Western Australia

FISHERIES DEPARTMENT

REPORT II

PRELIMINARY REPORT

ON THE

EFFECTIVENESS OF ESCAPE-GAPS

IN

CRAYFISH-POTS

By

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I - INTRODUCTION

The Western Australian commercial crayfish, Panulirus cygnus George, (1962)*, is caught in depths ranging from a few feet to approximately 45 fathoms. In the shallow waters large numbers of crayfish measuring less than the legal minimum length are brought to the surface in the standard commercial crayfish pots. The law requires that these undersize crayfish be returned to the sea, but there is always the temptation to retain them for illegal sale. In addition, the undersize crayfish which are returned to the sea are often damaged by handling. The probability is that their mortality rate is higher than those which are not caught.

One method of lessening the taking of undersize crayfish is to use pots with escape gaps. However, for such a method to be successful the crayfish must either look for an escape route after feeding or be forced towards an escape gap as the pot is being pulled to the surface. Field experiments were carried out during March, 1963, using normal and escape-gap pots to obtain information on these points. At the same time, underwater observations were made on the behaviour of crayfish in pots as they were being hauled to the surface.

II - METHODS

The work was carried out on fishing grounds approximately one mile north of Rat Island, Houtman Abrolhos, during the period February 28 to March 16, 1963. The vessel used was the Fisheries Department's r.v. "Lancelin" skippered by C.J. Seabrook. Crew members were C.R.C. Haynes and P.A. Smith. Assistance was given by technical officers R.J. McKay and J.S. Simpson.

Preliminary underwater observations on the behaviour of crayfish in pots with escape-gaps were made using self contained underwater breathing apparatus (SCUBA).

Twenty five cray-pots were used and they were pulled and rebaited daily. The pots were of four kinds :-

(i) Twelve normal "beehive" pots (Brownfield, 1953) similar to those used in commercial fishing operations. The gaps between the woven strands of spearwood did not exceed $1\frac{1}{2}$ in.

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* Panulirus longipes of Western Australia renamed.

(ii) Four "beehive" pots with escape gaps of $1\frac{3}{4}$ in.

(iii) Four "beehive" pots and two batten pots (Brownfield, 1953) with escape gaps of 2 in.

(iv) Three "beehive" pots with escape gaps of $2\frac{1}{4}$ in.

Except in those pots used for the preliminary observations the escape gaps were rectangles measuring 12 in. in length and $1\frac{3}{4}$ in., 2 in. or $2\frac{1}{4}$ in. in depth. They were constructed of $\frac{3}{8}$ in. mild steel rod and laced into the side of the trap close to the base. No attempt was made to select the pots set on any particular ground. They were merely taken "as they came" from the pots which lay on the deck of the ship. By doing this, experimental error was reduced to a minimum.

Length measurements were recorded in mm. and refer to the carapace as measured in accordance with the method prescribed by the Fisheries Act, 1905-1962, i.e., along the mid-dorsal line from the anterior edge of the pronounced ridge which joins the front edges of the rostral horns immediately posterior to the eye stalks, to the posterior margin of the carapace. Measurements were made to the nearest mm. below, e.g., crayfish measuring between 76.0 and 76.9 mm. were recorded as 76 mm. The legal minimum length for crayfish is 3 in., which, for all practical purposes, may be regarded as being equal to 76 mm.

The carapace depth was obtained by passing the crayfish through a grader. The grader was of ladder-like construction with varying spaces between the rungs. These spaces ranged from $1\frac{3}{4}$ in. to $2\frac{1}{4}$ in. in intervals of $\frac{1}{8}$ in. The depth measurements were recorded in inches (instead of mm.) to allow easy comparison with the escape gaps.

III - PRELIMINARY OBSERVATIONS

On February 28, eight double-pot sets were made. This consisted of the setting of one normal pot and one pot with an escape gap varying from $2\frac{1}{2}$ to $3\frac{1}{2}$ in. The following day the sets were pulled. Fifty-six crayfish were taken from the normal pots and one from those with escape gaps. This suggested that the crayfish were not remaining on the bait after feeding, but were either seeking an escape route or being forced through the gap as the pots were being hauled to the surface.

To gain information on this point a second double set of rebaited pots was made. The following morning dives were made by team personnel to observe the pots before they were pulled. There were 31 crayfish in the normal pots but not one crayfish in the escape gap pots. The pots

were closely watched while being hauled to the surface. There was no sign of panic on the part of the crayfish, but they gradually moved down the sides to the end opposite the hauling point. It seems evident from the observations that crayfish which do escape do so before the pots commence their movement to the surface.

