Experiments on the Development of an Artificial Bait for the Dungeness Crab, Cancer magister (Dana)

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INTRODUCTION

Conventional baits for the Dungeness crab include razor clam, squid and herring. Rising costs and sporadic availability of natural baits have made the development of an artificial bait increasingly attractive. Desirable features of an artificial bait can be summarized from statements made at a recent symposium on artificial baits and potfishing (Jaeger, 1972) as:

1. the chemical attractant should be effective in low concentrations; it should be species specific and for the case of the Dungeness crab fishery it should be, ideally, sex specific for legal-size males.
2. the chemattractant should be incorporated into a matrix which will release it in effective concentrations over a period of several days for long-soak fishing conditions. The matrix or carrier should also protect the chemattractant from attack by microbes and sand fleas.
3. the artificial bait should not require refrigeration during storage.
4. the cost of the bait (carrier plus chemattractant) must be competitive with natural baits.

Stated thusly, the design of a synthetic bait involves two problems: the selection of a suitable carrier and the determination of an effective chemattractant. In the

experiments described herein polyacrylamide gels were used as the carrier for chemattractants.

POLYACRYLAMIDE GEL

(Preparation and suitability as carrier)

Polyacrylamide gels are clear and can be made with pore radii ranging from 0.5 to 3 nanometers in order to control the rate of outward diffusion of chemattractant molecules (Chrambach and Rodbard, 1971). Rates of diffusion of solutes from polyacrylamide gels (as a function of gel pore size and solute molecular weight) have been determined in a study on the use of polyacrylamide gels as subcutaneous implants containing hormones for long-term control of diabetes and fertility (Davis, 1974). Polyacrylamide gels can be made so as to set immediately thus permitting preparation of finely dispersed emulsions of such potential, water-immiscible chemattractants as herring oil. The polyacrylamide matrix of the gel is not susceptible to microbial decomposition and the small pore size prevents penetration of the gel by microbes. Consequently, gels containing chemattractant can be stored at room temperature.

Ingredients for making polyacrylamide gels can be purchased from Eastman Organic Chemicals, Eastman Kodak Co., Rochester, New York 14650. Bulk prices and catalog numbers of the chemicals are given in Table 1.

Table 1. Chemicals for preparation of polyacrylamide gels.

Chemical	Catalog Number	Quantity	Unit Price
Acrylamide	5521	100 lb	$ 1.70/lb
N,N'-Methylenebisacrylamide (BIS)	P 8383	20 lb	$ 6.50/lb
N,N,N',N'-Tetramethylethylene-diamine (TEMED)	8178	10 lb	$10.50/lb
Ammonium persulfate (AP)	11151	2 Kg	$ 7.05/Kg

We prepare gels as outlined in Table 2 (Davis, 1964). Those undertaking preparation of polyacrylamide gel should be aware that the acrylamide monomer (prior to polymerization into the gel) is a neurotoxin which can be absorbed through the skin. Consequently, gloves should be worn. A description of precautions to be used in handling acrylamide and of the symptoms of acrylamide poisoning follows (Bunting, 1971):

> "Acrylamide monomer is a neurotoxin and should be handled accordingly. Care should be taken to avoid skin contact, and mouth pipetting of solutions should be avoided. If any is spilled on the skin, immediately wash the area in running water and then soap and water. The acrylamides produce unusual neurotoxic effects. The disease syndrome is characterized by incoordination, ataxia (irregularity of muscular action), and weakness in the extremities (particularly the legs). Initially the complaints are drowsiness, fatigue, and tingling in the fingers. The principal complaint is stumbling with a sense of unsteadiness. The mechanism is not clearly understood since no histological effects are seen in the nervous system. These effects can be produced by all routes of entry: oral, skin contact, and inhalation. Most investigators feel that exposed persons should be under careful medical supervision with examinations at intervals to detect early neurological symptoms."

Table 2. Preparation of polyacrylamide gels in one liter quantity.

Step
1. Heat 700 ml water to 60° C
2. Add 75 g acrylamide, stir until dissolved
3. Add 1.84 g BIS, stir until dissolved
4. Add chemattractant, stir until dissolved
5. Add 0.3 ml TEMED, mix
6. Make volume to 1000 ml with water
7. Add 1 g AP, stir until gel sets. AP is the polymerization catalyst. The gel should set within 1-2 minutes of its addition.

