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# Biometric relationships and condition factor of *Tetralia glaberrima* Herbst, 1790, Gulf of Aqaba, Red Sea, Egypt

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**Abstract**
The biometric relationships of the *Tetralia glaberrima* individuals collected from hermatypic branched coral colonies at Gulf of Aqaba were treated during this study. These results showed that the relationship between carapace length (CL) and total body weight (W) for the whole population (sex combined) is highly correlated with the formula Log W= - 0.42 + 3.32 Log CL, while carapace width-weight relationship for whole population was Log W= - 0.62 + 3.4 Log CW. No significant difference between sexes, these relations are curve linear and has positive high correlation coefficient ‘r’ being 0.87 and 0.94 respectively. The regression coefficient ‘b’ is 3.32 and 3.4 with an intercept of Y- axis ‘a’= - 0.42, -0.62 respectively, showing an allometric positive correlation coefficients which denotes to the faster increase in body weight than in carapace length. On contrast, the relationship between carapace length (CL) and carapace width (CW) for sex combined was isometric with regression coefficient (b= 1.0557). The relative condition factor ‘Kn’ varied from 0.758 in immatures and juveniles, increased to 1.180, with an average of 0.991±0.102 in adults. The average value for “kn” was ideally and very close to 1, indicating good well- being allover the year round.

**Keywords:** *Tetralia glaberrima*, carapace length, carapace width, body weight, condition factor

## Introduction
Trapeziid crabs are small, obligate symbionts of corals. It includes the genera *Tetralia*, *Tetraloides* and *Trapezia*, they found exclusively on scleractinian corals from the families Acroporidae and Pocilloporidae (Castro, 1988) [10]. Trapeziidae, are considered highly beneficial for host corals for two reasons: (1) they actively defend their host corals from larger and potentially devastating coral-feeding organisms, such as *Acanthaster planci* and *Drupella cornus* (Glynn, 1982, 1987; Vannini, 1985; Pratchett *et al*., 2000; Pratchett, 2001) [26, 28, 59, 46, 45]; and (2) in turbid conditions, they contribute to the removal of excess sediment, which can otherwise smother corals (Stewart *et al.,* 2006) [52]. *Tetralia* associates with species of *Acropora* that form discrete colonies with bushy or corymbose growth forms (Knudsen, 1967; Eldredge and Kropp, 1982; Castro, 1988; Patton, 1994) [33, 16, 10, 41]. It have been shown to increase coral survivorship (Abele and Patton, 1976; Glynn, 1983; Patton, 1994; Sin, 1999) [4, 27, 41, 50]. It would be expected that animals would select habitats that would optimize their survival and reproductive success (Orians and Wittenberger, 1991; Pulliam and Danielson, 1991) [38, 47]. The distribution of an organism is thought to be limited by that of its preferred habitat (Gaston, 1994; Gaston and Kunin, 1997) [24, 25].
The length-weight relationship is very useful in the conversion of length of individual fish to weight. Conversion of growth equation for length into growth equation for weight, and in comparisons between populations of the same species or between species (LeCren, 1951; Bolger and Connolly, 1989; Pauly 1993) [36, 8, 42]. This fact well known in fishes (Bagenal and Tesch, 1978) [7], shrimps (Thomas, 1977) [55], lobsters (Hossien *et al.,* 1987; Abd El-Razek *et al.,*1989) [31, 1], and crabs (Potter *et al.,* 1983; Du Preez and Mclachlan, 1984; Sloan, 1985; Thurman II,1985; El-Sayed 1992,1997; Fouda,2000; Salem,2014) [44, 15, 51, 56, 17, 18, 22, 48]. The formula applied is $W= aL^n$, where ‘n’ is a constant value ranging from 2.5 to 3.5 and usually nears to 3 for isometric relations and deviate from 3 for allometric ones (Bagenal and Tesch 1978) [7]. The relationship between either carapace length or width and total body weight were

studied in crabs with several authors. Potter *et al.,* (1983) [44] and Du Preez and Mclachlan, (1984) [15] used carapace width against body weight for *Portunus pelagicus* and *Ovalipes punctatus* respectively. However, Sloan (1985) [51], El-Sayed (1992, 1997) [17, 18] used the carapace length instead of width for this study. Both length and width of carapace were highly correlated with body weight (Urita, 1936-1937) [58]. On the other hand, the relationship between carapace length and carapace width in crabs is greatly correlated and often an isometric relationship was found between the two variables. It was isometric for *Ovalipes punctatus* (Du Preez and Mclachlan, 1984) [15] with slight negative allometry in *Telmessus cheiragonus* and *T. acutidens* (Urita, 1936-1937) [58]
It is worthy to mention that, total crab weights were greatly fluctuated all the year around. The fluctuation in its weight is an indicator to increase the feeding rate, maturation of gonads, increase storage of materials within hepatopancreas or increase in relative growth such as chelae weight of males. From the knowledge of length-weight relationship and their fluctuations, it can predict the well being of crab which is known as condition factors. The relative condition factor 'Kn' and Fulton's coefficient of condition or composite condition factor 'K' are known. No information is known about the biology of *Tetralia* in the Red Sea. Therefore, the present study aims to through light on biometric relationships comprised length/width-weight, length-width and condition factor of *Tetralia glaberrima* along the Gulf of Aqaba.

