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Observations on the Reproductive Condition of Female Snow Crabs from NW Cape Breton Island, November 1983

by

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Abstract

Concerns over recruitment trends in some Atlantic snow crab, Chionoecetes opilio, stocks, as well as instability in other male-only crab fisheries, have prompted a re-examination of the efficacy of the 95-mm carapace width (CW) minimum size regulation. In our study, all 98 mature female snow crabs captured off NW Cape Breton Island in November 1983 were carrying eggs. Ninety-six (98%) of the females had stored sperm and 94 (97%, n=97) had large ovaries, suggesting that they would have been capable of extruding at least one further brood without rebreeding. Estimates of the number of eggs carried by the females ranged from 23,144 to 102,022. Although there was no significant relationship between CW and fecundity for females carrying eggs without eyespots, fecundity increased significantly with CW for females carrying eggs with eyespots. Previous studies on newer egg clutches have shown a more marked relationship between numbers of eggs carried and CW as well as higher fecundity. However, fecundity of the Cape Breton Island sample remains within limits explainable by natural patterns of egg loss through the development period. Our data do not appear cause for amending the current minimum size regulation.

Résumé

Les inquiétudes formulées au sujet des tendances du recrutement de certains stocks de crabe des neiges de l'Atlantique (Chionoecetes opilio) ainsi que l'instabilité observée dans les autres pêcheries renfermant exclusivement des crabes mâles ont entraîné une révision de l'efficacité du règlement relatif à la taille limite minimum de 95 mm (largeur de carapace). Les 98 femelles capturées au nord-ouest du Cap-Breton en novembre 1983, aux fins de notre étude, portaient des oeufs. Quatre-vingt-dix-huit pour cent d'entre elles avaient emmagasiné des spermes et quatre-vingt-dix-sept pour cent avaient des gros ovaires, suggérant qu'elles auraient pu pondre au moins une autre fois sans être fécondées à nouveau. Les estimations du nombre d'oeufs portés variaient de 23 144 à 102 022. Bien qu'il n'existe pas de relation importante entre la largeur de carapace et la fécondité, pour femelles portant des oeufs sans ocelles, la fécondité a augmenté signativement en fonction de la largeur de la carapace des femelles portant des oeufs avec ocelles. Des études antérieures sur des nouvelles couvées ont révélé un lien plus marqué entre le nombre d'oeufs porté et la largeur de carapace, ainsi qu'une l'augmentation de la fécondité. Cependant, la fécondité des échantillons prélevés au nord-ouest du Cap-Breton peut s'expliquer encore par la mort naturelle des oeufs tout au long du développement. D'après les résultats de notre étude, il n'a pas lieu de modifier le règlement relatif à la limite minimale actuelle de la largeur de la carapace.

Introduction

The minimum legal size of 95 mm carapace width (CW) currently enforced throughout the Atlantic snow crab, Chionoecetes opilio, fishery focuses exploitation exclusively onto mature male crabs. Female snow crabs undergo a terminal molt to maturity and can reach maximum sizes of 47-95 mm CW (Watson 1970). Males attain maturity between 51 and 72 mm CW (Watson 1970) and are presumed able to mate in the intervening 1-4 yr before they recruit into the fishery. Thus, the 95-mm CW minimum size limit has been generally accepted as being a desirable management policy, effectively making the reproductive potential of the resource inviolate against high levels of exploitation on the fishable stocks. Hitherto, incidental observations, during sampling of commercial catches, on the dearth of barren mature females and the large numbers of eggs produced per female has supported the general concensus that there are sufficient mature males to preserve overall egg production at prefishery levels. However, unpredictable recruitment trends in some Atlantic snow crab stocks (Bailey 1982; Elner 1982), as well as instability in male-only crab fisheries on the west coast of North America (Cancer magister: Botsford et al. (1983); Chionoecetes sp.: Otto (1982)), has prompted concerns over longer-term effects and ramifications of the 95-mm CW recruit size regulation. In response to such concerns, Elner and Robichaud (1983) highlighted deficiencies in present knowledge of snow crab reproduction and growth but argued that a high reproductive potential was probably being maintained in snow crab populations.

This paper presents data on the reproductive biology of female snow crab (incidence of barren, mature females, incidence of spermatophores in spermathecae, fecundity, egg development stage and condition) gleaned from samples caught off NW Cape Breton Island in November 1983.