Based on the prices of Table 1, the cost of chemicals sufficient to make 300 ml of polyacrylamide gel, an amount sufficient to fill a typical bait cannister, should be approximately 10 cents.

CHEMATTRACTANTS FOR THE DUNGENESS CRAB

1. Background information

Testing of the efficacy of chemattractants must ultimately be performed in the field. The expense of field testing, however, forces the use of laboratory tests in the preliminary screening of chemicals. Laboratory investigations of

chemoreception in animals have taken the form of neurophysiological or behavioral studies. The neurophysiological approach provides information on the ability of a dissected chemoreceptor preparation to detect a specific chemical and code its concentration as a burst of nerve impulses without telling us what use the intact animal makes of the firing pattern of the chemoreceptors. Behavioral studies on intact animals permit direct determination of the response to a particular chemical signal. The latter approach was therefore selected for screening possible chemattractants.

Lindstedt (1971) reviewed the literature on the chemical control of feeding behavior in organisms as diverse as bacteria and vertebrates. She proposed a classification of the chemical effectors of feeding behavior comprising seven categories. The term attractant was suggested for those chemical stimuli which act over long distances to draw animals toward the source of food (distance chemoreception or olfaction).

Many decapod crustaceans have chemoreceptors on their antennules and the dactylopodite segment of the walking legs (Hazlett, 1971). The antennules appear to be distance chemoreceptors sensitive to low concentrations of chemattractants (Hazlett, 1971; Laverack, 1964 and 1968; Ache, 1972) while the dactylopodites are sensitive only to higher concentrations (Hazlett, 1971; Case and Gwilliam, 1961; Hodgson, 1958).

Neurophysiological and behavioral studies have established the responsiveness of decapod crustacean chemoreceptors to a wide variety of amino acids and amines (Table 3). Crab fishermen

Table 3. Compounds shown to elicit feeding responses or to evoke an electrophysiological response in decapod crustaceans.

COMPOUND	ANIMAL	REFERENCE
Alanine	*Homarus*	(Ache,1972; McLeese,1970)
Arginine	*Homarus*	(Ache,1972; McLeese,1970)
Betaine	*Cambarus*	(Hodgson,1958)
Betaine	*Panulirus, Homarus, Portunus, Carcinus*	(Laverack,1963)
Glutamic acid	*Homarus*	(Ache,1972; McLeese,1970)
Glutamic acid	*Betaeus*	(Ache & Case,1969)
Glutamic acid	*Cancer*	(Case,1964)
Glutamic acid	*Cambarus*	(Hodgson,1958)
Glutamic acid	*Carcinus*	(Case & Gwilliam,1961)
Glutamic acid	*Panulirus*	(Levandowdky & Hodgson,1965)
Glycine	*Bataeus*	(Ache & Case,1969)
Glycine	*Homarus*	(Ache,1972)
Glycine	*Cambarus*	(Hodgson,1958)
Glycine	*Cancer*	(Case,1964)
Hydroxyproline	*Cancer*	(Case,1964)
Leucine	*Homarus*	(Ache,1972; McLeese,1970)
Lysine	*Homarus*	(Ache,1972; McLeese,1970)
Methionine	*Homarus*	(Ache,1972; McLeese,1970)
Proline	*Homarus*	(Ache,1972; McLeese,1970)
Proline	*Cancer*	(Case,1964)
Serine	*Cancer*	(Case,1964)
Taurine	*Cancer*	(Case,1964)
Taurine	*Homarus*	(Ache,1972; McLeese,1970)
Threonine	*Cancer*	(Case,1964)
Tryptophan	*Homarus*	(Ache,1972; McLeese,1970)
Valine	*Cancer*	(Case,1964)
Glucosamine	*Homarus*	(McLeese,1970)
Trimethylamine oxide	*Cambarus, Panulirus*	(Hodgson,1958; Laverack,1963)
Trimethylamine oxide	*Homarus, Carcinus*	(Laverack,1963)
Fumaric acid	*Homarus*	(McLeese,1970)
Succinic acid	*Homarus*	(McLeese,1970)
Malic acid	*Homarus*	(McLeese,1970)
Indole	*Homarus*	(McLeese,1970)
α-amino N-butyric acid	*Cancer*	(Case,1964)
β-amino isobutyric acid	*Cancer*	(Case,1964)
Amino acid mixture	*Homarus*	(McLeese,1970)
Amino acid mixture	*Carcinides, Callinectes, Libinia, Pachygrapsus, Pagurus, Pugettia*	(Case & Gwilliam,1963)