**Materials and methods**

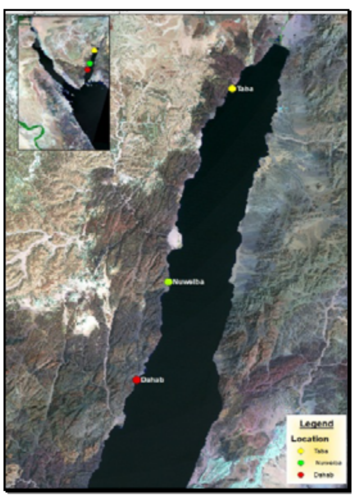


**Fig 1:** Map showing the different localities of collection.

A total of 423 specimens (175 males, 167 females and 81 juveniles) of *Tetralia glaberrima* were collected from coral reef of three study areas **(**Dahab (34º 54' 982″ E - 28º 60' 55″ N), Nuweiba (34º 64' 396″ E - 28º 88' 119″ N) and Taba (34º 54' 982″ E -28º 60' 55″ N)**)** along the Gulf of Aqaba (Fig.1) during the period from January to December 2014. *T. glaberrima* are crabs, which lives obligate as symbiotic between branches of hermatypic coral colonies of *Acropora* corals. Crabs were collected by snorkeling and scuba diving (to approximately 10 m).
Whole colonies of *Acropora* corals approximately 7–60 cm wide were extracted using hammer and chisel. Colonies were placed in plastic bags underwater in order to prevent crabs from being dislocated during transport. A thin, malleable stainless steel wire and with help of forceps were used to separate the crabs from their host corals. Samples of coral branches approximately 2 cm in length were collected for potential species identification of *Acropora* hosts. Coral colonies were returned to their approximate location at the collection site. The collected crabs were preserved in 6 % formalin with a small amount of seawater and then frozen in order to immobilize crabs and preserve color, with label provided with date and place of collection, then transported to the laboratory. Digital photographs for fresh crabs were taken with a Nikon Coolpix. At the laboratory, the collected specimens were sorted, sexed and identified to the species level using keys of (Serene, 1984; Galil, 1988; Castro, 1997a, b, 1999; Castro *et al.,* 2004) [49, 23, 11, 12, 14]. The total body wet weight was taken to the nearest 0.1 mg using an electric balance with accuracy of 0.01 mg after blotting excess water with absorbent tissues. All lengths and breadths of carapace, chelae, abdomen and first male pleopod were measured with a Caliper Verneer with accuracy of 0.01 mm. The carapace lengths and breadths were arranged into 1 mm intervals, to compute the relationships between carapace length or width and other dimensions.
The length-weight relationships of all collected samples were determined by the expression $Y = a \pm bX$ (Hile, 1936, Bagenal and Tesch, 1978) [30, 7], where Y is body weight (mg), X is the carapace length (mm) or width (mm), a is the intercept of the regression and b the regression coefficient. The parameters a (intercept) and b (slope) are most easily estimated by linear regression based on logarithms; $\log (W) = (a) + b \log (L)$ (Lagler, 1968) [35]. The significance of regression was assessed by analysis of variance (ANOVA). Equations expressing the length/width-weight relationships of *T. glaberrima* were calculated in relation to sex. For testing possible significant ($P > 0.01$) differences between the sexes Student's t-test was used for comparison of the two slopes. It is worth to mention that, sex and seasonal variations were taken in account. The relative condition factor Kn was calculated by the formula $Kn = W/W`$ (Hile, 1936, Bagenal and Tesch, 1978) [30, 7], Where W = observed weight, and W`= calculated weight from the length-weight relationship.

**Results**
**Length/Width-Weight relationship:**
A total of 423 specimens (175 males, 167 females and 81 juveniles) of *T. glaberrima* were used for studying the relationship between crab carapace length/width (CL/CW) and total body wet weight (W). The collected individuals are varied from 2 to 10.9 mm in (CL); from 2.2 to 12.2 mm in (CW) and between 2 to 1250 mg in total body weight. Missed chelae of all specimens were excluded.
The regression coefficient (b) for the carapace length-weight were (2.702, 2.487 and 3.478), whereas in width-weight relationship were (2.81, 2.35 and 3.9) for males, females and juveniles respectively. These relations are negative allometric for males and females, while positive allometric for juveniles. No significant difference between sexes. The results were treated by ANOVA and found to be highly significant ($p < 0.05$).
The coefficient of correlation (r) obtained for the carapace length-weight for males and females being (0.99 and 0.798; Fig.2, 3) while in carapace width -weight being (0.75 and 0.82; Fig. 4, 5) respectively indicating that the values were significant and a high degree of positive correlation existed between length-weight and width-weight in these crabs. While for juveniles there is weak correlation being (0.5498

and 0.5), these results are represented by the following equations:

Log W= 0.054+ 2.702 Log CL (For males, r =0.99)
Log W= 0.285+ 2.487 Log CL (For females, r =0.798)
Log W= 0.603+ 3.478 Log CL (For juveniles, r =0.5498)
Log W= - 0.13+ 2.81 Log CW (For males, r =0.75)
Log W= 0.283+ 2.35 Log CW (For females, r =0.82)
Log W= -1.3+ 3.9 Log CW (For juveniles, r =0.5)

Therefore, the relationship between carapace length (CL) and total body wet weight (W) for the whole population (sex combined) is considered (Table, 1 and Fig. 6), also the relation between carapace width-weight is considered (Fig. 7) and represented by the following equations:

Log W= - 0.42 + 3.32 Log CL (For the whole population, r = 0.87)

Log W= - 0.62 + 3.4 Log CW (For the whole population, r = 0.94)

Where W= total body wet weight (mg), CL = carapace length (mm), CW = carapace width (mm).

These relations are curve linear for the carapace length-weight and carapace width -weight, and has positive high correlation coefficient 'r' being 0.87 and 0.94 respectively. The regression coefficient 'b' is 3.32 and 3.4 with an intercept of Y- axis 'a'= - 0.42, -0.62 respectively, showing an allometric positive correlation coefficients higher than the isometric value (b=3.0) which denotes to the faster increase in body weight than in carapace length.

