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Lenght - weight relationship and condition factor of *Macrobrachium vollenhovenii* and *Macrobrachium felicinum* in Akor River, Ibere region, Abia state, Nigeria

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Abstract
The length-weight relationship and condition factor of Macrobrachium felicinum and Macrobrachium vollenhovenii were studied for January 2013 to December 2014, in Akor River, in Ibere region, Abia State, Nigeria. The length-weight relationship was estimated using linear regression at α= 0.05.The condition factor of the prawns were estimated from Fulton's condition factor. Result of the length-weight distribution of the two species showed normal distribution at the three stations. The class size for the length of the two species ranged from 6.6-7-6cm and 12.1-13.1cm while the weight ranged from 70-79g and 130-139g. Regression analysis revealed that the length and weight of both species Macrobrachium species females and males correlated positively, it ranged from (R= 0.8044* - 0.9856*). Regression coefficient (b) was recorded as 10.74, 4.98 and 4.37 for Macrobrachium felicinum males, females and combined sex respectively, while (b) was recorded as 7.022, 7.10 and 7.1 for Macrobrachium vollenhovenii males, females and combined sex respectively. The overall average condition factor for all the species was 4.18. Study therefore concludes that Akor River remains a healthy medium for the culture of prawn species and recommend that aqua culturists should take advantage of the blossom aquatic environment to improve prawn production.

Keywords: linear relationship, size class distribution, prawns, freshwater, Ibere

Introduction
In order to establish mathematical relationship between the two variables and enabling conversion of one variable to other, Lenght-weight relationship is used, for description of growth in the wild (Enin, 1994; Abohweyere and Williams, 2008; Deekae and Abowei, 2010) [1, 2, 3] to determine possible differences among different stocks of the same species (Petrakis and Stergiou, 1995; King, 2007) [4, 5], delineate the stocks and comparative growth studies (Sampaio and Valenti, 1996; Primavera *et al*., 1998; Peixoto *et al*., 2004) [6, 7, 8]. Length-weight relationships are typically represented by the function $W = aL^b$ (where: W = weight, L = length, a = regression intercept, b = regression coefficient) (Pinheiro and Taddei, 2005; Pinheiro and Fiscarelli, 2009) [9, 10]. Condition factor is the plumpness of a shrimp. It determines the wellbeing of a shrimp species in a particular water body. The condition factor and weight-length ratio have been investigated for several Prawn species of fishes (Moraes-Riodades and Valenti, 2002; Albertoni *et al*., 2003) [11, 12].
The condition factor (K) is an index reflecting interactions between biotic and abiotic factors in the physiological condition of the fishes. It shows the well-being of the population during various life cycle stages and assessments of fish condition based on weight at a given length are thought to be reliable indicators of the energetic condition or energy reserves in fish (Lambert and Dutil, 1997) [13].
Despite the great economic importance of these *Macrobrachium species*, there is little information on the biology of this species particularly in Akor River, Ibere. Furthermore, there is a need to investigate length–weight relationships at a wider size range, in order to determine how the relationships change with size or life stage and between sexes (Chow and Sandifer, 1991) [14].

The study on the length weight and condition factor in Akor River, Ibere, will provide information to bridge the gap and management decision for the management of the *Macrobrachium species.* Thus, the objective of this study was to investigate the length-weight relationship and condition factor for males and females of a population of *M. vollenhovenii and M. felicinum* that occur in the Akor River, Ibere Ikwuano, where it is economically exploited by riverside communities.

Study Area

Ibere is in Ikwuano Local Government Area of Abia State, Nigeria between latitudes 05.34829°N and Longitude 007°.34468' E with elevation of 77m. The Ibere region which is located in the northern part of Ikwuano LGA (Fig. 1) is a mountainous region. Indeed, so much so that 50 meters in whichever direction, one either climbs up a hill or totters down another (Chude and Chukwu, 2012) [15]. The soil is either completely clayey or else is clay-loam (Chude and Chukwu, 2012) [15]. The dry season topographic map of Ibere shows one river: Inyang itu (Akor) with its source from Mgbele Akor Ozuitem. Consequently, surface run-offs flowing into numerous valleys and channels occurring in the region transform Ibere into a region of innumerable anatomizing watercourses all linked up into one giant complex river network (Chude and Chukwu, 2012) [15].

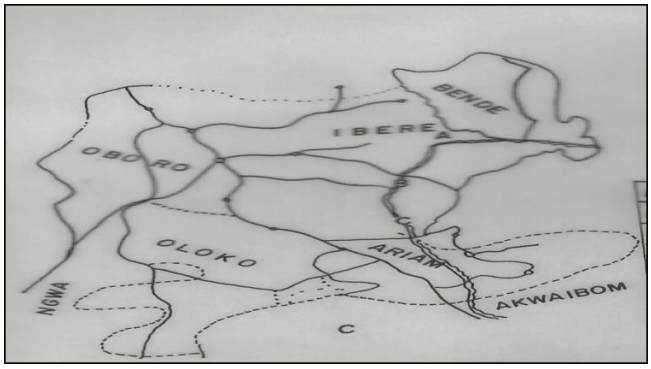

Fig 1: Map of the river showing sampling points A, B and C.

Materials and Methods

The area density method was employed for the population studies. For the purpose of sampling, Akor River was delineated into three sections designed as station A, B and C. The sampling programme spanned twenty months from January 2013 to December 2014 with the assistance of the artisanal fishers at the three different sampling points with the use of basket traps made of bamboo and had cone shape as described by Solarin *et al.* (2003) [16]. Sampling was conducted fortnightly between 7.30hrs and 12.30hrs on sampling days.

The sexes of the shrimps were determined based on morphological characteristics as stated by Sagua (1980) [17] and New and Singholka (1982) [18]. Literature revealed that male shrimps possess appendix masculina on the second pleopod while females have none. Females were broader than the males. The length – weight relationship of the shrimp was estimated using linear regression. It was estimated using linear regression at the three different stations (α=0.05).The correlation i.e. the degree of association between the variables was determined by computing the correlation co-efficient (r) (Wahua, 1999 and Ogbeibu, 2005) [19, 20].Length- weight relationship was expressed as Log W = log a + bLogL; Where W= weight of the prawn in (g), L= total length in (cm), a = regression constant and b regression coefficient, according to Pauly (1983) [21]. Condition factor is the plumpness of a shrimp. It determines the wellbeing of a shrimp species in a particular water body. The condition factors of the shrimps were estimated from Fulton's condition (CF) as suggested by Enin (1994) [1].

