OF OYSTER SHELLS FROM THE SOUTH WEST SECTOR

PHASE	MNI	No. valves	Left valves	Damaged	Right valves	Damaged
12th century	30	46	16	2	30	5
Medieval clay spread	2	2	2	0	0	0
Late med. chalk spread	3	6	3	0	3	0
Late med. clay spread	1	0	1	1	0	0
Late-Post med chalk spread	1	1	0	0	1	0
Post-medieval	2	2	2	0	0	0
Modern	5	9	4	2	5	2
TOTAL	44	67	28	5 (18%)	39	7 (18%)

TABLE 4
LUDGERSHALL
ALL SECTORS
NUMBERS OF OYSTER SHELLS FROM ALL SECTORS AT LUDGERSHALL CASTLE

SECTOR	MNI	No. V	LV	% damage	RV	% damage
SOUTH WEST	40	67	28	18	39	18
SOUTH EAST	153	261	111	33	151	24
EAST	1695	3259	1578	28	1681	15
	1888	3587	1717	28	1871	16

TABLE 3

NUMBERS OF OYSTER SHELLS FROM THE EAST SECTOR

PHASE	MNI	No. Valves	Left valves	Damaged	Right Values	Damaged
C1	0	0	0	0	0	0
C2	0	0	0	0	0	0
C3	0	0	0	0	0	0
C4	6	10	4	1	6	1
C5	5	8	3	1	5	1
C4/6	1	1	0	0	1	0
C5/6	17	28	11	6	17	2
C6	2	3	2	1	1	1
C6/HL5	8	16	8	0	8	0
C6/HL2	2	2	0	0	2	1
C7	4	5	1	0	4	1
HL1	11	17	11	5	6	2
HL2	28	56	28	4	28	2
HL3	11	21	11	4	10	2
HL3/HL4	1	1	1	1	0	0
HL4	138	276	138	23	138	13
	17	31	14	6	17	9
HL4 | DESTRUCTION	8	12	4	2	8	1
HL5	10	11	1	0	10	4
HL5 / DESTRUCTION	101	196	101	25	95	15
DESTRUCTION	1041	2021	980	279	1041	145
FARMYARD	240	457	217	80	240	52
MODERN	44	87	43	6	44	6
TOTAL	1695	3259	1578	440 (28%)	1681	258 (15%)

MNI Minimum number of individuals

TABLE 2
LUDGERSHALL
SOUTH EAST SECTOR
NUMBERS OF OYSTER SHELLS FROM THE SOUTH EAST SECTOR

PHASE	MNI	No. Valves	Left valves	Damaged	Right valves	Damaged
Pre-castle	2	3	2	1	2	0
Timber 1 / Timber 2	1	1	1	0	0	0
Timber 2 / Post-castle	2	2	0	0	2	0
Timber 2/3	0	0	0	0	0	0
Timber 3	7	9	2	1	7	3
Timber 3/4	1	1	1	0	0	0
Timber 4	6	9	3	2	6	1
Timber 4 / Post.castle dest.	2	2	0	0	2	1
Post-castle	28	48	20	9	28	8
Post-castle destruction	49	93	44	8	49	9
Modern	53	91	38	16	53	14
Ditchfill	2	2	0	0	2	0
TOTAL	153	261	111	37 (33%)	151	36 (24%)

the 12th century with numbers decreasing up to modern times. In the South East and East sectors the opposite is true. This also tends to correspond with periods when the area was most in use. Overall, there were very few shells and it is likely that oysters would have been a rare addition to diet rather than a staple food.

More right valves than left were found though the difference was not great. The percentage of damaged left valves is greater than right except for the South West sector where sample size is small. Left valves are vunerable to damage because infestation affects and weakens the left or lower valve more than the right and the cup-shape is more prone to break when the shell is trodden on. This probably accounts for the differing proportions found. The number and proportions of valves could possibly reveal something of the nature of the deposit. For example, there would be a high probability that shells occurring in small but almost equal numbers of left and right valves represented an individual meal opened by the consumer. Deposits like this were found at Alton (Coy, J P , personal communication). Larger samples with markedly higher numbers of right valves and a very high incidence of damage and infestation in the left valves could be waste that has been discarded from a kitchen or preparation area in which shells were opened prior to serving at table in their own liquor in the cupped left valve. This type of deposit has been found at Rockbourne Roman Villa (Winder, to be published shortly). Samples of left valve only, in good condition could be waste from the table disposed of separately.

In Ludgershall, early deposits of oyster shell probably came from individual meals. The larger collections from later phases could represent the debris from either a series of individual meals or a larger gathering of people consuming oysters on one occasion.

COMPARISONS

It is likely that oysters from different localities have different shape or size characteristics and infestation patterns. It would be useful to describe infestation and compare measurements of oyster shells from archaeological deposits and modern populations. The information would provide the basis for study of intra-site variability and inter-site comparisons. From this it might be possible to determine where oysters came from and thereby supply evidence of trade. For this reason the size and infestation of oyster shells from Ludgershall Castle has been examined in detail.

COMPARISON OF SIZE

A satisfactory method had to be found for comparing the Ludgershall samples, the sizes of which varied greatly. The arithmetic mean, variance and standard deviation were calculated for each sample in which the minimum number of individuals was at least five. For the South West and South East sectors the samples were all grouped into phases. In the East sector all phases were represented by grouped data but also individual contexts were used where the overall sample size met the above criterion (>5). Only the samples from the East sector were closely examined. See Tables 5,6,& 7a - d.

The arithmetic mean of the grouped data for each phase of the East sector was plotted on a graph. A trend for the average measurement to decrease from the earliest to the most recent phase of the site could be detected. However, the arithmetic mean was considered inadequate for comparison purposes because the sample numbers and variances differed so much. The high means in earlier phases could have been the result of small samples being used and vice versa. See Figs 1a-d.

Plots of size frequency for each measurement expressed as a percentage were drawn for the grouped data of those phases with larger shell numbers (>25). See Figs 2a-f for HL2, HL4, HL5/Destruction, Destruction, Farmyard and Modern Phases. These showed that the size of oyster most frequently occurring was much below what is considered today to be the size of a best grade oyster at 4 years, ie. 3½ - 4" (about 9 - 10 cm); and that sample construction was different from phase to phase but not whether this was significantly different.

The basic data for all samples was therefore transformed logarithmically to remove heterogeneity of the variances and then tested for significant difference between samples. A computer was used for the testing. The program incorporated a compensation factor for small samples. First all results were plotted (Tables 8a-d). Then the phases for which there were larger numbers and also the grouped data for each phase were extracted and plotted separately to facilitate their examination. See Tables 9,10,11a-d, & 12 .

Even though precautions were taken to minimise the inequality of the samples, some results were definitely less reliable than others

LUDGERSHALL
SOUTH WEST SECTOR
GROUPED DATA

TABLE 5

SUMMARY OF DATA FOR GROUPED SAMPLES FROM THE SOUTH WEST SECTOR

LEFT VALVE MAX. WIDTH PHASE	Number n	Mean $\bar{x}$	Variance s^2	Standard deviation s
12th century	15	56·666667	56·4	7·8
Medieval clay spread	2	69	25	7·071068
Late med. chalk spread	4	64·5	164·25	14·798649
Late-post med. chalk spread	0			
Post-medieval	2	53	100	14·142136
Modern	4	60·5	337·25	21·205345
LEFT VALVE MAX. LENGTH				
12th century	15	47·066667	35·262222	6·146621
Medieval clay spread	2	67	100	14·142136
Late med. chalk spread	4	63	52	8·326664
Late-post med. chalk spread	0			
Post-medieval	2	60·5	240·25	21·920310
Modern		54·666667	5·555556	2·886751
RIGHT VALVE MAX. WIDTH				
12th century	26	55·692308	72·674556	8·693764
Medieval clay spread	0			
Late med. chalk spread	3	46·666667	20·222222	5·507571
Late-post med. chalk spread	1	97		
Post-medieval	0			
Modern	5	51·8	72·96	9·549869
RIGHT VALVE MAX. LENGTH				
12th century	26	48·384615	79·852071	9·112966
Medieval clay spread	0			
Late med. chalk spread	3	53·	18	5·196152
Late-post-med chalk spread	1	84		
Post-medieval	0			
Modern	5	48·8	148·16	13·608821

LUDGERSHALL
SOUTH EAST SECTOR
GROUPED DATA

TABLE 6

SUMMARY OF DATA FOR GROUPED SAMPLES FROM THE 'SOUTH EAST SECTOR'

LEFT VALVE MAX. WIDTH PHASE	Number n	Mean $\bar{x}$	Variance s^2	Standard deviation s
Pre-castle, nat. old ground sur.	1	88		
Timber 1 / Timber 2	1	60		
Timber 2 / Post-castle	0			
Timber 3	2	69·5	240·25	21·920310
Timber 3/4	1	61		
Timber 4	1	62		
Timber 4 / Postcastle dest.	0			
Post-castle	19	56·789474	195·324099	14·358810
Post-castle destruction	44	63·454545	170·475207	13·207564
Modern	38	60·736842	184·193906	13·753986
Ditch fill	0			
LEFT VALVE MAX. LENGTH				
Pre-castle, nat. old ground sur.	1	75		
Timber 1 / Timber 2	1	55		
Timber 2 / Post-castle	0			
Timber 3	2	66	121	15·556349
Timber 3/4	1	54		
Timber 4	1	53		
Timber 4 / Post-castle destruct.	0			
Post-castle	19	48·578947	175·085873	13·594590
Post-castle destruction	44	57·590909	152·287190	12·483139
Modern	38	54·973684	186·762465	13·849552
Ditch fill	0			
RIGHT VALVE MAX. WIDTH				
Pre-castle, nat. old ground sur.	2	62·5	56·25	10·606602
Timber 1 / Timber 2	0			
Timber 2 / Post-castle	2	58	25	7·071068
Timber 3	7	53·857143	28·122449	
Timber 3/4	0			
Timber 4	6	72·166667	107·805556	11·373947
Timber 4 / Post-castle dest.	2	50·5	182·25	19·091883
Post-castle	28	49·857143	114·765306	10·909440
Post-castle destruction	49	57·632653	125·048730	11·298403
Modern	53	60·245283	133·468138	11·663400
Ditch fill	2	60·5	0·25	0·707107
RIGHT VALVE MAX. LENGTH				
Pre-castle, nat. old ground sur.	2	58	81	12·727922
Timber 1 / Timber 2	0			
Timber 2 / Postcastle	2	55·5	156·25	17·677670
Timber 3	7	52·285714	23·918367	5·282496
Timber 3/4	0			
Timber 4	6	62·666667	37·888889	6·742897
Timber 4 / Post-castle dest.	2	39·5	42·25	9·192388
Post-castle	28	43·642857	109·229592	10·643079
Post-castle destruction	49	52·448980	97·920866	9·998044
Modern	53	52·792453	109·032400	10·541782
Ditch fill	2	58·5	0·25	0·707107

TABLE 12

	CONTEXT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	A 28 ②		S	−	+	+	+	S	S	−	−	S	S	O	X	−	−	+	−
2	H 19 ②	S																	
3	H 21 ②				−	−	+			−	−				−	−	−	−	−
4	H 23 ②					−	+			+	−				−	−	+	−	+
5	N 19 ②						+			−	−				−	−	X	−	−
6	A 21 ③									−	−				+	+	−	+	+
7	L 26 ③	S																	
8	D 19 ④	S																	
9	D 28 ④										−				−	−	−	−	−
10	F 21 ④														−	−	−	−	−
11	H 23 ④	S																	
12	L 26 ④	S																	
13	D 19 ⑤	O																	
14	F 19 ⑤															−	−	−	−
15	J 21 ⑤																−	−	+
16	Baulk F19/21 ⑤																	+	−
17	H 21 [481]																		+
18	GROUPED DATA																		

LEFT VALVE MAXIMUM WIDTH

	CONTEXT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	A 28 ②		S	−	+	−	+	S	S	−	−	S	S	O	−	−	−	−	−
2	H 19 ②	S																	
3	H 21 ②				+	−	X			−	−				−	−	−	−	−
4	H 23 ②					−	+			+	−				−	−	+	+	+
5	N 19 ②						+			−	−				−	−	−	−	−
6	A 21 ③									X	+				+	+	−	+	+
7	L 26 ③	S																	
8	D 19 ④	S																	
9	D 28 ④										−				−	−	−	−	−
10	F 21 ④														−	−	−	−	−
11	H 23 ④	S																	
12	L 26 ④	S																	
13	D 19 ⑤	O																	
14	F 19 ⑤															−	+	+	+
15	J 21 ⑤																−	−	−
16	Baulk F19/21 ⑤																	−	−
17	H 21 [481]																		−
18	GROUPED DATA																		

LEFT VALVE MAXIMUM LENGTH

− NO SIGNIFICANT DIFFERENCE
+ SIGNIFICANT DIFFERENCE
X SIG. DIFF. BUT STATISTICS LESS RELIABLE
S TOO SMALL A SAMPLE < 5
O NO SAMPLE

TABLE 12 CHART SHOWING SIGNIFICANT DIFFERENCE IN SIZE OF OYSTER SHELL BETWEEN CONTEXTS FROM THE FARMYARD PHASE OF THE EAST SECTOR

STERN SECTOR SUMMARY OF DATA FOR SAMPLES FROM THE EAST SECTOR

BLE 7a

FT VALVE MAX. WIDTH	Number n	Mean $\bar{x}$	Variance S^2	Standard deviation s
ase C4 Grouped data	4	73.75	61.6875	9.069179
C5 Grouped data	3	77	146	14.798649
C5/6 Grouped data	11	69.545455	51.702479	7.541401
C5/6 C7 (8)	8	68.125	18.109375	4.549333
* C6/HL5 C 15 (11) [67]	8	65.625	211.234375	15.537397
C6/HL5 Grouped data	8	65.625	211.234375	15.537397
HL1 Grouped data	11	67.909091	80.082645	9.385676
HL2 L 21 (24) [442]	26	74.807692	91.924556	9.777604
HL2 Grouped data	28	74.035714	94.248725	9.886325
HL3 Grouped data	10	62.7	102.61	10.677600
HL4 C 21 (5)	5	67.6	123.04	12.401613
HL4 B 23 (6)	37	61.216216	102.818115	10.279794
HL4 H 26 (6)	4	55.5	14.25	4.358899
HL4 B 23 (7)	3	70.333333	206.888889	17.616280
HL4 D 28 (7)	1	54		
HL4 J 13 (9) [1004]	7	68.142857	113.836735	11.524301
HL4 J 13 (10) [1004]	26	69.576923	91.551775	9.757758
HL4 F 21 (14)	0			
HL4 D 21 (15)	3	75.666666	37.555556	7.505535
HL4 F 21 (15)	8	73.25	71.6875	9.051440
HL4 D 21 (16)	15	67.666666	175.888888	13.719989
HL4 H 26 [474]	11	57.636364	71.504132	8.868740
HL4 Grouped data	137	65.562044	150.757099	12.323376
HL4/Destruction C,D.	4	57	54.5	8.524475
HL5 Grouped data	1	65		
HL5 A 28 [472]	101	58.712871	126.204686	11.290117
HL4/D, D 26 (3-5)	14	58.857143	102.979592	10.530960
Destruction Z 15 (2)	0			
D. B 23 (3)	4	61	195.5	16.145175
D. C 28 (3)	2	57	49.	9.899495
D. D 24 (3)	5	74.2	108.56	11.649034
D. H 19 (3)	5	69.4	51.04	7.987490
D. H 21 (3)	12	57.833333	91.638889	9.998485
D. J 17 (3)	7	51.571429	144.530612	12.985340
D. J 24 (3)	44	60.090909	105.491736	10.389660
D. L 17 (3)	29	60.724138	55.579073	7.587097
D. L 19 (3)	1	59		
D. L 24 (3)	107	60.523364	96.548520	9.872151
D. L 24 (3) [18]	10	68.2	89.96	9.99778
D. N 24 (3)	6	76.166667	65.805556	8.88631
D. A 19 (4)	7	74.571429	128.244898	12.23188
D. A 24 (4)	8	61.25	91.4375	10.2225
D. A 28 (4)	10	55.4	25.64	5.33749
D. C 15 (4)	24	64.166667	90.722222	9.72968
D. J 13 (4) [1004]	100	69.5	134.39	11.6510
D. J 17 (4)	2	46.5	12.25	4.9497
D. J 23 (4)	4	64	16.5	4.69041
D. J 24 (4)	28	66.357143	106.372449	10.5029
D. L 17 (4)	4	53.5	38.75	7.18795
D L 24 (4)	22	63.136364	94.208678	9.93452

LEFT VALVE MAX. WIDTH cont.	Number n	Mean $\bar{x}$	Variance S^2	Standard deviation s
Phase Destruction N 21 (4)	7	70.857143	214.408163	15.815905
D. A 19 (5)	15	62.533333	151.182222	12.727174
D. A 21 (5)	10	81.7	75.41	9.153627
D. C 15 (5)	21	74.142857	100.027211	10.248345
D. H 21 (5)	10	63.8	194.36	14.695426
D. J 24 (5)	13	62.923077	76.071006	9.078009
D. L 17 (5)	8	52.5	124.25	11.916375
D. L 24 (5)	6	61.833333	118.472222	11.923366
D. A 21 (6)	14	70.642857	118.658163	11.304234
D. F 21 (6)	7	56.142857	4.122449	2.193063
D. J 13 (6) [1004]	88	66.227273	114.857438	10.778573
D. J 21 (6)	26	60.884615	89.948225	9.671926
D. J 24 (6)	5	67	77.2	9.823441
D. L 24 (6)	4	58.25	317.1875	20.564938
D. L 24 (6) [22]	5	77.6	3.04	1.949359
D. N 19 (6)	3	78	18.666667	5.291503
D. A 21 (7)	24	71.708333	111.123264	10.768227
D. C 15 (7)	91	64.285714	116.841444	10.869208
D. C 11 (8)	7	69.571429	171.673469	14.152234
D. D 19 (9)	6	48.833333	80.138889	9.806460
D. F 19 (10)	4	82	218.5	17.068489
* C6/HL5 C 15 (11) [67]	4	64	217.5	17.029386
D. F 19 (21)	5	67.2	27.76	5.890671
D. A 21 [406]	5	61.8	185.76	15.238110
D. D 26 [454]	25	56.56	207.4464	14.7
D. J 21 [393]	15	59.666667	88.355556	9.729679
D. Grouped data	976	64.415479	145.326359	12.061281
Phase Farmyard A 28 (2)	31	63.903226	67.377732	8.344079
F. H 19 (2)	1	59		
F. H 21 (2)	8	60.625	132.734375	12.316510
F. H 23 (2)	27	56.185185	74.595336	8.801386
F. N 19 (2)	12	56.5	100.916667	10.492422
F. A 21 (3)	10	78.9	37.49	6.454112
F. L 26 (3)	4	73	22	5.416026
F. D 19 (4)	2	65	289	24.041631
F. D 28 (4)	7	67.714286	25420408	17.221249
F. F 21 (4)	5	63.6	138.24	13.145341
F. H 23 (4)	3	71	128.666666	13.892444
F. L 26 (4)	4	66.75	131.6875	13.250786
F. D 19 (5)	0			
F. F 19 (5)	5	59	9.2	3.391165
F. J 21 (5)	10	59.5	148.45	12.843070
F. Baulk F19/21 (5)	5	70	125.6	12.529964
F. H 21 [481]	34	58.058824	49.408305	7.134811
F. Grouped data	214	61.537383	115.706546	10.781919
Phase Modern L 21 (1)	6	64	146.666666	13.266499
M. N 24 (1)	14	67.214286	61.454082	8.135190
M. J 24 (2)	7	58.857143	40.408163	6.866066
M. L 26 (2)	11	68.818182	121.785124	11.574266
M. Grouped data	43	65.534884	99.737155	10.105041