The length-weight relationship is also treated for the whole population (males and females) during different seasons. It was highly significant and represented by the following equations:

Log W= - 0.144 + 3.05 Log CL (spring, r = 0.64)
Log W= - 1.02 + 4.15 Log CL (summer, r = 0.73)
Log W= - 0.64 + 3.58 Log CL (autumn, r = 0.89)
Log W= 0.22 + 2.57 Log CL (winter, r = 0.71)

The slopes of these relations indicated heavier males and females during summer and autumn than those in spring and winter as the regression coefficient values being (3.05, 4.15, 3.58 and 2.57) for spring, summer, autumn and winter, respectively.

**Carapace length-carapace width relationship**

423 specimens of *T. glaberrima* (175 males, 167 females and 81 juveniles) were used to calculate the carapace length and carapace width relationship (Fig. 8). The Carapace width is slightly larger than carapace length. In juveniles, carapace varied from 2 to 4.2 mm in length and from 2.2 to 4.8 mm in width. In males, carapace varied from 3 to 10.2 mm in length and from 4.1 to 11.8 mm in width; whereas, female's carapace ranged between 3.1 and 10.9 mm in length, 3.9 and 12.2 mm in width. Significant difference was found between the slopes of this relationship for separated sexes (T-test= 0.03, df=10). The relation between carapace length (CL) and carapace width (CW) for both sex combined is considered, and represented by the following equation:

Log CW= 0.0086 +1.0557 Log CL (For the whole population, r = 0.99)

This relation is linear and shows an allometric positive regression coefficient (b= 1.055), with an intercept of Y-axis 'a'= 0.008, and high correlation coefficient 'r'= 0.99. These results also indicate progressively very slight increase in carapace breadth with a decrease in carapace length.

**Condition factor**

The results of relative condition factor 'Kn' for different size classes of the whole population of *T. glaberrima* are given in Tables (1) and represented in Figure (9). The overall value for "kn" varied from 0.758 to 1.180, with an average of 0.991±0.102, denotes to good well-being or fitness showing heavier organisms at lengths between 3.5 and 7 mm CL and at 10.5 mm. The values of condition factor were very close in separate sex (Table, 2). However, these values usually were not stable between different size classes; being very low in smaller or juveniles individuals, and increased slightly for maturing medium-sized individuals between 3.5-7 mm CL, but declined again gradually for larger individuals at 9, 10 mm CL, and increased again for large individuals at 10.5 mm CL (Table 1). Moreover, no significant seasonal fluctuations were noticed either within or between sexes except males during autumn which have lowest Kn' being 0.93±0.076 and for females during spring which recorded lowest Kn' being 0.87±0.04. The average value for "kn" was ideally and very close to 1 (Table 1).

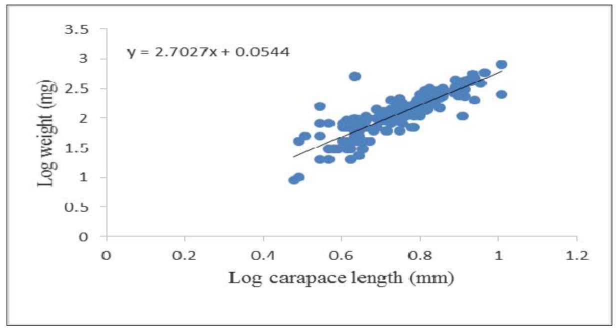


**Fig 2:** Logarithmic relationship between carapace length–weight of male *T. glaberrima* from Gulf of Aqaba, Red Sea, Egypt.

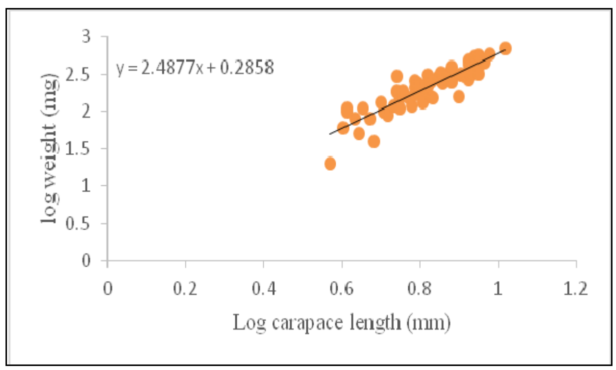


**Fig 3:** Logarithmic relationship between carapace length–weight of female *T. glaberrima* from Gulf of Aqaba, Red Sea, Egypt.

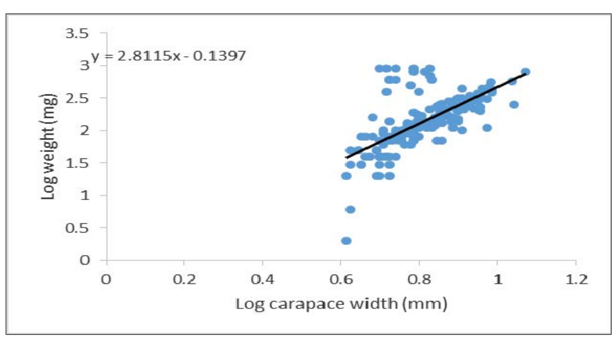


**Fig 4:** Logarithmic relationship between carapace width–weight of male *T. glaberrima* from Gulf of Aqaba, Red Sea, Egypt.