have reported sporadic success with oil-based baits (from diesel oil to anise oil, Jaeger, 1971). It has been reported that the molting hormone ecdysterone may function as a sex pheromone in crabs, attracting males to molting females (Kittredge, et al., 1971). A sex pheromone would make an ideal chemattractant for a synthetic bait in that it would attract solely males of reproductive age, most of which should be of legal size (6½" carapace width). We selected for testing as chemattractants those compounds or extracts which had been reported effective in eliciting chemoreceptor, feeding, or sexual responses in other decapod crustaceans. Curiously, while sophisticated studies have been conducted on chemoreception in *Cancer antennarius* and *C. productus* (Case, 1964) and on sex pheromones in *C. antennarius* and *C. anthonyi* (Kittredge, et al., 1971), these aspects of the biology of the commercially important *C. magister* have not been investigated.

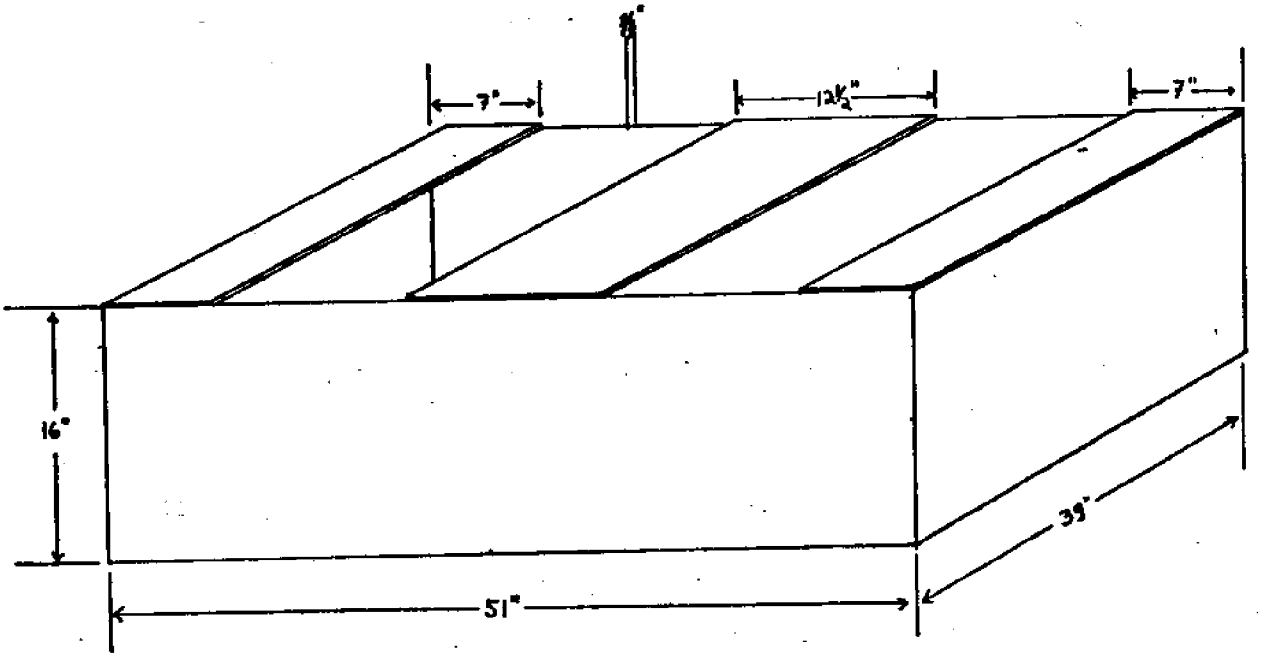
2. Methods and materials

Crabs used for behavioral studies were legal-size male *C. magister*. Individuals were tagged and kept in a test tank (Fig. 1). The tank had a capacity of approximately 100 gallons; water in the tank was continually filtered through activated charcoal except during test periods.