$K = 100 \times \overline{W} / \overline{TL}^3$ CF = Fulton's condition factor, $\overline{W}$ = Mean gutted weight (g), TL^3 = mean total length (cm). CF was determined for each month during the study.

Results

Results from the length and weight distribution of the two species show a normal distribution (Table 3 to Table 5). At station A, *Macrobrachium felicinum* female (MFF) had a size group 6.6-7.6 cm with 50% of the total stock and a modal class of 8. Thus, the population is made up more of that class. Males had a size group of 6.6-7.6 (cm) and 7.7-8.7 (cm) and a bimodal class of 7 which shows that the species belongs to two classes. *Macrobrachium vollenhovenii* female (MVF) had a size group of 6.6-7.6 cm and a modal class of 6 and a size group of 12.1-13.1cm showing that it has two modal classes. Males had two major groups 6.6-7.7 cm and 10.1-12.1 cm showing that it had a bimodal class of 6. Using the index of weight, the weight frequency distribution, it gives *Macrobrachium felicinum* a modal class of 6 and size group of 70-79g. The males had two major groups 70-79 g and 80-89g making them having a dual class size. *Macrobrachium vollenhovenii* female had a size group of 60-69 and 130-139 (g) indicating that the population consist of many sizes. The males of *Macrobrachium vollenhovenii* had a modal class of 8 and size group of 70-79g. At station B, for *Macrobrachium felicinum* female, it had a size group 7.7-8.7cm with 47% of the total stock and a modal class of 8 followed by another size group of 6.6-7.6cm. Thus, the population is made up more of those groups. Males had a size group of 8.8-9.8 and 7.7-8.7 (cm) and a modal class of 8 which shows that the species belongs more to that class group. *Macrobrachium vollenhovenii* female had a size group of 6.6-76 (cm) and a modal class of 15 showing that it is made up of one class. Males had one major group 6.6-7.7 (cm) showing that it had one modal class of 8. Using the index of weight, the weight frequency distribution, it gives *Macrobrachium felicinum* female a modal class of 11 and size group of 70-79(g) which shows they belong only to a class group. The males had two major groups 70-79 (g) and 80-89(g) making the having a dual class size. *Macrobrachium vollenhovenii* female had a size group of 70-79 (g) and 80-89 (g) indicating that the population consists of two class size groups. The males of *Macrobrachium vollenhovenii* had a modal class of 7 and class group of 70-79(g).

At station C, for *Macrobrachium felicinum* female, it had a size group 7.7-8.7 with 42% of the total stock and a modal class of 8 followed by another size group of 6.6-7.6. Thus the population is made up more of those two class groups. Males had a size group of 8.8-9.8 and 7.7-8.7 (cm) and a modal class of 8 which shows that the species belongs more to that class group. *Macrobrachium vollenhovenii* female had a size group of 6.6-7.6 (cm) and a modal class of 13 showing that it is made up of one class. Males had one major group 6.6-7.7 showing that it had one modal class of 10. Using the index of weight, the weight frequency distribution, it gives *Macrobrachium felicinum* female a modal class of 11 and size group of 70-79(g) which shows they belong only to a class

group. The males had one major group 90-99 (g) class size. *Macrobrachium vollenhovenii* female had a size group of 70-79 (g) and a modal size of 12 shows they belong only to one class group. The males of *Macrobrachium vollenhovenii* had a modal class of 8 and class group of 70-79(g). Results of length and weight frequency distributions for the two species *Macrobrachium felicinum* and *Macrobrachium vollenhovenii* has revealed different size classes at the different stations. At station A, *Macrobrachium felicinum* had three classes of size (6.6-7.6, 7.7-8.7, and 8.8-9.8 cm), while *Macrobrachium vollenhovenii* had two classes (6.6-7.6 and 12.1-13.1cm). At station B, *Macrobrachium felicinum* revealed one class (6.6-7.6cm) and *Macrobrachium vollenhovenii* revealed only one class equally (7.7-8.7cm). At station C, *Macrobrachium felicinum* revealed two classes (6.6-7.6 and 7.7-8.7cm), *Macrobrachium vollenhovenii* revealed only one class group (7.7-8.7cm).Weight distribution also displayed one class interval which is 70-79(g) for *Macrobrachium felicinum* and 100-109(g) for *Macrobrachium vollenhovenii* at station A. At station B, *Macrobrachium felicinum* revealed on one class (70-79g) while *Macrobrachium vollenhovenii* revealed two class groups (70-79g and 80-89g). At station C, weight distribution also revealed only one class group for *Macrobrachium felicinum* (70-79g) while *Macrobrachium vollenhovenii* displayed two class groups (70-79g and 80-89g). The average condition factor (k) for the prawns caught in the river are presented in Table 2. The overall average condition factor for all species was 4.18. The fish species that had the best overall average condition factor was *Macrobrachium vollenhovenii* for which an average value of 5.24 was obtained. *Macrobrachium felicinum* had the least condition factor of 3.18. On station by station basis, the fish species at station B had the best average condition factor (k) values of 4.12, followed by station C where k value was 3.65, followed by station A which had least value of k, which 3.18. Condition factor (k) is a factor of the body growth pattern in relation to weight and length. The two prawn species had an overall condition factor greater than 1. The average condition factor was 4.18. Thus the prawns in the river were generally in good condition. Regression result showed positive correlation of the length and weight, r was between 0.8044*-0.9856 while b values were between 4.110-10.744 at the three stations.

Table 1: Length-weight relationship of the fish species

Fish species	Correlation coefficient (r)		
	Station A	Station B	Station C
Macrobrachium felicinum (Female)(mff)	0.9557**	0.9357**	0.9557**
Macrobrachium felicinum (Male) (mfm)	0.9856**	0.9876**	0.9856**
Macrobrachium Vollenhoveni (Female)(mvf)	0.9321**	0.8044**	0.9321**
Macrobrachium vollenhovenii (Male) (mvm)	0.9459**	0.9658**	0.9459**

Table 2: Mean and ranges of condition factor (k) of prawn species in Akor River Ibere for the three Stations (Combined sex) MV = *Macrobrachium vollenvonii* MF = *Macrobrachium felicinum*

Fish specie	Station A	Station B	Station C	Overall Average (k)	Number b
MV	4.12 (2.6-5.20)	4.92 (2.9 – 5.42)	4.65 (2.80-5.32)	5.24	1,341 7.1
MF	3.18 (3.1-4.2)	4.12 (2.80- 5.30)	3.65 (2.90 – 4.50)	3.12	422 4.37