LUDGERSHALL

EASTERN SECTOR SUMMARY OF DATA FOR SAMPLES FROM THE EAST SECTOR

TABLE 7b

LEFT VALVE MAX. LENGTH	Number n	Mean $\bar{x}$	Variance S^2	Standard deviation S
Phase C4 Grouped data (G.D.)	4	65.25	8.6875	3.403430
P. C5 G.D.	3	67.	2	1.732051
P. C5/6 G.D.	11	63.454545	69.338843	8.733426
C5/6 C4 (8)	8	60.5	48.25	7.425824
P. * C6/HL5 C 15 (11) [67]	8	62.625	283.484375	17.999504
C6/HL5 G.D.	8	62.625	283.484375	17.999504
P. HL1 G.D.	11	62	78.727273	9.305912
P. HL2 L 21 (214) [442]	26	70.846154	96.284024	10.006767
HL2 G.D.	28	69.821429	103.075255	10.338900
P. HL3 G.D.	9	60.666667	92.222223	10.185774
P. HL4 C 21 (5)	~5	61.6	189.84	15.404545
B 23 (6)	37	53.837838	107.595325	10.515897
H 26 (6)	5	48	58.8	8.573214
B 23 (7)	3	60.3	294.888889	21.031722
D 28 (7)	1	38		
J 13 (9) [1004]	7	60.857143	86.122449	10.023781
J 13 (10) [1004]	26	65.576923	96.782544	10.032639
F 21 (14)	0			
D 21 (15)	3	63.666666	150.222222	15.011107
F 21 (15)	8	66.25	79.6875	9.543135
D 21 (16)	15	61.933333	90.328889	9.837731
H 26 [474]	11	52.432727	43.272727	6.899275
G.D.	136	59.294118	146.516436	.12.149146
P. H4/Destruction G.D.	4	54.75	79.6875	10.307764
P. HL5 G.D	1	55		
HL5 A 28 [472]	101	52.128713	121.003235	11.055011
HL4/D. D 26 (3-5)	14	53.428571	67.102041	8.500808
P. Destruction Z 15 (2)	0			
B 23 (3)	4	57	171	15.099669
C 28 (3)	2	51	16	5.656854
D 24 (3)	5	66.8	32.56	6.379655
H 19 (3)	5	58.6	57.04	8.443933
H 21 (3)	12	53.25	98.354167	10.358352
J 17 (3)	7	45.714286	71.061225	9.105205
J 24 (3)	44	54.181818	90.330579	9.614119
L 17 (3)	29	53.551724	95.419738	9.941206
L 19 (3)	1	54		
L 24 (3)	107	54.261682	93.445541	9.712214
L 24 (3) [18]	10	60.7	92.21	10.122033
N 24 (3)	6	66	113.666667	11.679041
A 19 (4)	7	72.428571	96.530612	10.612212
A 24 (4)	8	52.25	85.9375	9.910312
A 28 (4)	10	48.4	18.84	4.575296
C 15 (4)	24	63.125	142.526042	12.195197
J 13 4 [1004]	99	62.868687	110.053464	10.544025
J 17 (4)	2	43.5	0.25	0.707107
J 23 (4)	4	56.5	10.25	3.696846
J 24 (4)	28	60.607143	106.952806	10.531573
L 17 (4)	4	49	103.5	11.747340
L 24 (4)	22	57.636364	104.049587	10.440514

L. VALVE MAX. LENGTH cont.	Number n	Mean $\bar{x}$	Variance S^2	Standard deviation S
Phase Destruction N 21 (4)	7	64.857143	187.836735	14.803475
A 19 (5)	15	59.4	127.173333	11.672923
A 21 (5)	10	75.8	56.56	7.927449
C 15 (5)	21	72.285714	133.346939	11.832763
H 21 (5)	10	57	159.8	13.324997
J 24 (5)	13	55.153846	108.899408	10.861600
L 17 (5)	8	48.25	49.1875	7.497619
L 24 (5)	6	55.666667	132.555556	12.612163
A 21 (6)	14	67	99.142857	10.332920
F 21 (6)	7	50.142857	17.836735	4.561746
J 13 (6) [1004]	88	63.079545	156.118673	12.566349
J 21 (6)	26	55.730769	68.427515	8.435912
J 24 (6)	5	60	52.4	8.093207
L 24 (6)	4	53.5	280.25	19.330460
L 24 (6) [22]	5	72.2	17.36	4.658326
N 19 (6)	3	67.333333	160.888889	15.534907
A 21 (7)	24	64.916667	155.576389	12.741294
C 15 (7)	91	62.318681	158.634706	12.664806
C 11 (8)	7	59.571429	185.102041	14.695318
D 19 (9)	6	48.833333	36.138889	6.585337
F 19 (10)	4	66.25	205.1875	16.540355
* C6/HL5 C 15 (11) [67]	4	63	121.5	12.727922
F 19 (21)	5	65.8	52.96	8.136338
A 21 [406]	5	52.8	189.76	15.401299
D 26 [454]	25	48.6	198	14.361407
J 21 [393]	15	52	74.933333	8.960230
G.D.	974	59.194872	156.099461	12.500389
P. Farmyard A 28 (2)	31	57.645161	100.422477	10.186751
H 19 (2)	1	53		
H 21 (2)	8	57.125	107.359375	11.076842
H 23 (2)	28	49.821429	51.003827	7.272748
N 19 (2)	12	55	121.333333	11.504940
A 21 (3)	10	71.2	82.36	9.566144
L 26 (3)	4	71.75	9.1875	3.5
D 19 (4)	2	59.5	110.25	14.849242
D 28 (4)	7	60	199.428571	15.253415
F 21 (4)	5	54.5	103.04	11.349009
H 23 (4)	3	60.333333	66888889	10.016653
L 26 (4)	4	58.75	194.1875	16.090888
D 19 (5)	0			
F 19 (5)	5	49.8	26.56	5.761944
J 21 (5)	10	53.1	162.89	13.453211
Baulk F19/21 (5)	5	63	120.4	12.267844
H 21 [481]	34	55.5	50.955882	7.245688
G.D.	214	56.411215	119.307538	10.948409
P. Modern L 21 (1)	6	54.5	155.916667	13.678450
N 24 (1)	14	62.142857	91.408163	9.921671
J 24 (2)	7	56	63.714286	8.621678
L 26 (2)	11	62	88	9.838699
G.D.	43	59.906977	107.014603	10.467214

EASTERN SECTOR SUMMARY OF DATA FOR SAMPLES FROM THE EAST SECTOR

TABLE 7c

RIGHT VALVE MAX. WIDTH	Number n	Mean $\bar{x}$	Variance s^2	Standard deviation s
Phase C4 Grouped data (G.D.)	6	58·833333	72·472222	9·325[illegible]92
P. C5 G.D.	5	60·2	168·56	14·515509
P. C5/6 G.D.	17	71·235294	87·238754	9·627626
C5/6 C4 (8)	15	71·266667	98·728889	10·284987
P. * C6/HL5 C 15 (11) [6]	6	52	47·333333	7·536577
C6/HL5 G.D.	8	51·375	37·234375	6·523310
P. HL1 G.D.	6	69·833333	73·138889	9·368387
P. HL2 L 21 (214) [442]	16	61·25	161·1875	13·112335
HL2 G.D.	28	60·107143	171·309949	13·328719
P. HL3 G.D.	10	60·7	36·41	6·360468
P. HL4 C 21 (5)	5	68·6	113·44	11·907980
B 23 (6)	33	55·424242	88·486685	9·552586
H 26 (6)	7	48·428571	18·530612	4·649629
B 23 (7)	7	66·142857	81·551020	9·754120
D 28 (7)	6	54	46·333333	7·456541
[illegible] 13 (9) [1004]	3	56·666667	181·555556	16·502525
J 13 (10) [1004]	21	60·619048	78·426304	9·074559
F 21 (14)	6	75·166667	159·472222	13·833534
D 21 (15)	7	64·142857	321·836735	19·377208
F 21 (15)	7	66·285714	51·346939	7·739817
D 21 (16)	12	56·166667	193·305556	14·521666
H 26 [474]	10	49·3	30·21	5·793674
G.D	137	59·394161	151·976024	12·373096
P. HL4/Destruction G.D.	8	54·625	38·984375	6·674846
P. HL5 G.D.	10	54·6	72·64	8·983936
HL5 A 28 [472]	93	53·258065	98·621575	9·984666
HL4/D D 26 3-5	17	56·352941	94·228374	10·005881
P. Destruction Z 15 (2)	5	60·4	10·64	3·646917
B 23 (3)	7	56·857143	66·408163	8·802056
C 28 (3)	5	60	31·6	6·284903
D 24 (3)	5	63·4	90·64	10·644247
H 19 (3)	0			
H 21 (3)	16	58·0625	48·183594	7·169089
J 17 (3)	5	54	52	8·062258
J 24 (3)	65	52	76·4	8·808731
L 17 (3)	29	54·655172	60·984542	7·947488
L 19 (3)	5	44·2	111·36	11·798304
L 24 (3)	87	55·333333	78·084291	8·887758
L 24 (3) [18]	20	55·25	90·8875	9·781158
N 24 (3)	7	62·285714	137·632653	12·671678
A 19 (4)	3	74·666666	16·888889	5·033223
A 24 (4)	4	59·75	6·1875	2·872281
A 28 (4)	15	59·066667	79·928889	9·254085
C 15 (4)	22	64·545454	122·611670	11·333588
J 13 (4) [1004]	105	59·666667	105·117460	10·301854
J 17 (4)	5	47·6	111·84	11·823705
J 23 (4)	9	56·222222	34·395062	6·220486
J 24 (4)	31	56·612903	49·592092	7·158573
L 17 (4)	10	52·4	48·44	7·336363
L 24 (4)	24	51·416667	48·993056	7·150048

E MAX. WIDTH cont	Number n	Mean $\bar{x}$	Variance s^2	Standard deviation s
Destruction N 21 (4)	4	59	42·5	7·527727
A 19 (5)	19	59·526316	85·512465	9·500692
A 21 (5)	9	69·111111	60·765432	8·268078
C 15 (5)	27	59·777778	73·358025	8·728086
H 21 (5)	14	51·714286	101·204082	10·439780
J 24 (5)	15	58·866667	129·982222	11·801130
L 17 (5)	8	50·875	168·609375	13·881514
L 24 (5)	5	50·9	46·96	7·661593
A 21 (6)	9	60·111111	230·098766	16·089161
F 21 (6)	1	65		
J 13 (6) [1004]	92	57·043478	80·973637	9·047995
J 21 (6)	39	52·384615	57·108481	7·655804
J 24 (6)	7	57	70·571429	9·073772
L 24 (6)	7	52·571429	69·387755	8·997354
L 24 (6) [22]	9	67·555556	85·135802	9·786612
N 19 (6)	5	50·6	21·04	5·128353
A 21 (7)	13	64·769231	88·946746	9·816261
C 15 (7)	75	53·68	104·484267	10·290589
C 11 (8)	7	73	159·714286	13·650397
D 19 (9)	2	53·5	42·25	9·192388
F 19 (10)	13	73·692308	124·982249	11·636040
C6/HL5 C 15 (11) [67]	7	60·714286	35·346939	6·421689
F 19 (21)	2			
A 21 [406]	7	54·857143	36·122449	6·491753
D 26 [454]	18	51·111111	64·765432	8·281012
J 21 [393]	4	55	24·5	5·715476
G.D.	1039	56·682171	108·083093	10·4[illegible]1343
Farmyard A 28 (2)	32	54·21875	89·733398	9·624345
H 19 (2)	7	52·428571	39·[illegible]87755	6·778819
H 21 (2)	3	55·333333	124·222222	13·650397
H 23 (2)	25	52·04	88·4384	9·598090
N 19 (2)	9	51	25·777777	5·385165
A 21 (3)	12	63·833333	100·138889	10·451910
L 26 (3)	6	62·333333	56·222222	8·213810
D 19 (4)	5	53·4	67·84	9·208692
D 28 (4)	10	53·8	28·56	5·633235
F 21 (4)	5	56·8	161·36	14·202113
H 23 (4)	8	53·875	57·109375	8·078852
L 26 (4)	8	55·375	23·234375	5·153016
D 19 (5)	6	63·833333	50·472222	7·782459
F 19 (5)	2	55·5	90·25	13·435029
J 21 (5)	6	55·333333	92·222222	10·519823
Baulk F19/21 (5)	13	56·461538	105·325444	10·681880
H21 [481]	30	54·166667	74·672222	8·789034
G.D.	239	55·071130	102·300380	10·135591
Modern L 21 (1)	4	57·75	60·1875	8·958236
N 24 (1)	12	57·5	86·25	9·700047
J 24 (2)	3	58	8	3·464102
L 26 (2)	13	60·538462	61·940828	8·191615
G.D.	42	60·142857	88·884354	9·542131

LUDGERSHALL

EASTERN SECTOR SUMMARY OF DATA FOR SAMPLES FROM THE EAST SECTOR

TABLE 7d

RIGHT VALVE MAX. LENGTH	Number n	Mean $\bar{x}$	Variance s^2	Standard deviation s
Phase C4 Grouped data (G.D.)	6	54.166667	55.138889	8.134290
P. C5 G.D.	5	52.6	135.44	13.011533
P. C5/6 G.D.	17	63	51.647059	7.407766
C5/6 CY ⑧	15	63.2	57.893333	7.875822
P. * C6/HL5 C 15 ⑪ [67]	6	44.833333	45.805556	7.413951
C6/HL5 G.D.	8	44.75	37.4375	6.541079
P. HL1 G.D	6	58.5	30.583333	6.058052
P. HL2 L 21 (219) [442]	16	53.625	100.484375	10.352938
HL2 G.D	28	53.464286	118.248725	11.073767
P. HL3 G.D.	10	55.6	45.04	7.074210
P. HL4 C 21 ⑤	5	57.6	107.84	11.610340
B 23 ⑥	34	47.470588	76.190311	8.859972
H 26 ⑥	6	43.166667	39.805556	6.911343
B 23 ⑦	7	61.428571	65.673469	8.753231
D 28 ⑦	6	47.833333	52.472222	7.935154
J 13 ⑨ [1004]	3	50.666667	140.222222	14.502873
J 13 ⑩ [1004]	21	53.523810	67.678005	8.429822
F 21 ⑭	6	61.166667	58.472222	8.376554
D 21 ⑮	7	60.714286	375.632653	20.934137
F 21 ⑮	7	62.142857	4.693876	2.340126
D 21 ⑯	12	52.25	126.1875	11.732821
H 26 [474]	9	43.222222	31.506173	5.953524
G.D.	136	52.683824	132.216209	11.541039
P. HL4/Destruction G.D	8	48	31.75	6.023762
P. HL5 G.D.	10	48.5	63.25	8.383184
HL5 A 28 [472]	93	46.903226	86.108914	9.329785
HL4/D. D 26 (3-5)	17	51.176471	88.027682	9.671061
P. Destruction Z 15 ②	5	54.	40.	7.071068
B 23 ③	7	47.714286	16.775510	4.423961
C 28 ③	5	49.4	40.64	7.127412
D 24 ③	5	53.8	31.76	6.300794
H 19 ③	0			
H 21 ③	16	50.5625	45.996094	7.004463
J 17 ③	5	46.2	6.16	2.774887
J 24 ③	65	45.692308	63.259172	8.015460
L 17 ③	29	48.620690	56.304399	7.636444
L 19 ③	5	40.	55.6	8.336667
L 24 ③	87	47.609195	64.996697	8.108790
L 24 ③ [18]	20	48.35	81.8275	9.280852
N 24 ③	7	52.142857	67.551020	8.877473
A 19 ④	3	69.333333	22.222222	5.773503
A 24 ④	4	46.25	20.6875	5.251984
A 28 ④	15	50.2	133.626667	11.965426
C 15 ④	22	56.090909	87.173554	9.556394
J 13 ④ [1004]	106	51.556604	103.548683	10.224229
J 17 ④	5	41.6	29.84	6.107373
J 23 ④	9	47	28.444444	5.656854
J 24 ④	31	48.258065	39.610822	6.397748
L 17 ④	10	45.2	54.96	7.814516
L 24 ④	24	45.458333	52.498264	7.401405

R. VALVE MAX. LENGTH cont.	Number n	Mean $\bar{x}$	Variance s^2	Standard deviation s
Phase Destruction N 21 ④	4	50	43.5	7.615773
A 19 ⑤	19	52.157895	70.764543	8.642680
A 21 ⑤	9	64.	96	10.392305
C 15 ⑤	27	55.703704	81.393690	9.193705
H 21 ⑤	14	46.285714	91.346939	9.918348
J 24 ⑤	15	51.4	105.706667	10.642234
L 17 ⑤	8	44.375	152.484375	13.201055
L 24 ⑤	5	44.8	42.6	7.259477
A 21 ⑥	9	53.444444	219.135803	15.701203
F 21 ⑥	1	63		
J 13 ⑥ [1004]	92	51.021739	79.043006	8.939329
J 21 ⑥	39	46.384615	62.082840	7.982268
J 24 ⑥	7	49.857143	63.836735	8.629959
L 24 ⑥	7	47.857143	70.693878	9.081640
L 24 ⑥ [22]	9	59.111111	71.876543	8.992281
N 19 ⑥	5	44.2	16.16	4.494441
A 21 ⑦	13	55.615385	69.928994	8.703816
C 15 ⑦	75	48.253333	121.095822	11.078459
C 11 ⑧	7	61.714286	130.204082	12.324965
D 19 ⑨	2	48.5	20.25	6.363961
F 19 ⑩	13	64.153846	114.437870	11.134377
* C6/HL5 C 15 ⑪ [67]	7	54.857143	57.551020	8.194075
F 19 ㉑	2			
A 21 [406]	7	49.428571	33.387755	6.241184
D 26 [454]	18	43.444444	64.135802	8.240661
J 21 [393]	4	48	41	7.393691
G.D.	1042	50.115163	101.080787	10.058722
P. Farmyard A 28 ②	32	47.40625	54.116211	7.474082
H 19 ②	7	43.857143	28.979592	5.814596
H 21 ②	3	50	12.666666	4.358899
H 23 ②	24	46.291667	86.456597	9.498188
N 19 ②	9	48.	41.777777	6.855655
A 21 ③	12	53.833333	122.972222	11.582380
L 26 ③	6	52.83	32.138889	6.210207
D 19 ④	5	52.6	63.04	8.876936
D 28 ④	10	47.2	40.16	6.679987
F 21 ④	5	49.8	104.56	11.432410
H 23 ④	8	49.75	27.4375	5.599745
L 26 ④	8	48.25	36.9375	6.497252
D 19 ⑤	6	55.833333	80.138889	9.806460
F 19 ⑤	2	53.5	90.25	13.435029
J 21 ⑤	6	51.833333	73.138889	9.368387
Baulk F19/21 ⑤	13	51.846154	109.668639	10.899894
H 21 [481]	30	47.3	49.543333	7.159031
G.D.	238	48.857143	82.945978	9.126662
P. Modern L 21 ①	4	47.5	25.25	5.802298
N 24 ①	12	48.583333	77.576389	9.199391
J 24 ②	3	48.666666	44.222222	8.144528
L 26 ②	13	52.615385	52.082840	7.511530
G.D.	44	51.159091	94.542872	9.835728

Fig 1a GRAPH TO SHOW THE CHANGES IN ARITHMETIC MEAN OF GROUPED SAMPLES FROM MAJOR PHASES IN THE EAST SECTOR. LEFT VALUE MAXIMUM WIDTH