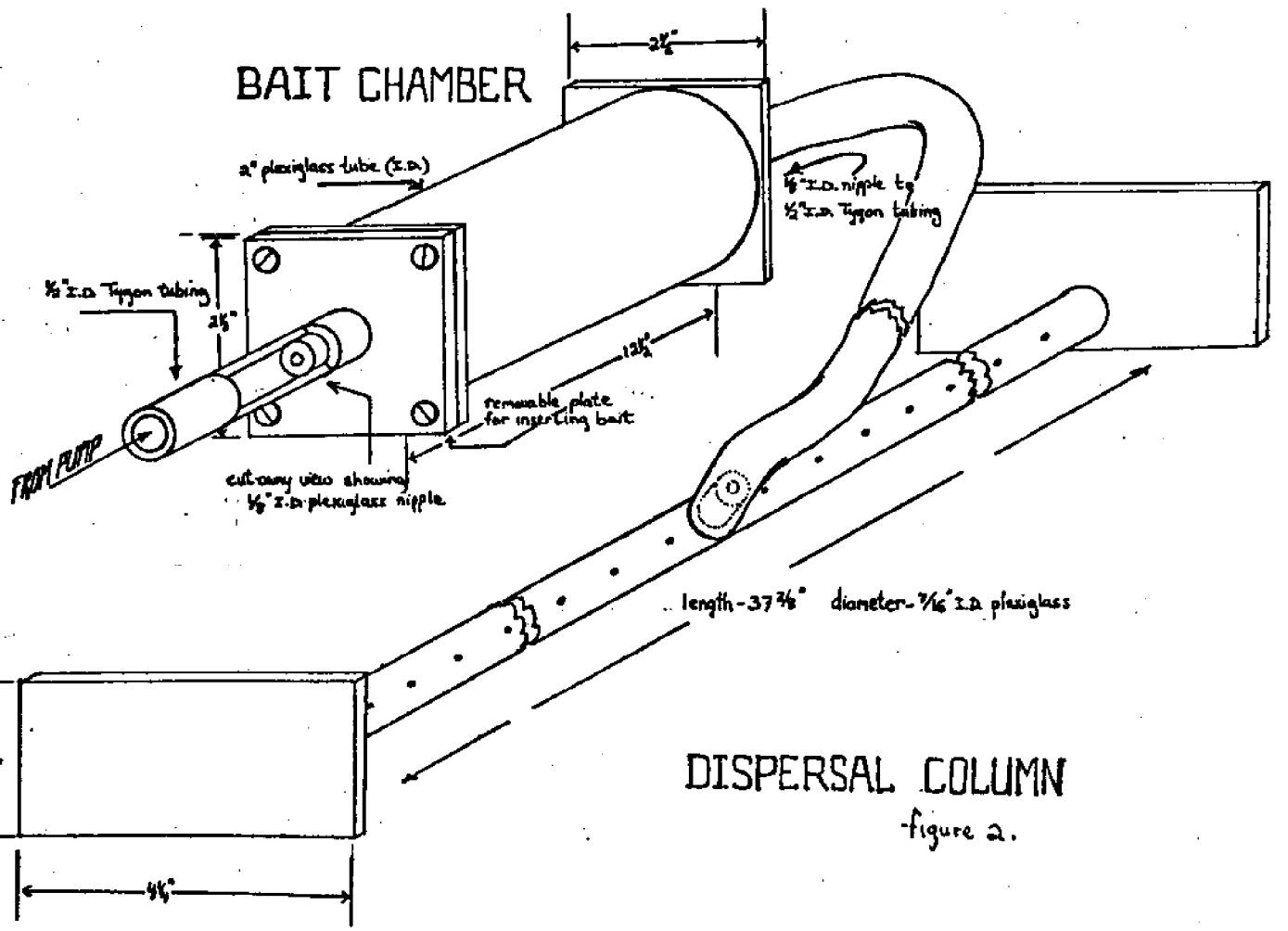
Rather than place test baits (gel containing a specific chemattractant) directly in the tank, they were inserted into a bait chamber (Fig. 2). Water from the test tank was pumped by a tubing pump (Sigmamotor, Model T65) through the bait

OBSERVATION TANK

figure 1.