Methods

Ninety-eight mature female snow crab (maturity based on abdomen allometry, Watson (1970)) were caught in Snow Crab Management Area 1, off NW Cape Breton Island (depth ca. 120 m; position: Lat. 46°53'00"-46°34'00" N, Long. 61°07'00"-61°25'00" W) by a commercial vessel using a Danish seine on November 21, 1983.* The snow crabs were frozen within 8 h of capture and stored at ca. -20°C. Prior to examination, the crabs were thawed overnight at room temperature. For each female snow crab we recorded:

- size, as determined by measuring the CW to the nearst 0.1 mm, across the widest part of the carapace from tip to tip of the distal marginal teeth;

- the presence or absence of external eggs;

- egg color and the presence or absence of eyespots;

*The size frequency of 46 male snow crabs captured with the females is shown in Appendix 1.

- ovary color and size (subjective relationship);

- the presence and type of internal parasites;

- presence or absence of spermatophores; a spermatheca was removed, dissected longitudinally, and its contents examined under a dissecting microscope. Spermatophores are recognizable under x50 magnification as minute, white, spherical bodies embedded in an acellular, jelly-like substance;

- the condition of the exoskeleton; careful examination was made in an attempt to separate primiparous and multiparous females. We assumed that the carapaces of primiparous females would be distinguishable by having less epifauna, a lighter color and less wear and scratches than multiparous females. At the time of sampling, primiparous females would have had a postmolt age of approximately 9 mo (the female molt to maturity has been most frequently observed in February-April (Watson 1972)), whereas multiparous females would have had an approximate postmolt age of 21 mo.

General observations were made on the fauna associated with the egg masses.

Ovigerous snow crabs were found to be carrying either eggs without eyespots or later stage eggs with eyespots. Twenty-five females were chosen at random from each egg stage category for individual fecundity estimates. All external eggs were removed and dried to a constant weight at 70°C for 48 h. The mean dry weight of one egg was calculated for each female by weighing four subsamples of 30 eggs and dividing the combined weight of the four subsamples by 120. The number of eggs present in the egg clutch was then estimated by dividing the total egg mass dry weight by the mean dry weight of one egg.

The relationship between CW (X) and the number of eggs per female (Y) was approximated for each of the two egg stage categories by using a curvilinear equation of the form:

$$Y = aX^b$$

after transforming both X and Y by $\log_e$.

Results

The carapace width distribution of the 98 female snow crabs is shown in Table 1 and Fig. 1. All of the females had extruded eggs under their abdomens. Sixty-eight (69.4% of total) females were carrying orange or orange/brown eggs with no visible cell cleavage (x60 examination under a dissecting microscope) or eyespot development, whereas 25 (25.5%) females had later stage orange/brown or brown eggs with distinctive eyespots. The remaining 5 (5.1%) females were not examined for egg development. There was no significant relationship ($X^2 = 5.69$; df = 6; $P > 0.3$) between egg development stage and carapace width (Table 1, Fig. 1).

Most ovaries examined were large and bright orange in color (n=80; 82.5%); of the remainder, 14 (14.4%) were large and light orange and 3 (3.1%) were small and cream colored. There was no significant relationship (X^2 = 5.68; df = 6; $P > 0.3$) between ovary development and carapace width (Table 1, Fig. 2).

Spermatophores were present in the spermathecae of 96 (98%) of the 98 females examined. The two females without spermatophores were 64.3 and 73.2 mm CW, respectively (Table 1).

All females collected had dark colored exoskeletons showing similar wear patterns and widespread encrustacean with a bryozoan "mat." Therefore, primiparous and multiparous females, assuming both groups were present in the sample, could not be distinguished on the basis of shell condition.

Fecundity:carapace width regression relationships are shown separately for 25 females carrying eggs without eyespots and 25 females carrying eggs with eyespots in Table 2 and Fig. 3. The low correlation coefficient (r=0.223) for females carrying eggs without eyespots indicates that there is no significant relationship ($P > 0.05$) between CW and fecundity. In contrast, for females carrying eyed eggs, the correlation coefficient (r=0.500) is significant ($P < 0.05$) demonstrating a real relationship between number of eggs and CW. Fecundity estimates for the two groups (without eyespots: mean ± SE = 61,430 ± 3154; range = 31,276-102,022; with eyespots: mean ± SE = 58,193 ± 2930; range = 23,144-85,365) show considerable overlap (Fig. 3). Given fecundity appears independent of female size in one instance and size-dependent in the other instance, there appears no requirement for further statistical comparisons between fecundity in the two groups.

A nematomorph parasite, *Nectonema* sp., was found in the haemocoel of 82 out of 92 female snow crabs examined.* Free-living nematodes, *Oncholaimus* sp., and turbellarian, *Ectocotyla* sp., egg capsules were commonly associated with egg clutches.