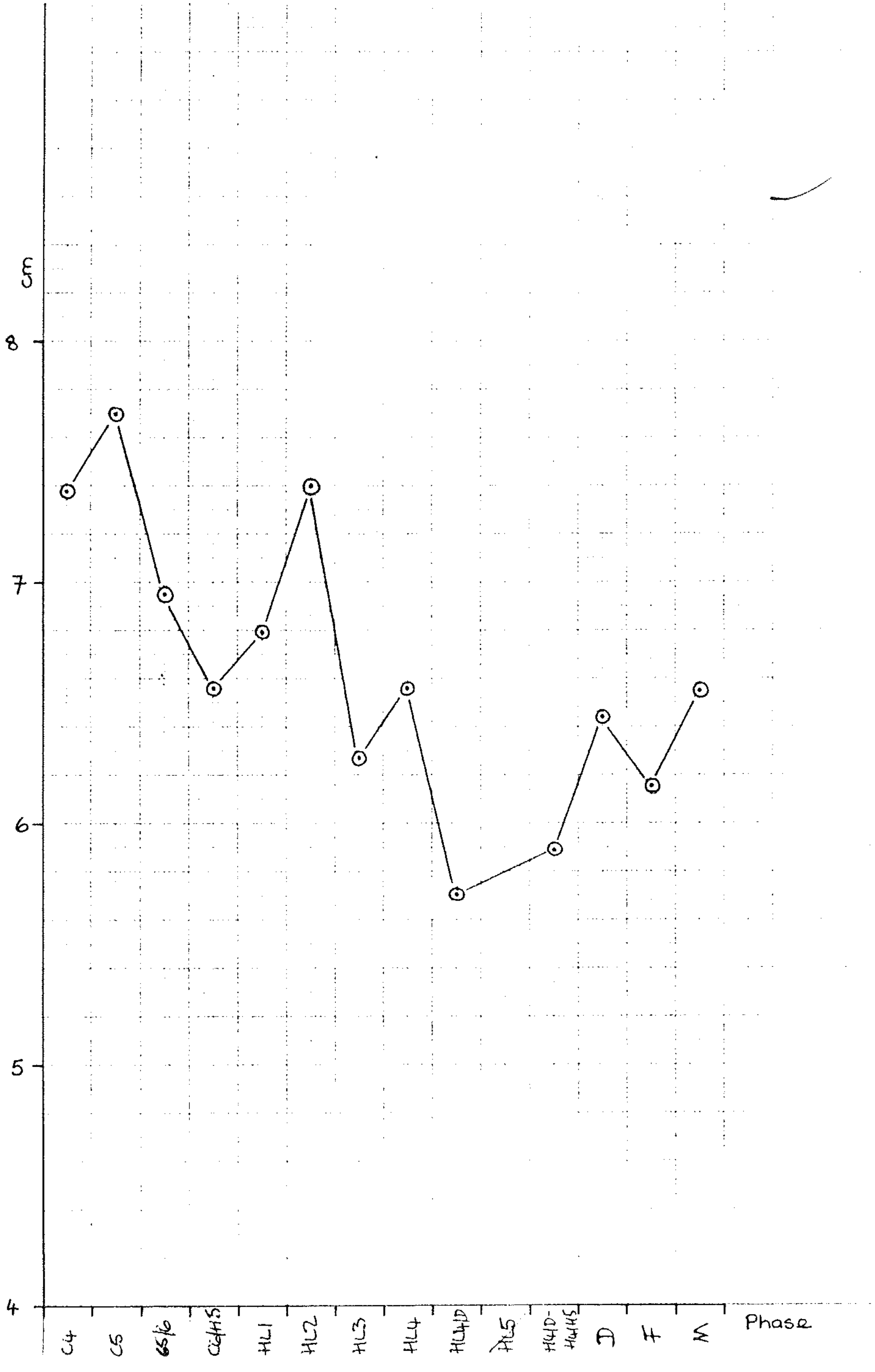


FIG 1b GRAPH TO SHOW THE CHANGES IN ARITHMETIC MEAN OF GROUPED SAMPLES FROM MAJOR PHASES IN THE EAST SECTOR. LEFT VALVES MAXIMUM LENGTH

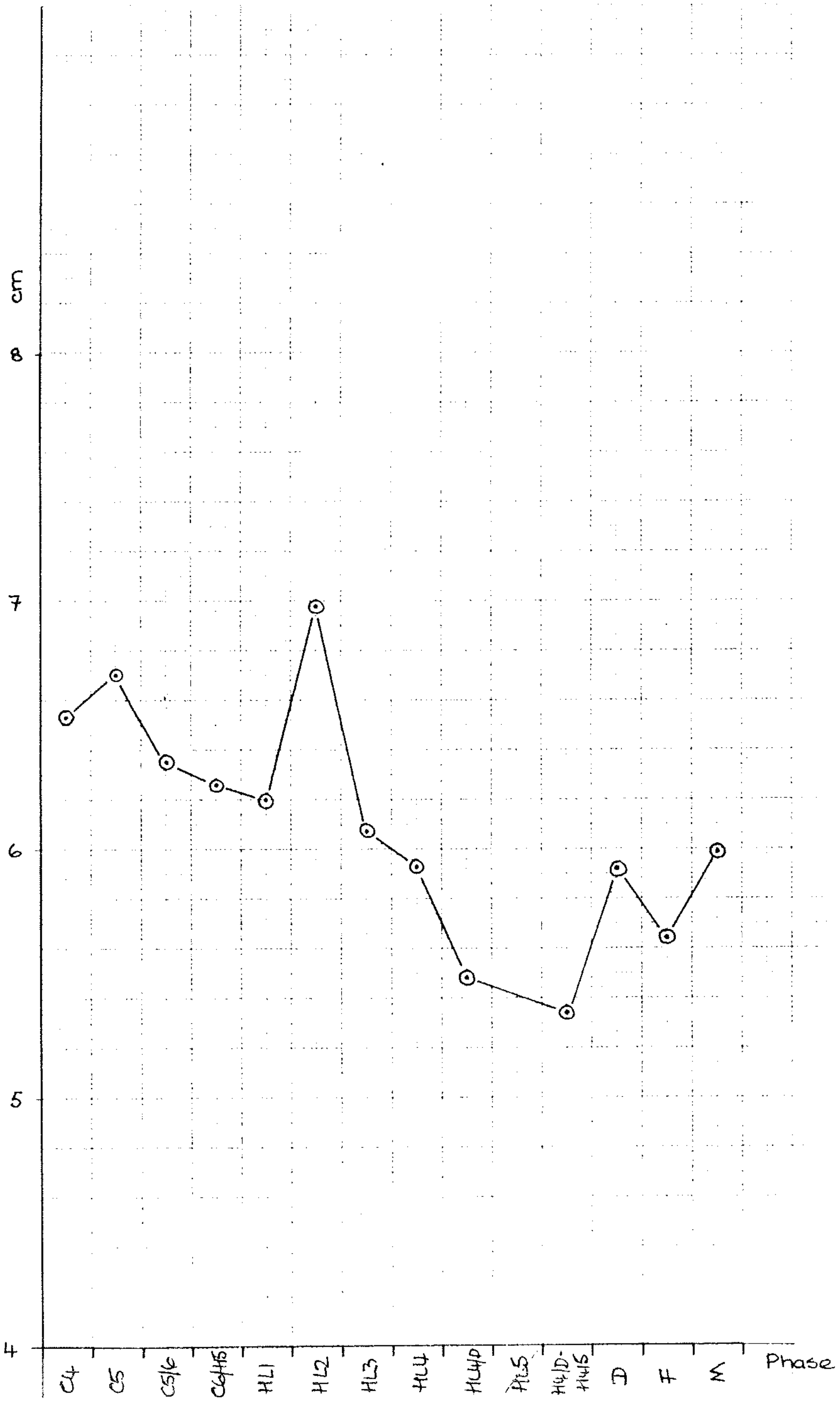


FIG 1c GRAPH TO SHOW THE CHANGES IN ARITHMETIC MEAN OF GROUPED SAMPLES FROM MAJOR PHASES IN THE EAST SECTOR. RIGHT VALVES MAXIMUM WIDTH

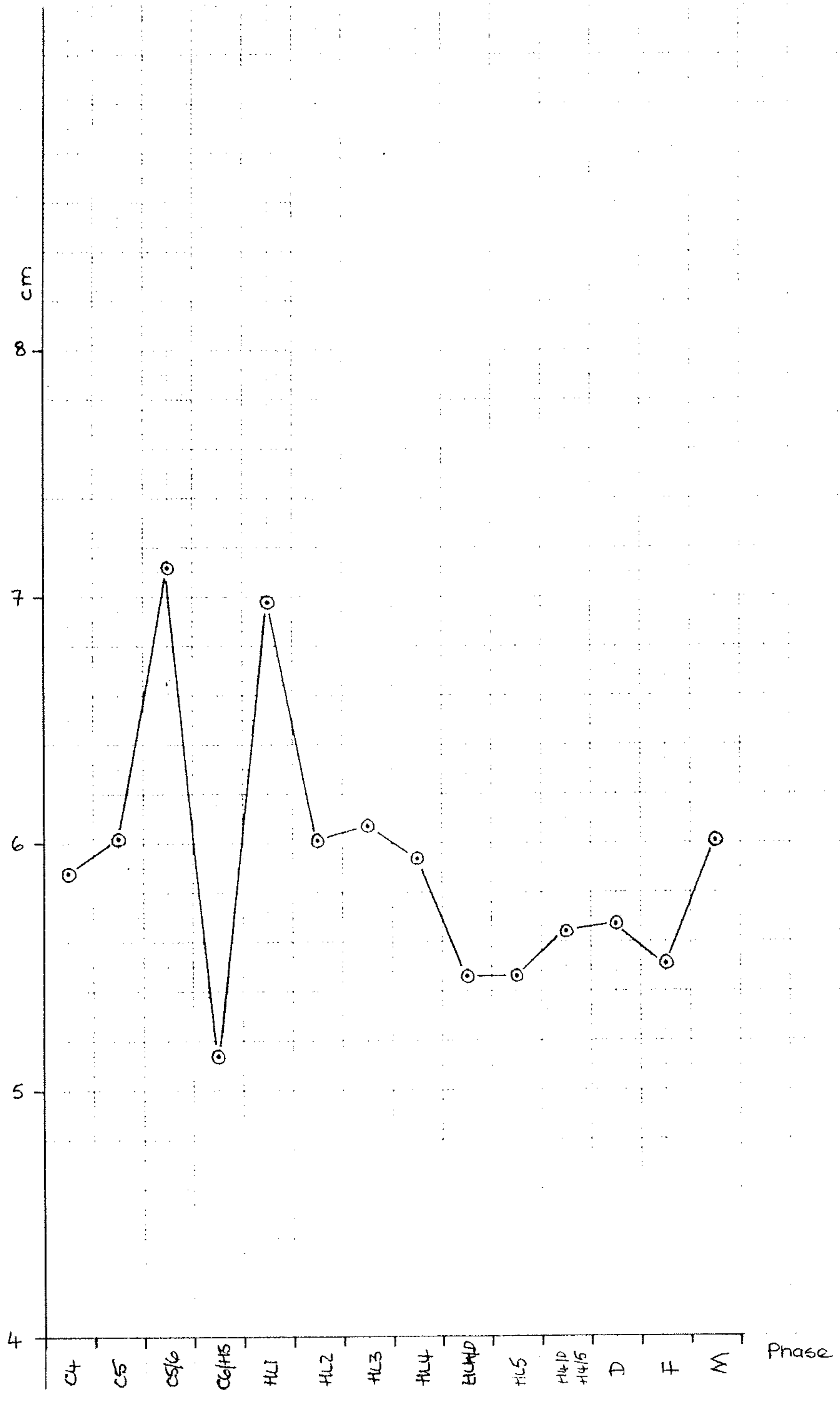
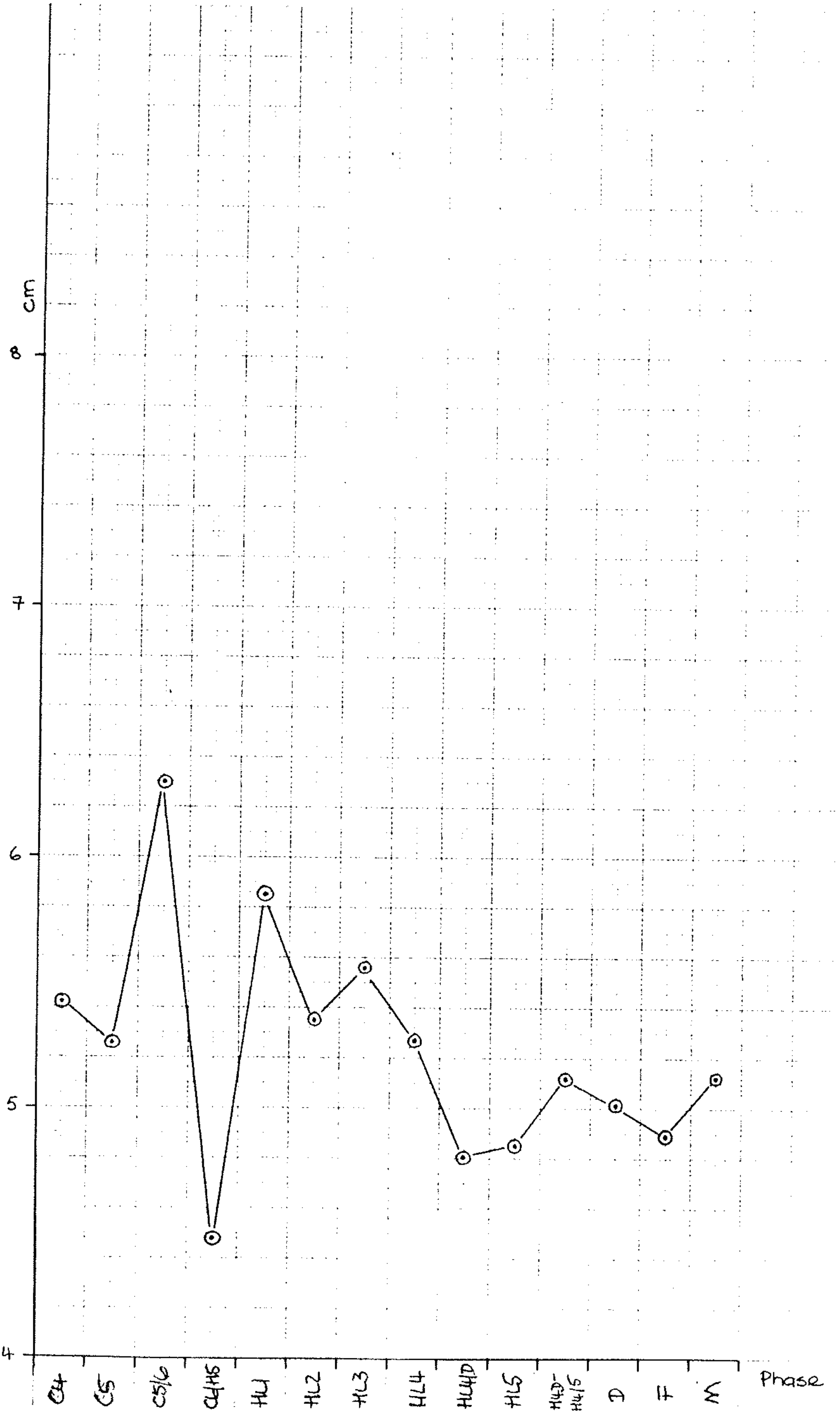


FIG 1d GRAPH TO SHOW THE CHANGES IN ARITHMETIC MEAN OF GROUPED SAMPLES FROM MAJOR PHASES IN THE EAST SECTOR . RIGHT VALVES MAXIMUM LENGTH



2a

[illegible] (EXPRESSED AS A PERCENTAGE) FOR GROUPED OYSTER SHELL SAMPLES FROM HL2 PHASE, EAST SECTOR. LEFT VALVES (n = 28)

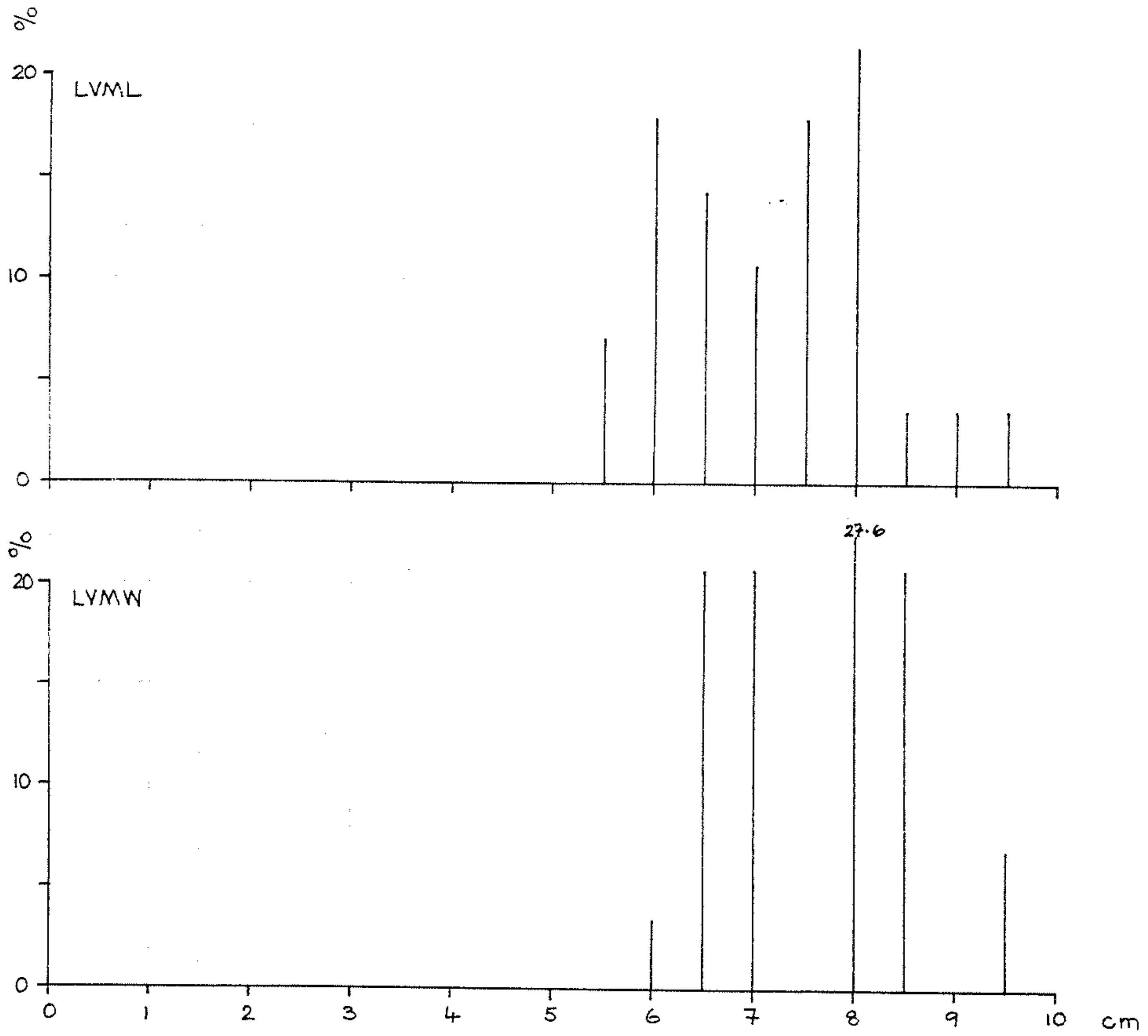
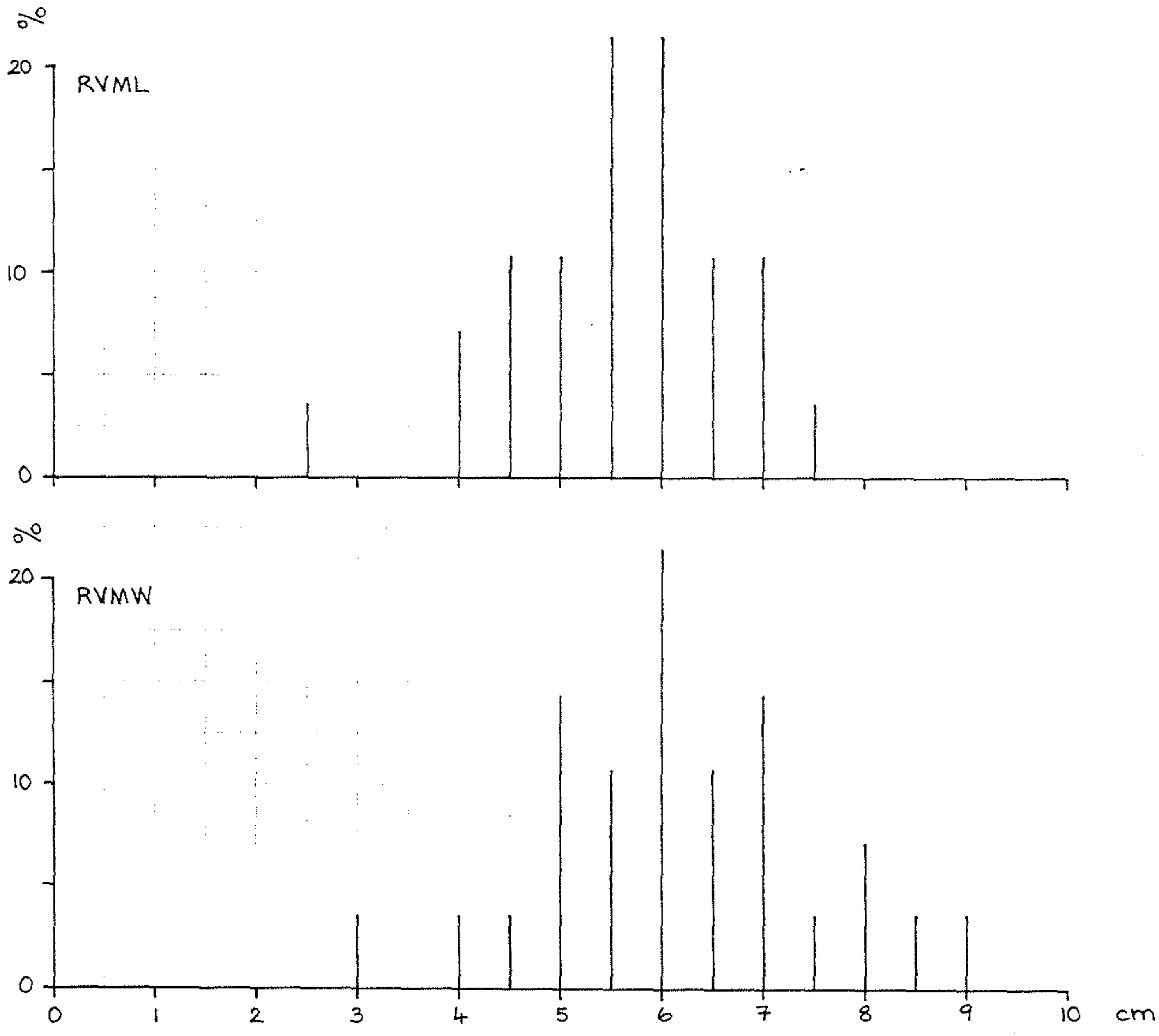
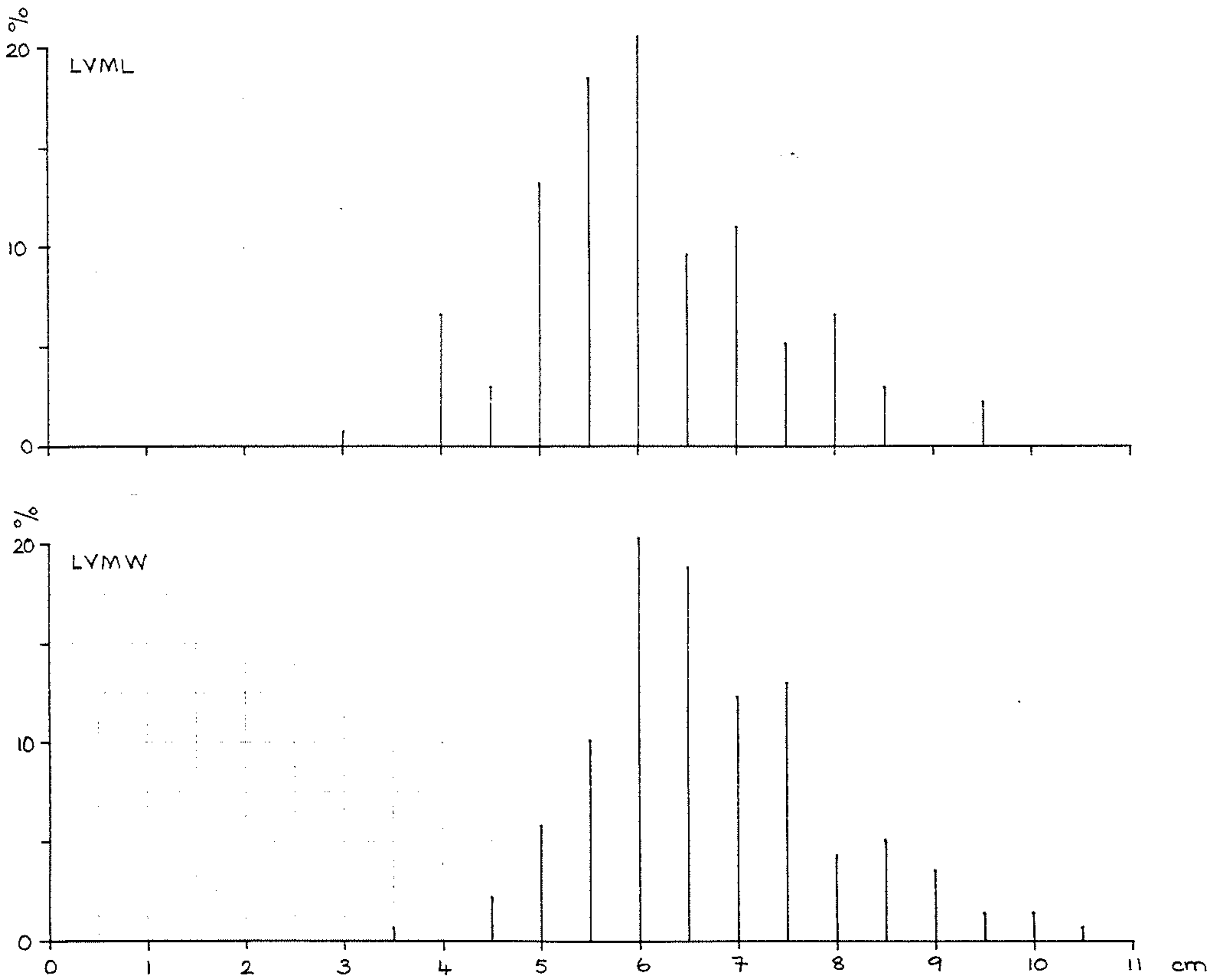


