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Creel catches of crab, *Cancer pagurus* L. using different baits

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Creel catches of the edible crab, *Cancer pagurus* were compared using fresh fish bait with or without the addition of recently killed *Cancer*. The addition of the crab to the fish bait reduced the catch of live *Cancer* by 54%. The reduction in catch was proportionately less when only part of the crab (carapace or chelae) was added to the fish bait. These results lend some support to the suggestion of Hancock (1974), that chemically induced intraspecific avoidance responses may be well developed in some crustaceans.

Hancock, D.A. 1974. J. Cons. int. Explor. Mer, 35: 328–31.

Introduction

Hancock (1974) has suggested that some crustaceans release a "chemical substance" when damaged or killed, which elicits an avoidance response in others of the same species. He cited reports from fishermen suggesting that the edible crab *Cancer pagurus* may show this behaviour. Lobster fishermen, for example, were said to add dead crab to their bait when they wished to reduce the catch of crab in proportion to that of lobsters. This paper describes three experiments conducted on a crab fishing ground in Loch Torridon, Wester Ross, Scotland, to test this idea.

Methods

Standard Scottish soft-eyed crab creels were shot in fleets of 10 from a 4 m outboard motor boat. Experiment 1 was conducted at 20 m depth off Ardheslaig (57°33′N 05°43·3′W) in September 1976. A single fleet of 10 creels was fished daily using three baits; (i) fish (various species depending on availability but mainly the dogfish, *Scyliorhinus canicula* (L.)); (ii) fish and one recently killed crushed whole crab; (iii) one crushed whole crab. In baits (i) and (ii) a similar quantity of fish was added to each creel. The order of baiting was varied each day in such a way that each creel was fished with each bait on four occasions.

Experiment 2 was conducted in November 1976 at 20 m depth off Inverbain (57°32·3′N 05°42′W). Three fleets of 10 creels were used, baited with, (i) fish (fresh whiting, *Merlangius merlangus* (L)); (ii) whiting and crushed crab carapace; and (iii) whiting and crushed crab chelae. On the first day, only one fleet could be fished, but three fleets were fished on the other two days.

Experiment 3, carried out during December 1976 in the same area and depth as experiment 2, employed two baits; (i) fish (fresh whiting); and (ii) fish and crushed whole crab. Up to three fleets of 10 creels were fished on three successive days.

The data were subjected to analysis of variance after a square root transformation as the number of crabs in each category exhibited a Poisson distribution; the means shown are the estimates of the means of these distributions.

Results

Experiment 1

The mean numbers of crabs per creel caught by each bait on each day are shown in Table 1. Variation due to different baits was highly significant (F with 2,84 degrees of freedom $= 82{\cdot}7$, $P < 0{\cdot}001$). The lowest catch was always achieved with crab bait, and on all but one day the highest occurred with fish bait. The mean number of crabs caught using fish bait was 5·5 (95% confidence interval 4·7–6·4), but the mean catch fell to 2·5 (2·0–3·0) crabs when whole crushed crab was added to the fish bait and to 0·8 (0·6–1·1) when whole crab alone was used. The catch-rate of crabs was reduced by about 54% using fish and whole crab.

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Table 1. Experiment 1; estimated mean number of crabs caught in each creel per shot

Shot	Date Sep 1976	Bait Fish	Fish + whole crab	Crab
1	10	6·4	4·3	1·8
2	11	4·4	4·5	0·9
3	13	7·5	2·2	2·1
4	14	3·7	0·9	0·7
5	15	5·6	1·7	0·3
6	16	5·1	3·8	0·7
7	17	2·8	2·0	0·3
8	18	9·1	2·4	0·3
9	22	5·1	4·2	0·3
10	23	3·2	0·7	0·4
11	24	3·1	0·9	0·5
12	27	10·2	2·4	0·3
Overall mean		5·5	2·5	0·8
95% confidence interval		(4·7, 6·4)	(2·0, 3·0)	(0·6, 1·1)