Discussion

All of the 98 female snow crabs sampled in November were carrying eggs; of the 93 egg clutches examined, 73% (68) were without eyespot development and 27% (25) were later-stage eggs with eyespots. The ratio of non-eyed to eyed eggs is in close agreement with observations by Watson (1969) on egg development stages (new eggs, 75%; new/eyed eggs, 15%; eyed eggs, 10%) for ovigerous snow crabs from the Gulf of St. Lawrence in November. The presence of more than one egg stage in females from the same sampling suggests that Atlantic *C. opilio* may be similar to *C. opilio* from the Japan Sea in having two distinct spawning cycles. Ito (1967), Kon (1974, 1980) and Sinoda and Kobayashi (1982) determined that primiparous female snow crabs from the Japan Sea require 18 mo to hatch their eggs whereas

*New host species record (see Leslie et al. 1981).

multiparous females require only 12 mo. Further evidence for such a phenomenon in Atlantic snow crab is that although females with hatching and freshly extruded eggs are most common during field sampling in late April-June (Watson 1969; R. W. Elner, personal observations) all laboratory observations on mating and primiparous egg extrusion have been made in February-early March (Watson 1970, 1972).

Three distinct ovarian stages were observed in our samples. All 25 females carrying eggs with eyespots were categorized in the group of 76 females with large orange (type III) ovaries. The remaining three females with small cream (type (I) ovaries and 12 females with large light orange ovaries (type II) had eggs without eyespots (Fig. 4). Such a significant relationship ($X^2 = 8.15$; df = 1; $P < 0.05$) between egg development and ovary development may further substantiate the existance of separate spawning cycles for primiparous and multiparous females, with crabs having large orange ovaries and carrying eyed-eggs representing either the primiparous or multiparous component.

Somerton and Myers (1983) distinguished primiparous and multiparous female tanner crabs, Chionoecetes bairdi, from the eastern Bering Sea on the basis of shell condition and determined that primiparous females are approximately 70% as fecund as multiparous females. Similarily, we had hoped to compare fecundity values between primiparous and multiparous females in our samples; however, as the females all appeared similar in shell condition we were unable to pursue this.

Watson (1972) determined that female snow crabs can produce at least two egg clutches from sperm received during copulation at the molt to maturity. However, critical information is sparse on the length of time sperm stored by female snow crabs remains viable, the number of egg clutches that can be fertilized from sperm stored at the original mating or the occurrence of rebreeding in multiparous females. Ninety-eight percent of the ovigerous females we examined had spermatophores stored in their spermatheca suggesting that they would have been capable of producing at least one further brood without rebreeding. Watson (1970) collected snow crabs from off the Gaspé peninsula during May-September 1969, and found that 100% (n=75) mature females with new hard shells had spermatophores. In contrast, 80% (n=46) of mature females with old hard shells were without spermatophores; no immature females (n=9) had spermatophores. Adams and Paul (1983), in studying relationships between male parent size, the number of eggs produced and the number of sperm remaining after egg extrusion for tanner crab, found that all sizes of mature males examined produced an excess of sperm at mating and that following egg extrusion 93% of the females had enough stored sperm to fertilize additional egg clutches.

In comparison to our study, all previous studies on snow crab fecundity (see Elner and Robichaud (1983) for review) have found significant relationships between number of eggs carried and carapace width (Table 3; Fig. 5). Although our ranges for egg numbers (23,144-102,022) are within limits found for Atlantic snow crab by other investigations, the slopes of both the regressions and their correlation coefficients (r) are well below previous values (Table 3). Davidson's (1983) expression of fecundity (Y) for snow crab sampled off NW Cape Breton Island in July 1980:

$$Y = 38.4554 CW^{1.7649} \quad (r = 0.6347)$$

(Mean Fecundity : 74,500; Range : 32,600-128,400) is higher in mean, range and slope than both our expressions for the same area in November. However, Kon (1974) showed that about 50% of deposited snow crab eggs may be lost during the course of embryonic development. Thus, direct comparisons between ranges, means, slopes and intercepts of expressions for recently extruded eggs in July (Davidson, 1983) and our later stage samples are probably confounded by natural patterns of egg loss. Furthermore, Kon (1974) demonstrated a progressive decrease in both intercept and slope of the fecundity: CW relationship through the egg development period, suggesting that egg loss may be proportionately greater for larger, more fecund females. Such a differential may explain the trend for decreased slope between the Davidson (1983) CW:fecundity equations and our own findings. Similarly, the differences in slopes between the CW:fecundity equations for our two egg development stages may be attributable to the non-eyed eggs having been extruded by primiparous females at an earlier date to the eyed eggs (presumably from the multiparous component). The contention by Ito (1967) that eggs from primiparous females spend at least 12 mo in the stage prior to eye formation would support our hypothesis.