FIG 2b

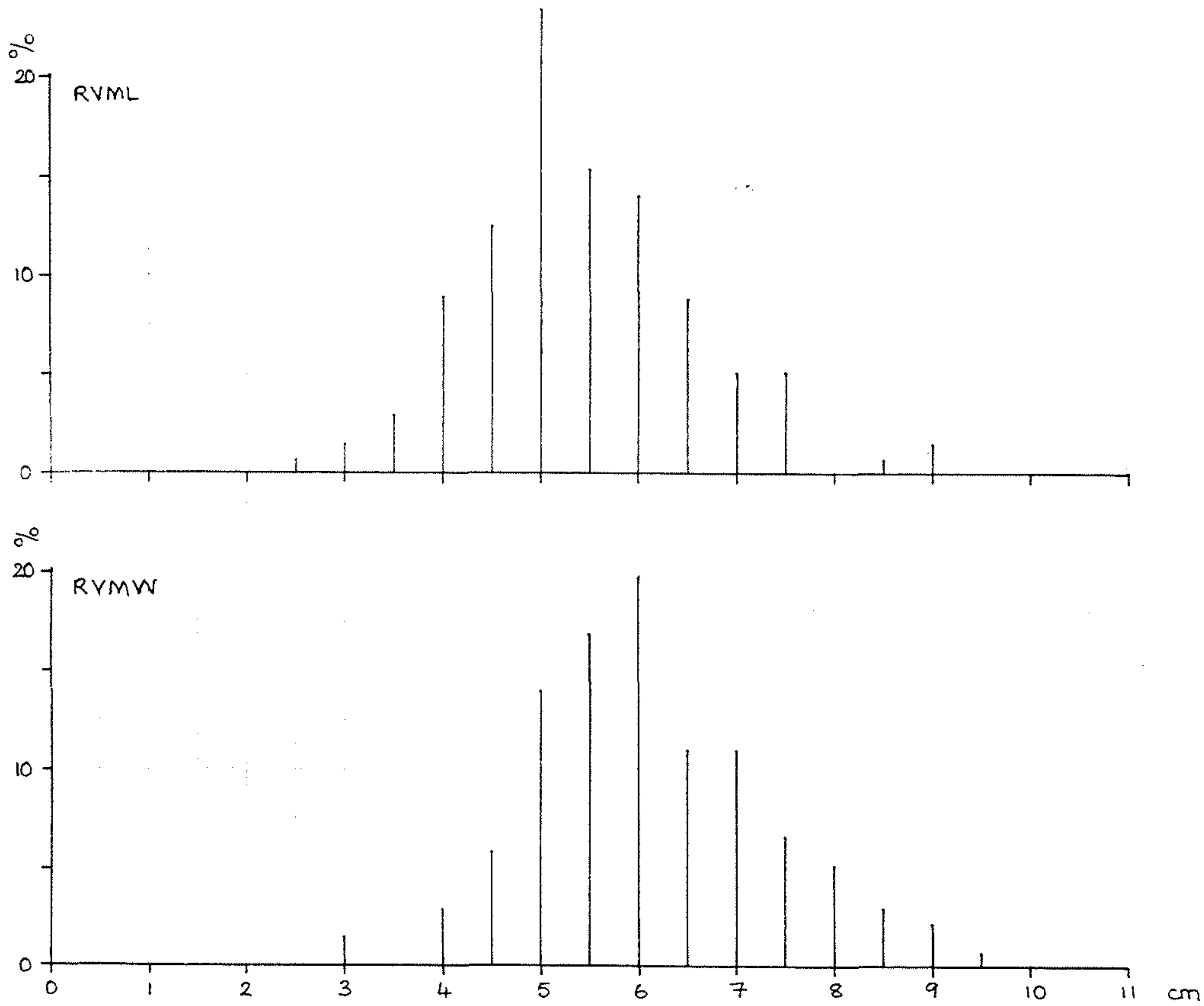
SIZE FREQUENCY (AS %) FOR GROUPED OYSTER SHELL SAMPLES FROM HL2 PHASE, EAST SECTOR. RIGHT VALVES (n = 28)



3q SIZE FREQUENCY (AS %) FOR GROUPED OYSTER SHELLS SAMPLES FROM HL4 PHASE, EAST SECTOR. LEFT VALVES



3b SIZE FREQUENCY (AS A %) FOR GROUPED OYSTER SHELL SAMPLES FROM HL4 PHASE, EAST SECTOR. RIGHT VALVES



49

SIZE FREQUENCY (AS %) FOR GROUPED OYSTER SHELL SAMPLES FROM HL5/DESTRUCTION PHASE, EAST SECTOR. LEFT VALVES.

