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COMPARATIVE FECUNDITY OF ELEVEN SPECIES OF ANOMURAN CRABS (*CRUSTACEA, DECAPODA, DIOGENIDAE*)

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ABSTRACT

In this work fecundity, expressed as egg mass volume(EMV), was studied in 11 species belonging to 2 genera of the family Diogenidae (anomuran crab). The relationship between both carapace volume (CV) and (EMV) and between carapace length (CL) and egg number per egg mass (EN) were determined.

Regression equations of mean EN on mean CL and of mean EMV on mean CV exhibited positive linear relationships with regression coeficients (r) equal 0.870 and 0.881 respectively. The present study shown the similarity between the linear and log-transformed regression equaions (linear, EMV = 0.08 CV + 7.347, r = 0.881. Log, EMV = 0.83 log CV - 0.57, r = 0.873).

The significant relationship predicted between CV and EMV allows the fecundity of a diogenid crabs to be estimated in terms of EMV or in terms of EN by dividing the calculated EMV by an observed mean Egg volume.

INTRODUCTION

Little is known of the reproductive biology and life histories of most genera of the anomuran crabs family Diogenidae (Lang and Young, 1977; Brossi & Hebling, 1983; Brossi 1987). Most information exist as distributional records which may or may not include breeding times (Williams, 1984).

Very strong linear relationship between the carapace volume

(CV) and fecundity, expressed as egg mass volume (EMV) in the ovigerous decapod crustaceans have been shown to exist within *Mysidacea* (Mauchline, 1973) and *Cumaceans* (Corey, 1981) and within *Porcellanidae*, *Portunidae*, *Astacidea* and *Palinura* (Reid, 1991). Relationship between female size (CV) and fecundity have also been reported between caridean shrimp (Corey & Reid, 1991).

It has been shown in the mentioned decapod crustacean families that the relationship between mean carapace volume (CV) and mean egg mass volume (EMV) is very much stronger and therefore more useful in estimating fecundity than that between carapace length (CL) and egg number per egg mass (EN) (Reid, 1991; Corey & Reid, 1991).

In the present study 11 species from two genera of *Diogenidae* (anomuran crabs) were analysed to determine the strength of the relationship between both CV and EMV and between CL and EN to determine their respective utility in reproductive studies.

MATERIAL AND METHODS

The specimens in this study were collected from Egyptian waters Hurghada (Red Sea) and Abu-Qir (Mediterranean Sea) sites. Location and habitat for each species were shown in table 1. Carapace length (CL) for each ovigerous female was taken from the tip of the rostrum dorsally along a line parallel to the mid-line to the posterior edge of the carapace. Carapace width (CW) was taken at the widest point on mid-line, and carapace depth (CD) at the deepest point. Carapace volume (CV) was calculated as : CV = CL x CD x CW.

The eggs were removed, counted and measured as described by Corey & Reid (1991). These data allowed calculation of carapace volume (CV), egg number per egg mass (EN), individual egg volume (EV) and the volume of the egg mass (EMV) to be determined for each studied specimen as the following : EMV = EN x EV. Egg number was regressed on CL and EMV on CV for each species, dependent upon available data. Equations for means of EN on CL and EMV on CV for each species were derived, with 95% confidence limits to illustrate the relative strength of the respective relationships in the family *Diogenidae*. Individual ENs and EMVs were also regressed on CLs and CVs, respectively, for comparison. All data were also log-transformed, with log EMV regressed on log CV, and 95% confidence limits again calculated all as described above.

RESULTS AND DISCUSSION

Sample data on the 11 species of *Diogenidae* have been listed in table 1. Means and ranges of CLs, ENs, CVs and EMVs, with mean EVs from ovigerous females were recorded in table 2. Carapace Lengths (CL, CW and CD) were shown in Fig. 1. A & B respectively.

Ovigerous females varied in mean CL (mm) from 8.4 in *Calcinus ornatus* to 14.1 in *Clibanarius lineatus*. Mean ENs ranged from 83.1 in *Calcinus nitidus* to 212.2 in *Calcinus gaimardi*. Also ovigerous females varied in mean CV (mm^3) from 187.2 in *Calcinus ornatus* to 676.8 in *Clibanarius lineatus*. Mean EMVs (mm^3) varied from 17.70 in *Calcinus nitidus* to 59.42 in *Calcinus gaimardi*.