Our observations on the type and frequency of parasites and free-living fauna associated with the female snow crabs are similar to observations made on snow crab from the same area during 1980-82 (unpublished data).

Overall, our study demonstrates a lack of barren, mature females, fecundity within explainable levels and a high incidence of females with stored spermatophores, suggesting that population fecundity of snow crab is being maintained at a historic, pre-fishery level (assuming no decrease in the absolute number of mature females). The data do not appear cause for amending the current minimum size regulations in an attempt to improve egg production. The 'bottom-line' still remains that in the face of high exploitation rates on male crabs >95 mm CW there still appear sufficient numbers of males escaping the fishery and/or sufficient mature males 95 mm available to produce adequate amounts of sperm and mate the majority of mature female crabs.

High population fecundity and egg production do not necessarily translate in high recruitment levels into the snow crab fishery. Recruitment trends have been unpredictable (Elner 1982) and there is no reason why they should not continue to be so. Presently a large proportion of the snow crab population (mature males >95 mm CW) is removed annually by the fishery; whereas the remainder of the population remains subject only to natural mortality. Density-dependent effects on the production/population dynamics of the population as a whole, as a result of the "ecological vacuums" created by the fishery appear inevitable. Bailey (1982) and Waiwood and Elner (1982) have hypothesized on production-feedback responses and density-dependent controls on stock abundance and recruitment; such indirect effects of the minimum size limit may be the most important limits on the long-term 'health' of the fishery.

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Table 1. List of data on ovigerous snow crabs females from NW Cape Breton Island, November 1983.

Ref. no.	CW	Shell condition	Egg Condition color[a]	Egg Condition eyespot[b]	Ovary Condition color[c]	Ovary Condition size[d]	Spermatophors Y/N	Internal parasites
049	49.1		3	Y	3	L	Y	N
014	56.5		3	Y	3	L	Y	Y
084	58.3		1	N	3	L	Y	Y
033	58.5		1	N	3	L	Y	Y
012	59.0		3	Y	3	L	Y	N
013	59.8		1	N	3	L	Y	Y
018	60.4		1	N	3	L	Y	Y
080	61.0		1	N	3	L	Y	Y
095	61.4		1	N	3	L	Y	Y
043	61.7		3	Y	3	L	Y	Y
065	61.9		1	N	2	L	Y	Y
067	62.0		1	N	3	L	Y	Y
070	62.0		1	N	3	L	Y	Y
041	62.1		2	N	3	L	Y	Y
002	62.7		1	–	2	–	Y	–
036	62.8		–	–	3	L	Y	Y
064	62.8		1	N	3	L	Y	Y
046	62.8		3	Y	3	L	Y	Y
078	63.1		1	N	3	L	Y	Y
069	63.3		1	N	3	L	Y	Y
004	63.4		1	–	3	–	Y	–
087	63.7		1	N	3	L	Y	Y
053	63.9		3	Y	3	L	Y	Y
062	64.0		2	Y	3	L	Y	Y
091	64.1		1	N	3	L	Y	Y
019	64.3		3	Y	3	L	N	N
001	64.5		1	–	2	–	Y	–
063	64.5		1	N	3	L	Y	Y
022	64.6		3	Y	3	L	Y	Y
026	64.6		3	Y	3	L	Y	N
051	64.6		2	Y	3	L	Y	N
068	64.7		1	N	3	L	Y	Y
055	65.0		2	Y	3	L	Y	Y
035	65.1		1	N	3	L	Y	N
005	65.2		1	–	3	–	Y	–
050	65.4		2	Y	3	L	Y	Y
037	65.5		1	N	3	L	Y	Y
061	65.6		2	Y	3	L	Y	Y
088	65.7		1	N	3	L	Y	Y
011	65.8		1	N	3	L	Y	Y
052	65.9		3	Y	3	L	Y	Y
098	65.9		1	N	1	S	Y	Y
017	66.3		2	N	3	L	Y	Y
092	66.6		1	N	3	L	Y	Y
032	66.8		1	N	3	L	Y	Y
066	67.4		1	N	3	L	Y	N
020	67.6		1	N	3	L	Y	N
042	68.1		1	N	3	L	Y	Y
083	68.3		1	N	2	L	Y	Y
031	69.1		3	Y	3	L	Y	Y