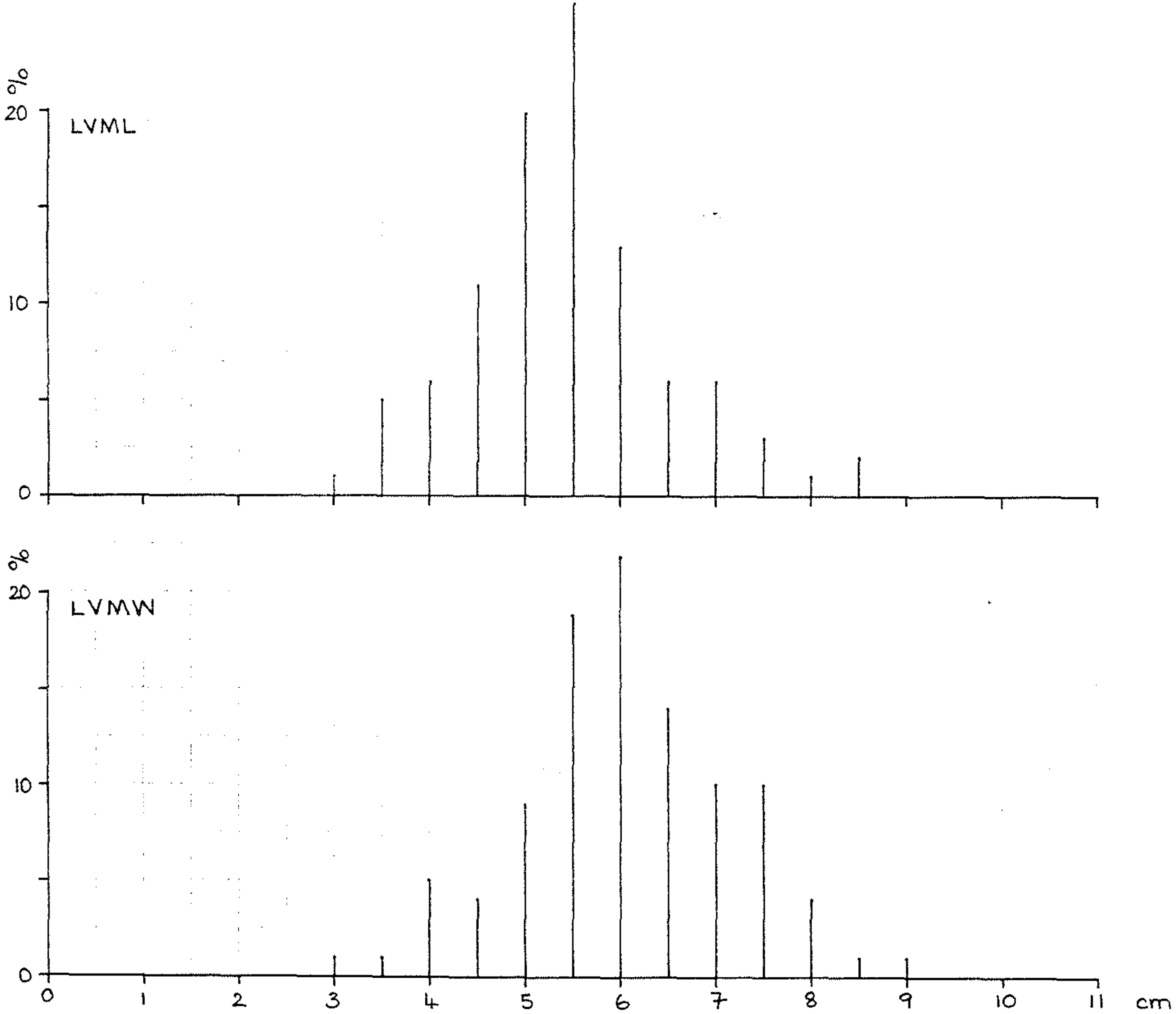


FIG 4b

SIZE FREQUENCY (AS A %) FOR GROUPED OYSTER SHELL SAMPLES FROM HLS/DESTRUCTION PHASE. RIGHT VALVES

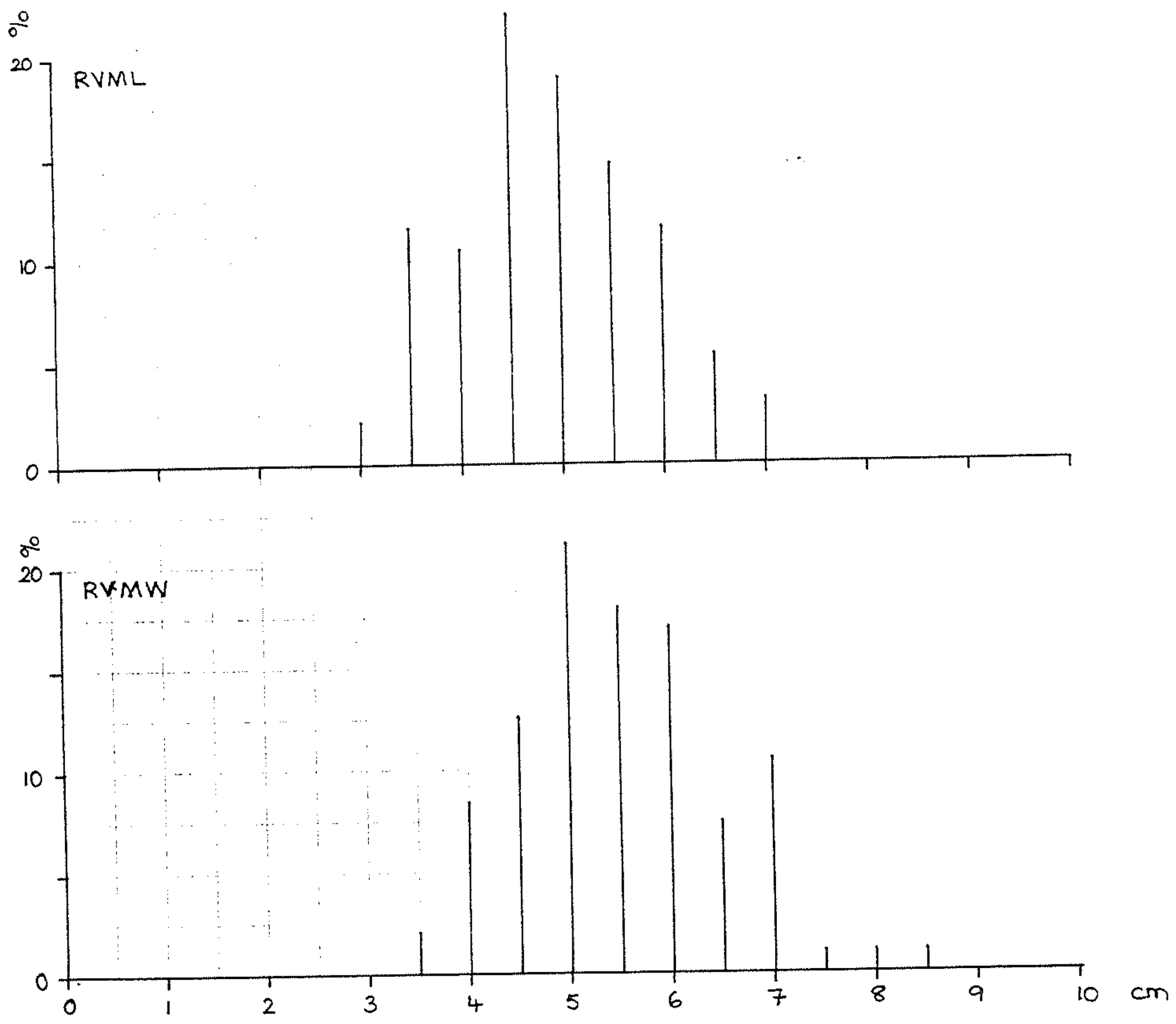


Fig 5a
SIZE FREQUENCY (AS %) FOR GROUPED OYSTER SHELL SAMPLES FROM DESTRUCTION PHASE , EAST SECTOR. LEFT VALVES

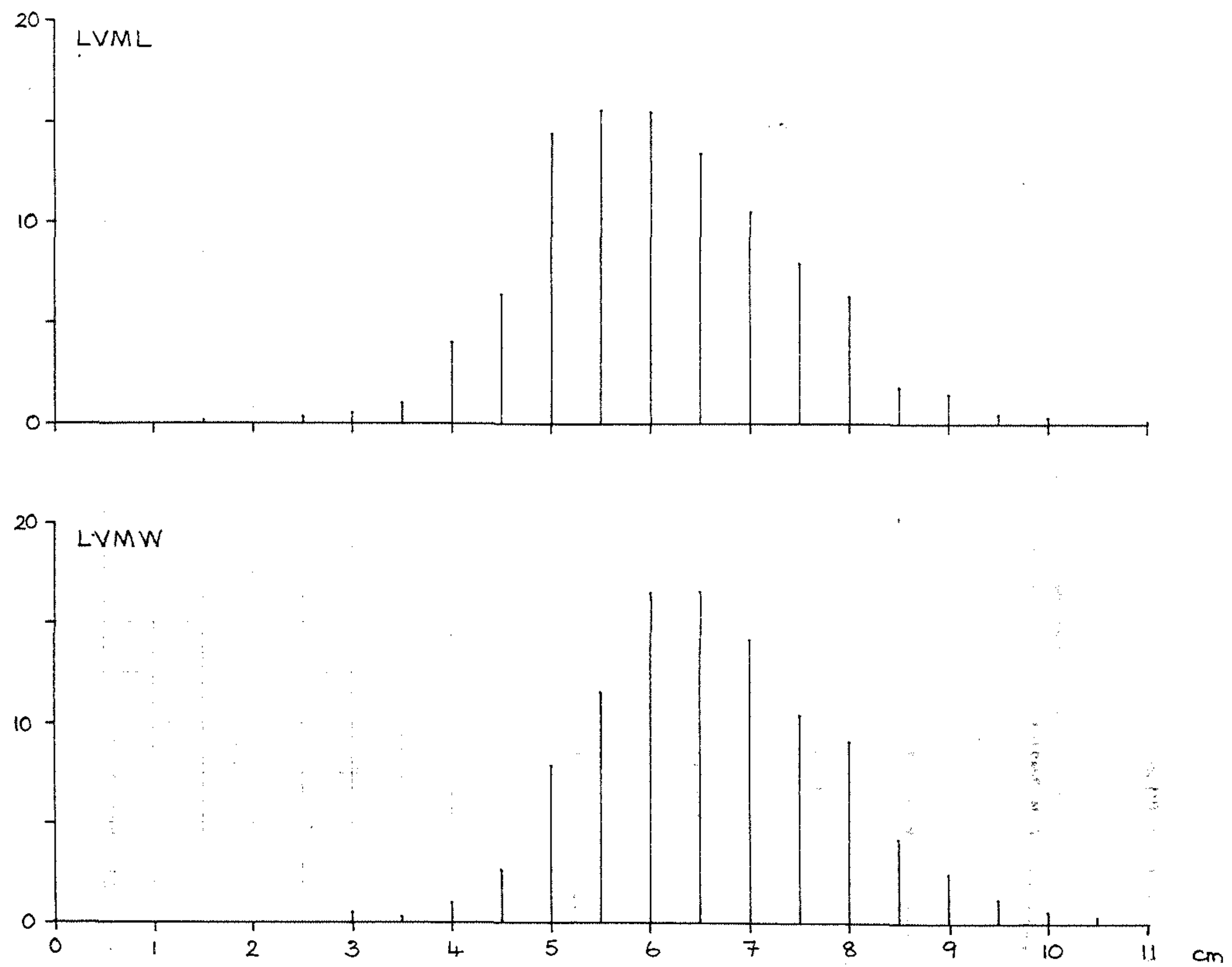


FIG 5b
SIZE FREQUENCY (AS %) FOR GROUPED OYSTER SHELL SAMPLES FROM DESTRUCTION PHASE, EAST SECTOR. RIGHT VALVES

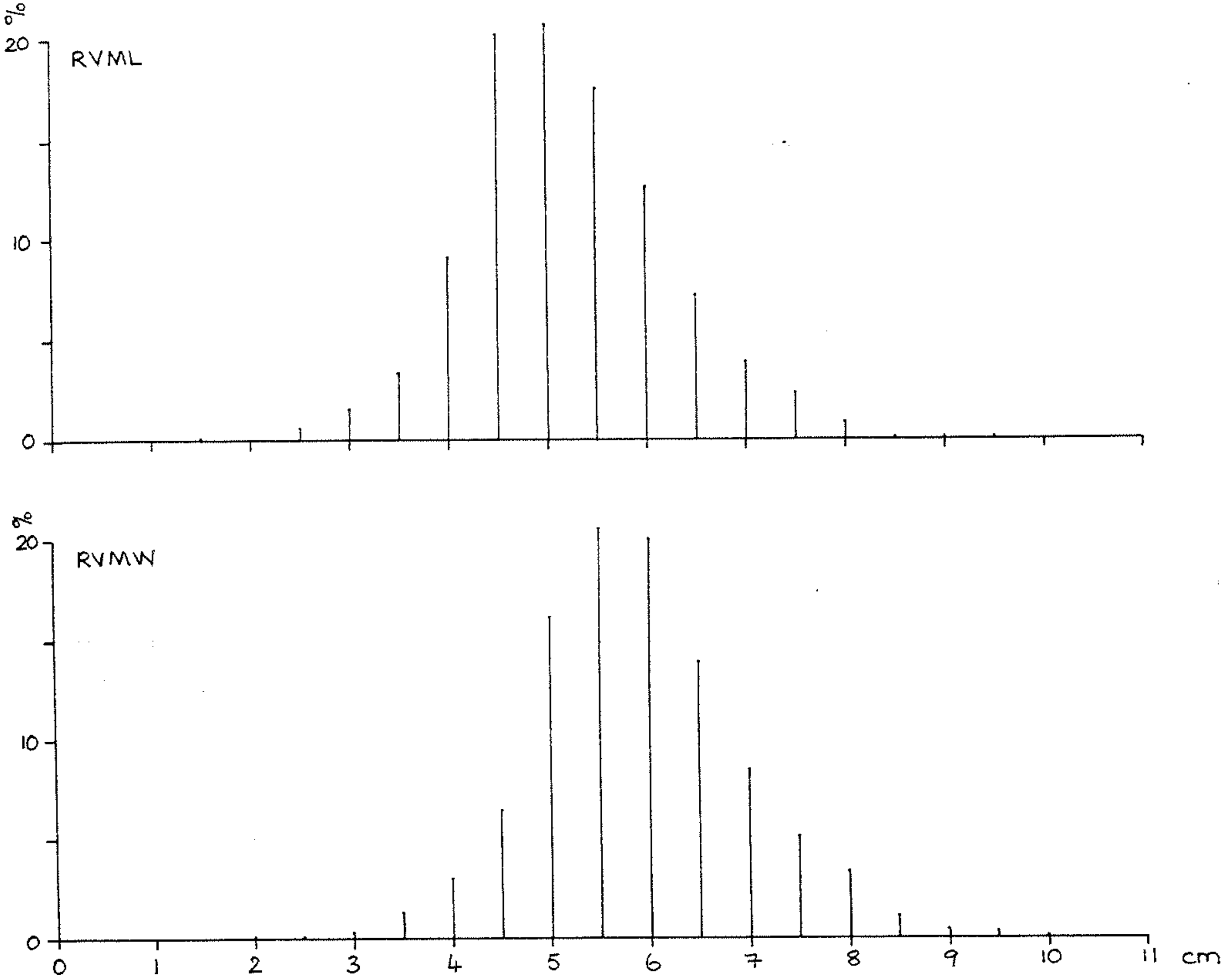


FIG 6a. SIZE FREQUENCY (AS %) FOR GROUPED OYSTER SHELL SAMPLES FROM FARMYARD PHASE, EAST SECTOR. LEFT VALUES

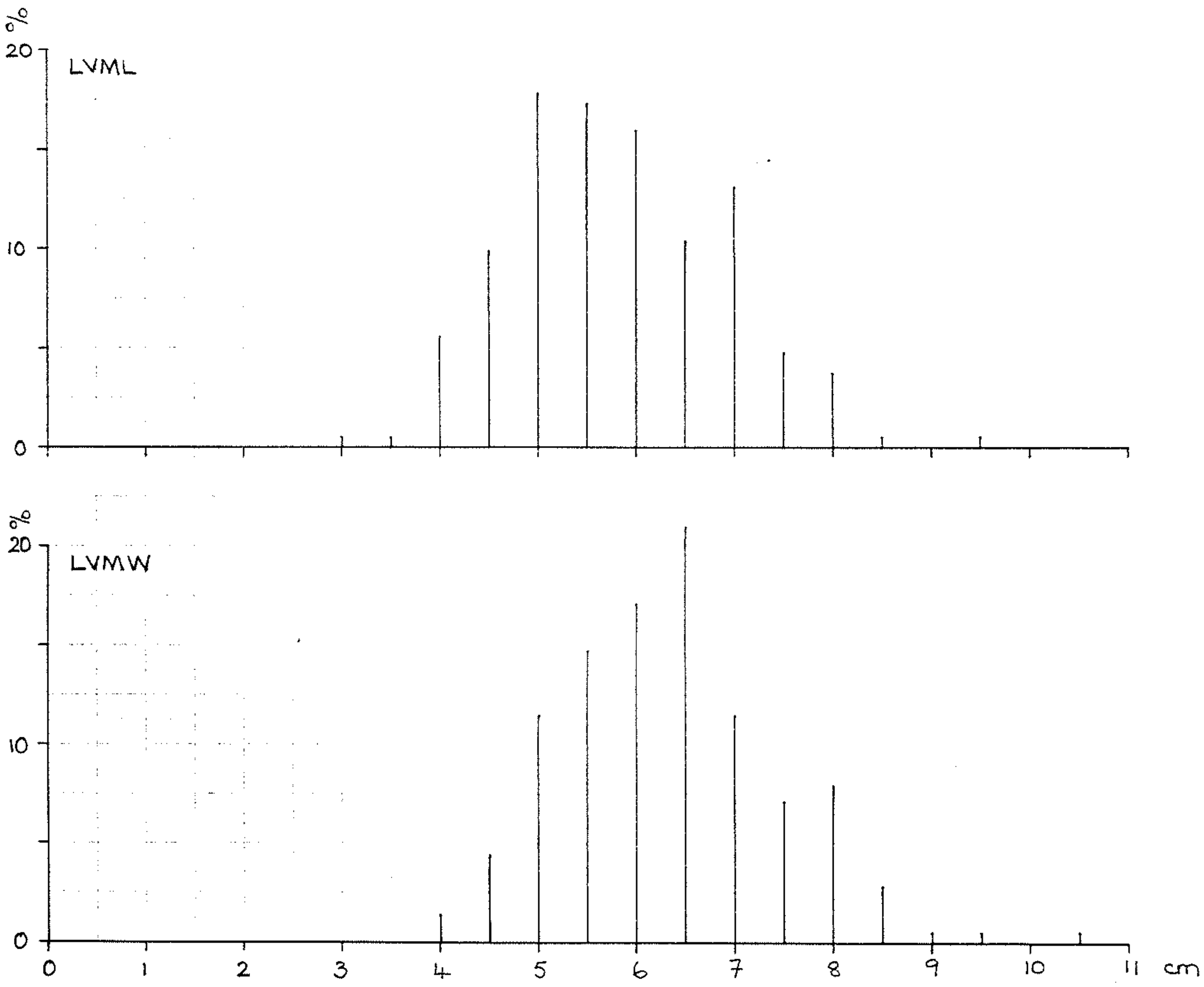


FIG 6b

SIZE FREQUENCY (AS %) FOR GROUPED OYSTER SHELL SAMPLES FROM FARMYARD PHASE, EAST SECTOR. RIGHT VALUES.

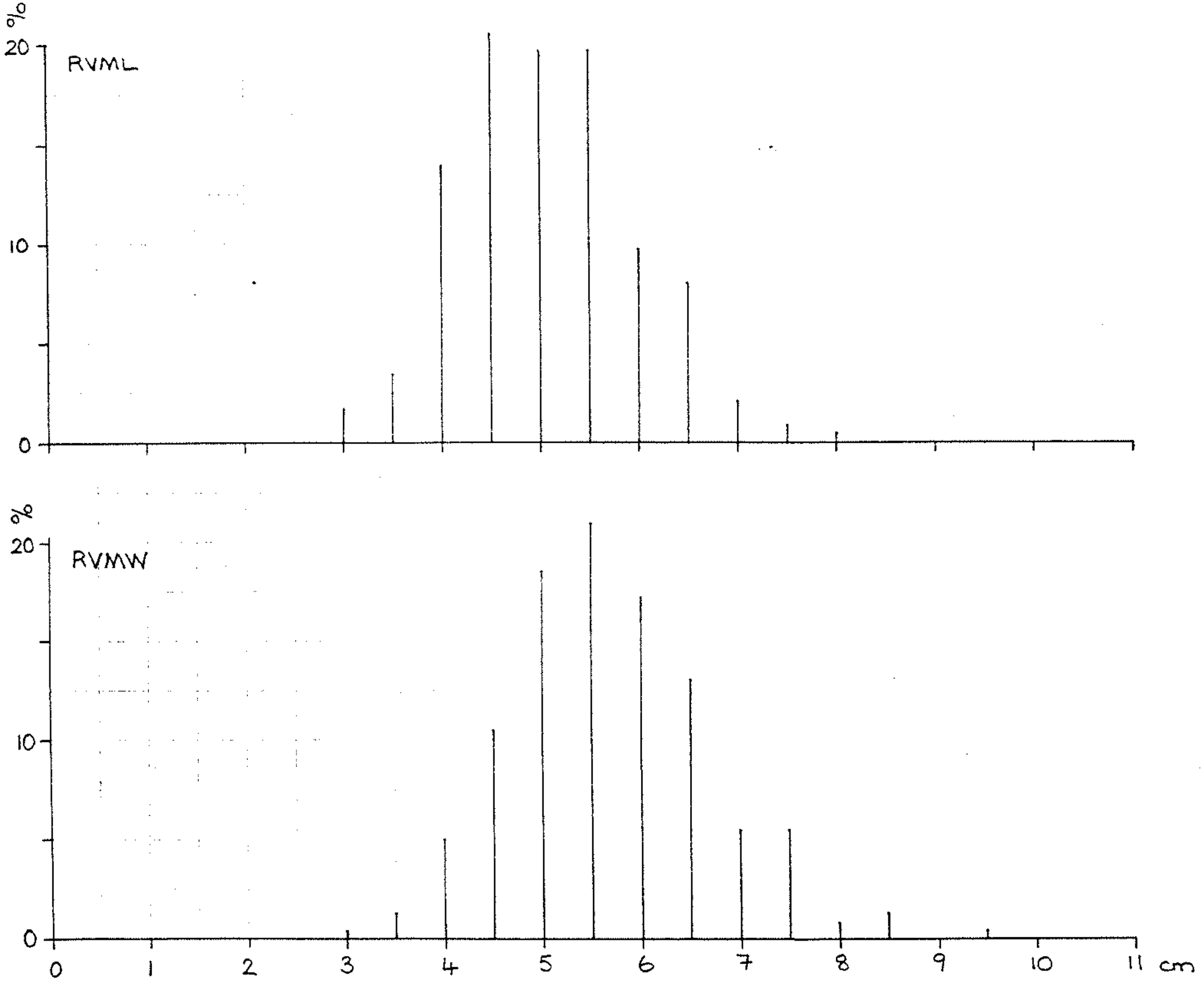


Fig 79
SIZE FREQUENCY (AS %) FOR GROUPED OYSTER SHELL SAMPLES FROM MODERN PHASE, EAST SECTOR. LEFT VALUES

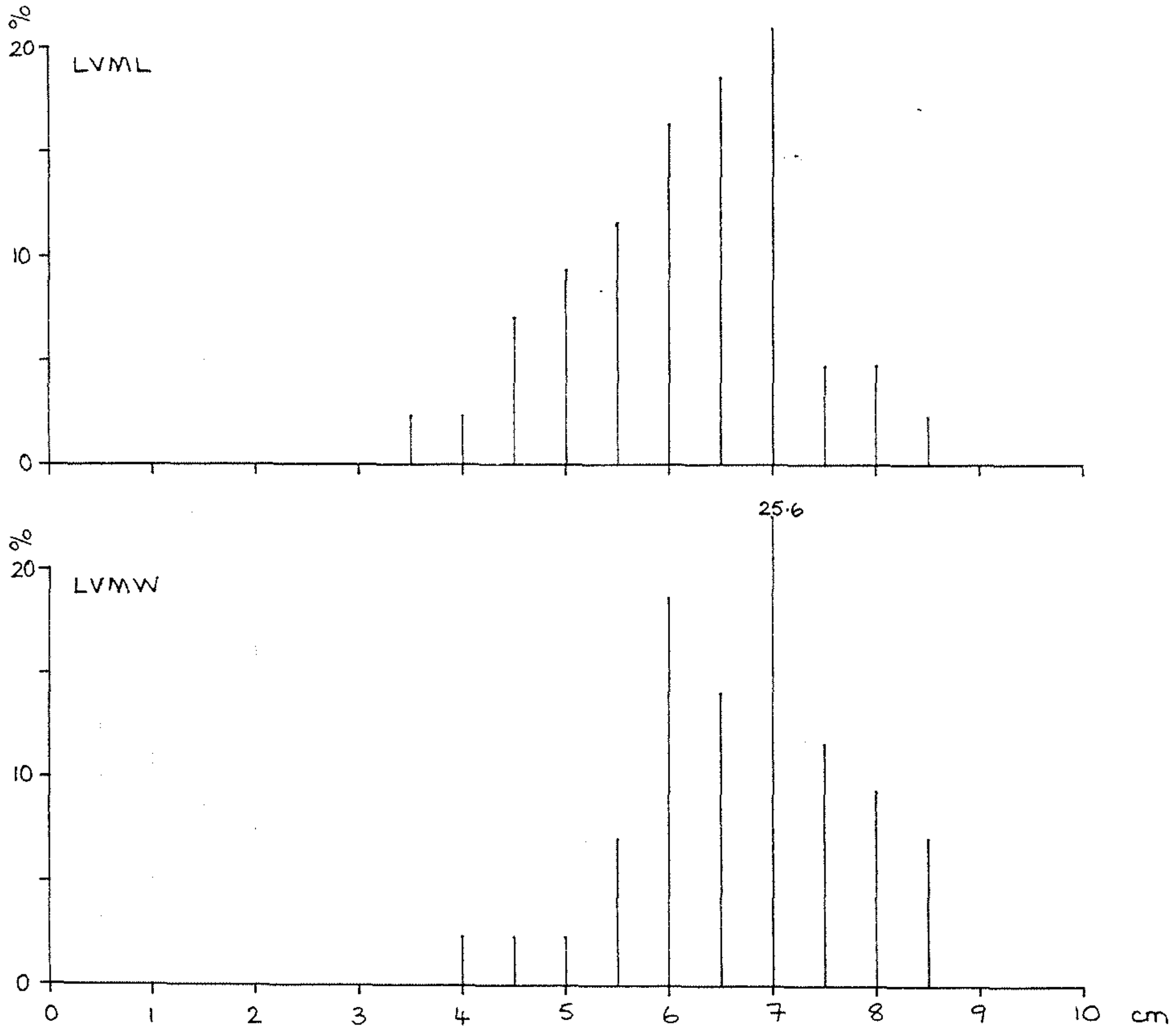
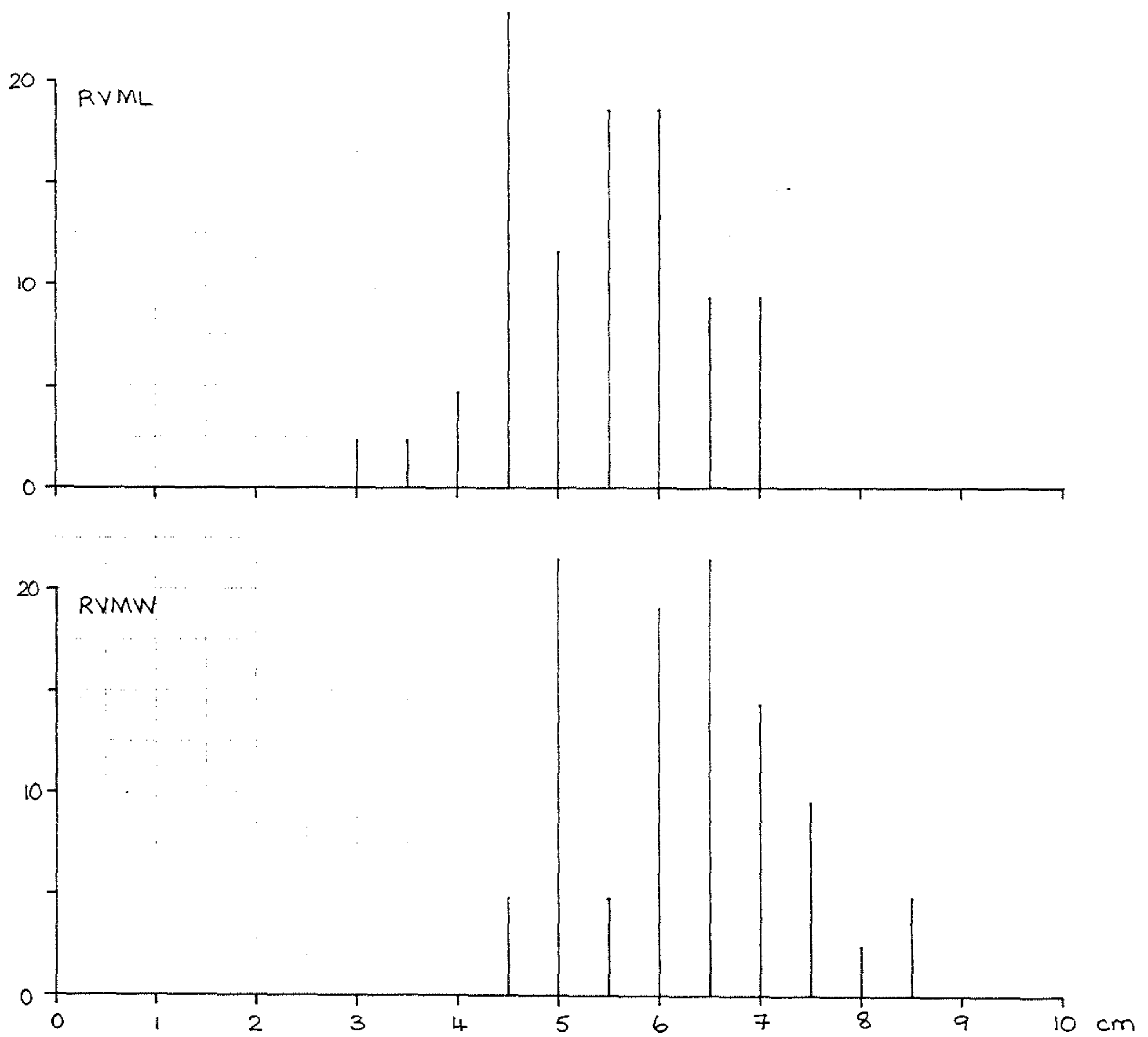