IV - RESULTS

(a) Length Frequency

A total of 1416 crayfish were captured by normal and escape gap pots during the period March 6 to 16. As the number of pot-hauls were different for each group of pots, the frequencies have been transformed to the catch per 30 pot-hauls. The data are set out in Table I and shown in Fig. I.

TABLE I.

LENGTH FREQUENCIES OF CRAYFISH CAUGHT IN NORMAL AND ESCAPE-GAP POTS, RAT ISLAND, HOUTMAN ABROLHOS, MARCH 6 TO 16.

Carapace Length	Normal		$1\frac{3}{4}$-in. escape gap		2-in. escape gap		$2\frac{1}{4}$-in. escape gap	
5 mm. intervals	No.	No. per 30 pot-hauls	No.	No. per 30 pot-hauls	No.	No. per 30 pot-hauls	No.	No. per 30 Pot-hauls
Less than 61	14	3	2	2	-	-	-	-
61 -	120	29	37	36	-	-	-	-
66 -	279	68	71	69	22	15	-	-
71 -	324	79	91	88	102	67	4	4
76 -	129	31	21	20	38	25	23	26
81 -	55	13	4	4	12	8	22	24
86 and greater	31	8	1	1	9	6	5	6
Total	952	231	227	220	183	121	54	60
No. of hauls	123		31		46		27	

The length frequencies of the crayfish caught in the normal and $1\frac{3}{4}$-in. escape-gap pots were similar. However, pots with a 2-in. escape-gap caught no crayfish less than 66 mm. in carapace length and the $2\frac{1}{4}$-in. pots caught only four undersize crayfish per 30 pot hauls. Although the numbers of undersize crayfish differed considerably, a homogeneity test did not reveal a significant difference (at 1% level only) in the numbers of legal-size crayfish caught in the size ranges 76-80 mm, 81-85 mm, and 86 mm. and over ($X^2 = 14{\cdot}06$, 6d.f.).

(b) Carapace Depth

(i) Normal Pots. The crayfish caught in the normal pots during the period March 7 to 15 were measured for depth by means of the grader. Of the 29 crayfish with a carapace measurement of 76 mm., 23 had a depth of 2 in. and 6 had a depth of $2\frac{1}{8}$ in. (Table 2). The crayfish with larger carapace measurements also had depths of 2 in. or greater. Crayfish with a depth of 2 in. or greater are unable to escape through a 2-in. gap. Therefore, from the data obtained, crayfish with carapace lengths of 76 mm. or greater would have been retained by a 2-in. escape gap. In addition, at least theoretically, all crayfish with a depth less than 2 in. would escape through a 2-in. gap. This means that crayfish less than 67 mm. in carapace length would have escaped capture (Table 2). A small percentage of the 67 mm. crayfish would have been retained and this percentage would gradually have risen until at 76 mm. all crayfish would have been retained. A theoretical selection curve showing the percentage of crayfish likely to be retained at each carapace length can, therefore, be drawn for 2-in. escape-gap pots (Fig 2). Similar curves can be drawn for escape gaps measuring $1\frac{3}{4}$ in. and $2\frac{1}{8}$ in. (Fig. 2).

(ii) Escape-gap pots. The crayfish caught in the escape-gap pots were also measured for maximum depth and compared with the catch by normal pots (Table 3). In the $1\frac{3}{4}$-in. pots, three crayfish with a depth less than $1\frac{3}{4}$ in. were retained. The 2-in. escape-gap pots retained 3 crayfish with a depth less than 2 in. and the $2\frac{1}{4}$-in. pots retained 38 crayfish which could have escaped. However, most of the crayfish which could have escaped, but remained in the pots, were of a depth just below the particular size of the escape gap. It is quite clear that the use of a gap does cause a marked difference in the size frequency of crayfish caught. (Fig. 3).

TABLE 2.

JOINT FREQUENCY DISTRIBUTION OF CARAPACE LENGTHS AND DEPTHS OF CRAYFISH CAUGHT IN NORMAL POTS, RAT ISLAND, HOUTMAN ABROLHOS, MARCH 7 TO 15.