Table 1. (cont'd)

Ref. no.	CW	Shell condition	Egg Condition color[a]	Egg Condition eyespot[b]	Ovary Condition color[c]	Ovary Condition size[d]	Spermatophors Y/N	Internal parasites
073	69.2		1	N	3	L	Y	Y
006	69.3		1	N	3	L	Y	Y
029	69.7		1	N	3	L	Y	Y
044	69.9		1	N	3	L	Y	Y
071	70.0		1	N	3	L	Y	Y
003	70.1		1	-	3	-	Y	-
030	70.5		1	N	3	L	Y	Y
057	70.5		3	Y	3	L	Y	Y
007	70.7		1	N	2	L	Y	Y
010	70.7		3	Y	3	L	Y	Y
023	70.8		1	N	2	L	Y	Y
039	71.0		2	N	1	S	Y	Y
077	71.0		1	N	3	L	Y	Y
090	71.0		1	N	3	L	Y	Y
058	71.1		2	Y	3	L	Y	Y
025	71.3		1	N	3	L	Y	Y
045	71.6		1	N	3	L	Y	Y
021	71.7		1	N	2	L	Y	Y
048	71.7		1	N	1	S	Y	Y
024	71.9		1	N	-	-	-	-
072	72.0		1	N	3	L	Y	Y
016	72.4		1	N	2	L	Y	Y
076	72.7		1	N	2	L	Y	Y
079	72.7		1	N	3	L	Y	Y
089	72.7		1	N	3	L	Y	Y
074	72.9		1	N	3	L	Y	Y
056	73.0		3	Y	3	L	Y	Y
085	73.0		1	N	2	L	Y	Y
027	73.2		3	Y	3	L	N	Y
059	73.7		3	Y	3	L	Y	Y
075	73.8		2	N	2	L	Y	Y
086	73.9		1	N	2	L	Y	Y
054	74.0		3	Y	3	L	Y	Y
094	74.2		1	N	3	L	Y	Y
093	74.3		1	N	3	L	Y	Y
097	74.4		1	N	3	L	Y	Y
008	74.8		1	N	3	L	Y	Y
040	74.8		1	N	3	L	Y	Y
081	75.5		1	N	3	L	Y	Y
047	75.8		1	N	3	L	Y	Y
015	77.5		3	Y	3	L	Y	Y
034	77.6		1	N	3	L	Y	Y
060	77.7		2	Y	3	L	Y	Y
096	79.3		1	N	3	L	Y	Y
028	79.8		1	N	3	L	Y	Y
009	79.9		1	N	2	L	Y	Y
038	80.9		1	N	2	L	Y	Y
082	81.4		1	N	3	L	Y	N

[a] 1-orange, 2-brown/orange, 3-brown.

[b] Present (Y) or absent (N).

[c] 1-cream, 2 light orange, 3-orange

[d] L-large, S-small.

Table 2A. List of data on fecundity of snow crabs from NW Cape Breton Island, November 1983. Egg stage I - no eyespot development.

Ref. no.	CW (mm)	Dry wt. of egg mass (g)	Dry wt. of 120 eggs (g)	Mean egg dry wt. (gx10^{-5})	Estimated fecundity
033	58.5	3.4135	.0083	6.89	49543
013	59.8	4.2800	.0087	7.27	58872
018	60.4	3.6542	.0088	7.30	50058
041	62.1	3.4503	.0077	6.38	54080
035	65.1	3.7588	.0055[a]	4.58	82070
037	65.5	5.0969	.0092	7.69	66280
011	65.8	3.6222	.0075	6.28	57678
017	66.3	3.3228	.0078	6.48	51278
032	66.8	5.3581	.0084	6.96	76984
020	67.6	5.6492	.0092	7.62	74136
006	69.3	2.1049	.0081	6.73	31276
029	69.7	4.3380	.0078	6.53	66432
030	70.5	4.5674	.0080	6.69	68272
007	70.7	2.0640	.0070	5.85	35282
023	70.8	4.1790	.0076	6.33	66019
039	71.0	3.1077	.0081	6.72	46246
021	71.1	3.9901	.0075	6.21	64253
025	71.3	4.1104	.0079	6.56	62658
016	72.4	2.5520	.0086	7.17	35593
008	74.8	4.8549	.0076	6.34	76576
040	74.8	5.0784	.0082	6.82	74463
034	77.6	4.1205	.0078	6.48	63588
028	79.8	7.1518	.0063	7.01	102022
009	79.9	3.7391	.0078	6.47	57791
038	80.9	4.6239	.0086	7.19	64310
Mean: ($\pm$SE)	69.70	4.0900		6.62 $\pm$ .14	61430 $\pm$ 3153.8

[a]90 eggs.