FIG 7e
SIZE FREQUENCY (AS %) FOR GROUPED OYSTER SHELL SAMPLES FROM MODERN PHASE, EAST SECTOR. RIGHT VALVES



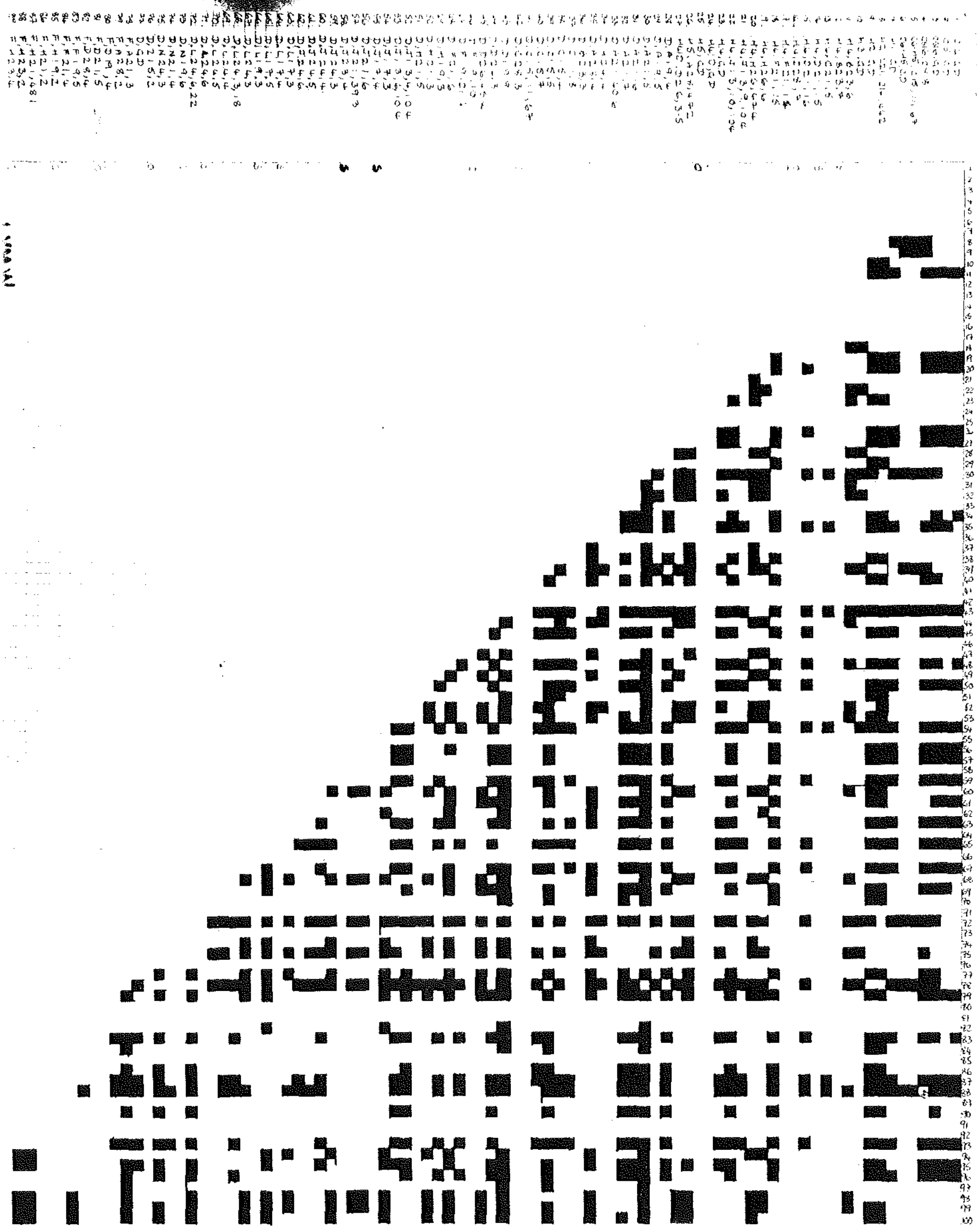


TABLE 8a

TABLE 64 CHART SHOWING [illegible] DIFFERENCE IN SIZE BETWEEN SAMPLES OF OYSTER SHELL IN THE EAST SECTOR OF LUDGERSHALL CASTLE . LEFT VALVES MAXIMUM WIDTH

■ represents [illegible] [illegible] significant difference

[illegible] represents a less reliable result but did not apply for this process

S rep. too small a sample < 5

O rep. no sample

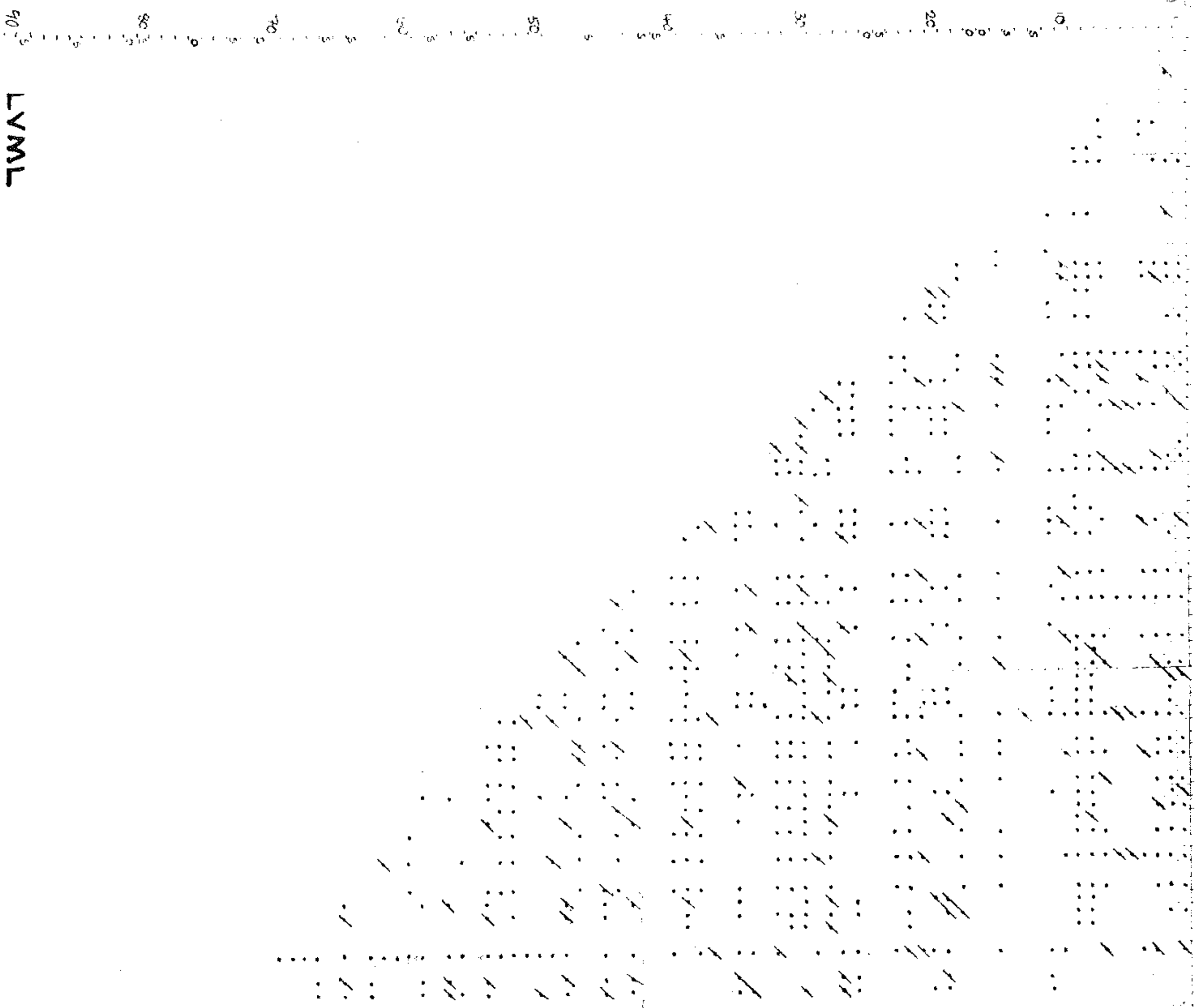


TABLE 8b

TABLE 7D CHART SHOWING SIGNIFICANT DIFFERENCE IN SIZE OF OYSTER SHELLS BETWEEN SAMPLES IN THE EAST SECTOR OF LUDGERSHALL CASTLE LEFT VALVES MAXIMUM LENGTH

- • represents presence of significant difference
- ✓ represents a less reliable result
- S represents too small a sample, <5
- O represents no sample

BLE 8C

TABLE [illegible] CHART SHOWING SIGNIFICANT DIFFERENCE IN SIZE OF OYSTER SHELLS BETWEEN SAMPLES FROM THE EAST SECTOR OF LUTGERSHALL CASTLE, RIGHT VALVES MAXIMUM WIDTH

- • represents presence of significant difference
- ↘ rep. a less reliable result
- s rep. too small a sample, < 5
- o rep. no sample

TABLE 8d

TABLE [illegible] CHART SHOWING SIGNIFICANT DIFFERENCE IN SIZE OF OYSTER SHELL BETWEEN SAMPLES FROM THE EAST SECTOR OF LUDGERSHALL CASTLE. RIGHT VALVES MAXIMUM LENGTH.

• represents presence of significant difference

⁄ rep. a less reliable result

s rep too small a sample, < 5

o rep. no sample.

TABLE 9 , EASTERN SECTOR , COMPARISON OF MEASUREMENTS FOR GROUPED DATA OF EACH PHASE

- – NO SIGNIFICANT DIFFERENCE
- + SIGNIFICANT DIFFERENCE
- X SIG. DIFF. BUT STATS. LESS RELIABL
- S TOO SMALL A SAMPLE <5
- O NO SAMPLE

LEFT VALVE MAXIMUM WIDTH

PHASE	1	2	3	4	5	6	7	8	9	10	11	12	13	14
C4		–	–	–	–	–	–	–	S	O	+	–	+	–
C5			–	–	–	–	–	–			+	–	+	–
C5/6				–	–	–	–	–			+	X	+	–
C6/HL5					–	+	–	–			–	–	–	–
HL1						–	–	–			+	–	–	+
HL2							+	+			+	+	–	+
HL3								–			–	–	–	–
HL4											+	–	+	–
HL4/DESTRUCTION	S													
HL5	O													
HL5/DESTRUCTION												+	+	+
DESTRUCTION													+	–
FARMYARD														+
MODERN														

LEFT VALVE MAXIMUM LENGTH

PHASE	1	2	3	4	5	6	7	8	9	10	11	12	13	14
C4		–	–	–	–	–	–	+	S	O	+	+	+	X
C5			–	–	–	–	–	+			+	+	+	+
C5/6				–	–	–	–	–			+	–	+	–
C6/HL5					–	–	–	–			+	–	–	–
HL1						+	–	–			+	–	–	–
HL2							+	+			+	+	+	+
HL3								–			+	–	–	–
HL4											+	–	+	–
HL4/DESTRUCTION	S													
HL5	O													
HL5/DESTRUCTION												+	+	+
DESTRUCTION													+	–
FARMYARD														–
MODERN														

RIGHT VALVE MAXIMUM WIDTH

PHASE	1	2	3	4	5	6	7	8	9	10	11	12	13	14
C4		+	X	–	–	–	–	–	–	–	–	–	–	–
C5			–	–	–	–	–	–	–	–	–	–	–	–
C5/6				+	–	+	+	+	+	+	+	+	+	+
C6/HL5					+	X	+	X	–	–	–	–	–	+
HL1						–	X	X	+	+	+	+	+	+
HL2							–	–	–	–	+	–	–	–
HL3								–	X	–	+	–	+	–
HL4									–	–	+	–	–	–
HL4/DESTRUCTION										–	–	–	–	–
HL5											–	–	–	–
HL5/DESTRUCTION												+	–	+
DESTRUCTION													+	+
FARMYARD														+
MODERN														

RIGHT VALVE MAXIMUM LENGTH

PHASE	1	2	3	4	5	6	7	8	9	10	11	12	13	14
C4		–	X	X	–	–	–	–	–	–	–	–	–	–
C5			–	–	–	–	–	–	–	–	–	–	–	–
C5/6				+	–	+	X	+	+	+	+	+	+	+
C6/HL5					+	–	+	–	–	–	–	–	–	–
HL1						–	–	X	+	X	+	+	+	–
HL2							–	–	–	–	+	–	+	–
HL3								–	X	X	+	+	+	–
HL4									–	–	+	+	+	–
HL4/DESTRUCTION										–	–	–	–	–
HL5											–	–	–	–
HL5/DESTRUCTION												+	–	+
DESTRUCTION													–	–
FARMYARD														–
MODERN														

LUDGERSHALL, EASTERN SECTOR HL4 PHASE COMPARISON OF MEASUREMENTS

TABLE 10

LEFT VALVE MAX. WIDTH

CONTEXT	13	11	19	12	16	21	32	17	14	18	15	20	23
13 C 21 (5)		–	–	S	O	–	–	O	S	–	–	–	–
11 B 23 (6)			–			–	+			+	–	–	+
19 H 26 (6)						–	+			+	–	–	–
12 B 23 (7)	S												
16 D 28 (7)	O												
21 J 13 (9) [1004]							–			–	–	X	–
32 J 13 (10) [1004]										–	–	+	+
17 F 21 (14)	O												
14 D 21 (15)	S												
18 F 21 (15)											–	+	–
15 D 21 (16)												X	–
20 H 26 [474]													+
23 GROUPED DATA													

LEFT VALVE MAX. LENGTH

CONTEXT	13	11	19	12	16	21	32	17	14	18	15	20	23
C 21 (5)		–	–	S	O	–	–	O	S	–	–	–	–
B 23 (6)			–			–	+			+	+	–	+
H 26 (6)						X	+			+	+	–	+
B 23 (7)	S												
D 28 (7)	O												
J 13 (9) [1004]							–			–	–	X	–
J 13 (10) [1004]										–	–	X	+
F 21 (14)	O												
D 21 (15)	S												
F 21 (15)											+	+	–
D 21 (16)												–	–
H 26 [474]													X
GROUPED DATA													

RIGHT VALVE MAX. WIDTH

CONTEXT	13	11	19	12	16	21	32	17	14	18	15	20	23
C 21 (5)		+	+	–	X	S	–	–	–	–	X	+	–
B 23 (6)			X	+	+		–	+	–	+	–	–	–
H 26 (6)				+	–		+	+	–	+	–	–	+
B 23 (7)					X		–	–	–	–	–	+	–
D 28 (7)							–	+	–	+	–	–	–
J 13 (9) [1004]	S												
J 13 (10) [1004]								+	–	–	–	+	–
F 21 (14)									–	–	X	+	X
D 21 (15)										–	–	–	–
F 21 (15)											X	+	X
D 21 (16)												–	–
H 26 [474]													+
GROUPED DATA													

RIGHT VALVE MAX. LENGTH

CONTEXT	13	11	19	12	16	21	32	17	14	18	15	20	23
C 21 (5)		+	X	–	–	S	–	–	–	–	–	+	–
B 23 (6)			–	+	–		+	+	–	+	–	–	X
H 26 (6)				+	–		+	+	–	+	–	–	+
B 23 (7)					+		X	–	–	–	–	+	+
D 28 (7)							–	+	–	+	–	–	–
J 13 (9) [1004]	S												
J 13 (6) [1004]								–	–	+	–	+	–
F 21 (14)									–	–	–	+	–
D 21 (15)										–	–	–	–
F 21 (15)											+	+	+
D 21 (16)												X	–
H 26 [474]													+
GROUPED DATA													

– NO SIGNIFICANT DIFFERENCE

\+ SIGNIFICANT DIFFERENCE

X SIGNIFICANT DIFFERENCE

S TOO SMALL A SAMPLE <5

O NO SAMPLE

among those samples with low numbers. The criterion for this was a dividing factor less than 30 and a t value between two and three. This kind of result has been denoted by a separate symbol on the charts.

The patterns of similarity and difference obtained were complex. It was hoped that all four measurements for a sample would give the same result for the same comparison. However, it was not surprising that they sometimes differed because the numbers of left and right valves for the same sample were often different and so were the number of width and length measurements since damage prevented some measurements being taken. Consequently, even with this fairly objective method of comparison some personal judgement was necessary to interpret the results. Generally, whichever comparison result was in the majority had to be used. Also the fact that left valve measurements tend to be less accurate gave weight to results from the right valves.

It was noted that there was a correlation of results between the length and width comparisons. It was decided to test the length/width relationship by linear regression to determine the degree of correlation. Details of this linear regression analysis are given later. A very good correlation between the two parameters was generally found. In future work, if this good relationship can be proved on a sample of shells at the beginning of analysis, it should be possible to take only one measurement for each valve. This would save a lot of time and simplify size comparisons. Although a constant relationship also exists between the right and left valves, with the right valve copying the shape of the left and tending always to be smaller, no use can be made of this to further cut back on work because the two valves of a pair rarely occur together.

The charts showing significant difference were here used to study samples of oyster shell from areas of Ludgershall Castle thought to be particularly interesting. Details of this follow. The meaning of the other patterns of similarity and difference was not fully investigated. Nevertheless, some mention must be made of the kinds of discoveries made after a brief examination of the charts. Some contexts were most distinct, for example, in D19 layer 9 (Destruction phase) 84% of possible comparisons of left valve maximum width showed a significant difference; in A21 layer5 LVMW (Destruction phase) 87% were significantly different ; and in A21 layer 3 LVMW (Farmyard phase) 77%.

Other contexts were noticeable in that they showed mostly no significant difference from other contexts, eg. LVM.V D21 layer 16 (HL4), J13 layer 9 feature 1004 (HL4), C11 layer 8 (Destruction) among others.

A look at the right valve comparisons of contexts from the Farmyard phase showed that shells from all contexts within a layer were alike but a significant difference existed between the layers except for layers 3 and 4 which were similar. It is hoped that these random examples have given an idea of the use of such comparisons in describing inter-site variability. They can also be used for inter-site comparability.

An aspect of the shape of the shell is reflected by the relationship between width and length. Linear regressions of length and width measurements of oyster shells shows that in most samples examined there was a very good relationship between the two values with an angle of slope often approaching 45° and correlation co-efficients nearly 1. Linear regressions for some samples in the South West and South East sectors can be seen in Table 13, and for the East sector in Table 14.

One would expect this regular relationship in neat rounded cultivated oysters where individuals are separated out at an early stage of development. It would be valuable to compare the correlation co-efficients of length/width of shells from a natural population, where shells exhibit a wide variety of shapes due to overcrowding during growth, with those from a cultivated population, to see how they relate. This might be a way of determining if archaeological shells came from a natural or cultivated population.

An examination of linear regression results from the East sector (Table 14) shows an interesting trend in that for smaller shells the left valve is wider than the right valve of the same length as one might expect, while for a larger than average shell the opposite is true with the right valve being wider than the left valve of the same length. This could be a natural phenomenon of growth related to the thickening of the shell with age or it could possibly be the result of trimming prior to transit. That part of the left valve that overlaps the right has been seen to be trimmed before packing for marketing in present day oysters.