Table 3: Table of Length – Weight frequency distribution of prawns at Station A

Average length (cm)	MF				MV			
	Female		Male		Female		Male	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
5.5 -6.5	0	0.00	0	0.00	2	9.52	2	8.33
6.6 - 7.6	8	50.00	7	38.89	6	28.57	6	25.00
7.7 -8.7	4	25.00	7	38.89	4	19.05	2	8.33
8.8 -9.8	4	25.00	3	16.67	5	23.81	1	4.17
9.9 - 10.9	0	0.00	1	5.56	0	0.00	2	8.33
11.0 - 12.0	0	0.00	0	0.00	0	0.00	6	25.00
12.1 - 13.1	0	0.00	0	0.00	4	19.05	3	12.50
13.2 - 14.2	0	0.00	0	0.00	0	0.00	2	8.33
Total	16	100.00	18.00	100.00	21.00	100.00	24.00	100.00

Average weight (g)	MF				MV			
	Female		Male		Female		Male	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
50-59	1	6.25	0	0.00	2	10.00	0	0.00
60-69	2	12.50	1	5.88	3	15.00	2	8.33
70-79	6	37.50	6	35.29	2	10.00	8	33.33
80-89	3	18.75	5	29.41	3	15.00	1	4.17
90-99	3	18.75	2	11.76	3	15.00	0	0.00
100-109	1	6.25	3	17.65	3	15.00	2	8.33
110-119	0	0.00	0	0.00	1	5.00	3	12.50
120-129	0	0.00	0	0.00	0	0.00	3	12.50
130-139	0	0.00	0	0.00	3	15.00	5	20.83
Total	16	100	17	100	20	100	24	100

Table 4: Table of Length-Weight frequency distribution of prawn species at Station B

Average length (cm)	MF				MV			
	Female		Male		Female		Male	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
5.5 -6.5	1	5.26	1	5.26	0	0.00	1	4.35
6.6 - 7.6	7	36.84	1	5.26	15	65.22	8	34.78
7.7 -8.7	8	42.11	5	26.32	6	26.09	6	26.09
8.8 -9.8	1	5.26	8	42.11	2	8.70	3	13.04
9.9 - 10.9	1	5.26	3	15.79	0	0.00	5	21.74
11.0 - 12.0	0	0.00	1	5.26	0	0.00	0	0.00
12.1 - 13.1	1	5.26	0	0.00	0	0.00	0	0.00
Total	19	100	19	100	23	100	23	100

Average weight (g)	M F				MV			
	Female		Male		Female		Male	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
60 – 69	0	0	1	5.26	2	8.70	1	4.35
70 – 79	11	57.89	0	0.00	8	34.78	7	30.43
80 -89	6	31.58	5	26.32	6	26.09	5	21.74
90 - 99	2	10.53	7	36.84	3	13.04	3	13.04
100 – 109	0	0.00	2	10.53	2	8.70	4	17.39
110 – 119	0	0.00	4	21.05	1	4.35	3	13.04
120 -129	0	0.00	0	0.00	1	4.35	0	0.00
TOTAL	19	100	19	100	23	100	23	100

Table 5: Table of Length-Weight frequency distribution of prawn species at Station C

Average length (cm)	MF				MV			
	Female		Male		Female		Male	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
5.5 -6.5	3	15.79	1	5.26	2	8.70	2	8.70
6.6 - 7.6	6	31.58	2	10.53	13	56.52	10	43.48
7.7 -8.7	8	42.11	6	31.58	6	26.09	4	17.39
8.8 -9.8	1	5.26	8	42.11	2	8.70	0	0.00
9.9 - 10.9	1	5.26	1	5.26	0	0.00	6	26.09
11.0 - 12.0	0	0.00	1	5.26	0	0.00	1	4.35
12.1 - 13.1	0	0.00	0	0.00	0	0.00	0	0.00
13.2 - 14.2	0	0.00	0	0.00	0	0.00	0	0.00
Total	19	100.00	19.00	100.00	23.00	100.00	23.00	100.00

Average weight (g)	MF				MV			
	Female		Male		Female		Male	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
50-59	0	0.00	0	0.00	0	0.00	0	0.00
60-69	1	5.26	0	0.00	2	8.70	2	8.70
70-79	11	57.89	0	0.00	12	52.17	8	34.78
80-89	5	26.32	6	31.58	6	26.09	4	17.39
90-99	2	10.53	8	42.11	1	4.35	2	8.70
100-109	0	0.00	3	15.79	2	8.70	4	17.39
110-119	0	0.00	2	10.53	0	0.00	3	13.04
120-129	0	0.00	0	0.00	0	0.00	0	0.00
130-139	0	0.00	0	0.00	0	0.00	0	0.00
Total	19	100	19	100	23	100	23	100

Discussion

At the study stations, the differences in mean weight and total length among sexes indicate the existence of sex dimorphism with respect to size in *Macrobrachium* species. This differential body growth rates between males and females have been reported for many *Macrobrachium* species. Mossolin and Bueno (2003) [22] and Fransozo *et al*., (2004) [23] studying *M. Olfersi* and *M. iheringi* respectively, observed that males reached a greater total length than females as a function of the differences in growth rates and patterns of population structure between sexes. In *Macrobrachium vollenhovenii* and *Macrobrachium felicinum*, dimorphism seems to be due to the same causes, with the additional fact that the larger size reached by males may be related to domination over females, as well pre-adult males, during the copulation process. Another hypothesis is the relation with the hierarchy in favor of male size that can interfere with the growth of submissive individuals in the population, as demonstrated to *M. rosembergii* by Sampaio and Valenti (1996) [6]. Size frequency distribution revealed a greater abundance of females in the first size classes and a larger number of males in the final classes for *Macrobrachium vollenhovenii*. The high increase in number of individuals starting from the 2nd class characterizes a marked recruitment of females measuring 5.5 – 7.5cm, indicating an early preparation for reproduction compared to males. Furthermore,

females seem to have a shorter life span or to grow less than males, as confirmed by the larger number of males in the final size classes. A similar result was obtained by Fransozo *et al*. (2004) [23], who studied the species *M. iheringi* in the Botucatu region in São Paulo State. Lawal-Are and Owolabi (2012) [24] in their findings on the Comparative Biology of the Prawns *Macrobrachium Macrobrachium* (Herklots) and *Macrobrachium vollenhovenii* (Herklots) from two interconnecting Fresh/Brackish Water Lagoons in South-West Nigeria reported that males of the species were more than the females in the final class sizes which equally supports the findings of this study. There was also a higher incidence of adults (mature individuals) of both sexes from December to May, followed by a low recruitment of young individuals in summer (November to January), probably due to low reproductive activity in winter. Although this population showed evidence of a greater reproductive rate in summer, this activity occurred throughout the year, as proved by the constant presence of juveniles in the population. The reproductive activity of this population could be better characterized if ovigerous females were captured and gonadal analysis were performed during the studied period. According to Williams *et al*., (1990) [25], the frequency of juveniles in a population may be altered as a function of factors such as predation, mortality and shelters. According to Anger and Moreira (1998) [26], not enough data are available to allow generalizations about the morphometric patterns of prawn, particularly with regard to sexual dimorphism in the proportions of body dimensions.