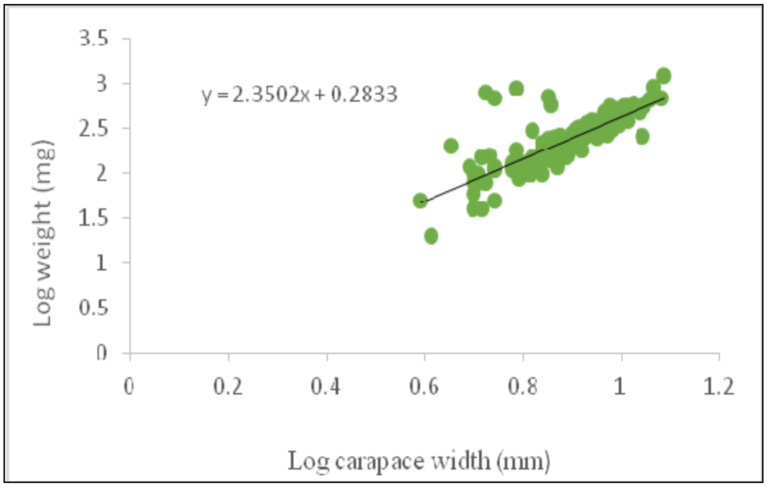


**Fig 5:** Logarithmic relationship between carapace width–weight of female *T. glaberrima* from Gulf of Aqaba, Red Sea, Egypt.

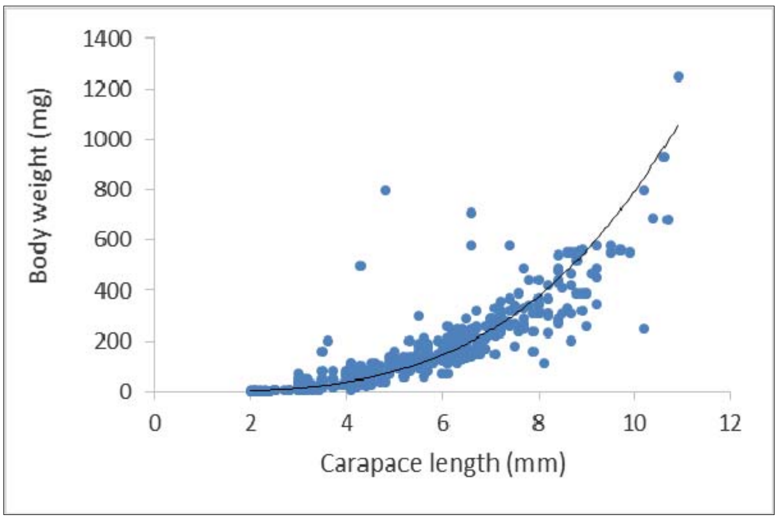


**Fig 6:** The length–weight relationship for the whole population of the *T. glaberrima* from Gulf of Aqaba, Red Sea, Egypt.

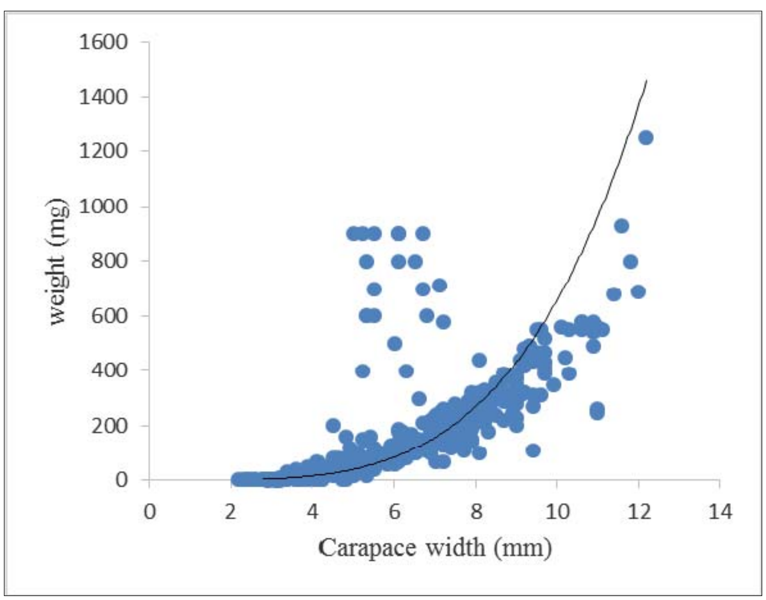


**Fig 7:** The width–weight relationship for the whole population of the *T. glaberrima* from Gulf of Aqaba, Red Sea, Egypt.

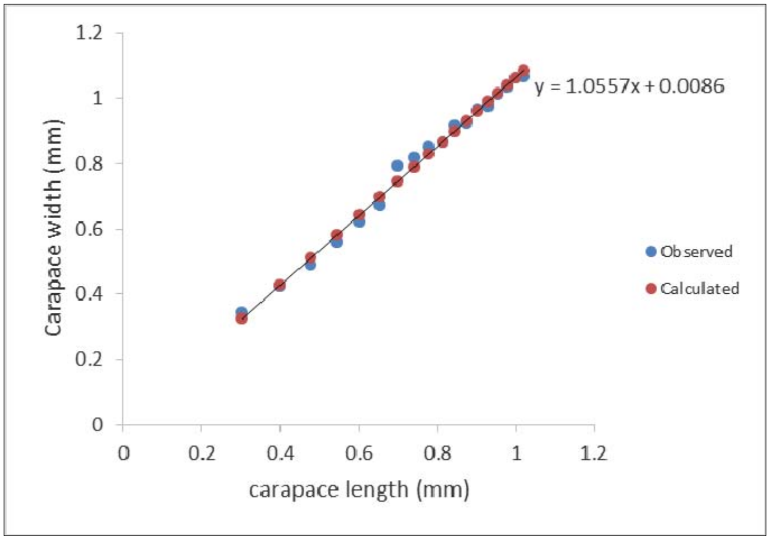


**Fig 8:** Carapace length–carapace width relationship for the whole population of the *T. glaberrima* from Gulf of Aqaba, Red Sea, Egypt.