BAIT CHAMBER



DISPERSAL COLUMN

figure 2.

chamber. After passing over the bait the water was returned to the test tank via a dispersal column which consisted of a 37-3/8" long plexiglas tube with 1/8" holes drilled along its length at 1" intervals (Fig. 2). The dispersal column was placed at one end of the test tank. Its function was to disperse chemattractants emanating from the bait in a uniform front from one end of the tank.

To test a chemattractant 100 ml of polyacrylamide gel containing 200 mg (for the case of solids) or 0.3 ml (for the case of liquids) of chemattractant were prepared. The gel was cut into small pieces (<1/2 inch in diameter) and placed in a nylon net (15 denier) made from a section of women's hose. This last step was necessary to prevent blockage of the dispersal column by small pieces of gel. The gel was then placed in the bait chamber and the tubing pump was started (zero time of the behavioral test).

Starting from zero time, the crabs in the test tank (from 8-11 marked individuals) were observed for a period of thirty minutes. The responses of each crab to the chemattractant were recorded for each of 10 three minute intervals during the thirty minute duration of the test. Feeding responses were noted as: A = antennule movement in the direction of the dispersal column (Snow, 1973, has studied the relationship of antennular movements to chemoreception in great detail for a hermit crab); F = flexing or slight extension of the mouth parts without further movement; CH = cheliped movement in a shoveling motion toward the mouth; MP = mouth part movement,

the characteristic circular movement of the third maxilliped as if drawing food into the mouth; and D = directional movement toward the dispersal column. The data collected for each crab during the test were quantified using a grading system based on relative significance of a specific response. Although all five responses (A, F, MP, CH, and C) can and do occur in the absence of chemattractant, there was a high degree of correlation between the frequency and type of response and the "activity" of a test substance. The feeding response was divided into three stages, the first of which involved initial detection of the test substance and was marked by antennule movement in the direction of the dispersal column sometimes associated with flexion of the third maxillipeds. The second stage represented initiation of feeding and was demonstrated by feeding motions of the chelipeds and/or mouth parts. The final stage involved actual movement toward the dispersal column and in some cases culminated in attempts to devour the column.

For each three minute interval during the test a point value of one was assigned for occurrence of either A or F, two points for MP or CH, and three points for D. The maximum that one crab could score for one three minute interval was thus nine points. The total possible for the thirty minute test was ninety points/crab. Tabulation of results was accomplished by adding all points scored during the thirty minute test and then dividing by the number of crabs in the sample. The resultant value was termed the Mean Behavioral Response (MBR).

Because of the significance of the directional response D, an additional calculation was made for the Mean Directional Response (MDR) by totaling directional responses and dividing by the sample number. In this case each directional response was valued at one as opposed to three in the MBR calculation.

All behavioral tests were conducted at 10°C ± 2°C and under dim red illumination to prevent movements of the observer from affecting behavior of the crabs. *C. magister* appears to lack red vision.

Amino acids and amines were purchased from Schwarz/Mann, Orangeburg, New York. Organic acids, glucose and sulfide compounds were reagent grade. Anise oil was U.S.P. grade; cod liver oil was N.F. grade and herring oil was extracted from frozen bait herring. Casamino acids (vitamin free casein hydrolysate) were obtained from Nutritional Biochemicals Corp., Cleveland, Ohio.

3. Results and discussion.

Two types of blank control test were run: pump operating without bait in the bait chamber and with gel sans chemattractants (Table 4). MBR and MDR values for these tests were low. As another control 100 g of squid (not incorporated into gel) were placed in the bait chamber. MBR and MDR values were nearly double those observed for the most active gels (Table 4). Glycine proved to be the most effective pure chemical. Many chemicals yielded widely divergent MBR and MDR values for different test runs using the same group of crabs, citric acid

Table 4. Mean Behavioral Response (MBR) and Mean Directional Response (MDR) of substances tested for feeding response activity.*

