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Length- weight relationship, condition factor and age of kawakawa (*Euthynnus affinis*), in the eastern Mediterranean coast, North Sinai, Egypt.

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Abstract

Monthly length composition data (Total length) of kawakawa (*Euthynnus affinis*), which landed between January and December 2020 in the Coastal Waters of the Mediterranean coast of North Sinai Egypt were used to estimate the length-weight relationship, condition factor, age and growth. The computed length-weight relationship ($W = 0.0186\ L^{2.8595}$) showed a negative allometric growth pattern. The average condition factor was 1.12 and the relative condition factor was 1.01. The age was determined indirectly by the analysis of length frequency data using the standard statistical method of Bhattacharya involved in the FiSAT II . Five age stages were found, and the length at the end of each age was 22.62, 37.56, 52.28, 59.21, 62.85 for years 1, 2, 3, 4, and 5, respectively.The growth parameters of the von Bertalanffy equation were estimated as $L\infty$=87.67.2 cm, K= 0.24 per year and to = -0.56 per year.The study recommended not to catch small fish less than 48 cm

Keywords: kawakawa (*Euthynnus affinis*), length-weight relationship, condition factor, age, growth,

Introduction

In order to achieve one of the fundamental goals of fishery science, namely, optimising fish populations, it is important to comprehend the population biology of fish species. Yet understanding the population biology of fish species is essential to meet one of the main objectives of fishery science, that of maximizing yield to fisheries, while safeguarding the long-term viability of populations and ecosystem **(Jenning *et al.*, 2000**).

Euthynnus affinis is a pelagic fish from the Scombridae family and one of the commercially important species. The fish is mostly found in the water column from the surface. down to about 50 m. *Euthynnus affinis* spread widely in the tropical and subtropical waters, including the Indian Ocean,

Pacific, Mediterranean Sea, and the Black Sea. Since the level of exploitation of this fish resource is relatively high, it is critical to have an accurate assessment of the status of the stock (**Jaya *et al* 2019** . Kawakawa (*Euthynnus affinis*) is one of the commodities representing as much as 10% of neritic tuna in the world trade in marine fisheries **(Ahmed *et al.*, 2015)**. Kawakawa is a type of pelagic fish and fast swimmer that live in groups where the distribution area is in coastal and oceanic waters **(Nurhayati, 2001**). Indian Ocean Tuna Commission/**IOTC (2006**) reported that kawakawa inhabits coastal water and has a preference to stay in relatively warm water18°-29°C. This species forms a school that appears down to 400 m depth.

Kawakawa (*Euthynnus affinis*) is an epipelagic migratory tuna species that is widely distributed in the tropical and subtropical waters of the Indo-Pacific region. In the western Pacific Ocean, this species is distributed along the Asian continent from Malaysia northeastward through Mainland China, Taiwan, and southern Japan (**Yasaki, 1994).** Kawakawa is also a merit species and is most commonly seen in the set net catches, although a few of them also were caught by gill net, long line and small purse seine (**Yasaki, 1994).**

Previous reports conducted on *E. affinis* were focused mainly on the population dynamics, biological characteristics, reproductive, mortality, and stock assessment. . Different aspects of the biological work of kawakawa have been done by different authors (**Talebzadeh., 1997, Pillai *et al*., 2002 Darvishy *et al*., 2003 ;(Thaghavi Motlagh *et al*., 2010);,** Rohit *et al*., 2012, **Johnson and Tamatamah, 2013, Sulistyaningsih *et al.*, 2014**, **Nissar *et al*., 2015, Ardelia *et al.*, 2016, Kumar *et al*., 2019).** No studies have been conducted on this species in the North Sinai coastal waters of the eastern Mediterranean Sea. In this context, the main objective of this study some provides biological reference points information required for the management of E. affinis

Materials and method

A total of 1065 samples of *E. affinis*, were collected monthly from the Mediterranean coast of North Sinai Egypt(Fig. 1). Length-frequency (total length) data of Kawakawa were collected from January to December 2020. Total length (TL) was taken to the nearest cm for all fish and total weight (TW) of individual fish to nearest g was measured. The samples were mainly caught by the gill net method in the study area.