LUDGERSHALL

SOUTH WEST SECTOR AND SOUTH EAST

LINEAR REGRESSION IN GROUPED DATA

TABLE 13

	n		SLOPE	CORRELATION CO-EFFICIENT	y - INTERCEPT
SOUTH WEST 12th CENTURY G.D.	16	L	0·871385	0·730357	15·728
	27	R	0·674046	0·706844	23·124835
SOUTH EAST POSTCASTLE DESTR.	44	L	0·940236	0·888665	9·305480
	49	R	1·029795	0·911273	3·620966
MODERN	38	L	0·869348	0·875388	12·945603
	53	R	0·961753	0·869266	9·471986

LUDGERSHALL

EAST SECTOR

LINEAR REGRESSIONS IN SELECTED SAMPLES

TABLE 14

	n		SLOPE	CORRELATION CO-EFFICIENT	Y-INTERCEPT
C4 G.D.	4	L	2.165468	0.812644	-67.546763
	6	R	1.130982	0.986504	-2.428212
C5 G.D.	3	L	0.994850		
	5	R	1.084465	0.972102	3.157118
C5/6 G.D.	11	L	0.415971	0.481722	43.150179
	17	R	1.097950	0.844794	2.064451
C5/HL5	8	L	0.780411	0.904078	16.751750
C15 (11) [67]	8	R	0.710351	0.712286	19.586811
HL1 G.D.	11	L	0.780600	0.773967	19.511862
	6	R	1.310627	0.847515	-6.838329
HL2 G.D.	28	L	0.628590	0.657366	30.146651
(incl. [442])	28	R	1.045800	0.868872	4.194182
HL3 G.D.	9	L	0.814458	0.836944	14.922892
	10	R	0.672291	0.747733	23.320604
HL4	37	L	0.753147	0.770445	20.668427
B23 (2)	33	R	1.030057	0.939409	6.917927
HL4	26	L	0.731754	0.752368	21.590753
J13 (10) [1004]	21	R	1.006299	0.934803	6.758092
HL5/D	1st 100	L	0.900563	0.881781	11.764628
A28 [472]	93	R	0.906994	0.847505	10.717134
DESTRUCTION	91	L	0.746668	0.870018	17.754368
C15 (7)	75	R	0.884928	0.952680	10.979281
L24 (3)	1st 100	L	0.782258	0.765658	17.984022
	87	R	0.916109	0.835817	11.718119
J13 (6) [1004]	88	L	0.722091	0.841860	20.678087
	92	R	0.877606	0.867066	12.266491
J13 (4) [1004]		L	0.926957	0.842272	11.066884
		R	0929956	0.888999	11.683L99
J24 (3)	44	L	0.943824	0.873372	8.952790
	65	R	0.953829	0.867932	8.417331
FARMYARD	31	L	0.573363	0.699982	30.851605
A28 (2)	32	R	1.122810	0.858034	1.095788
FARMYARD	34	L	0.591631	0.600825	25.223326
H21 [481]		R	1.045213	0.851369	4.728094
MODERN G.D.	43	L	0.746723	0.773486	20.800991
	42	R	0.863998	0.856407	15.358970

To sum up, in future analyses it would only be necessary to take one measurement , eg. maximum width, for each shell or maybe use a ratio such as width divided by length, if it was proved from a test sample that a good relationship existed between width and length. This would save time at the recording and analysis stages. There would be no need to draw graphs and histograms, but if graphs were required these should use the transformed or geometric means of samples. Since there is some question of reliability in small samples used in significance tests, then it could be argued that only samples of more than 30 should be used. Obviously, if shells are really numerous on a site, it would be advantageous to use samples of more than 100. It would also be advisable to use a computer more extensively particularly for plotting the charts of significant difference (a facility not available in the compilation of this report). Comparisons of small numbers of samples can be done manually.

COMPARISON OF INFESTATION

Evidence was found of various types of infesting or encrusting organisms on the oyster shells. These included: Polydora ciliata and Polydora hoplura which are marine polychaete worms that burrow into the shell, the burrow is typical for each species; Cliona celata, a boring sea sponge that leaves numerous small holes in the shell; Serpulid marine worms such as Pomatoceros triqueter and Hydroides norvegica which form hard, pale-coloured calcareous tubes of characteristic shape on the surface of the shell; Sabellid or fan worms that leave traces of muddy/sandy tubes on the shell but which may be under- represented due to cleaning prior to consumption of the oyster or following excavation; barnacles leaving attachment scars on the shell or being incorporated into the shell especially at the holdfast where they could be seen inverted; Polyzoa or sea mats which are minute tentacle-bearing animals occupying a colony of small compartments that appear as lacey or moss-like encrustations; drill holes, usually healed over, would have been caused by the European rough tingle Ocenebra erinacea (L.) or possibly the dog whelk Nucella lapillus (L.); Anomia ephippium Linnaeus, the saddle oyster, which attaches to the oyster by means of a short chalky stalk or byssus, was found sometimes still attached but usually only the byssi and separate valves were recorded (presence of saddle oysters may have been over-estimated); lastly, minute oyster spat were found on shells.

Organisms infesting oysters have certain preferences for water and sea-bed conditions. There is no need to elaborate here as details have already been published, (one useful reference is Hancock, 1974). Only the presence or absence of a character was recorded for each shell not the degree of infestation. Some shells exhibited evidence of more than one type of infestation but this is not apparent in the analysis. Tables were drawn showing the number of shells in which each infestation type was recorded for each phase of the site. Some of the sample sizes were very small and this complicated interpretation. To obtain a better idea of relative proportions, these numbers were expressed as a percentage frequency for the whole of the East sector sample, and percentage frequency for individual larger samples in the South East and East sectors.

The 67 shells of the South West sector were relatively free of infestation. Signs of Polydora ciliata were most frequently noted, 11.9% of all shells were affected. Polydora hoplura occurred to a lesser degree, 4.5% of all shells. There were occasional records of Cliona celata, calcareous tubes, barnacles, drill holes and saddle oyster (Table 15).

More shells were recovered from the South East sector, 261. Polydora ciliata was again the main infestation with 18.8% of all shells affected. Polydora hoplura followed in frequency with 11.1%. Drill holes were present in 7.7% . Cliona celata, calcareous tubes, barnacles and saddle oysters were present in small proportions (Table 16). In the larger samples from the Post-castle, Post-castle destruction and Modern phases there was a steady increase with time of the proportion of shells affected by Polydora ciliata. This is matched by a corresponding decrease in the abundance of Polydora hoplura. It would be interesting to determine whether this could be a reflection of a change of fishing locality or change of sea-bed conditions.

Overall in the East sector Polydora ciliata and Polydora hoplura are the commonest infestation and occur in almost equal quantities, 13.7% and 13.6% respectively. Drill holes are found in 8.1% of shells. Saddle oysters and oyster spat both appear 3.5% of shells. Small percentages of all other types of infestation were present (Table 17).

Examination of samples with more than 50 shells, and the combination of samples closely related in either time or origin provided a clearer picture of the pattern of infestation. Percentage frequencies of infesting forms can be seen in Tables 18 & 19 & FIG 8

LUDGERSHALL

TABLE 15

SOUTH WEST SECTOR

INFESTATION OF OYSTER SHELLS

COUNTS OF INFESTATION IN OYSTER SHELLS FROM THE SOUTH WEST SECTOR

	No. shells in sample	Polydora ciliata	Polydora hoplura	Cliona celata	Calcareous tube	Sand tube	Barnacle	Polyzoa	Drill hole	Saddle oyster	Oyster spat
12th century	46	6	3	0	0	0	2	0	1	1	0
Medieval clay spread	2	0	0	1	1	0	0	0	1	0	0
Late Med. chalk spread	6	0	0	1	0	0	0	0	0	0	0
Late Med. clay spread	1	1	0	0	0	0	0	0	0	0	0
Late - post Med. chalk spread	1	0	0	0	0	0	0	0	0	0	0
Post Medieval	2	0	0	1	0	0	0	0	0	0	0
Modern	9	1	0	0	0	0	0	0	0	0	0

LUDGERSHALL
SOUTH EAST SECTOR
INFESTATION OF OYSTER SHELLS

TABLE 16

COUNTS OF INFESTATION IN OYSTER SHELLS FROM THE SOUTH EAST SECTOR

	No. shells in sample	Polydora ciliata	Polydora hoplura	Cliona celata	Calcareous tube	Sand tube	Barnacle	Polyzoa	Drill hole	Saddle oyster	Oyster spat
Pre-castle	3	1	–	1	–	–	–	–	1	–	–
Timber 1 / Timber 2	1	–	1	–	–	–	–	–	–	–	–
Timber 2 / Post-castle	2	–	–	–	–	–	–	–	–	–	–
Timber 2 / Timber 3	0	–	–	–	–	–	–	–	–	–	–
Timber 3	9	1	1	–	–	–	–	–	1	–	–
Timber 3 / Timber 4	1	–	–	–	–	–	–	–	1	–	–
Timber 4	9	1	1	–	–	–	–	–	1	–	–
Timber 4 / Post-castle dest.	2	–	–	–	–	–	–	–	–	–	–
Post-castle	48	6	9	1	–	–	–	–	4	–	–
Post-castle destruction	93	16	10	4	–	–	4	–	6	5	–
Modern	91	24	7	2	1	–	–	–	6	2	–
Ditch fill	2	–	–	–	–	–	–	–	–	–	–

LUDGERSHALL

EAST SECTOR

TABLE 17

INFESTATION OF OYSTER SHELLS FROM THE EAST SECTOR

	No. shells in sample	Polydora ciliata	Polydora hoplura	Cliona celata	Calcareous tube	Sand tube	Barnacle	Polyzoa	Drill hole	Saddle oyster	Oyster spat
C1	0	–	–	–	–	–	–	–	–	–	–
C2	0	–	–	–	–	–	–	–	–	–	–
C3	0	–	–	–	–	–	–	–	–	–	–
C4	10	3	3	–	–	–	–	–	3	–	–
C5	8	4	–	–	–	–	–	–	–	–	–
C4/6	1	–	–	–	–	–	–	–	–	–	–
C5/6	28	5	3	–	–	–	–	–	2	–	–
C6	3	1	2	–	–	–	–	–	1	–	–
C6/HL5	16	–	1	–	–	–	2	–	–	–	3
C6/HL2	2	–	–	–	–	–	–	–	–	–	–
C7	5	1	2	–	–	–	–	–	–	–	–
HL1	17	3	4	1	–	–	–	–	2	–	–
HL2	56	7	6	2	1	4	–	–	–	4	1
HL3	21	3	4	–	–	–	–	–	3	2	2
HL3/HL4	1	–	–	–	–	–	–	–	–	–	–
HL4	307	61	26	1	3	1	10	3	21	2	8
HL4/Destruction	12	–	4	3	–	–	1	–	4	1	–
HL5	11	5	2	–	–	–	–	1	1	–	–
HL5/Destruction	196	5	38	–	–	–	–	–	13	2	6
Destruction	2021	266	263	39	20	11	50	22	178	87	81
Farmyard	457	75	79	12	4	0	6	12	33	11	11
Modern	87	9	6	–	3	–	–	2	5	4	1
Total numbers	3259	448	443	58	31	16	69	40	266	113	113
% of total		13·7	13·6	1·8	1·0	0·5	2·1	1·2	8·1	3·5	3·5

LUDGERSHALL
SOUTH EAST SECTOR
INFESTATION AS A PERCENTAGE OF INDIVIDUAL SAMPLES

TABLE 18

	Polydora ciliata	Polydora hoplura	Cliona celata	Calcareous tube	Sand tube	Barnacle	Polyzoa	Drill hole	Saddle oyster	Oyster spat
Post-castle	12·5	18·8	2·1	0	0	0	0	8·3	0	0
Post-castle destruction	17·2	10·8	4·3	0	0	4·3	0	6·5	5·4	0
Modern	26·4	7·7	2·2	1·1	0	0	0	6·6	2·2	0

LUDGERSHALL
EAST SECTOR
INFESTATION AS A PERCENTAGE OF INDIVIDUAL SAMPLES

TABLE 19

	Polydora ciliata	Polydora hoplura	Cliona celata	Calcareous tube	Sand tube	Barnacle	Polyzoa	Drill hole	Saddle oyster	Oyster spat
HL2	12·5	10·7	3·6	1·8	7·1	–	–	–	7·1	1·8
HL4	19·9	8·5	0·3	1·0	0·3	3·3	1·0	6·8	0·7	2·6
HL4/Destruction	–	33·3	25	–	–	8·3	–	33·3	8·3	–
HL4 + HL4/Destruction	19·1	9·4	1·3	1·0	0·3	3·4	1·0	7·8	1·0	2·5
HL5	45·5	18·2	–	–	–	–	9·1	9·1	–	–
HL5/Destruction	2·6	19·4	–	–	–	–	–	6·6	1·0	3·1
HL5 + HL5/Destruction	4·8	19·3	–	–	–	–	0·5	6·8	1·0	2·9
Destruction	13·2	13	1·9	0·9	0·5	2·5	1·1	8·8	4·3	4·0
Farmyard	16·4	17·3	2·6	0·9	–	1·3	2·6	7·2	2·4	2·4
Modern	10·3	6·9	–	3·4	–	–	2·3	5·7	4·6	1·1
Farmyard + Modern	15·4	15·6	2·2	1·3	–	1·1	2·6	7·0	2·8	2·2

FIG 8

LUDGERSHALL HISTOGRAMS TO SHOW %FREQUENCY OF INFESTATION TYPES FOR PHASES IN EAST SECTOR
EAST SECTOR

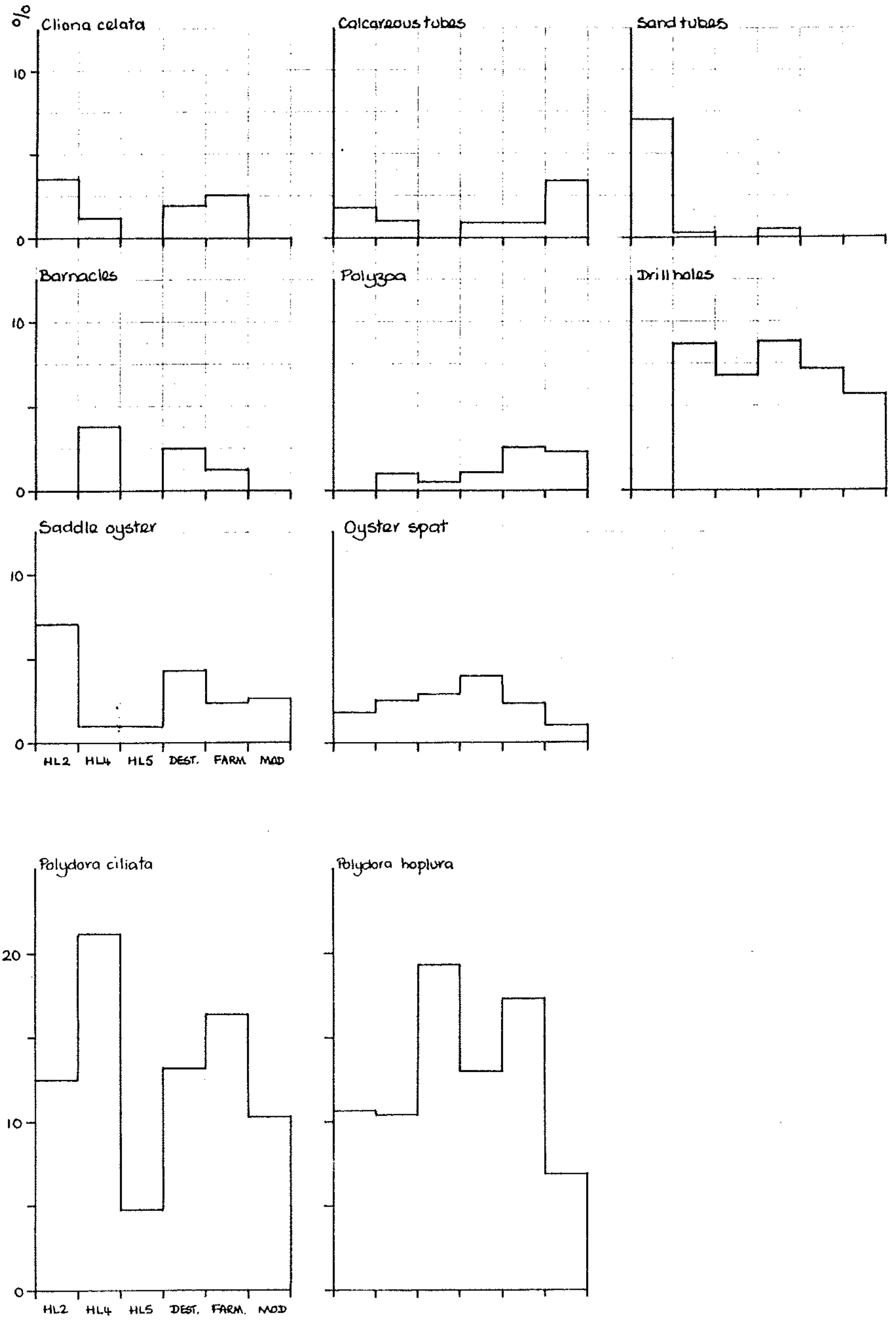


FIG 8

Whereas in most samples the two Polydora species were recorded in equal proportions, in HL4 phase P.ciliata predominated, and in HL5 phase P. hoplura is more marked. It can also be seen that HL5 and HL5/Destruction had a lower incidence of all types of infestation.

As organisms infesting or attaching themselves to oysters have preferred habitats, the study of the different combinations of these animals should provide a clue to the place where the oyster was bred. In the instance of Ludgershall Castle, Poole, Christchurch or the Solent seem likely places. Ecological data on the distribution of infesting organisms in Poole Harbour will be used to interpret the patterns of infestation in the massive deposits of oyster shell recently discovered in Poole. From their dating it seems likely that Poole could have been trading in oysters for a considerable period of time, perhaps even from the 6th century A.D. (Winder, forthcoming) Comparisons will then be possible with Ludgershall, Christchurch and perhaps Southampton.

OTHER MARINE MOLLUSCS

Only a few specimens of marine mollusc other than oyster were recovered. These were the edible mussel Mytilus edulis L., the cockle Cerastoderma edule (L.), winkle Littorina littorea (L.) and whelk Buccinum undatum L. Their numbers and distribution can be seen in Fig 9.

Some mussels and cockles were attached to oyster shells and were possibly cultch. Winkles occurred in insignificant numbers. The inclusion of the occasional winkle with oysters could possibly be accounted for if the oysters were held in storage pits on the shore prior to transit. These shallow pits, the use of which in oyster culture is documented from Roman times, may sometimes have had abundant growth of filamentous green weeds. A known method of control has been to place some ordinary winkles in the pit to browse on the weeds and other growths on the shells to keep them clean, (Cole, 1956).

There were two groups of mussels and one of whelks that might represent individual meals.

FIG 9

COUNTS AND DISTRIBUTION OF MARINE MOLLUSCS OTHER THAN OYSTER

	MUSSEL	COCKLE	WINKLE	WHELK
SOUTH WEST SECTOR				
12th century	–	3	1	–
Post medieval	1	–	–	–
SOUTH EAST SECTOR				
Timber 2/Timber 3	–	–	1	–
Timber 3	–	–	2	–
Post-castle destruction	1	–	–	–
Modern	–	2	–	–
EAST SECTOR				
HL2	1	–	–	–
HL4	18	4	–	16
HL5	3	–	–	–
Destruction	19	2	–	–
Farmyard	1	2	–	1
Modern	1	–	–	–

AREAS OF SPECIAL INTEREST

Certain latrine pits and the courtyard area of the East sector were examined to see whether the oyster shells differed from the rest of the site. There were few shells from the kitchen area; most of these came from layer 8 of the courtyard. Only one valve and fragment came from the Great Hall. The latrine pits feature 67, 442 and especially 1004 held most shells.

The sizes of shells from the courtyard area were compared with those from the latrine pits and all other contexts using the significant difference charts. There seemed to be no obvious distinction in size between the courtyard and the rest of the site, but there was some degree of difference between them and those from the latrine pits with the exception of layer 9 of feature 1004. There was no significant difference in size between the shells from all three pits. So there was some size distinction in shells from these three pits.

The shells from all layers of pit 1004 were very uniform in size. Statistically there was no significant difference in their measurements. Examination of the length/width ratio by linear regression for shells from layer 4 of this pit showed that left and right valves had almost identical slope, correlation co-efficient and y-intercept. This was not seen in any other sample and indicates a remarkable degree of uniform roundness in both valves.

Infestation did occur in shells from these areas. However, it has already been noted that the shells from HL5 and HL5/Destruction had the lowest incidence of infestation for all samples. These phases were mostly composed of shells from pit 442.

Shells from courtyard layers 8 and 28, pit 1004 layers 4 and 12, and pit 442 layer 15 were noted as frequently being of purplish or pinkish hue. Shells like these have been found in the Paradise Street excavations at Poole. The colour is believed to be an indicator of excellent condition. Iron stains and concretions are also recorded fairly often in pit 442 layer214, courtyard layer 45 and on all valves from pit 1004 layer 4. What this signifies is not understood.

GENERAL NOTE

Some evidence of opening and handling was observed. Four parallel cut marks were found on the inner surface of the left valve on shells from HL4 D19 layer 15, Destruction A21 layer 5 and Destruction J24 layer 3. These compare well with those illustrated from Saxon Southampton (Winder, 1980).

W-shaped notches were also found on the margins of the shell opposite the umbo in HL4 F21 layer 15 and Destruction J21 layer 6. These have also been recorded at Poole (Winder, forthcoming).

CONCLUSIONS

Counting the shells showed that abundance was greatest in the East sector and in the later phases. It was concluded that the right to left valve ratio could yield information about the nature of the deposit, ie whether the shells represented an individual meal, a series of such meals, waste from the kitchen or waste from the table. Here reference was made to work on other sites which tended to support this hypothesis.

A technique was evolved for comparing shell size in the most objective way possible and suggestions made on ways to save time in this proceedure for future analyses. This technique showed that there was a great deal of variability in the samples from Ludgershall. It is hoped that the archaeologist could use this more extensively to compare and contrast areas of the excavation.

The study of measurements and infestation attested to the fact that the courtyard area and certain pits (67,442 & 1004) contained shells which were of distinct size and appearance, and were distinguishable from shells found elsewhere on the site. They seemed to be specially selected top quality oysters.