TEST SUBSTANCE	mg/100 ml of GEL (or as noted)	MBR	MDR
Pump only (no gel)	0	7.4	0.00
	0	12.0	0.25
	0	12.3	0.23
	0	11.9	0.36
Blank gel	0	12.8	0.00
	0	13.7	0.50
	0	11.3	0.12
	0	18.1	0.62
	0	11.1	0.00
Whole squid (no gel)	100 g	38.3	2.38
Squid (homogenized)	10 g	23.0	0.75
Razor clam (homogenized)	660	9.1	0.38
	6,000	22.6	1.18
	6,600	23.6	1.50
	7,400	22.3	0.70
	6,000 (a)	16.6	0.25
(a) stored 46 days, dehydrated	6,000 (b)	6.0	0.00
(b) rehydrated	6,000	21.5	0.75
Glycine	200	21.5	0.62
	200	22.1	0.42
	200	22.3	0.54
	200	27.3	0.55
	200	28.5	1.38
	200	24.2	1.44
	1,000	23.1	1.38
	5,000	27.8	1.25
	5,000	28.6	1.36
Arginine	200	19.8	0.73
Betaine	200	24.0	1.27
	200	17.6	0.28
	200	13.6	1.11
Cysteine	200	13.3	0.38
Casamino acids	200	21.7	1.27
	1,000	25.0	1.27
Amino acid mixture (equimolar protein amino acids)	50	24.7	0.67

Table 4. (cont.)

TEST SUBSTANCE	mg/100 ml of GEL (or as noted)	MBR	MDR
Glutamic acid	200	14.6	0.45
	200	18.1	0.55
Lysine	200	15.7	0.36
Methionine	200	8.8	0.00
Taurine	200	17.6	0.66
	200	16.0	0.54
Citric acid	200	28.8	2.00
	200	8.0	0.23
	200	21.0	0.09
	1,000	21.0	1.20
	5,000	14.4	0.00
Lactic acid	200	10.9	0.50
Malic acid	200	13.0	0.09
Succinic acid	200	7.5	0.09
Trimethylamine	200	9.9	0.62
Trimethylamine oxide	200	20.1	0.76
	200	19.1	0.44
Methyl sulfide	0.3 ml	20.6	1.10
	0.3 ml	16.8	0.90
	0.3 ml	16.1	0.00
Methyl disulfide	0.3 ml	17.9	0.90
Glucose	200	14.2	0.37
	200	18.9	0.72
Anise oil	0.3 ml	11.0	0.00
Cod liver oil	1.5 ml	13.1	0.22
	0.3 ml	16.1	0.54
	0.3 ml	12.0	0.00
Herring oil	0.3 ml	28.6	0.62
	0.3 ml	15.8	0.88
Terpene mixture	2.0 ml	4.0	0.00
Yew leaves (homogenized)	6,000	18.5	1.38
	6,000	20.9	0.67

*Maximum possible MBR=90; maximum possible MDR=9. Each line gives the test result for a separate thirty minute run. Each MBR and MDR value is the average total response/crab of test samples of 8-11 crabs over the thirty minute run.

being a striking example. Varying the concentration of glycine from 200 mg to 5,000 mg/100 ml of gel did not cause a marked increase in MBR and MDR values. Complete mixtures of protein amino acids (casamino acids and equimolar amino acid mixture) were no more effective than glycine (Table 4).

Methyl sulfide and methyl disulfide were suggested by Max Patashnik of the National Marine Fisheries Service, Seattle, Washington, as they have a clam odor to the human nose. Results with our test crabs suggest that crabs smell clams via the agency of other chemicals. Fishermen often claim that oily baits are effective. The three oils tested (anise, cod liver and herring oil) were not especially active (Table 4). The terpene mixture (Table 4) contained equal weights of cinnamaldehyde, geraniol, linalool, limonene, camphor, camphene, pinene, citronellal, menthol, and farnesol. The individual terpenes were practical grade (Eastman Organic Chemicals) and were shown by gas chromatography to contain considerable quantities of other compounds. The mixture was fragrant to the human nose but seemed actually to inhibit feeding responses in *C. magister* (Table 4).