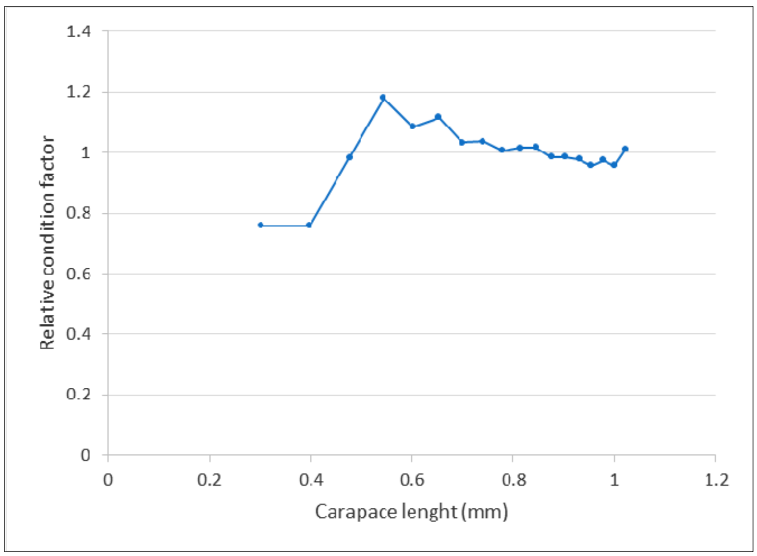


**Fig 9:** Relative condition factor (Kn) of the *T. glaberrima* from Gulf of Aqaba, Red Sea, Egypt.

**Table 1:** The length–weight relationship and condition factor for *T. glaberrima* from Gulf of Aqaba, Red Sea, Egypt.

| Items/ Size class (mm) | Mean weight (mg)x | | Relative condition factor "Kn" |
|---|---|---|---|
| | Observed weight | Calculated weight | |
| 2 | 0.575 | 0.758 | 0.758 |
| 2.5 | 0.798 | 1.053 | 0.758 |
| 3 | 1.274 | 1.294 | 0.984 |
| 3.5 | 1.769 | 1.497 | 1.180 |
| 4 | 1.815 | 1.674 | 1.084 |
| 4.5 | 2.044 | 1.830 | 1.117 |
| 5 | 2.034 | 1.969 | 1.033 |
| 5.5 | 2.172 | 2.095 | 1.036 |
| 6 | 2.227 | 2.210 | 1.007 |
| 6.5 | 2.351 | 2.316 | 1.01 |
| 7 | 2.454 | 2.414 | 1.016 |
| 7.5 | 2.470 | 2.505 | 0.985 |
| 8 | 2.553 | 2.590 | 0.985 |
| 8.5 | 2.615 | 2.670 | 0.979 |
| 9 | 2.630 | 2.746 | 0.957 |
| 9.5 | 2.748 | 2.817 | 0.975 |
| 10 | 2.763 | 2.885 | 0.957 |
| 10.5 | 2.979 | 2.950 | 1.009 |
| Average ±SD | 2.126± 0.669 | 2.12672±0.65 | 0.991±0.102 |

**Table 2:** Seasonal fluctuations in relative condition factor, (Kn), for *T. glaberrima* from Gulf of Aqaba, Red Sea, Egypt.

| Seasons / Sex | | Spring | Summer | Autumn | Winter |
|---|---|---|---|---|---|
| Males | Average | 0.99±0.20 | 0.99±0.18 | 0.93±0.076 | 1.0004±0.109 |
| | Range | 0.36-1.38 | 0.19-1.49 | 0.77-1.13 | 0.67-1.26 |
| Females | Average | 0.87±0.04 | 1±0.076 | 0.99±0.104 | 1±0.70 |
| | Range | 0.77-0.97 | 0.86-1.41 | 0.73-1.44 | 0.88-1.19 |
| Males &females | Average | 1±0.15 | 0.99±0.14 | 0.99±0.099 | 1.013±0.11 |
| | Range | 0.37-1.43 | 0.19-1.48 | 0.81-1.52 | 0.69-1.38 |

## Discussion

In Crustacea many studies were carried out on carapace length/width and weight relationship (El- Sayed, 1997, 2004a; Fouda, 2000; Atar and Secer, 2003; Josileen, 2011; Patil and Patil, 2012; Aydin, 2013; Salem 2014) [18, 19, 22, 5, 32, 40, 6, 48]. The relationships between carapace length/width and weight have many uses they are indicators of condition, and are used to calculate biomass and to estimate the recovery of edible meat from crabs of various sizes (Lagler, 1968) [35]. They also have a practical value since they make it possible to convert length into weight and vice versa. On the other hand, body weight, CL and CW are the most frequently used dimensions in the study of crustaceans (Sukumaran and Neelakantan, 1997) [53]. It also, reflects the effects of gonad development, rate of feeding, metamorphosis, maturity and well being of the individuals within population (Le Cren, 1951; Bolger and Connolly, 1989) [36, 8].