Table 2. Experiment 2; estimated mean numbers of crabs caught by each bait

Date Nov 1976	Fleet	Bait Fish	Fish + crab carapace	Fish + chelae
10	III	4·9	2·7	2·1
11	I	3·2	4·8	5·2
11	II	5·3	1·3	4·1
11	III	5·2	1·6	2·4
12	I	3·4	3·1	1·1
12	II	3·4	0·4	2·8
12	III	2·1	2·2	3·8
Overall mean		3·9	2·2	3·0
95% confidence interval		(3·1, 4·8)	(1·6, 2·8)	(2·3, 3·8)

Day-to-day variation, measured by the variation between shots, was significant ($F_{11,84} = 3{\cdot}22$, $P < 0{\cdot}01$). Since the fishing was spread over a 17-day period, fluctuations in the numbers and availability of crabs in the area were to be expected. Day-to-day variation in the composition and quality of the fish bait used may also have contributed to the fluctuation in catches. Neither the variation of catch between creels ($F_{9,90} = 1{\cdot}22$) nor the interaction between creels and baits ($F_{18,90} = 0{\cdot}76$) was significant.

Experiment 2

Each set of a fleet of 10 creels was regarded as a separate shot giving a two-way classification with three baits and seven shots and unequal numbers of creels receiving each bait in each shot. The results are presented in Table 2. The variation between the seven shots was not significant ($F_{6,49} = 1{\cdot}66$). Variation between baits was highly significant ($F_{2,49} = 5{\cdot}98$, $P < 0{\cdot}01$) but there was significant interaction ($F_{12,49} = 2{\cdot}51$, $P < 0{\cdot}05$) between baits and shots, i.e., there was no one bait which always attracted the highest numbers of crabs. Mean catches with fish bait varied from 2·1 to 5·3, those with fish and crab carapace ranged from 0·4 to 4·8 and fish plus crab chelae caught between 1·1 and 5·2 crabs. On average, addition of crushed crab reduced the catch rate by 45% (carapace) and 22% (chelae).

Table 3. Experiment 3; estimated mean numbers of crabs caught by each bait in each shot

Date Dec 1976	Fleet	Bait Fish	Fish + whole crab
8	I	3·1	1·7
9	I	4·0	1·4
9	II	4·0	1·9
9	III	2·1	1·5
10	I	3·7	1·2
10	II	3·1	1·3
Overall mean		3·3	1·5
95% confidence interval		(2·5, 4·2)	(1·0, 2·1)

Table 4. Summary of experiments 1, 2 and 3. Mean numbers of crabs taken per creel shot by each bait and the % decrease in catch caused by addition of crushed crab to fish bait

Bait	Experiment 1 Mean No.	%	Experiment 2 Mean No.	%	Experiment 3 Mean No.	%
Fish	5·5	–	3·9	–	3·3	–
Fish + whole crab	2·5	54	–	–	1·5	54
Fish + crab carapace	–	–	2·2	45	–	–
Fish + crab chelae	–	–	3·0	22	–	–
Whole crab	0·8	–	–	–	–	–

Experiment 3

The results are summarized in Table 3. Variation between the two baits was highly significant ($F_{1,48} = 14{\cdot}4$, $P < 0{\cdot}001$), and within every fleet the catch was approximately halved by adding crab to the bait. The overall mean catches were 3·3 (95% confidence interval 2·5–4·2) with fish bait and 1·5 (1·0–2·1) when crab was added, a reduction in catch rate of 54%. The variation between shots ($F_{5,48} = 0{\cdot}37$) and the