Equations regressing EN on CL, and EMV on CV, with sample sizes and regression coefficients, are listed in table 3. Over all species studied, both mean EN versus mean CL and mean EMV versus mean CV exhibited positive linear relationships (Fig. 2, 3 respectively, table 3). The former relationship was weaker (r = 0. 870) (Fig. 2) compared to the latter relationship (r = 0.881) (Fig. 3) Regressing EMV on CV for all 195 individuals still resulted in a strong relationship (r = 0.820, table 3).

Table 1

Species	Local distribution	Habitat	Months
Cl carnifex* Heller, 1861	Red Sea Hurghada	Under rocks & tide pools	May, July, Spt.
Cl signatus* Heller, 1861	Hurghada	Under rocks	Apr., Aug., Oct.
Cl infraspinatus* Hilgendorf, 1869	Hurghada	Under rocks & tide pools	May, July, Spt.
Cl longitarsis* (De Hean, 1844)	Hurghada	Tide pools	Apr., Aug., Nov.
Cl anomalus* Milne Edwards & Bouvier, 1890	Hurghada	Under rocks & tide pools	Feb., Mar., July.
Cl lineatus* (Milne Edwards), 1848	Hurghada	Under rocks	Mar., Apr., Oc.
Cl erythropus* Latreille, 1818	Mediterranean Sea Alexandria	Tide pools & stoney grounds	Apr., Aug., Nov.
Cl mediterraneus* Kossmann, 1878	Mediterranean Sea Alexandria	Tide pools & stoney grounds	July, Aug., Oct.
Ca ornatus* (Roux), 1828	Mediterranean Sea Alexandria	Tide pools	Apr., July, Nov.
Ca gaimardi* (Milne Edwads. A), 1848	Mediterranean Sea Alexandria	Tide pools	Mar., Oct., Nov.
Ca nitidus* Heller, 1865	Hurghada	Tide pools	Aug., Oct., Nov.

Cl = Clibanarius* , *Ca* = Calcinus*

Table (2) : Means and ranges of carapace lengths (CL : mm) and volumes (CV : mm3), egg numbers (EN) and egg mass volumes (EMV : mm3), mean volumes of individual egg (EV : mm3) for females of the 11 species of *Diogenidae* analysed.

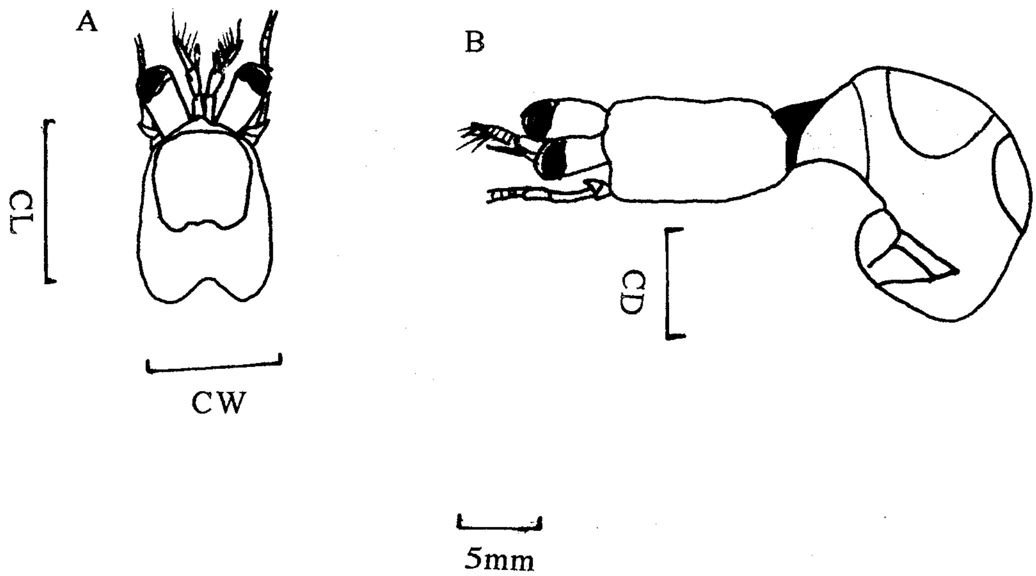
Species	CL (mm)		CV $(mm)^3$		EN		Mean	EMV $(mm)^3$	
	Mean	range	Mean	range	Mean	range	EV $(mm)^3$	Mean	range
Cl carnifex*	12.0	10.2-14.8	420.2	307.1-611.6	188.3	154-223	0.282	53.10	43.43-62.89
Cl signatus*	11.2	11.0-12.6	336.3	211.3-502.2	185.1	172-211	0.243	44.98	41.80-51.27
Cl infraspinatus*	13.2	12.1-15.4	544.5	321.1-706.7	202.1	186-280	0.255	51.54	47.43-71.40
Cl longitarsis*	9.0	7.6-10.5	198.7	88.3-305.3	98.5	48-138	0.236	23.25	11.33-32.80
Cl anomalus*	8.9	8.2- 9.5	192.4	85.1-301.6	100.6	86-108	0.264	26.56	22.70-28.51
Cl lineatus*	14.1	10.8-15.3	676.8	411.2-903.7	211.6	182-283	0.281	59.42	51.14-79.52
Cl erythropus*	11.0	10.2-13.1	357.5	199.6-511.1	103.3	75-154	0.238	24.59	17.85-36.07
Cl mediterraneus*	11.1	10.0-13.2	353.1	189.1-503.6	92.1	72-132	0.273	25.14	19.66-36.04
Ca ornatus*	8.4	8.0- 9.1	187.2	79.4-298.2	91.7	80-115	0.193	17.70	15.44-22.20
Ca gaimardi*	14.0	12.0-16.2	543.9	374.6-803.5	212.2	92-277	0.250	53.11	23.00-69.25
Ca nitidus*	9.5	7.8-12.2	212.6	122.0-398.4	83.1	45-135	0.270	22.47	12.15-36.45