Carapace Length	Depth ($\frac{1}{8}$ in. intervals)						
m.m.	less than $1\frac{3}{4}$	$1\frac{3}{4}$	$1\frac{7}{8}$	2	$2\frac{1}{8}$	$2\frac{1}{4}$	$2\frac{3}{8}$
57	1						
58	1						
59	3						
60	2						
61	8	1					
62	8	4					
63	5	14					
64	7	21	1				
65		27	2				
66		31	7				
67		23	18	4			
68		16	31	5			
69		16	27	8			
70		4	22	10			
71		3	17	35			
72			10	41			
73			6	38	2		
74			4	43	2		
75			1	45	5		
76				23	6		
77				11	14		
78				8	19	1	
79				3	13	1	
80				1	13	-	
81				2	3	2	1
82				1	6	1	-
83					1	4	-
84					3	2	3
85					2	4	3
86						2	3
87						1	3
88						1	2
89							1
90							2
91							1

TABLE 3.

DEPTH FREQUENCIES OF CRAYFISH CAUGHT IN NORMAL AND ESCAPE-GAP POTS, RAT ISLAND, HOUTMAN ABROLHOS, MARCH 6 TO 16. NUMBERS REDUCED TO 30 POT-HAULS.

Carapace Depth $\frac{1}{8}$in. intervals	Normal	$1\frac{3}{4}$-in. escape gap	2-in. escape gap	$2\frac{1}{4}$-in. escape gap
	No.	No.	No.	No.
Less than $1\frac{3}{4}$	14	3	-	-
$1\frac{3}{4}$ -	48	49	1	-
$1\frac{7}{8}$ -	44	41	7	-
2 -	83	108	82	7
$2\frac{1}{8}$ -	28	13	18	31
$2\frac{1}{4}$ -	6	1	7	12
$2\frac{3}{8}$ -	6	4	5	10
$2\frac{1}{2}$ and greater	2	1	1	-
Total	231	220	121	60

(c) Selection curve from comparison of catches.

The selective action of different mesh-size cod-ends in trawl nets has been studied by comparing the length frequency of the fish caught in the two nets (cf. Beverton and Holt, 1957). If the length frequency of the fish caught in the smaller mesh can be regarded as a true index of the length distribution of the population over the selection range of the larger mesh, then the ratio of the catches per unit of effort allows a selection curve to be drawn.

The length frequencies of the crayfish caught in the 2-in. escape-gap pots and the normal pots have been treated in a similar manner to obtain the selection curve for 2-in. pots (Table 4). With the exception of the upper portion, this curve is in good agreement with the theoretical curve calculated from the carapace-depth measurements (Fig. 4). The theoretical curve gives 100% selection at 76 mm. carapace length compared with 72 mm. for the experimental curve. This difference could be due either to experimental error or to a reluctance on the part of crayfish just able to pass through a 2-in. gap to do so.

TABLE 4.

LENGTH FREQUENCIES OF CRAYFISH OVER THE RANGE 65 TO 75 mm. CAUGHT IN NORMAL AND 2in. ESCAPE-GAP POTS, RAT ISLAND, HOUTMAN ABROLHOS, MARCH 6 TO 16. NUMBERS REDUCED TO 46 POT-HAULS

Carapace Length	Normal	2-in. escape gap	2-in. pots x 100 / Normal Pots.
m.m.	No.	No.	%
65	20	-	0
66	24	3	13
67	19	2	11
68	26	5	19
69	16	2	13
70	30	10	33
71	23	14	61
72	21	24	114
73	25	26	104
74	22	26	118
75	15	12	80

V - DISCUSSION

Providing escape gaps are a successful means of allowing small crayfish to escape capture, there are a number of advantages to be obtained from their use: (a) the saving of time in picking out undersize crayfish from the catch; (b) the minimising of injuries to small crayfish and, therefore, a probable decrease in the natural mortality rate; (c) a probable reduction in the number of small crayfish eaten by predators as the crayfish slowly sink to the bottom or lie on the bottom during daylight hours in unprotected areas; and (d) the lessening of the number of undersize crayfish available to those fishermen who wish to retain them for illegal purposes. Although advantage (d) theoretically exists, it would be a simple matter for a fisherman who wished to catch undersize crayfish to cover the escape gaps. The use of escape gaps in lobster traps is law in Newfoundland and Templeman (1958) gives a similar list of advantages to be obtained from their use.