According to Bagenal (1978) [27], Diaz *et al*., (2000) [28] and Deekae (2009) [29], fish is in a relatively good condition, when the condition factor or k value is higher than 1. K values are shown to exhibit distinct seasonality. This may be due to number of factors such as availability of food, stage of gonadal development and environmental condition. For these species of prawn to be well adapted and established in the environment, shows they can be successfully used for prawn post-larval production in the river to boost prawn production, thereby reducing importation of fish to meet demand, increasing the protein intake of the populace and generating more income for the local fisher folk. However, in producing post larva, both species can be used. This is because they grow to a large size and command higher market value.

On the other hand corelation coefficient to establish their relationship showed positive relationship at the different study stations (r= 0.8044*- 0.9856*) Fig 2-13. The result of this study in Akor river is in line with the work of Conides and Al-Hassan (2000) [30] who used length weight relationship to determine the general well-being of fish species in an aquatic environment. The result is also supported by the report of similar studies carried out by Aderonke and Aminat, 2012) [31] on Lagos lagoon who reported that Prawns from the Lekki and Lagos Lagoons showed a linear relationship between length and weight. Regression coefficient (b) was recorded as 10.74, 4.98 and 4.37 for *Macrobrachium felicinum* males, females and combined sex respectively, while (b) was recorded as 7.022, 7.10 and 7.1 for *Macrobrachium vollenhovenii* males, females and combined sex respectively. This shows a positive allometric growth pattern, (b>3) in all the stations of the river.

Conclusion and Recommendation

Size class distribution showed that males were of higher size class than the females in terms of length and weight. It also showed an isometric relationship. The study further concludes that the study stations supported the occurrence of *Macrobrachium* species which showed high condition factor, for the two species. Aqua culturists are encouraged to take advantage of these species which are generally in good condition for more *Macrobrachium* fish production