All data from Ludgershall Castle oyster shells will be compared with that from other sites in order to find out where they came from.

ACKNOWLEDGEMENTS

I should like to acknowledge the assistance of Dave Cooling with the size analysis and Dr A.D.Berrie of the Freshwater Biological Association for provision of computer facilities.

BIBLIOGRAPHY

Cole, H A (1956a) Oyster Culture in Britain - a manual of current practice. HMSO

Coy, J P (1981a) Animal bones and shells fron excavations at Alton, Hampshire. Ancient Monuments Laboratory Report no. 3451

Hancock, D A (1974) Oyster pests and their control. Ministry of Agriculture, Fisheries and Food Laboratory Leaflet (New Series) no. 19.

Winder, J M (1980) in Excavations at Melbourne Street, Southampton, 1971 - 76, Southampton Archaeological Research Committee Report 1, Council for British Archaeology Research Report 33.

Winder, J M in Recent Excavations at Rockbourne 1978 - 1982 in Proceedings of the Hampshire Field Club, forthcoming.

Winder, J M in Excavations in Poole 1972 - , Dorset Natural History and Archaeological Society Monograph Series, Horsey, forthcoming.

ILLUSTRATIONS

LIST OF TABLES

LIST OF TABLES continued

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	A 28 (2)		–	S	–	–	+	–	–	–	–	–	–	–	S	–	–	–	–
2	H 19 (2)				–	–	X	X	–	–	–	–	–	+		–	–	–	–
3	H 21 (2)	S																	
4	H 23 (2)					–	+	X	–	–	–	–	–	X		–	–	–	–
5	N 19 (2)						+	+	–	–	–	–	–	+		–	–	+	–
6	A 21 (3)							–	–	X	–	X	–	–		–	–	+	+
7	L 26 (3)								–	X	–	–	–	–		–	–	+	–
8	D 19 (4)									–	–	–	–	–		–	–	–	–
9	D 28 (4)										–	–	–	+		–	–	–	–
10	F 21 (4)											–	–	–		–	–	–	–
11	H 23 (4)												–	X		–	–	–	–
12	L 26 (4)													+		–	–	–	–
13	D 19 (5)															–	–	+	+
14	F 19 (5)	S																	
15	J 21 (5)																–	–	–
16	Bauik F19/21 (5)																	–	–
17	H 21 [481]																		–
18	GROUPED DATA																		

RIGHT VALVE MAXIMUM WI

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	A 28 (2)		–	S	–	–	–	–	–	–	–	–	–	+	S	–	–	–	–
2	H 19 (2)				–	–	–	X	+	–	–	X	–	+		–	–	–	–
3	H 21 (2)	S																	
4	H 23 (2)					–	–	–	–	–	–	–	–	+		–	–	–	–
5	N 19 (2)						–	–	–	–	–	–	–	–		–	–	–	–
6	A 21 (3)							–	–	–	–	–	–	–		–	–	–	–
7	L 26 (3)								–	–	–	–	–	–		–	–	–	–
8	D 19 (4)								–	–	–	–	–	–		–	–	–	–
9	D 28 (4)										–	–	–	X		–	–	–	–
10	F 21 (4)											–	–	–		–	–	–	–
11	H 23 (4)												–	–		–	–	–	–
12	L 26 (4)													–		–	–	–	–
13	D 19 (5)															–	–	+	–
14	F 19 (5)	S																	
15	J 21 (5)																–	–	–
16	Bauik F19/21 (5)																	–	–
17	H 21 [481]																		–
18	GROUPED DATA																		

RIGHT VALVE MAXIMUM LE

LUDGERSHALL, EASTERN SECTOR, DESTRUCTION PHASE, COMPARISON OF MEASUREMENTS

TABLE 11a — LEFT VALVE MAXIMUM WIDTH

CONTEXT	Z15①	B23③ C28③ D24③ …					
Z15 ②	O	S S S S S	S		S	S	S
B23 ③	S						
C28 ③	S						
D24 ③		- + + + + + - - - x + x -	-	x - - - - - x + - - + - x -	-	- - - +	- - x - -
H19 ③		x x + + - - - - - + - -	-	- - - x - - - x - - + - - -	-	- - - +	- - + - -
H21 ③		- - - - x + + - - + +	+	- x - + + - - - - + - + - -	+	+ - x -	- - - - -
J17 ③		- - - + + + - - x +	+	- x - + + - - - - + - x - x	+	+ + x -	x - - - +
J24 ③		- - + + + - - - +	+	- + - + + - - + - + - + - -	+	+ + + +	- - - - +
L17 ③		- + + + - + - +	+	- - - + + - - - - + + + - -	+	+ - + +	- - - - +
L19 ③	S						
L24 ③		+ + + - x - +	+	- + - + + - - + - + + + - -	+	+ + + +	- - - - +
L24 ③ [18]		- - - + - -	-	- - - + - - - + - - + - + -	x	- - - +	- - + x -
N24 ③		- + + x -	+	x - x - - - + + x - + + + -	-	- + - +	- - + + +
A19 ④		x + x -	-	x - - - - - x + - - + - + -	-	- + - +	- - + + +
A24 ④		- - +	-	- - - + + - - - - x - - - -	+	+ - - x	- - - - -
A28 ④		+ +	+	+ x - + + - x - - + - + - +	+	+ + x -	+ - - - +
C15 ④		-	-	- - - + + x - x - - + - - -	+	+ - - +	- - + - -
J13 ④ 1004			-	+ - + - + - - + - - + - + -	+	- + - +	- - + + +
J17 ④	S						
J23 ④	S						
J24 ④				- - - + + - - + - - + - + -	+	- - - +	- - + + -
L17 ④	S						
L24 ④				- - + + - - + - + + - - -	+	+ - - +	- - + - -
N21 ④				- - - - - x - - x - - -	-	- - - +	- - + - -
A19 ⑤				+ x - - - - - - - - -	+	x - - x	- - - - -
[illegible]				x + + + + x + + + +	-	+ + x -	[illegible]
A21 ⑤				+ + + x - + + + -	-	- + - +	- - + + +
C15 ⑤				- - - - - - - -	+	- - - x	- - - - -
H21 ⑤				x - x x - - -	+	+ - - +	- - + - -
J24 ⑤				- + - x - x	+	+ + x -	x - - - +
L17 ⑤				- - - - -	+	x - - x	- - - - -
L24 ⑤				+ - + -	x	- - - +	- - + x -
A21 ⑥				+ + x	+	+ + x -	+ - - - +
F21 ⑥				+ -	+	+ - - +	- - + + -
J13 ⑥ [1004]				-	+	+ - - +	- - - - -
J21 ⑥					-	- - - +	- - - - -
J24 ⑥							
L24 ⑥	S					x + - +	+ - + + +
L24 ⑥ [22]							
N19 ⑥	S					+ - +	- - + + +
A21 ⑦						- +	- - + - -
C15 ⑦						+	- - + - -
C11 ⑧							+ - - x +
D19 ⑨							
F19 ⑩	S						- + - -
F19 ㉑							- - -
A21 [406]							- x
D26 [454]							-
J21 [393]							
GROUPED DATA							

- NO SIGNIFICANT DIFFERENCE
+ SIGNIFICANT DIFFERENCE
x SIG. DIFF. BUT STATISTICS LESS RELIABLE
S TOO SMALL A SAMPLE < 5
O NO SAMPLE

TABLE 11a

LUDGERSHALL, EASTERN SECTOR, DESTRUCTION PHASE, COMPARISON OF MEASUREMENTS

TABLE 11 b , LEFT VALUE MAXIMUM LENGTH

CONTEXT	76	36	42	44	49	50	54	59	63	66	67	68	75	28	34	35	38	52	55	58	60	64	69	74	29	30	39	51	61	65	70	31	48	53	56	62	71	72	73	32	40	37	43	46	41	47	33	45	57	77
76 Z 15 (2)	O	S	S							S									S	S		S															S		S					S	S					
36 B 23 (3)	S																																																	
42 C 28 (3)	S																																																	
44 D 24 (3)					−	+	+	+	+		+	−	−	−	x	−	−	−			−		−	−	−	x	−	−	−	−	−	−	−	−	−	−		−		−	−	−	+			−	−	−	+	+
49 H 19 (3)						−	x	−	−		−	−	−	x	−	+	−	−			−		−	−	−	+	x	−	−	x	−	−	x	−	−	−		+		−	−	−	x			−	−	−	−	−
50 H 21 (3)							−	−	−		−	−	x	+	−	−	+	+			+		−	−	−	+	+	−	−	−	−	+	−	+	−	−		+		+	+	−	−			x	−	−	−	−
54 J 17 (3)								+	−		+	+	+	+	−	−	+	+			+		x	x	x	+	+	x	−	−	−	+	−	+	+	x		+		+	+	x	−			+	−	−	+	+
59 J 24 (3)									−		−	+	+	+	−	x	+	+			+		−	+	−	+	+	−	−	−	−	+	−	+	−	−		+		+	+	−	−			+	−	+	−	+
63 L 17 (3)											−	−	+	+	−	−	+	+			+		−	+	−	+	+	−	−	−	−	+	−	+	−	−		+		+	+	−	−			+	−	−	−	+
66 L 19 (3)	S																																																	
67 L 24 (3)												−	+	+	−	+	+	+			+		−	+	−	+	+	−	−	−	−	+	−	+	−	−		+		+	+	−	−			+	−	x	−	+
68 L 24 (3) [18]													−	x	−	+	−	−			−		−	−	−	+	x	−	−	+	−	−	x	−	−	−		+		−	−	−	x			−	−	+	x	−
75 N 24 (3)														−	x	+	−	−			−		−	−	−	x	−	−	−	+	−	−	+	−	+	−		−		−	−	−	+			−	−	x	x	−
28 A 19 (4)															+	+	−	+			+		+	−	x	−	−	x	+	+	x	−	+	−	+	x		−		−	−	−	+			−	−	+	+	+
34 A 24 (4)																−	+	+			+		−	−	+	+	+	−	−	−	−	+	−	+	−	−		+		+	−	−	−			x	−	−	−	−
35 A 28 (4)																	+	+			+		+	x	+	+	+	−	−	−	−	+	−	+	+	+		+		+	+	−	−			+	−	−	−	+
38 C 15 (4)																		−			−		−	−	−	+	+	−	+	+	−	−	+	−	+	−		+		−	−	−	+			−	−	+	+	−
52 J 13 (4) [1004]																					−		+	−	−	+	+	−	+	+	−	−	+	−	+	−		+		−	−	−	+			−	−	+	+	+
55 J 17 (4)	S																																																	
58 J 23 (4)	S																																																	
60 J 24 (4)																							−	−	−	+	−	−	−	+	−	−	+	−	−	−		+		−	+	−	+			−	−	+	+	−
64 L 17 (4)	S																																																	
69 L 24 (4)																								−	−	+	+	−	−	x	−	+	x	−	−	−		+		+	−	−	−			−	−	−	−	−
74 N 21 (4)																									−	−	−	−	−	x	−	−	x	−	−	−		−		−	−	−	x			−	−	+	x	−
29 A 19 (5)																										+	+	−	−	x	−	−	x	−	−	−		+		−	−	−	−			−	−	+	−	−
30 A 21 (5)																											−	+	+	+	+	x	+	+	+	+		−		+	+	x	+			x	x	+	+	+
39 C 15 (5)																												+	+	+	+	−	+	+	+	x		−		+	+	x	−			−	−	+	+	+
51 H 21 (5)																													−	−	−	x	−	−	−	−		+		−	−	−	−			−	−	−	−	−
61 J 24 (5)																														−	−	+	−	+	−	−		−		+	−	−	−			−	−	−	−	−
65 L 17 (5)																															−	+	−	x	+	x		+		+	+	+	−			+	−	−	−	+
70 L 24 (5)																																+	−	−	−	−		+		−	−	−	−			−	−	−	−	−
31 A 21 (6)																																	+	−	+	−		−		−	−	−	+			−	−	+	+	+
48 F 21 (6)																																		+	−	x		+		+	+	−	−			+	−	−	−	+
53 J 13 (6) [1004]																																			+	−		+		−	−	−	−			−	−	−	+	+
56 J 21 (6)																																				−		+		+	+	−	−			x	−	+	−	−
62 J 24 (6)																																						+		−	−	−	x			−	−	−	−	−
71 L 24 (6)	S																																																	
72 L 24 (6) [22]																																								x	+	x	+			−	−	+	+	+
73 N 19 (6)	S																																																	
32 A 21 (7)																																									−	−	+			−	x	+	+	+
40 C 15 (7)																																										−	+			−	−	+	+	−
37 C 11 (8)																																											−			−	−	−	−	−
43 D 19 (9)																																														+	−	−	−	−
46 F 19 (10)	S																																																	
41	S																																																	
47 F 19 (21)																																															−	+	x	−
33 A 21 [406]																																																−	−	−
45 D 26 [454]																																																	−	+
57 J21 [393]	S																																																	
77 GROUPED DATA																																																		

−. NO SIGNIFICANT DIFFERENCE

\+ SIGNIFICANT DIFFERENCE

X SIG. DIFF. BUT STATISTICS LESS RELIABLE

S TOO SMALL A SAMPLE < 5

O. NO SAMPLE

LUDGERSHALL, EASTERN SECTOR, DESTRUCTION PHASE, COMPARISON OF MEASUREMENTS

TABLE 11C

RIGHT VALVE MAXIMUM WIDTH

CONTEXT	
Z 15 (2)	− − − O − − + X + + X − S S − − − X − − X X S − X − + − − X − S X + − X − + − + X S + S − + S X
B 23 (3)	− − − − − − X − − − − − − − − − − − − − + − − − − − − − − − − − X − − − + + − − −
C 28 (3)	− − − − − X − − − − − − X − − − X − X − − − − − − − − + − − − X − − X X − X −
D 24 (3)	− − + + X − − − X − − X − − X + − − − X − − X − − + − − − X − − − − − X −
H 19 (3)	O
H 21 (3)	− + − X − − − − − − X − − − + − + − X − − X − − + − − X X X + + + − + −
J 17 (3)	− − − − − − − − X − − − − − − − + − − − − − − − − − − − − X X − + − − − −
J 24 (3)	− + + − + + + + − − + − − + + + − + − − − + − − − + − + − + + − − +
L 17 (3)	+ − − − − + + − − − − − − + + − − − − − − − − − + − + − + + − − −
L 19 (3)	+ X X − + + − − − − − + + + − X − − − + + X − + − + X + + + − +
L 24 (3)	− − − + + + − − − − − + + − − − − − − − − − − + − + − + + − − −
L 24 (3) [18]	− − + − − − − − − − − + − − − − − − − − − − − X − + − + + − − −
N 24 (3)	− − − X − − − X − − − − − − − − − − − − − − − − − − − X − X −
A 19 (4)	S
A 24 (4)	S
A 28 (4)	+ + − − − − + − + − − − − − − − − − − − + − + − + + − − −
C 15 (4)	− + X + + + − − − + − + X − + + − X − X − + − + X + +
J 13 (4) [1004]	+ − − + + − + − + − + − − − + − − + − − + + + − + +
J 17 (4)	X + − − X + + − − − − − − + − − − + − + − + + − − +
J 23 (4)	− − − − + − − − − − − − − − − − + − X + + + − − −
J 24 (4)	− + − + − − − − − − − − + − − + − + − + + − + −
L 17 (4)	− X + + − − − − − − − − − − + − + − + + − − −
L 24 (4)	+ + + − − − − − − + − − − + − + − + + − − +
N 21 (4)	S
A 19 (5)	X − + − + − − − X − − X − − + X + + + −
A 21 (5)	+ + X + + − + + + + − + − + − X + + +
C 15 (5)	+ − − X − − + − + + + − + + + − + −
H 21 (5)	− − − − + − − − + − + − + + − − −
J 24 (5)	− − − − − − − − − − − − − + − + −
L 17 (5)	− X − − − − + − X − + + − − −
L 24 (5)	− − − − − + − + − + + − X −
A 21 (6)	− − − − − − − − − − X − − −
F 21 (6)	S
J 13 (6) [1004]	+ − − + − + + + + − − −
J 21 (6)	− − + − + − + + − − +
J 24 (6)	− X − − − + + − − −
L 24 (6)	+ − X − + + − − −
L 24 (6) [22]	− − + − − + + +
N 19 (6)	+ − + + − − −
A 21 (7)	+ − X X + +
C 15 (7)	+ + − − +
C 11 (8)	− + + +
D 19 (9)	S
F 19 (10)	+ + +
F 19 (21)	S
A 21 [406]	− −
D 26 [454]	X
J 21 [393]	S
GROUPED DATA	

− NO SIGNIFICANT DIFFERENCE

+ SIGNIFICANT DIFFERENCE

X SIG. DIFF. BUT STATISTICS LESS RELIABLE

S TOO SMALL A SAMPLE < 5

O NO SAMPLE

LUDGERSHALL, EASTERN SECTOR, DESTRUCTION PHASE, COMPARISON OF MEASUREMENTS

TABLE 11d

RIGHT VALVE MAXIMUM LENGTH

CONTEXT	Comparisons
Z 15 (2)	- - - O - x + - + - - - S S - - - + x - x x S - - - - - - - - S - - - - - + - x - S x S - x S -
B 23 (3)	- - - - - - x - - - - x - x - - - - - + + - - - - - - - - - - + - + - + + - - -
C 28 (3)	- - - - - - - - - - - - - - - - - - - + - - - - - - - - - - - x - - - - + - - -
D 24 (3)	- x + - + - - - - - - + x - x x - - - - - - - - - - - - - - + - x - x - x -
H 19 (3)	O
H 21 (3)	- + - + - - - - - - x - - - + - + - - - - - - - - - - - x - - - x + - + -
J 17 (3)	- - - - - - - - + x - - - - - x + + - - - - - - x - - - + - + - + + - - -
J 24 (3)	- - - - - - - + + - - - - - + + + - + - - - + - - - + - + - + + - - +
L 17 (3)	+ - - - - + - + - - - - - + + - - - - - - - - - - + - + - + + - + -
L 19 (3)	+ - x - + + - - + - - + + + - x - - - + - x - + - + - + + x - +
L 24 (3)	- - - + + - - - - - + + + - - - - - + - - - + - + - + + - + +
L 24 (3) 18	- - + - - - - - - - + + - - - - - - - - - - x - + - x + - - -
N 24 (3)	- - - x - - - x - x - - - - - - - - - - - - - - - - - x - x -
A 19 (4)	S
A 24 (4)	S
A 28 (4)	- - - - - - - - - + - - - - - - - - - - - x - - - x + - - -
C 15 (4)	- + x + + + - + - + - + x - + + - x - x - + - + - + +
J 13 (4) 1004	+ - - - + - + - - - + - - - + - - + - - + + + - + -
J 17 (4)	- + - - x + + - - - - - - + - - - + - - + - + + x - -
J 23 (4)	- - - - + + - - - - - - - - - - + - x - + + - - -
J 24 (4)	- - - + + - - - - - - - - - - + - + - + + - + -
L 17 (4)	- x + + - - - - - - + - - - + - + - + + - - -
L 24 (4)	+ + + - + - - - + - - - + - + - + - - - x
N 21 (4)	S
A 19 (5)	+ - - - - - - - - + - - - - - - x + - + -
A 21 (5)	+ + x + + - + + + + - + - + - - + + +
C 15 (5)	+ - + + - + + - + - + - + - + - - +
H 21 (5)	- - - - - - - - + - x - + + - - -
J 24 (5)	- - - - - - - - - - - - + - + -
L 17 (5)	- - - - - - x - x - x + - - -
L 24 (5)	- - - - - + - x - + + - - -
A 21 (6)	- - - - - - - - - - - - -
F 21 (6)	S
J 13 (6) 1004	+ - - + - - - + + - + -
J 21 (6)	- - + - + - + + - - +
J 24 (6)	- x - - - - + - + -
L 24 (6)	+ - - - x + - - -
L 24 (6) 22	+ - + - - x + +
N 19 (6)	+ - + + - - -
A 21 (7)	+ - + - - -
C 15 (7)	+ + - - -
C 11 (8)	- x + +
D 19 (9)	S + + +
F 19 (10)	
F 19 (21)	S - -
A 21 406	+
D 26 454	
J 21 393	S
GROUPED DATA	

- NO SIGNIFICANT DIFFERENCE

\+ SIGNIFICANT DIFFERENCE

X SIG. DIFF. BUT STATISTICS LESS RELIABLE

S. TOO SMALL A SAMPLE <5

O NO SAMPLE