Experiments carried out with normal and escape-gap pots showed that the length frequency of crayfish caught depends upon the escape gap. The normal and $1\frac{3}{4}$-in. escape-gap pots caught approximately the same number of undersize crayfish per unit of effort; the 2-in. pots caught less undersize crayfish, and the $2\frac{1}{4}$-in. pots caught less still.

It is evident that crayfish seek an escape route after feeding. It seems that few, if any, are forced through the gap while the pot is being hauled to the surface.

Carapace depth measurements have shown that, in the sample of crayfish tested, legal size crayfish (76 mm. and above) are unable to pass through a 2-in. gap. However, a gap of this width also retains crayfish well below the minimum legal size. It is interesting to note that although a $2\frac{1}{4}$-in. gap allowed some crayfish up to 85 mm. in length to escape, this group of pots did not catch a smaller number of legal size crayfish than the other pots. In fact, the $2\frac{1}{4}$-in. pots caught more legal size crayfish per unit of effort than the other pots. At the same time the difference was not highly significant.

The selection curve obtained by comparing the catches of the 2-in. pots and the normal pots differed from the theoretical curve in the range 72 to 76 mm. Crayfish which could have forced their way through the escape gaps remained in the pots. In practice, therefore, an escape gap of $2\frac{1}{8}$ in. may now allow any crayfish of or above legal size to escape capture. Further experimental fishing with normal and escape-gap pots would help to resolve this point.

During the experiments carried out the number of crayfish caught per pot was usually less than 10. However, during the "white" crayfish season (George, 1958), and on the shallow reefs, catches of 30 to 40 crayfish are common. It is not known what effect crowding of this nature would have on the efficiency of an escape gap. Work on this aspect is necessary.

VI - CONCLUSIONS

The following conclusions can be drawn from the study.

(1) Escape gaps do allow small crayfish to escape capture.

(2) The escape occurs before commencement of the haul to the surface.

(3) The theoretical minimum carapace length for 100% retention of crayfish in 2-in. escape-gap pots is 76 mm. The 100% retention length found in field experiments is 72 mm.

(4) At this stage, it is not possible to state whether or not escape gaps would be successful if each pot were catching large quantities of crayfish e.g., during the flush of the "white" crayfish season or on shallow reefs.

VII - ACKNOWLEDGEMENTS

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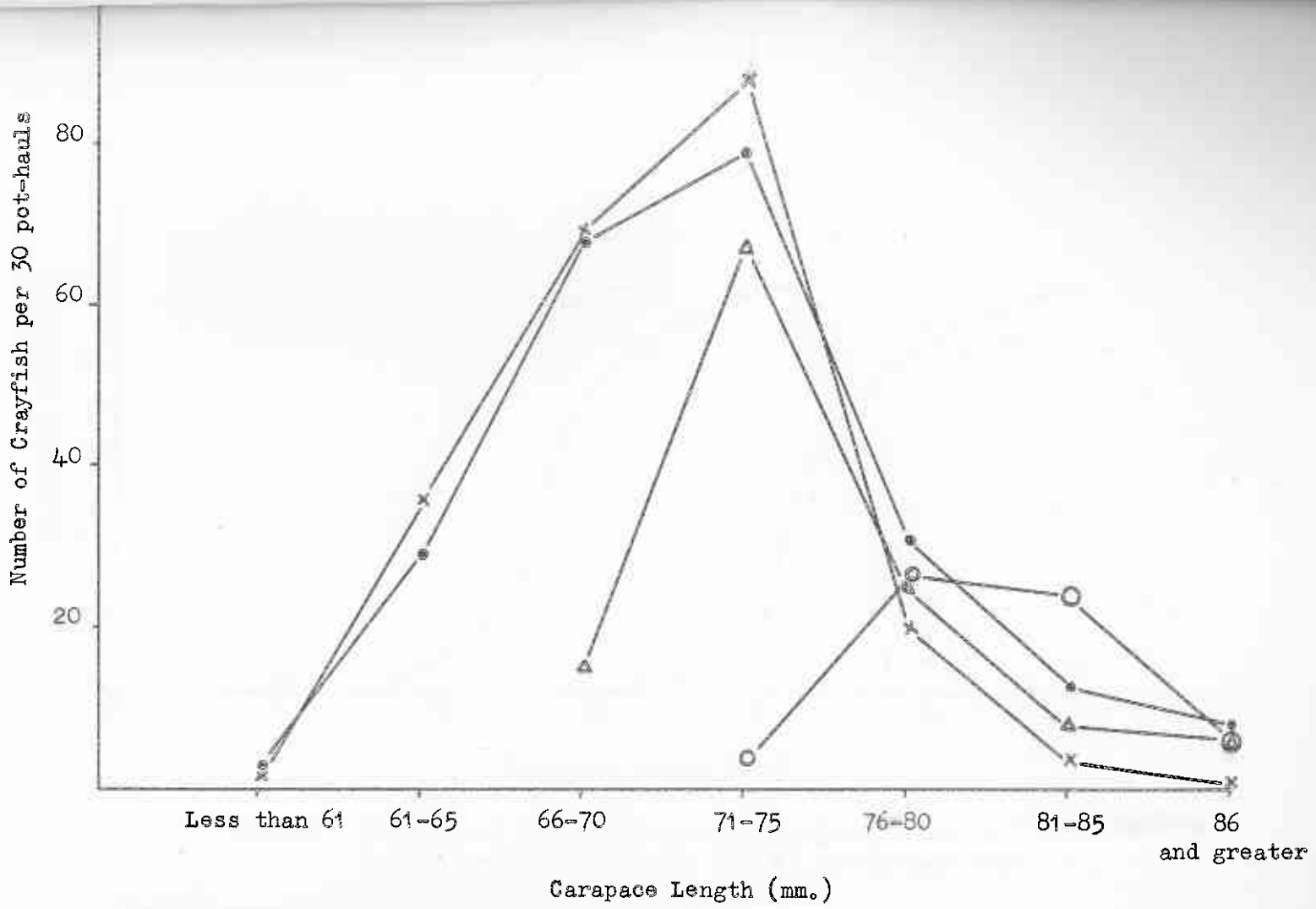