Cl = Clibanarius* *Ca* = Calcinus*

Table (3) : Regression equations of egg number (EN) on carapace length (CL : mm) and egg mass volume (EMV : mm3) for females from two genera (11 species of *Diogenidae*), as well as for all species.

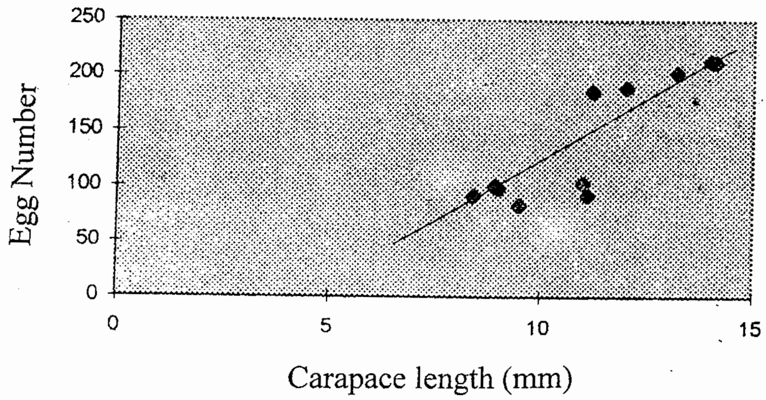
Species	n	Equation (EN on CL)	r	Equation (EMV on CV)	r
Cl carnifex*	20	EN=43.47CLL-1271.55	0.932	EMV=0.07CV+29.22	0.960
Cl signatus*	18	EN=15.15CL-19.77	0.974	EMV=0.04CV+37.40	0.991
Cl infraspinatus*	21	EN=21.45CL-55.63	0.728	EMV=0.05CV+30.46	0.827
Cl longitarsis*	16	EN=32.90CL-145.26	0.963	EMV=0.21CV-13.88	0.974
Cl anomalus*	19	EN=16.11CL-42.39	0.959	EMV=0.04CV+17.96	0.994
Cl lineatus*	17	EN=32.13CL-213.88	0.959	EMV=0.08CV+5.40	0.962
Cl erythropus*	18	EN=42.50CL-359.60	0.946	EMV=0.07CV+4.71	0.920
Cl mediterraneus*	16	EN=19.14CL-117.76	0.897	EMV=0.05CV+8.93	0.915
Calcinus ornatus	20	EN=26.20CL-116.23	0.991	EMV=0.24CV+5.30	0.993
Calcinus gaimardi	15	EN=48.33CL-480.58	0.990	EMV=0.08CV-8.25	0.994
Calcinus nitidus	15	EN=25.38CL-137.95	0.812	EMV=0.06CV+7.62	0.825
Species mean	11	EN=23.97CL-124.12	0.870	EMV=0.08CV+7.347	0.881
All females	195	EN=29.85CL-142.31	0.786	EMV=0.08CV+6.813	0.826