In *T. glaberrima* the carapace length/width-weight relationship showed a negative allometric growth in males and females, The regression coefficient (b) for the CL–W relationship were (2.702 and 2.487) while CW-W relationship were (2.81 and 2.35) for males and females respectively, these relations were negative allometric under the ideal isometric value '3'.These values are similar with those found by Can *et al.,* (2007) [9] in Cakalburnu lagoon, Izmir (Turkey) and in partially agreement with Mori *et al.,* (1999) [29] in the lagoon of San Teodoro (Italy) and Ozcan *et al.,* (2009) [39] in the Homa lagoon (Aegean Sea, Turkey). Conversely, Aydin (2013) [6] in the Black Sea and Kocak *et al.,* (2011) [34] in the Homa lagoon (Aegean Sea, Turkey) found a positive allometry. Considered that the *b* value provide useful information about the increase in weight and vary according to the sex, feeding and environmental conditions, our findings seem to be in agreement with those reported in others Mediterranean lagoons. For the whole population (sex combined) the relationships between carapace length\width-weight were greatly correlated, with high positive allometric (regression coefficient b-value are 3.32 and 3.4 respectively). It denotes to faster increase in body weight than in carapace length. Du Perez and Mclachlan (1984) [15] mentioned a similar result isometric positive relationships between carapace width and body weight of *Portunus pelagicus* and *Ovalipes punctatus*. These results not agree with (Salem, 2014) [48] on *Trapezia cymodoce* from the Red Sea. On the other hand, remarkable seasonal fluctuations in "b" values of *T. glaberrima* were detected. It was increased to 4.15, 3.58 and 3.05 during summer, autumn and spring respectively and declined to 2.57 during winter. The slopes of these values indicated heavier males and females during summer and autumn than those in spring and winter. These fluctuations may be correlated either with availability of food or onset of breeding (Le Cren, 1951; Bolger and Connolly, 1989; El-Sayed, 1997, 2004a; Abdel-Razek *et al.,* 2006, Josileen, 2011; Thirunavukkarasu and Shanmugam, 2011; Patil and Patil, 2012; Aydin, 2013) [36, 8, 18, 19, 2, 32, 54, 40, 6].

On the other hand, an isometric and allometric relative growth rates were detected between CL-CW. For *T. glaberrima* an isometric growth rate was 1.055 for the sex combined, without significant differences between sexes. The regression coefficient "b" showed increase in carapace lengths with width. Du Perez and Mclachlan (1984) [15] recorded a positive allometric growth rate (greater than "1") between these two variables for *Ovalipes punctatus*, while these value reached 2.133 and 1.968 for males and females of *Portunus pelagicus* from Bardawil Lagoon (Abdel-Razek *et al*., 2006) [2]. However, a slight negative allometry was calculated in several decapod crabs comprised *Leucosia siganta* and *Eucrate crenata* (El-Sayed, 1992) [17] from Suez Canal, *L. exaratus* (El-Sayed, 2004a) [19], *L. exaratus* and *M. messor* (Fouda, 2000) [22] from Gulf of Suez, Salem (2014) [48] on *Trapezia cymodoce* from Gulf of Aqaba, and close to isometric value in spider crab, *Meanthius Monoceros* (El-Sayed, 1997) [18], but lower than those reported by Arab (2010) [4] on *P. mamromratus* and *P. transeverus* from the Mediterranean along Lebanese shores.

The relative condition factor 'Kn' for the whole populations of *T. glaberrima* were varied from 0.758 to 1.180 with an average 0.991±0.102, which agree with Arab (2010) [4] on *P. marmoratus* and *P. transversus*. These values denote to good well-being or fitness for whole population. However, these values were not stable and were higher in smaller sizes than medium sized individuals, but increased again in larger individuals, and were seasonally fluctuated either within or between sexes. The values of "Kn" decreased in males during autumn reached to 0.93±0.076, and in females during spring recorded 0.87±0.04. Similar results of well being on crabs were recorded by El-Sayed (1992) on *L. signata* and *E. crenata*, Fouda (2000) [22] on *L. exarartus* and *M. messor* and El-Sayed (2004b) [20] on *L. exarartus* from the Red Sea. The changes in "Kn" reflect fluctuations in crabs weight which considered as an indicator to regular changes associated with increasing of feeding rate, maturation of gonads, increase storage of materials within hepatopancreas or increase in relative growth such as chelae weight of males (Le Cren, 1951; Turobyoski, 1973; Bagenal and Tesch. 1978; Bogler and Connolly, 1989; Pinheiro and Fransozo, 1993; El-Sayed, 2004a; Patil and Patil, 2012) [36, 57, 7, 8, 43, 19, 40].

## Reference


1. Abdel Razek FA, Ezzat A, El-Hady HA. Biometric studies and length-weight relationship of Lobster *Thenus Orientalis* in Dammam water (Arabian Gulf) King of Saudia Arabia. Alexandria Journal of Veterinary Sciences. 1989; 5(1):649-663.
2. Abdel-Razek FA, Taha SM, Ameran MA. Population biology of the edible crab *Portunus pelagicus* (Linnaeus) from Bardawil Lagoon, Northern Sinai, Egypt. Egyptian Journal of Aquatic Research. 2006; 32(1):401-418.
3. Abele LG, Patton WK. The size of coral heads and community biology of associated decapod crustaceans.