Fig. I. Length frequency of crayfish per 30 pot-hauls caught in normal (• - •), $1\frac{3}{4}$-in. (x - x), 2-in. (Δ -Δ), and $2\frac{1}{4}$-in. (O - O) escape-gap pots.

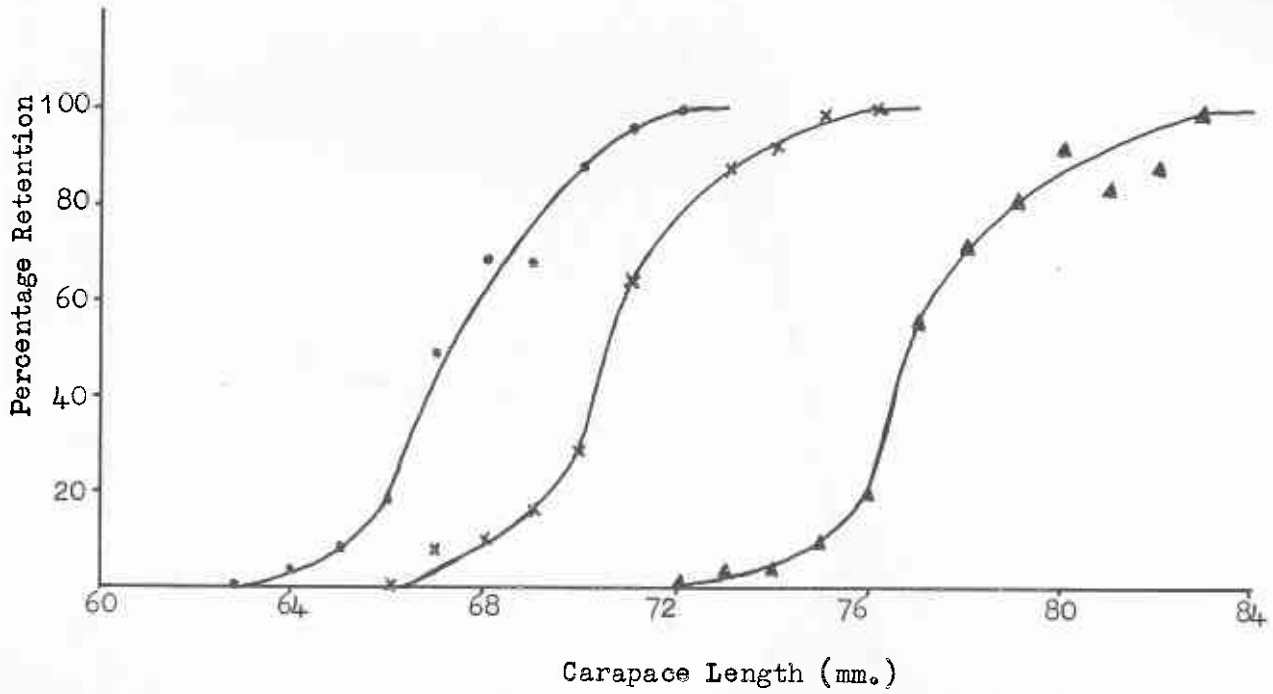

Fig. 2. Theoretical selection curves for $1\frac{7}{8}$-in. (• – •), 2-in. (x – x), and $2\frac{1}{8}$-in. (▲ – ▲) escape-gap pots.