Table 2B. List of data on fecundity of snow crabs from NW Cape Breton Island, November 1983. Egg stage II - eyespot development.

Ref. No.	CW (mm)	Dry wt. of Egg mass (g)	Dry wt. of 120 eggs (g)	Mean egg dry wt. ($gx10^{-5}$)	Estimated fecundity
049	49.1	2.5048	.0089	7.42	33757
014	56.5	2.9534	.0083	6.92	42679
012	59.0	3.9035	.0086	7.18	54366
043	61.7	3.4722	.0079	6.60	52609
046	62.8	4.4203	.0067[a]	7.49	59016
053	63.9	2.8094	.0087	7.27	38644
062	64.0	3.3776	.0078	6.47	52204
019	64.3	4.6490	.0080	6.66	69805
022	64.6	1.5877	.0082	6.86	23144
026	64.6	4.0502	.0089	7.41	54658
051	64.6	5.2562	.0088	7.33	71708
055	65.0	4.0056	.0090	7.46	53694
050	65.4	3.9923	.0087	7.25	55066
061	65.6	4.7547	.0086	7.17	66314
052	65.9	5.5874	.0088	7.34	76123
031	69.1	3.5811	.0077	6.42	55780
057	70.5	4.0133	.0081	6.77	59281
010	70.7	3.8425	.0079	6.58	58397
058	71.1	5.7792	.0081	6.77	85365
056	73.0	5.7653	.0087	7.26	79412
027	73.2	3.9025	.0079	6.61	59039
059	73.7	3.6665	.0083	6.89	53215
054	74.0	5.4268	.0087	7.25	74852
015	77.5	6.1598	.0098	8.14	75673
060	77.7	3.6570	.0088	7.31	50027
Mean ($\pm$SE)	66.7	4.1247		7.07 $\pm$ .08	58193 $\pm$ 2929.5

[a]90 eggs.

Table 3. Estimates of total fecundity and regressions of fecundity (Y) with carapace width (X) for female snow crabs, _Chionoecetes opilio_, from various areas.

Sample area	No. of females sampled	Fecundity regressions	Corr. coef. (r)	Mean fecundity	Range
Newfoundland[a]	51	$Y = 6.4080X^{2.169}$	0.7767	52,048	37,934- 81,239
Anticosti[a]	98	$Y = 13.2530X^{1.9922}$	0.7472	58,760	12,134-122,891
Pleasant Bay[a]	98	$Y = 38.4554X^{1.7649}$	0.6347	74,475	32,564-128,433
Gabarus[a]	115	$Y = 14.7361X^{1.9859}$	0.6598	80,068	42,284-120,378
All four of the above areas[a]	361	$Y = 9.2490X^{2.0893}$	0.7694	66,338	12,134-128,433
Southeastern Bering Sea[b]	42	$Y = 0.4905X^{2.7206}$	0.7329	36,273	- -
Gulf of St. Lawrence[b]	99	$Y = 0.0012X^{4.200}$	0.8086	-	20,000-140,000[c]
NW Cape Breton Island[d] (non-eyed)	25	$Y = 3092.23X^{0.70}$	0.223	61,430	31,276-102,022
NW Cape Breton Island[d] (eyed)	25	$Y = 147.17X^{1.42}$	0.500	58,193	23,144- 85,365

[a]From Davidson (1983).
[b]From Haynes et al. (1976).
[c]From Watson (1969).
[d]From present study.

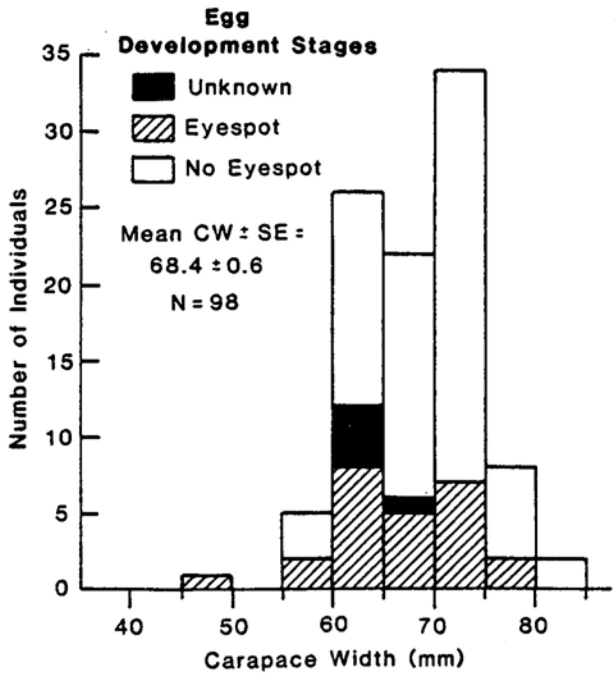


Fig. 1. Carapace width distribution for ovigerous female snow crabs captured off NW Cape Breton Island, November 1983; and frequncy of egg development stages is illustrated for each size class.