Journal of Biogeography. 1976; 3:35-47.
4. Arab AS. Population structure and biology of Lebanese rocky shore crabs *Pachygrabsus marmoratus* and *P. transversus* (Grabsidae), M.Sc. Thesis, Fac. of Arts and Science at the American University of Beirut, Lebanon, 2010.
5. Atar HH, Secer S. Width/Length-Weight relationships of the Blue crab (*Callinectes sapidus* Rathbun 1896) population living in Beymelek Lagoon Lake. Turkish Journal of Veterinary and Animal Sciences. 2003; 27:443-447.
6. Aydin M. Length-weight relationship and reproductive features of the Mediterranean green crab, *Carcinu saestuarii,* Nardo, 1847 (Decapoda: Brachyura) in the eastern Black Sea, Turkey. Pakistan journal of zoology. 2013; 45(6):1615-1622.
7. Bagenal TB, Tesch FW. Age and growth" in: Methods for Assessment of Fish Production in Freshwaters (W.E. Ricker, ed.), Oxoford and Edinburgh, Blackwell, 1978, 101-136.
8. Bolger T, Connolly PL. The selection of suitable indices for the measurement and analysis of fish condition. Journal of Fish Biology, 1989; 34:171-182.
9. Can E, Tiraşin EM, Cihangir B, Yilmaz U. Weight-carapace width relationship of the Mediterranean green crab (*Carcinus aestuarii*, Nardo 1847) in Cakalburnu Lagoon, Izmir Bay. Rapp. Comm. Int. Mer. Médit. 2007; 38:443.
10. Castro P. Animal symbioses in coral-reef communities – A review. Symbiosis. 1988; 5:161-184.
11. Castro P. Trapeziid crabs (Brachyura: Xanthoidea: Trapeziidae) of New Caledonia, eastern Australia, and the Coral Sea. *In* B. Richer de Forges (ed.), Les fonds meubles des lagons de Nouvelle-Calédonie (Sédimentologie, Benthos). Etudes & Thèses. 1997a; 3:59-107.
12. Castro P. Trapeziid crabs (Brachyura: Xanthoidea: Trapeziidae) of French Polynesia. *In* B. Richer de Forges (ed.), Les fonds meubles des lagons de Nouvelle-Calédonie (Sédimentologie, Benthos). Etudes & Thèses. 1997b; 3:109139.
13. Castro P. Trapeziid crabs (Crustacea, Brachyura, Trapeziidae) of the Indian Ocean and the Red Sea. Zoosystema. 1999; 21(1):93-120.
14. Castro P, Ng PKL, Ahyong ST. Phylogeny and systematics of the Trapeziidae Miers, 1886 (Crustacea: brachyura), with the description of a new family. *Zootaxa.* 2004; 643:1-70.
15. Du- Preez HH, McLachlan A. Biology of the three spot swimming crab *Ovalipes punctatus*, 3: Reproduction, fecundity and egg development. Crustaceana. 1984; 47(3):285-297.
16. Eldredge LG, Kropp RK. Decapod crustacean-induced skeletal modification in *Acropora*. In: E.D.G Omez, C.E. Birkeland, R.W. Buddemeier, R.E. Johannes, J. A. Marsh, JR. & R.T. Tsuda (eds.), Proceedings of the Fourth International Coral Reef Symposium, Manila, 1981-1982; 2:115-119.
17. El-Sayed AAM. Biological studies on some bracyuran crabs (crustacean) form Suez Canal. Ph. D. Thesis. Zool. Department, Faculty of Science, Al-Azhar University, 1992.
18. El-Sayed AAM. The biology of spider crab, *Menathius monoceros* from the Red Sea and Gulf of Aqaba, Egypt. Egyptian journal of aquatic biology and fisheries, 1997; 1(1):1-16.
19. El-Sayed AAM. The swimming crabs, family Portunidae (Brachyura: Decapoda: Crustacea), from the Egyptian Red Sea and Suez Canal, with remarks on their migration towards the Mediterranean Sea. Journal of Union of Arab Biologists Cairo. 2004a; 20(A):113-165.
20. El-Sayed AAM. Some aspects of the ecology and biology of the intertidal xanthid crab, *Leptodius exaratus* (H. Milne Edwards, 1834) from thre Egyptian Red Sea Coast. Journal of the Egyptian-German Society of Zoology 2004b; 45(D):115-139.
21. El-Sayed AAM, Fouda MM, Azab AM, Ismail MI. Reproductive biology of the flattened porcelain crab *Petrolisthes rufescens* (Porcelanidae: Anomura: Crustacea) from Ain Sukhna, Gulf of Suez, Egypt. Al-Azhar Bulletin of Science. 2011; 22(2):17-32.
22. Fouda MMA. Biological and ecological studies on some crustacean decapods from the Suez Gulf. M. Sci. Thesis, Zoology Department, Faculty of Science, Azhar University, Cairo, 2000.
23. Galil B. Further notes on species of *Tetralia* (Decapoda, Trapeziidae). Crustacean a. 1988; 54:57-68.
24. Gaston KJ. Rarity. Chapman and Hall, London, 1994.
25. Gaston KJ, Kunin WE. Rare-common differences: an overview. In: Kunin WE and Gaston KJ (Eds.) The biology of Rarity: Causes and consequences of Rare-Common Differences. Chapman and Hall, London, U.K. 1997, 13-29.
26. Glynn PW. *Acanthaster* population regulation by a shrimp and a worm. Proceedings from the 4th International Coral Reef Symposium. 1982; **2**:607-612.
27. Glynn PW. Increased survivorship in corals harboring crustacean symbionts. Marine Biology Letters, 1983; 4:105-111.
28. Glynn PW. Some ecological consequences of coral crustacean guard mutualisms in the Indian and Pacific Ocean. Symbiosis. 1987; 4:301-324.
29. Hartnoll RG. Growth. In: *The Biology of Crustacea*. Vol. II (L. G. Abele, ed.), Academic Press, New York, 1982, 111-197.
30. Hile R. Age and growth of the Cisco, *Leucichthys artedi* (Le Sueur), in the Lakes of the North-eastern High Lands. Wisconsin. Bulletin of Marine Fishes U.S. 1936; 48(19):211-317.
31. Hossain MA, Hartnoll RG, Mohamedeen H. The length weight relationship and flesh production of the Norway lobster, *Nephrops Norvegicus* (L.)(Decapoda, Astacidea) Crustaceana. 1987; 52(1):40-46.
32. Josileen J. Food and feeding of the blue swimming crab, *Portunus pelagicus* (Linnaeus, 1758) (Decapoda, Brachyura) along the coast of Mandapam, Tamil Nadu, India. Crustaceana. 2011; 84(10):1169-1180.
33. Knudsen JW. Trapezia and Tetralia (Decapoda, Brachyura, Xanthidae) as obligate ectoparasites of the pocilloporid and acroporid corals. Pacific Science. 1967; 21:50-57.
34. Koçak C, Acarlı D, Katağan T, Özbek M. Morphometric characters of the Mediterranean green crab (Carcinus aestuarii Nardo, 1847) (Decapoda, Brachyura) in Homa Lagoon, Turkey. Turkish Journal of Zoology. 2011; 35:551-557.
35. Lagler KF. Capture, Sampling and Examination of Fishes. In W.E. Ricker (ed). Methods for Assessment of