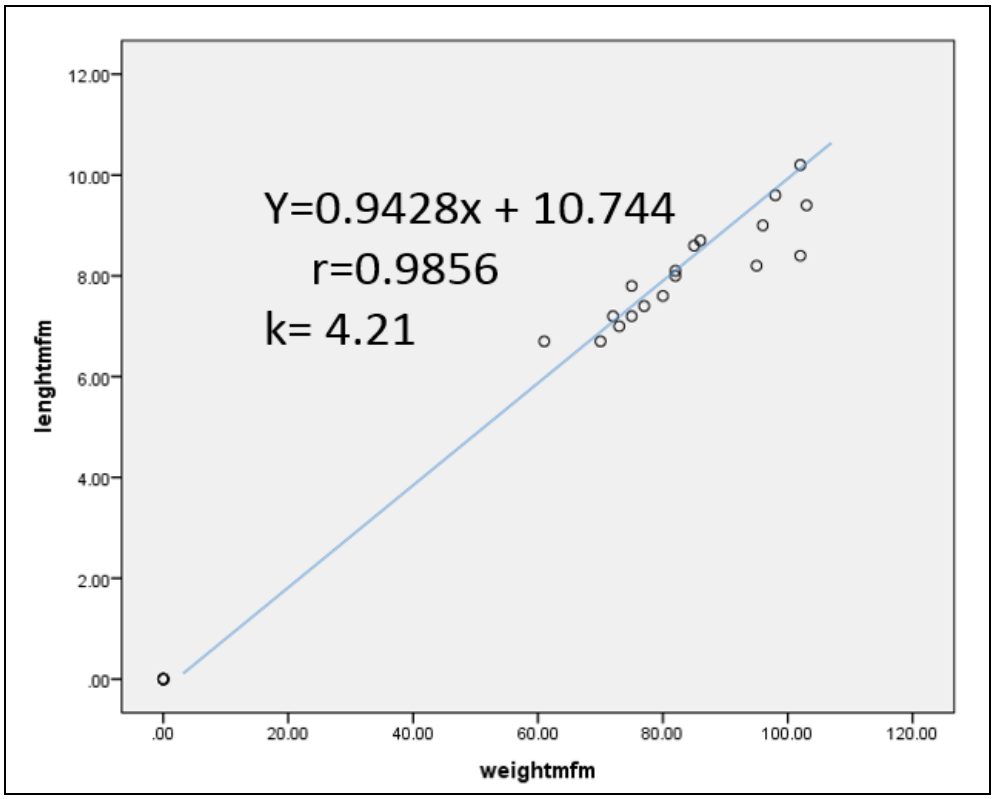

Fig 2: Length weight relationship of *M. felicinum* male at station A

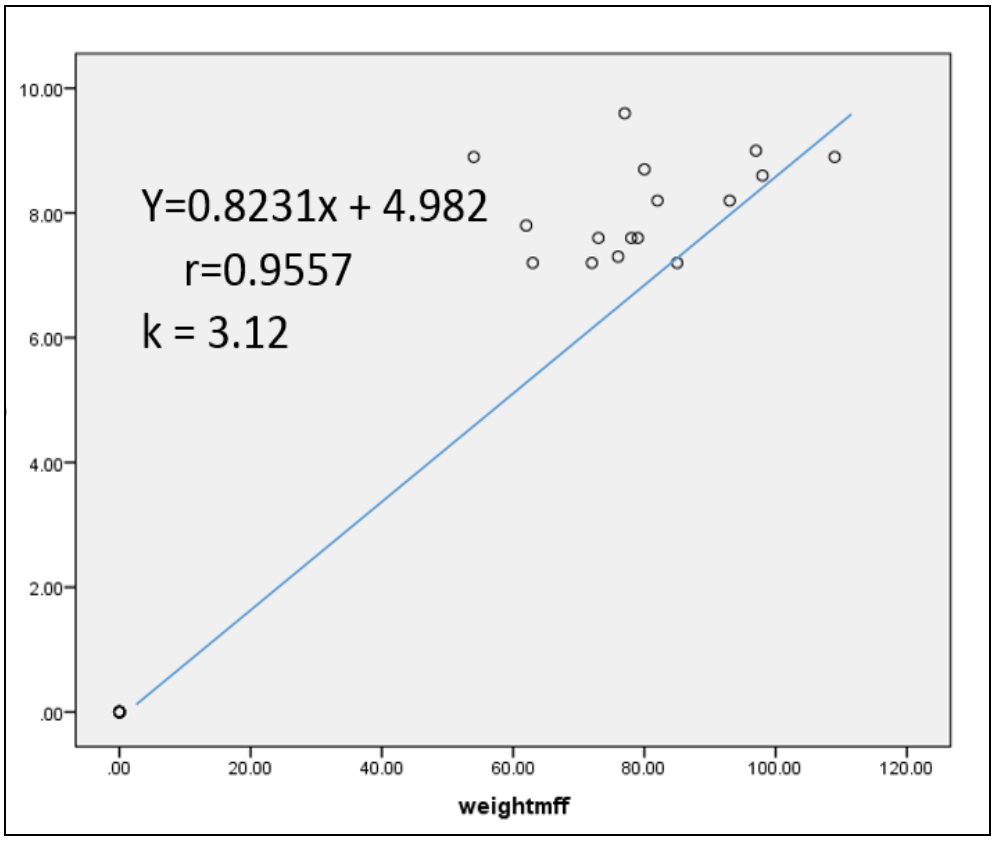

Fig 3: Length weight relationship of *M. felicinum* female at station A

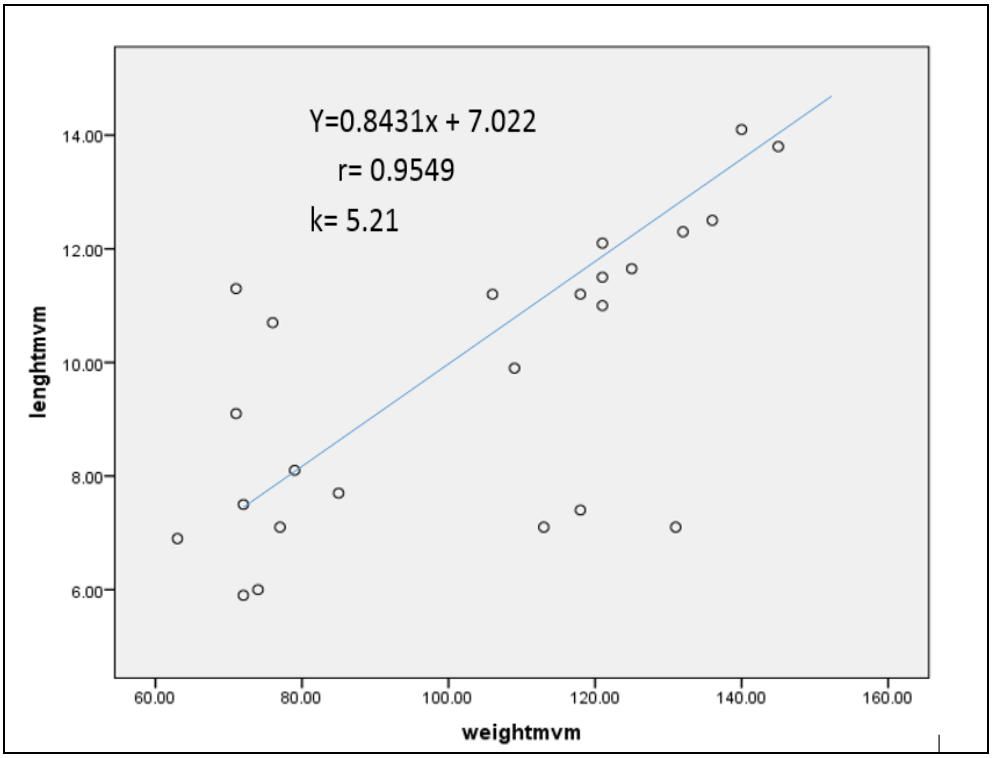

Fig 4: Length weight relationship of *M. vollenhovenii* male (station A)

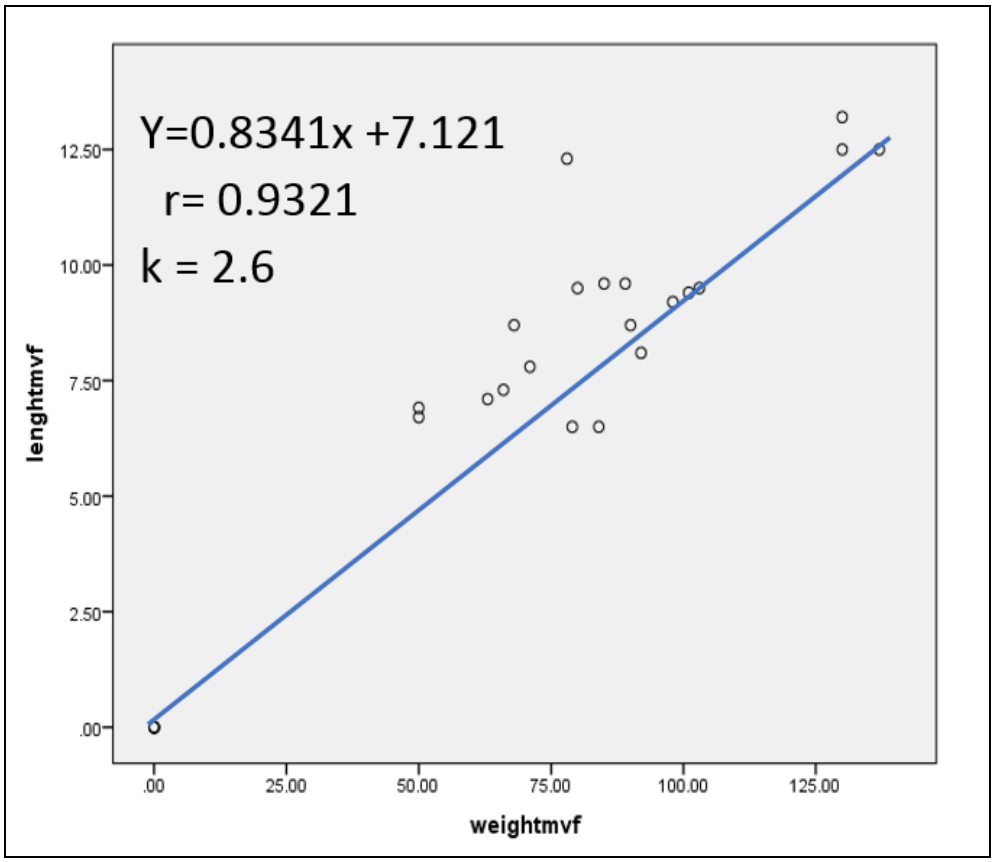

Fig 5: Length-weight relationship of *M. vollehonvenii* female (station A)