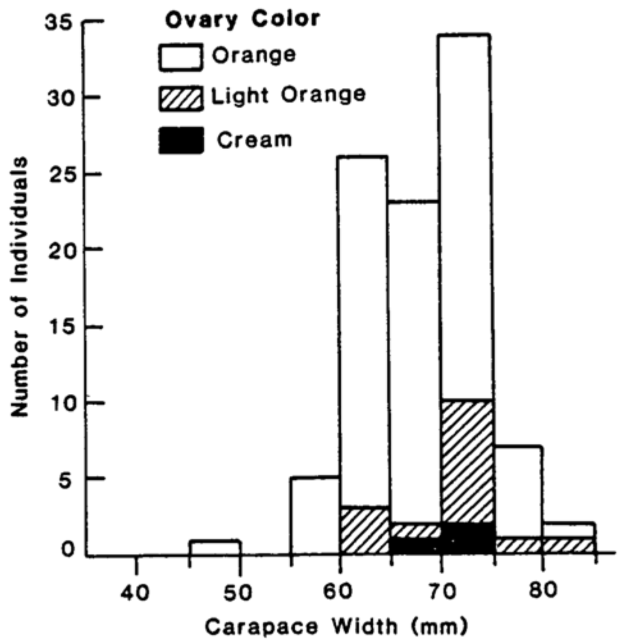


Fig. 2. Carapace width distribution for ovigerous female snow crabs showing frequency of ovary development stages for each size class.

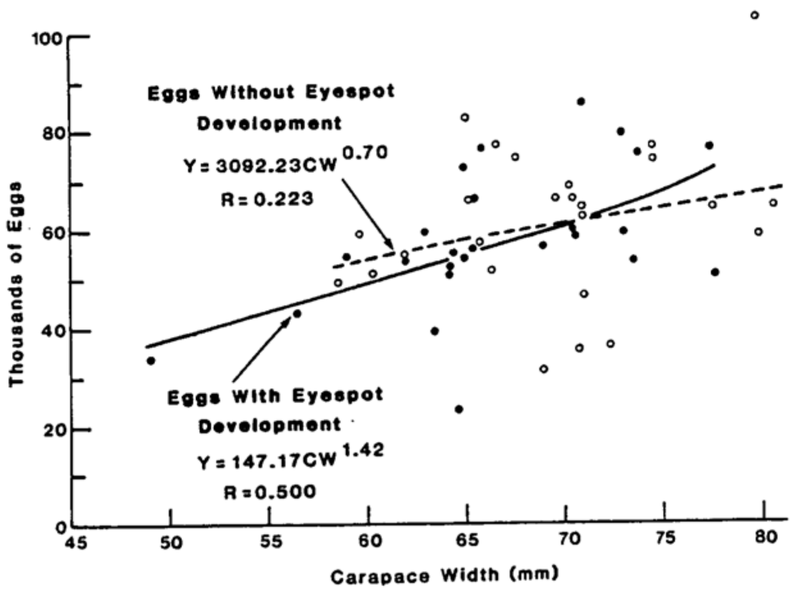


Fig. 3. Fecundity of ovigerous female snow crabs captured off NW Cape Breton Island, November 1983.