Fish Production in Freshwaters. IBP, Handbook 1968; III:7-45.
36. Le Cren CD. The length-weight relationship and seasonal cycle in gonad weights and condition in the perch (*Percafluviatilis*). Journal of Animal Ecology. 1951; 20:201-219.
37. Mori M, Manconi R, Fanciulli G. Notes on the reproductive biology of *Carcinus aestuarii* Nardo (Crustacea, Decapoda) from the lagoon of San Teodoro (Island of Sardinia, Italy). Rivista d'Idrobiologia, 1999; 29:763-774.
38. Orians GH, Wittenberger JF. Spatial and temporal scales in habitat selection. American Naturalist. 1991; 137:S29-S49.
39. Ozcan T, Bakir K, Katağan T. Length/width-weight relationships of the Mediterranean Green Crab *Carcinus aestuarii* Nardo, 1847 in the Homa Lagoon, Aegean Sea Turkey. J. Fish.Sci.com. 2009; 3:1-4.
40. Patil DV, Patil ME. Transmission of Compressed Image over Wireless Network: An Embedded Approach Using ARM9 Processor. International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181. 2012; 2:7.
41. Patton WK. Distribution and ecology of animals associated with branching corals (*Acropora* spp.) from the Great Barrier Reef. Bulletin of Marine Science, 1994; 55:193-211.
42. Paulay D. Editorial Fish byte. NAGA, The ICLARM Quarterly. 1993; 16(2-3):26.
43. Pinheiro MAA, Fransozo A. Relative growth of the speckled swimming crab *Arenaeus Cribarius* (Lamarck, 1818) (Brachyura, Portunidaes, Nearubatuba, State of Sao Paulo. Brazil, Crustaceana. 1993; 65:377-369.
44. Potter IC, Chrystal PJ, Loneragan NR. The biology of the blue crab, *Portunus pelagicus* in an Australian Estuary. Marine Biology, 1983; 78:75-85.
45. Pratchett MS. Influence of coral symbionts on feeding preferences of crown-of-thorns starfish *Acanthaster planci* in the western Pacific. Marine Ecology Progress Series, 2001; 214:111-119.
46. Pratchett MS, Vytopil E, Parkes P. Coral crabs influence the feeding patterns of crown-of-thorns starfish. Coral Reefs. 2000; 19:118.
47. Pulliam HR, Danielson BJ. Sources, sinks and habitat selection: a landscape perspective on population 1 dynamics. American Naturalist, 1991; 137:S50-S66.
48. Salem S. Biological studies on some marine invertebrates and their relation with coral reefs at Abu Galum Protected Area, Gulf of Aqaba, South Sinai, Egypt, M.Sc. Thesis, Marine Biology, Fac. Of Science, Al-Azhar university, Cairo, Egypt, 2014.
49. Serène R. Crustacés Décapodes Brachyoures de l'Océan Indien occidental et de la Mer Rouge. Xanthoidea: Xanthidae et Trapeziidae. Addendum: Carpillidae et Menippidae par A. Crosnier. Faune Trop. Orstom, Paris, 1984; 24(1-400):1-48.
50. Sin TM. Distribution and host specialization in *Tetralia* crabs (Crustacea: Brachyura) symbiotic with corals in the Great Barrier Reef, Australia. Bulletin of Marine Science. 1999; 65:839-850.
51. Solan NA. Life history Characteristics of Fjord-dwelling golden King crabs *Lithodes aequispina*. Marine Ecology Progress Series. 1985; 22:219-228.
52. Stewart HL, Holbrook SJ, Schmitt RJ, Brooks AJ. Symbiotic crabs maintain coral health by clearing sediments. Coral Reefs. 2006; 25:609-615.
53. Sukumaran KK, Neelakantan B. Length-weight relationship in two marine portunid crabs, *Portunus (Portunus) sanquinolentus* (Herbst) and *Portunus(Portunus) pelagicus* (Linnaeus) from the Karnataka coast. Indian Journal of Marine Sciences. 1997; 26:39-42.
54. Thirunavukkarasu N, Shanmugam A. Length-weight and width-weight relationships of mud crab *Scylla tranquebarica* (Fabricius, 1798). Journal of the Marine Biological Association of India. 2011; 53(1):142-144.
55. Thomas MM. Age and growth, Length-weight relationship and relative condition factor of *Penaeus Semisulcatus* De Haan. Indian Journal of Fisheries. 1977; 22(1-2):133-142.
56. Thurman II CL. Reproductive biology and population structure of the fiddler crab *Uca subcylindrica* (Stimpson). Biological Bulletin, 1985; 169:215-229.
57. Turoboyski K. Biology and Ecology of the crab *Rhithropanopeus harrisii* ssp. *tridentatus*. Marine Biology, 1973; 23:303-313.
58. Urita T. Dimensional, morphological and zoogeographical study of Japanese crabs of the genus *Telmessus*. Sci. Rep. Tohoku Imp. Univ. Sendai, Ser. 4;XI:69-89. 7 fig. USA. Journal of shellfish research 1936-37; 3(2):117-128.
59. Vannini M. A shrimp that speaks crab-ese. Journal of Crustacean Biology. 1985; **5**:160-167.
60. The rate of growth of fishes of Indiana. Investigations of Indiana Lakes, No.2. Depart. Conser, Division of Fish and Game; Indiana, Publication. 1931; 107:9-55. Indianapolis.