Homogenized razor clam in gel form was tested at several concentrations (Table 4). At 660 mg/100 ml of gel MBR and MDR values were low; at 6,000 mg/100 ml values were comparable to those observed for glycine. The main purpose of this study was to design a completely synthetic bait. However, the obvious possibility of using polyacrylamide as a vehicle and extender for homogenized razor clam and squid deserves

consideration. For example, if 300 ml of polyacrylamide gel (sufficient to fill the bait cannister of crab pots) containing a total of 18 g of razor clam homogenate should fish as well as 100 g of whole razor clam, a given quantity of razor clams would serve to bait considerably more pots.

A series of tests was run to study the effect of room temperature storage on the activity of gels containing homogenized razor clam (6 g/100 ml). An initial sample of this gel yielded an MBR of 16.6. The gel was then stored at room temperature for 46 days during which time it dehydrated. The dehydrated gel had an MBR of 6.0 when tested without rehydration. The same gel when tested following rehydration (a 24 hour soak in water - dehydrated polyacrylamide rehydrates slowly) produced an MBR of 21.5 (Table 4).

It must be noted that none of the test compounds or extracts approximated whole squid in chemattractant potency. Admittedly, many other compounds might have been tested. There is evidence, however, to indicate that decapod crustaceans determine the attractancy of food by a complex of chemical signals. Shelton and Mackie (1971) prepared a synthetic mixture of chemicals based on the composition of the clam *Tapes japonica*. None of the major components of this mixture when tested alone was as effective as the complete mixture in attracting the shore crab *Carcinus maenus*. Similarly, McLeese (1970) observed that individual amino acids were never as attractive to lobsters as extracts of cod, shrimp or lobster.

It is logical therefore to consider the possible superiority of sex pheromones to chemattractants which induce feeding behavior. Kittredge, et al. (1971) reported that the crustacean molting hormone ecdysterone induced male sex displays (of the type described by Snow and Neilsen, 1966, for *Cancer magister*) in *C. anthonyi* and *C. antennarius*. We tested the response of four male *C. magister* to ecdysterone (= crustecdysone from Schwarz/Mann) at 10^{-7} M concentration (10 times the threshold level cited for *C. antennarius* and *C. anthonyi* by Kittredge, et al., 1971) and observed no male sex display. A homogenate of yew leaves (*Taxus sp.*) stated to contain high concentrations of ecdysones (Wigglesworth, 1970) induced no sex displays in the test tank but some feeding behavior (Table 4). Female lobsters release a pheromone which initiates courting behavior in males (Atema and Engstrom, 1971). The lobster pheromone does not appear to be any of several ecdysones (Atema and Gagosian, 1973) or ecdysone metabolites (Gagosian and Atema, 1973). The latter authors regard the hypothesis advanced by Kittredge and Takahashi (1972), that molting hormones act as sex attractants in decapod crustaceans, as having been substantially weakened by their work. Additional research on the chemical nature of *C. magister* sex pheromones is warranted. In our opinion an artificial bait based on a sex attractant has the potential for outperforming natural baits whereas baits using synthetic, feeding chemattractants do not offer this promise.

FIELD TESTING OF ARTIFICIAL BAIT

Polyacrylamide gels containing glycine or razor clam homogenate proved most consistently effective in laboratory tests. These artificial baits were therefore selected for field testing.

The California Department of Fish and Game tested glycine gels (2 g/100 ml) and gels impregnated with a homogenate of surf fish (10 g/100 ml), razor clams were unavailable at the time, during the cruise of the research ship N. B. Scofield from October 1 to November 2, 1974. Two strings of 36 pots each were set in 15 to 19 fathoms off the mouth of the Mad River and one string of 36 pots was set in 10 fathoms off Table Bluff (both locations on the coast of Humboldt County, California). Comparisons were made between pots with no bait, pots baited with market squid and rockfish carcasses, and pots with artificial bait (Table 5). The results of test 1 were encouraging in that the fish homogenate gel fished as well as natural bait. However, test 2 suggested that neither fish homogenate nor glycine gels performed better than unbaited pots. Unfortunately, test 2 did not include a group of pots with natural bait. Test 3 indicated that the artificial baits were superior to unbaited pots (glycine being superior in turn to fish homogenate), but neither artificial bait fished as well as natural bait.