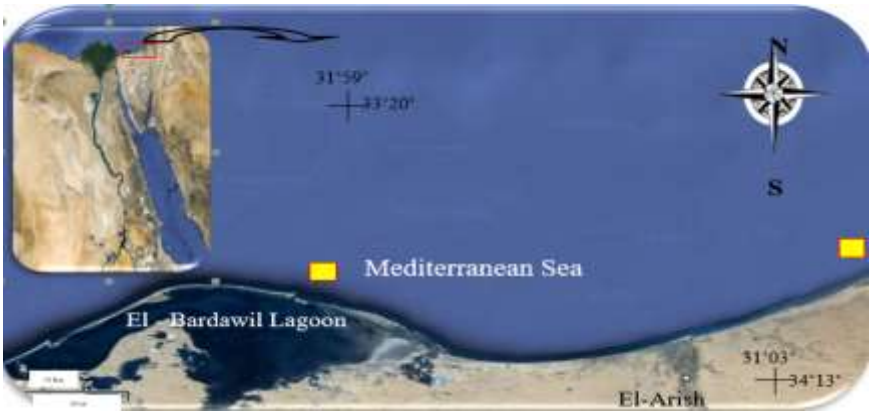

Fig (1): Map of sampling areas (East Mediterranean fisheries, North Sinai)

The length-weight relationship was estimated for the pooled samples using a simple power regression model ($W = a L^b$, **Ricker, 1975**), where W is the total weight (g), and L is the total length (cm), a and b are constants.

The condition factor was calculated monthly by the formula $Kc = (W * 100) / L^3$ **(Hile, 1936**), Where: K = condition factor W = weight in g. and L = length in cm. and $Kn= W / W^*$ Where Kn = relative coefficient of condition , W = observed weight in g. W* = calculated weight in g.

The age was determined indirectly by the analysis of length frequency data using the standard statistical method of **Bhattacharya (1967**) involved in the FiSAT II software of **Gayanilo *et al*. (1997**), which allows the conversion of length frequency data into age groups.

Results

Length frequency

The total length of 1065 Sample that collected Euthynnus affinis from Mediterranean coast was ranged from 20 to 64.5 cm.A The average length of the fish in the catch is 35.1 cm . Afrequency distribution was made for these lengths and the Lengths from 29 cm to 38 cm constituted the majority of the catch (72%) (Fig 2).

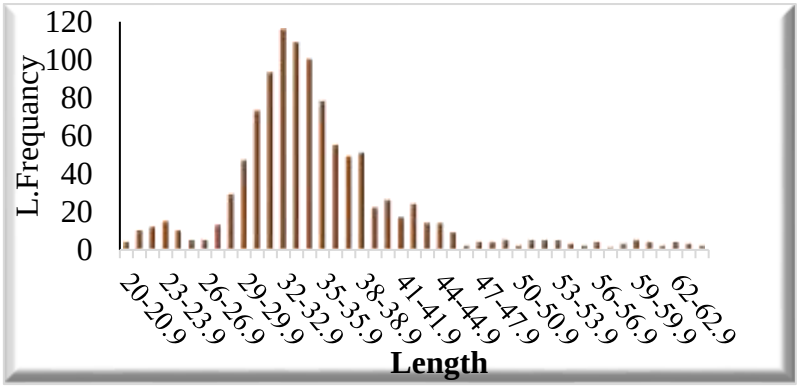

Fig (2): Length frequency distribution of kawakawa (*E. affinis*) in the eastern Mediterranean coast

Length-weight relationship

The length-weight relationship of kawakawa *E. affinis* on the Mediterranean coast of North Sinai Egypt during fishing season 2020 was estimated as $W = 0.0186\ L^{2.8595}$. The results showed a negative allometric growth pattern for the monthly and whole data analysis (Fig. 3 and Table 1).

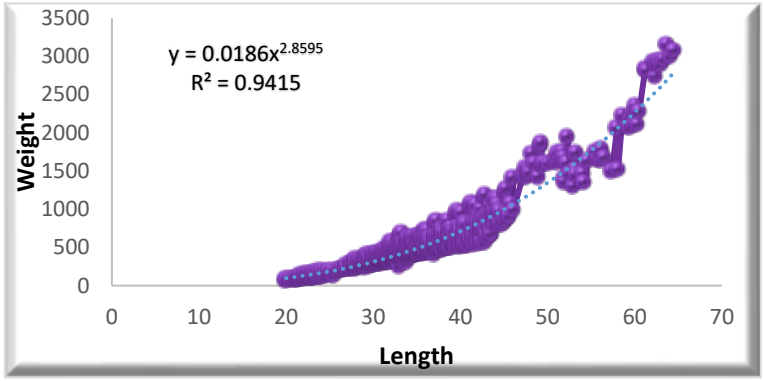

Fig. (3) Length-weight relationship of kawakawa (*E. affinis*) in the eastern Mediterranean coast during fishing season 2020.

Condition factors:

The average condition factor (K) of *Euthynnus affinis* was calculated using the total weight of all samples (regardless of sex) with the value of 1.3 (Fig. 4 and 5). Monthly average values of Kn and Kc for the period from January to December 2020 as calculated from the observed total weight and represented in Figures (4and5) from these figures it is obvious that both composite (Kc) and relative (Kn) condition factor follows the same trend of fluctuations.