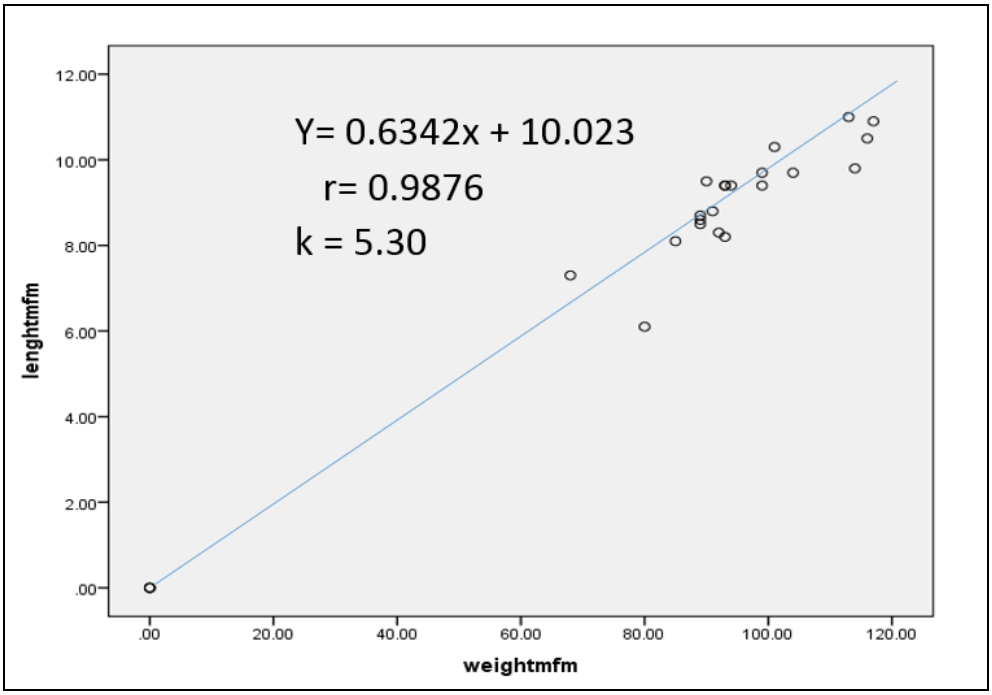

Fig 6: Length -weight relationship of *M. felicinum* male (station B)

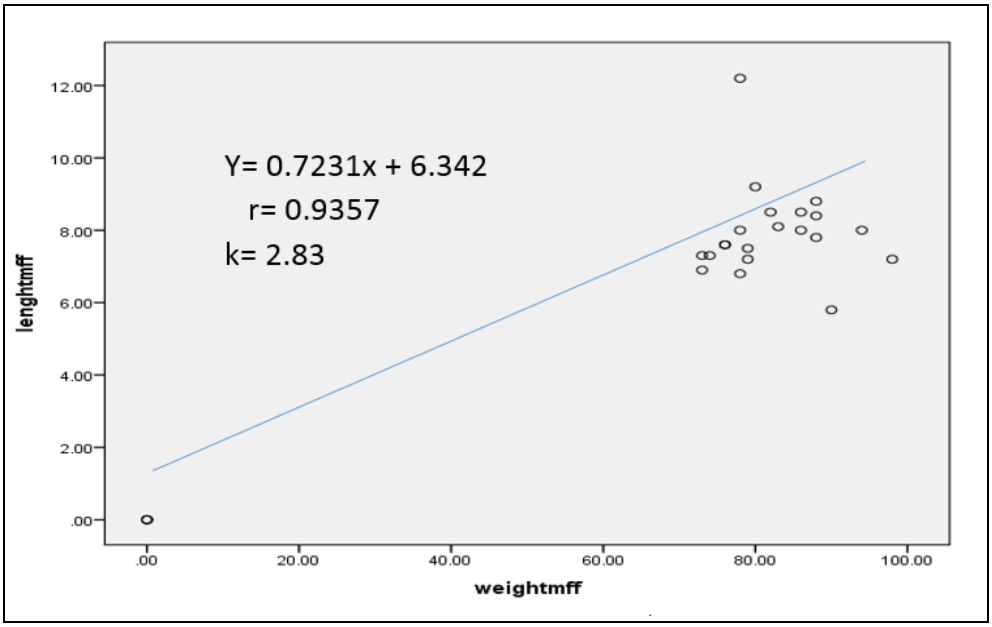

Fig 7: Length weight relationship of *M. felicinum* female at station B.