One of us (RW) conducted field tests with crab rings at the Kenmar Docks, Fields Landing, California and the Trinidad

Table 5. Results of N. B. Scofield field tests.

	Natural bait	No bait	Fish homogenate gel	Glycine gel
Test #1 (Mad River)				
Number of pots	12	--	12	12
Crabs/pot	10.3	--	10.4	6.8
Legals/pot	2.8	--	2.3	2.0
Test #2 (Mad River)				
Number of pots	--	12	12	12
Crabs/pot	--	3.9	3.7	3.8
Legals/pot	--	1.0	1.1	1.4
Test #3 (Table Bluff)				
Number of pots	9	9	9	9
Crabs/pot	18.1	3.4	5.4	9.1
Legals/pot	3.0	0.4	0.6	2.6

Pier, Trinidad, California. Tests extended from April through May, 1974. Results (Table 6) for the artificial baits were much poorer than those obtained from the N. B. Scofield tests. The poorer showing of artificial baits in the crab ring test series may be attributable to the short time (15 minutes) the rings were left in the water between pulls. By contrast, the pots used in the Scofield tests were soaked for an average of 29 hours. There is little doubt that the initial rate of diffusion of chemattractants from polyacrylamide gels is inferior to that for natural baits. Mr. Roger Marshall, commercial fisherman from Eureka, California, has used polyacrylamide gels impregnated with razor clam homogenate fairly extensively, but has lacked the time and personnel to keep detailed records. He has informed us that the artificial bait is inferior to whole razor clams for short soaks (1-2 days) but appears to compete effectively with natural bait over longer fishing periods (personal communication). The artificial bait, being immune to attack by sand fleas and microorganisms, should be an effective source of chemattractants for longer periods than natural bait.

Mr. David Helliwell (commercial fisherman, Eureka, California) performed a series of field tests using standard fishing gear during April, 1974. Polyacrylamide gels containing razor clam homogenate (6 g/100 ml) were compared to whole razor clams (Table 7). Results of test 5 indicated that the artificial bait was 39% as effective as natural bait when mean catch/pot values were compared. At another

Table 6. Results of crab ring field tests.

	Type of bait			
	No bait	Minced Razor Clam	Razor clam gel (18g/100ml)	Glycine gel (5g/100ml)
Mean number of crabs/pull	0.17	0.80	0.25	0.12
Number of pulls	66	114	114	96
Standard error	0.06	0.10	0.05	0.03
Maximum number of crabs/pull	3	4	4	1
Minimum number of crabs/pull	0	0	0	0
Range	3	4	4	1
Mean/mean for minced razor clam	0.21	1.00	0.31	0.15

Table 7. Catch comparison between artificial razor clam bait (6 g/100 ml of gel) and whole razor clams. Pots in water for two days.

	Location	Razor clam gel	Whole razor clams
Test 5	West of Samoa, California		
Number of pots		22	19
Juvenile males		9	11
Females		20	54
Legal males		1	2
Total		30	67
Mean catch/pot		1.36	3.51
Test 6	SW of Mad River mouth, Humboldt Co., California		
Number of pots		24	21
Juvenile males		13	11
Females		1	1
Legal males		7	21
Total		21	33
Mean catch/pot		0.88	1.57

location where catches were lower (test 6), the razor clam gel fished 56% as effectively as natural bait.

CONCLUSIONS

It seems unlikely that a completely synthetic bait which uses a feeding response chemattractant will be able to compete with natural baits in fishing effectiveness. Results of the behavioral studies and field tests on polyacrylamide-glycine (our most potent synthetic bait) support this conclusion as does an examination of the literature on the role of chemoreception in crustacean feeding. Polyacrylamide gels impregnated with homogenates of razor clams (or, preferably, cheap trash fish or fish offal) may be able to compete with natural baits under conditions requiring longer soaks (pots in the water for 3 days or longer).

It would seem that the brightest prospect for developing a totally synthetic bait for the Dungeness crab centers on the isolation and structural determination of the sex pheromone of this animal. A synthetic bait containing the sex pheromone in even trace quantities might well perform better than natural baits and should display advantages in species, size, and sex selectivity not possessed by the latter.

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