*Cl** = *Clibanarius*, n = number of specimens, r = regression coeffecient

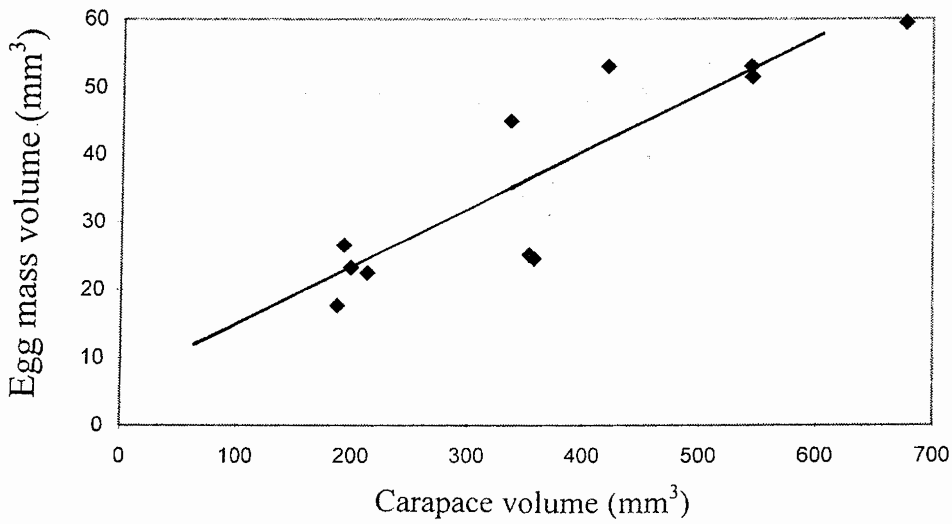


(Fig. 1) A : Carapace dorsal view
B : a diogenid crab lateral view (without leg)

CL = Carapace Length
CW = Carapace width
CD = Carapace Depth
scale = 5 mm.



(Fig. 2) : **Relationship between mean egg number per egg mass (EN) and mean carapace length (CL) for 11 species of anomuran crabs (EN = 23.97 CL - 124.12, r = 0.870).**



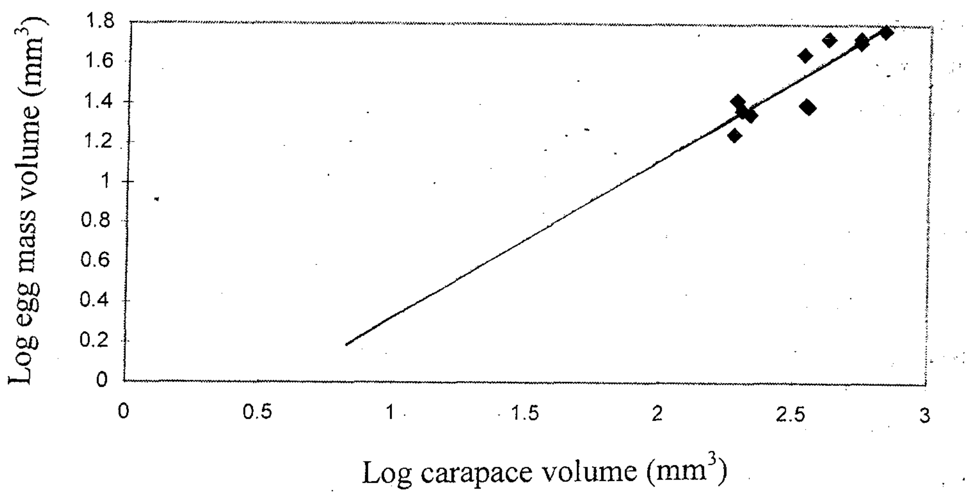
(Fig. 3) : **The linear relationship between mean volume of the egg mass volume (EMV) and mean carapace volume (CV) for 11 species of anomuran crabs (EMV = 0.98 CV + 7.347, r = 9.881)**

In general, mean CV and mean EMV ranged from 187.2 and 17.7 mm^3 (respectively) in *Calcinus ornatus* to 676.8 and 59.42 mm^3 respectively) in *Clibanarius lineatus* (Table 2).