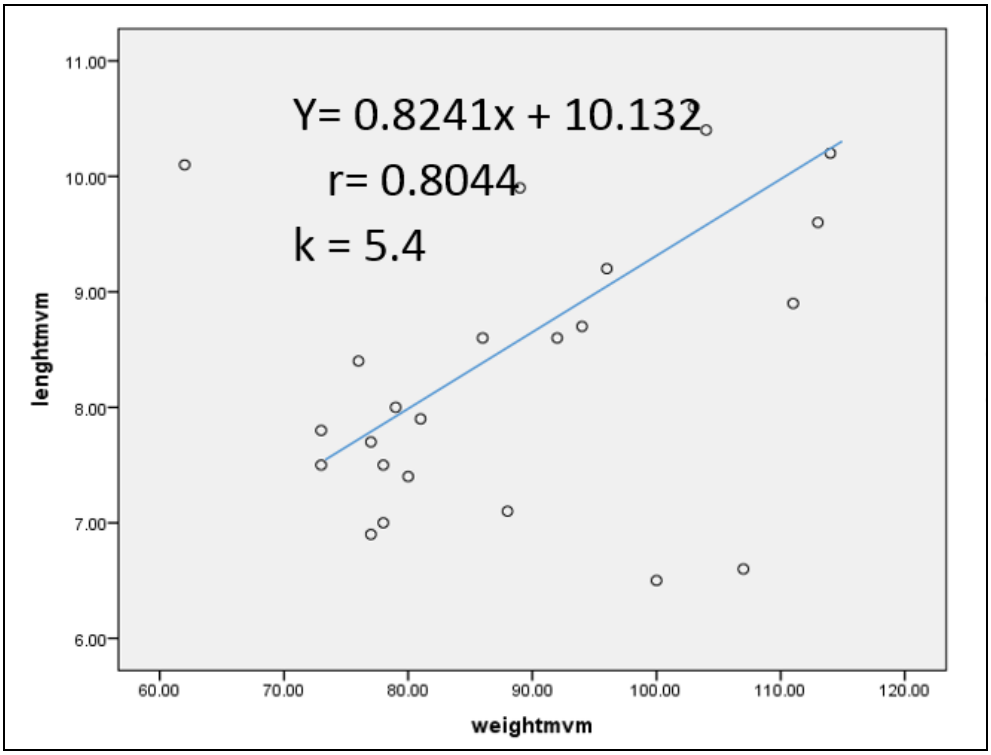

Fig 8: Length weight relationship of *M. vollenhovenii* male at station B

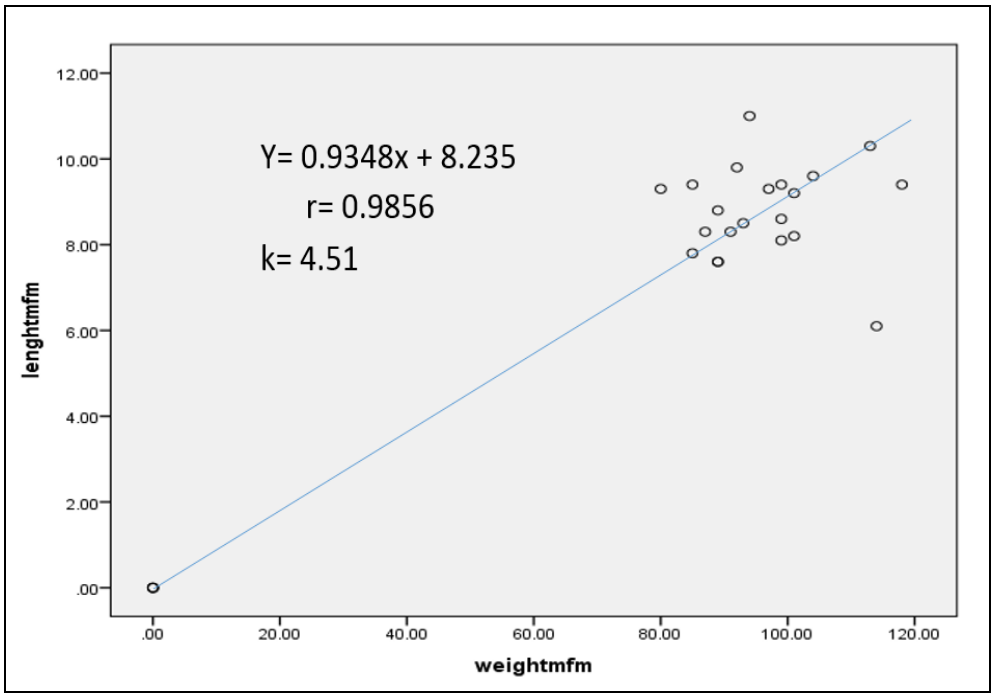

Fig 9: Length weight relationship of *M. vollenhovenii* female at station B

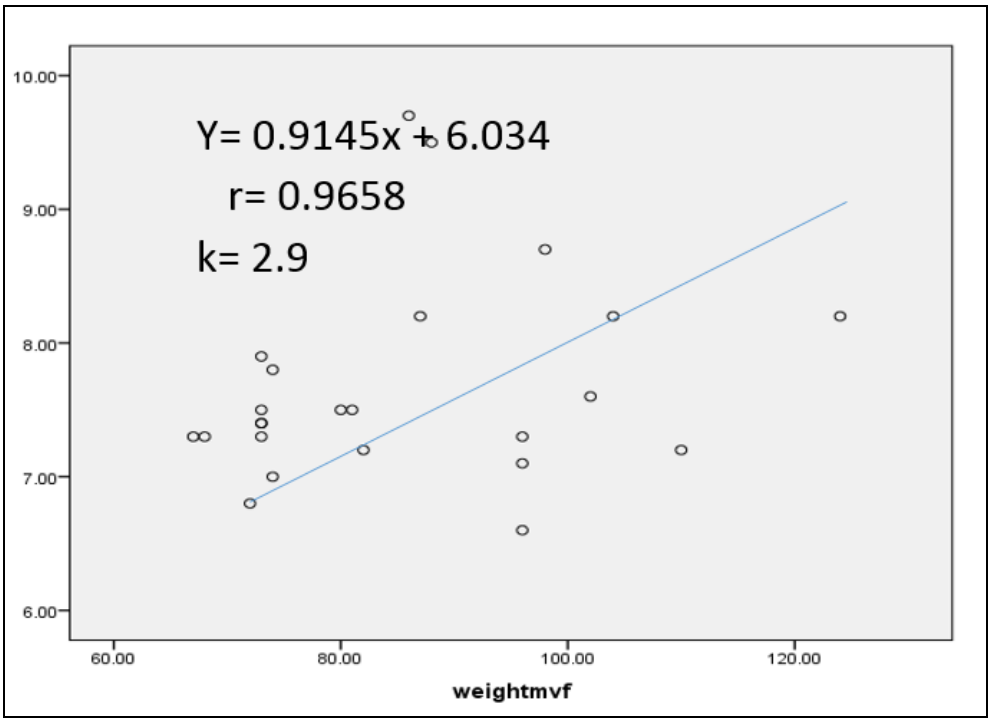

Fig 10: Length weight relationship of *M. felicinum* male at station C

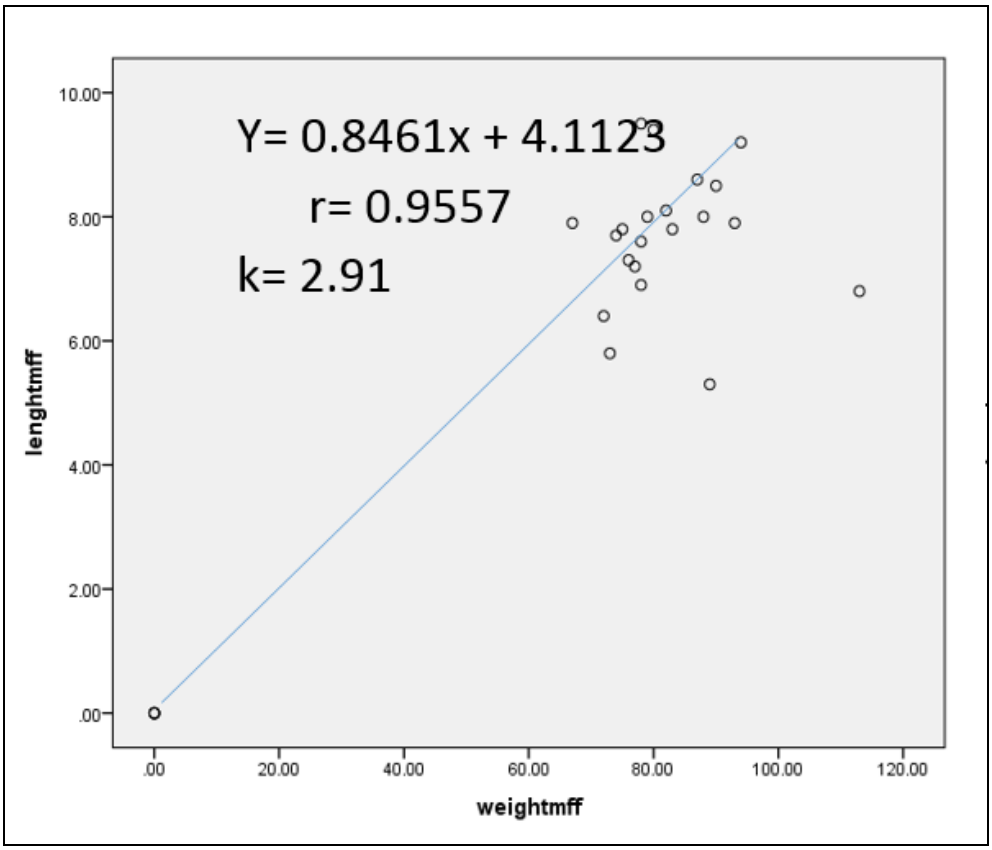