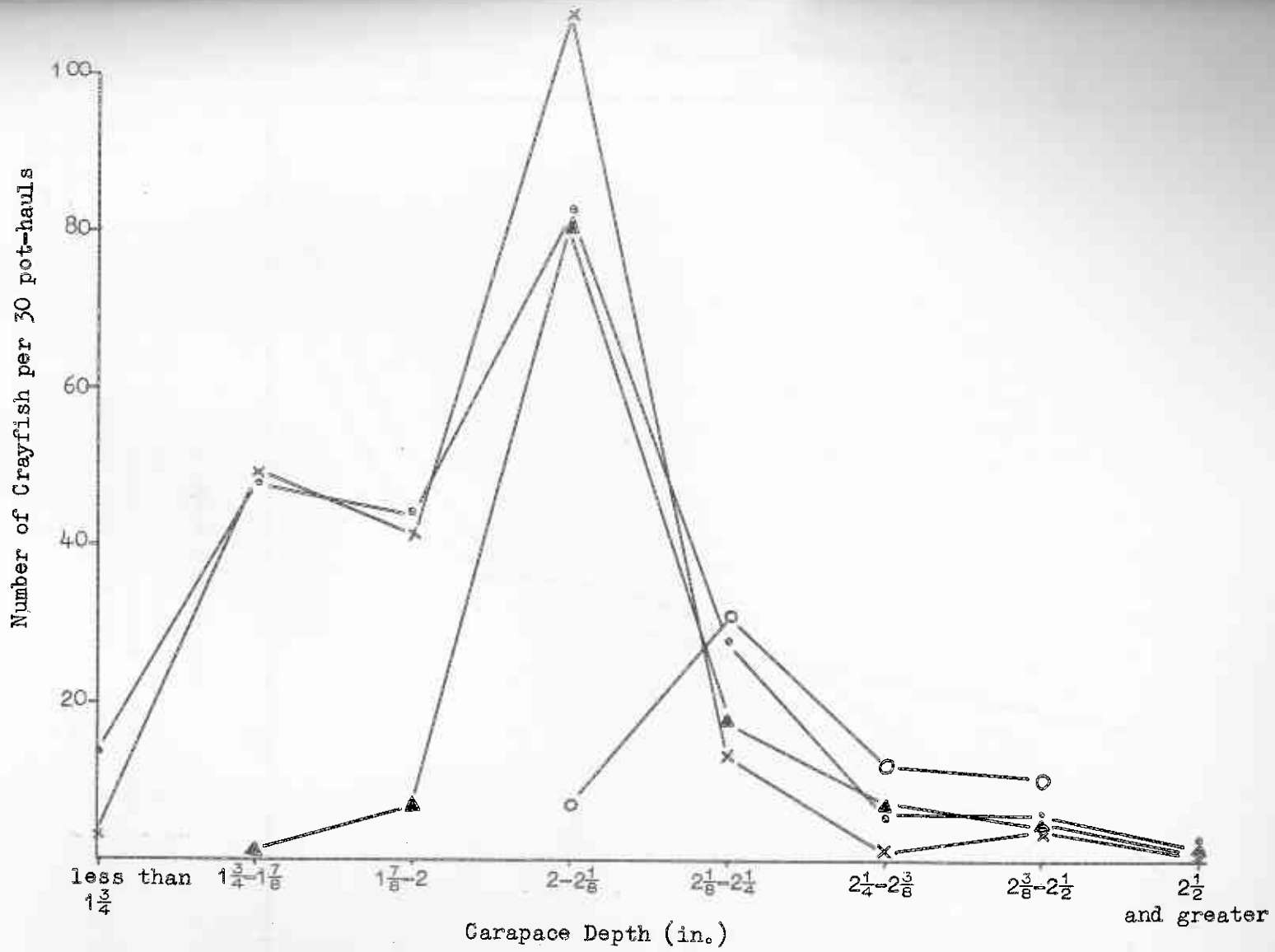

Fig. 3. Depth frequency of crayfish per 30 pot-hauls caught in normal (∘ - ∘), 1¾-in. (x - x), 2-in. (▲ - ▲), and 2¼-in. (O - O) escape-gap pots.