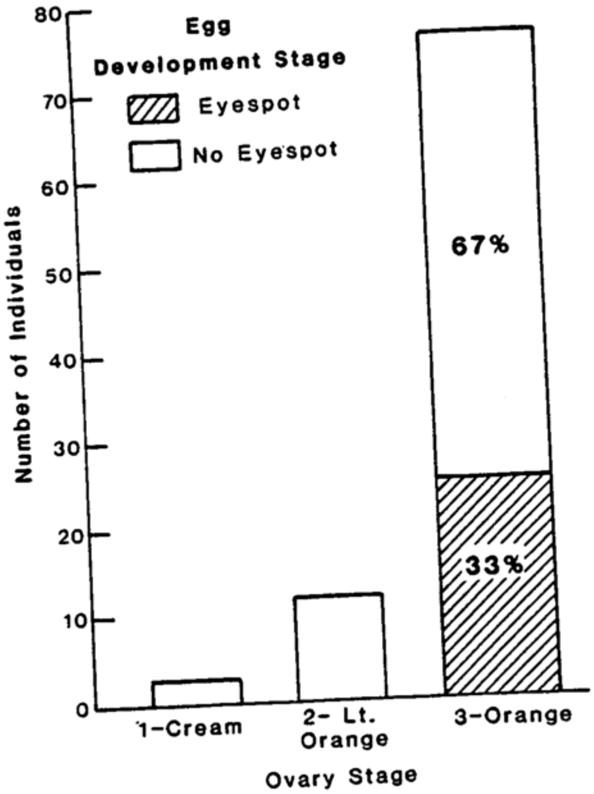


Fig. 4. Relationship of ovary development stage to egg development stage for ovigerous female snow crab.

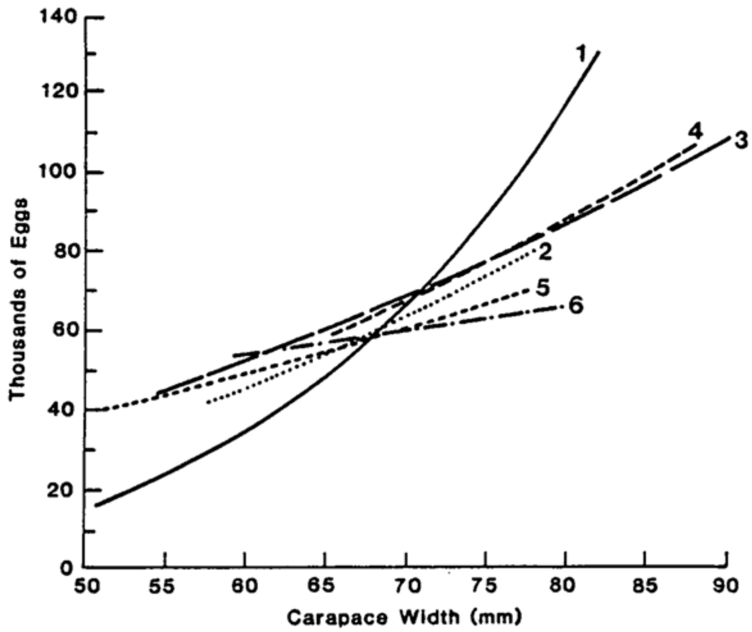
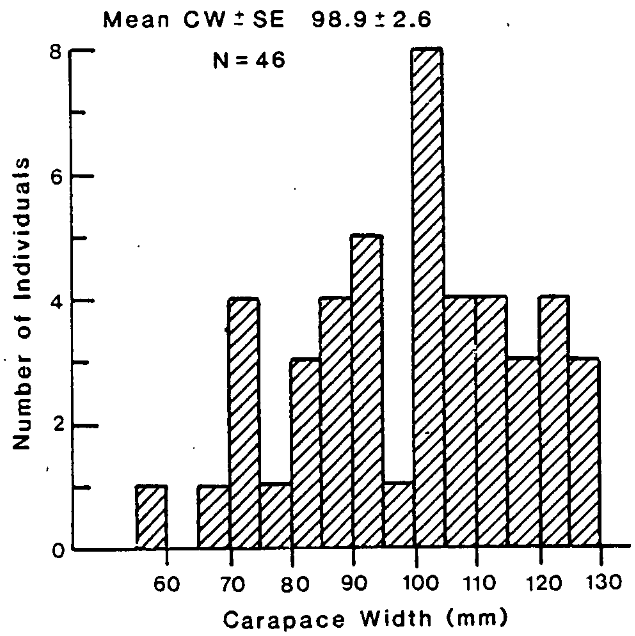


Fig. 5. A comparison of estimated snow crab, <u>Chionoecetes opilio</u>, fecundities from various areas: 1, Gulf of St. Lawrence females; 2, Newfoundland females; 3, Pleasant Bay/Cheticamp females (NW Cape Breton Island); 4, Gabarus females; 5, NW Cape Breton Island females without eyespot development; 6, NW Cape Breton Island females with eyespot development (1, after Haynes et al. 1976; 2-4, after Davidson, 1983; 5, 6, present study).



Appendix I. Size-frequency histogram for male snow crabs caught off N.W. Cape Breton Island, November, 1983, along with the female snow crabs used in the reproduction study.