Fig 11: Length weight relationship of *M. felicinum* female at station C.

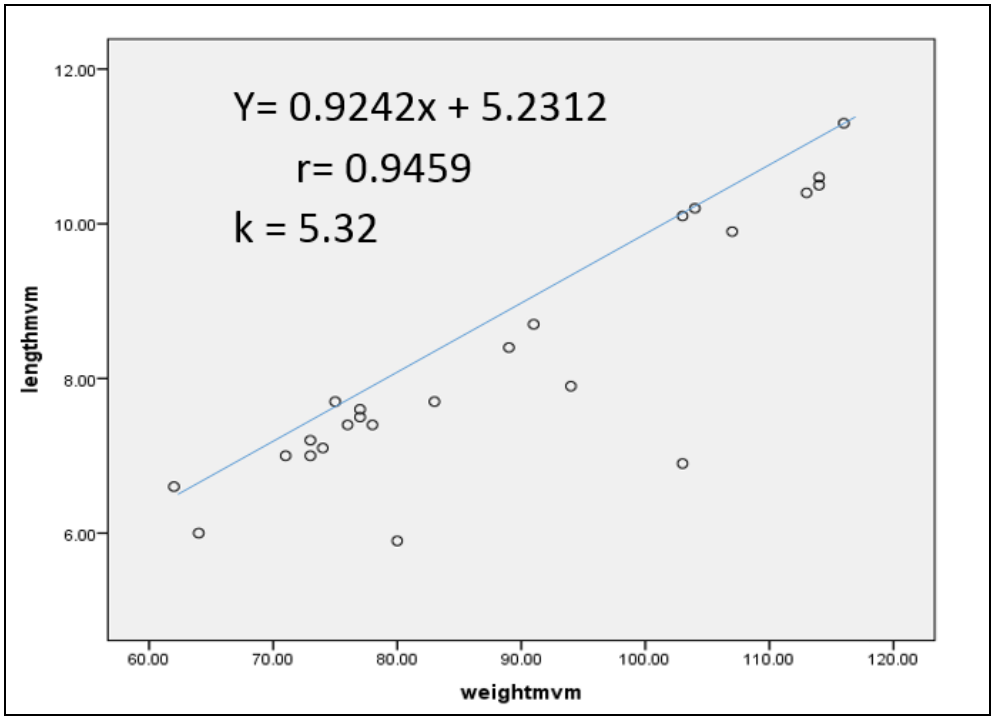

Fig 12: Length weight relationship of *M. vollehonvenii* male at station C

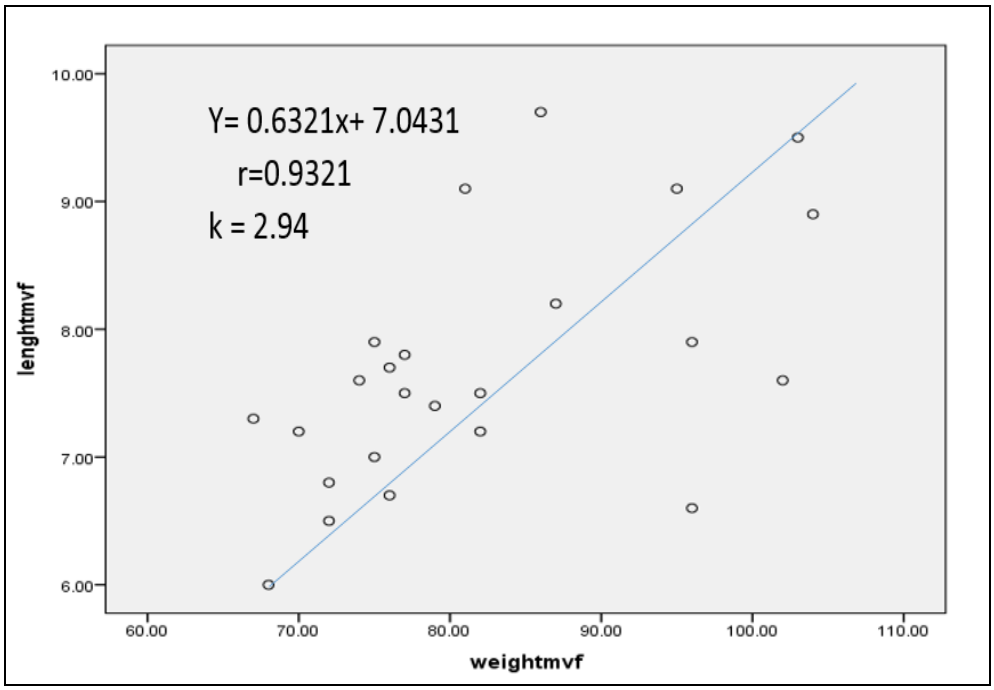

Fig 13: Length weight -relationship of *M.vollenhovenii* female at station C

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