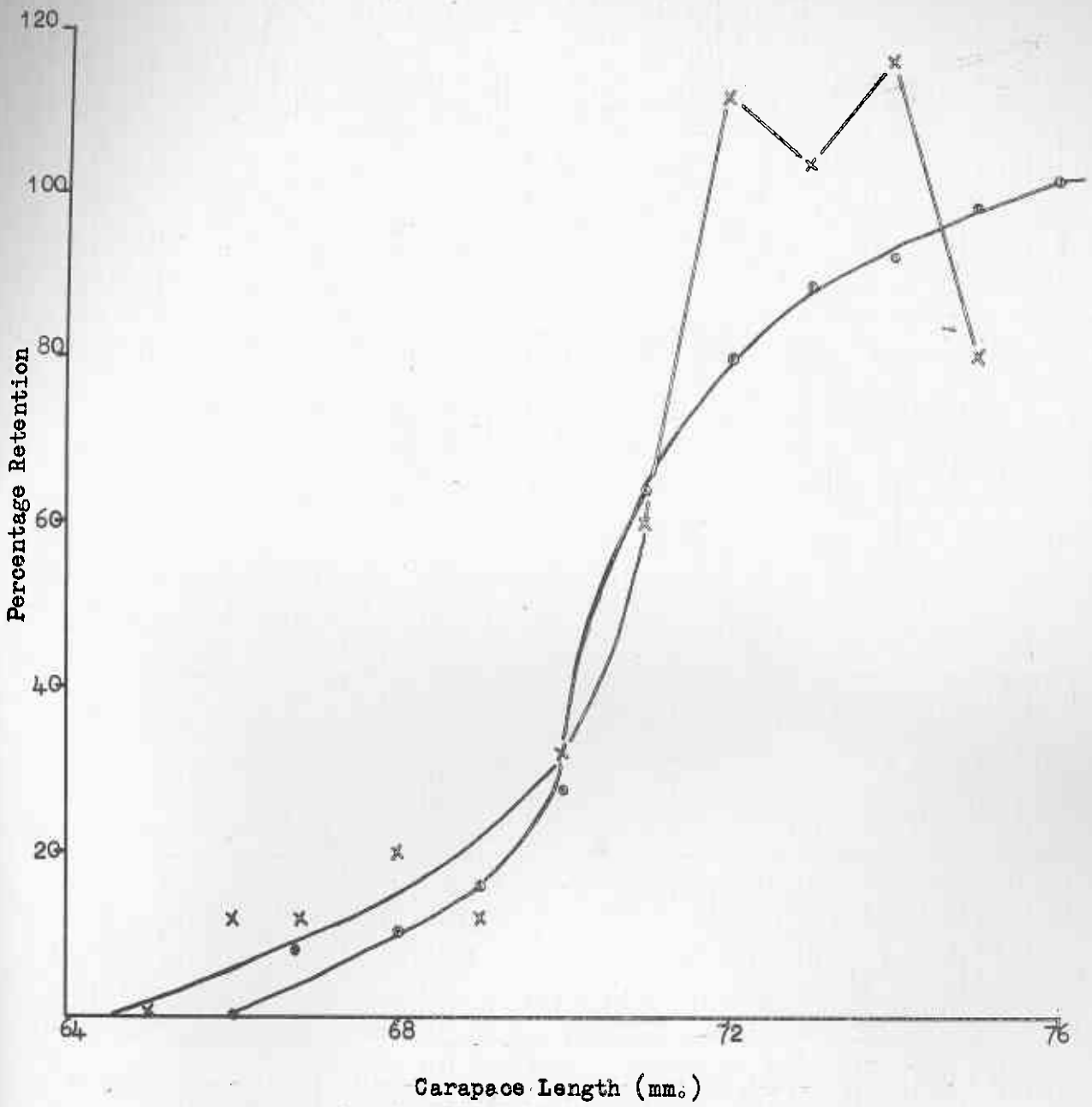

Fig. 4. Theoretical (∘ – ∘) and experimental (x – x) selection curves for a 2-in. escape-gap crayfish pot.