The linear and log - transformed data yielded the following regression equations :

Linear, EMV = 0.08 CV + 7.347

Log-transformed : Log EMV = 0.83 (log CV) - 0.57. The relative strengths of these two relationships were similar (linear, r = 0.881, Fig. 3; log transformed, r = 0.873, Fig. 4).



(Fig. 4) : The logarithmic relationship between mean egg mass volume (EMV) and mean carapace volume (CV) for 11 species of anomuran crabs (Log EMV = 0.83 Log CV -0.57, r = 0.873).

The strong relationship (r = 0.881) seen between CV and EMV allows the fecundity of a diogenid species to be estimated in terms of EMV, using the appropriate equation in table 3, or in terms of EN by dividing the calculated EMV by an observed mean EV. This relationship between CV and EMV was however, not as strong as in species as *Portunidae* (r= 0.978) (Reid 1991) hippolytid (r = 0.999, 6 species), alpheid (r = 0.996, 9 species) and palaemonid shrimp (r = 0.993, 10 species) (Corey & Reid, 1991), but was stronger than that seen in porcellanid crabs (r = 0.843, 9 species) (Reid, 1991).

The similarity in relative strength of the linear and log-transformed regression equations over all 11 studied species is in contrast to what has been previously observed in caridean shrimp (Corey & Reid, 1991), Where the logarithmic relationship (r = 0.971) was much stronger than the direct linear relationship (r = 0.802). In that study, the log-transformation reduced the overall influence of a few larger species plotted some distance from the regression line.

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مقارنة الإخصابية لأحد عشرنوعاً من السرطانات ملتوية البطن (قشريات عشرية الأرجل)

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تم دراسة أحد عشر نوعاً من السرطانات ملتوية البطن تنتمى إلى جنسين يتبعان عائلة (ديو جنيدى لمعرفة علاقة الإرتباط بين عدد البويضات الذى تحمله الأنثى وطول الدرقة من جهة ، وكذلك علاقة الإرتباط بين حجم كتلة البويضات وحجم الدرقة من جهة أخرى ، وذلك لتوضيح أيهما ذو فائدة تختص بدراسة التناسل لهذه الحيونات .

وقد أوضحت الدراسة أنه فى إناث هذه الحيوانات يتراوح متوسط طول الدرقة من ٤ر٨ مم لنوع كالسينس اورناتس إلى ١ر١٤ مم لنوع كليباناريس لينياتس ، وأن متوسط عدد البويضات يتراوح من ١ر٨٣ فى نوع كالسينيس نيتيدس إلى ٢ر٢١٢ فى نوع كالسينس جيماردى . وكذلك متوسط حجم الدرقة يتراوح من ٢ر١٨٧ مم٣ لنوع كالسينس اورناتس إلى ٨ر٦٧٦ مم٣ لنوع كليباناريس لينياتس ، وأن متوسط حجم كتلة البويضات يتراوح من ٧ر١٧ مم٣ إلى ٤٢ر٥٩ مم٣ فى النوعين كالسينس نيتيدس وكالسينس جيماردى بالترتيب .

هذا وقد أثبتت الدراسة أن هناك علاقة إرتباط موجبة بين حجم كتلة البويضات وحجم الدرقة وكذلك بين عدد البويضات وطول الدرقة مما يشير إلى إمكانية التعبير عن الإخصابية لهذه الحيوانات بحجم كتلة البويضات الذى تحمله الأنثى أو بعدد البويضات الذى يمكن معرفته بقسمة حجم كتلة البويضات على حجم البويضة الواحدة، وذلك ييسر معرفة أوقات تناسلها كخطوة فى مجال دراسة بيولوجية التكاثر لهذه المجموعة الهامة من الحيوانات التى تشكل يرقاناتها جزءاً هاماً من البلانكتون الذى يعتبر غذاءً هاما لكثير من الحيوانات البحرية