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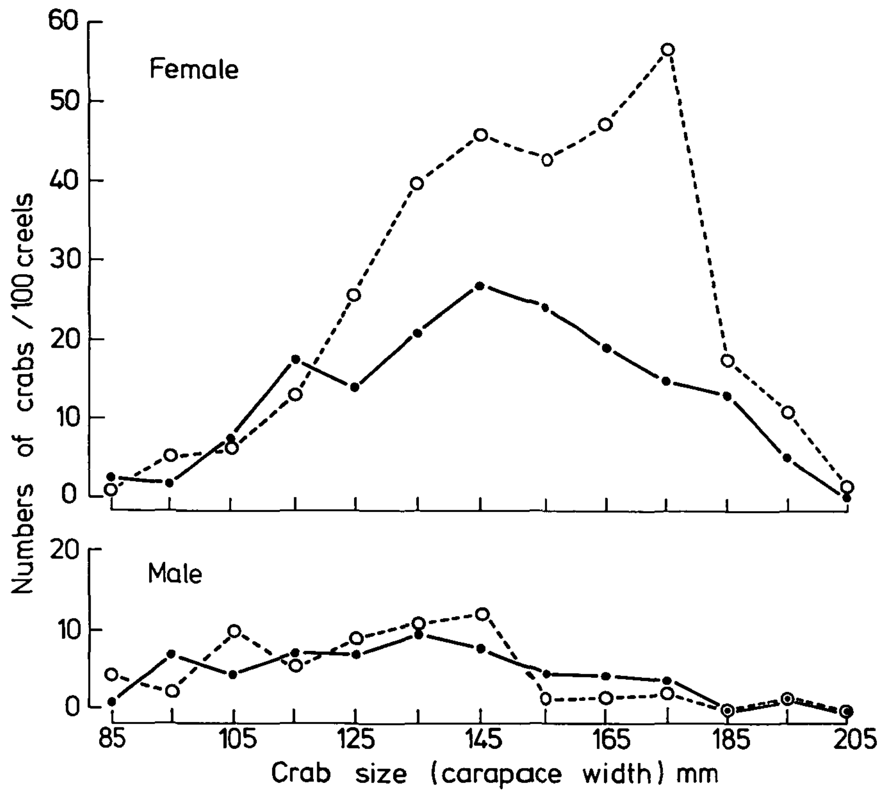

Figure 1. Size distribution (pooled in 10 mm groups) of female and male *Cancer* taken by creels using fish bait with (solid circles) and without (open circles) addition of crushed crab.

interaction with the baits were not significant ($F_{5,48} = 0{\cdot}37$).

The results from all three experiments are summarized in Table 4.

Size and sex composition of the catches

The crab catches from the three experiments were combined in two categories: a) those taken by fish bait and b) those taken by fish bait with crushed crab. Females accounted for 85% of the catch with fish bait alone and 75% of crabs when crab bait was added. Size/frequency distributions of the catches are shown in Figure 1. These suggest that the addition of crushed crab to fish bait was most effective in deterring female crabs over 120 mm carapace length. There was little difference in the catches of males but the sample was rather small. The crabs used for baits were mainly females but no account was taken of the sex of the crab bait employed in each creel.

Discussion

Addition of crushed whole crab to fish bait produced a significant 54% decrease in the number of crabs caught in creels. These results lend support to the suggestion of Hancock (1974) that some crustaceans can be repelled by dead specimens of their own species. Where separate parts of the crab were added, the effects were less clear, but there was a slight reduction roughly in proportion to the bulk of crab added (the carapace was more effective than the chelae). This could mean that the substance or substances responsible are present throughout the body tissues, possibly in the blood.

The fact that crab bait was only partially effective in reducing the catch of live crabs may have been due to the relatively long fishing time. Each fleet of creels was fished for at least 24 h and it is quite likely that the effectiveness of crab bait would be reduced after prolonged immersion. Leaching of any chemical substance would probably occur quite rapidly from the tissues and open circulatory system of the crab.

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It seems that odour dependent alarm reactions may be widely found among aquatic animals. The best known example is the "schreckreaktion" shown by fish of the order Ostariophysi (Pfeiffer, 1962). In these fish the alarm odour is released from special cells when the skin is damaged and this induces other fish of the same or related species to flee. Other examples have been found in several invertebrates (Snyder and Snyder, 1970; Howe and Sheikh, 1975; Stenzler and Atema, 1977). It would be premature to draw parallels between these cases and the results reported here for *Cancer*. Behaviour experiments are now needed to investigate the avoidance response in crustaceans in more detail and to identify the substance or substances involved.

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