Table 1 Monthly length-weight relationship of *E. affinis* in the eastern Mediterranean coast during fishing season 2020.

Month	No.	Length (cm)			Weight (g)			Parameters		
		Ave.	Min	Max	Ave	Min	Max	A	b	R
Jan.	104	34.7	21.7	60.5	544.7	122.0	2277.7	0.0237	2.7982	0.94
Feb.	90	35.2	20.5	63.4	568.1	77.8	2957.6	0.0116	2.9890	0.95
March	81	35.1	20.6	62.5	566.4	89.8	2883.4	0.0152	2.9179	0.93
April	76	35.8	21.5	64.5	593.1	90.0	3075.8	0.0172	2.9698	0.93
May	131	34.7	21.0	60.1	517.2	83.5	2354.9	0.0275	2.7491	0.92
June	106	35.0	21.1	64.1	530.7	95.5	2998.2	0.0300	2.7248	0.91
July	65	35.5	21.3	62.8	533.5	87.0	2941.7	0.0153	2.8977	0.94
Aug.	105	34.3	20.0	61.2	506.0	75.0	2833.4	0.0164	2.8996	0.93
Sept.	70	34.1	20.1	62.2	502.0	87.0	2934.9	0.0130	2.9497	0.95
Oct.	84	36.1	22.0	63.0	594.3	101.8	2894.2	0.0214	2.8197	0.92
Nov.	75	35.3	21.7	62.4	560.0	100.0	2733.9	0.0231	2.7952	0.94
Dec.	78	35.7	21.4	63.7	592.3	99.0	3155.2	0.0182	2.8715	0.93
Total	1065	35.1	20.0	64.5	548.2	75.0	3155.2	0.0186	2.8595	0.93

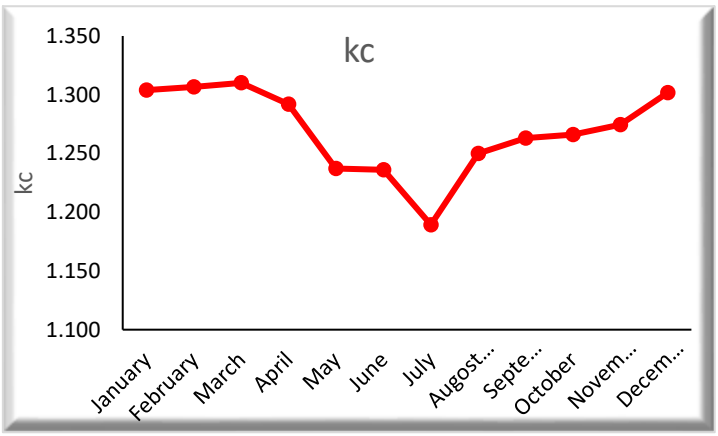

Fig. (4) Monthly changes of condition factor (Kc) of *E. affinis* in the eastern Mediterranean coast during 2020

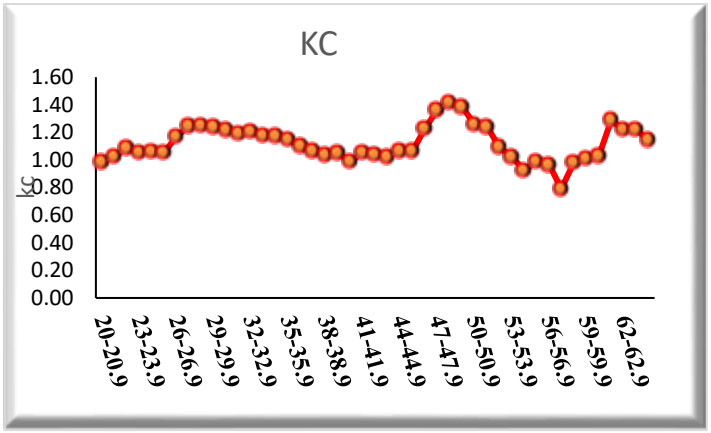

Fig. (5) condition factor based on length frequency of kawakawa

Condition factor was also estimated for each length group. The relative condition factor (Kn) of kawakawa is 0.9 and low in small-sized fish (20-26 cm TL), it shows a declining trend with increasing length. The highest relative condition factor appears at the upper limit of the 48 cm length class, and the lowest occurs at the upper limit of the 57cm length class (Fig.6).

Whereas the relative monthly condition factor tends to be stable during the observation period. Generally, the monthly value fluctuated from 0.837 to 1.171 (Fig. 7). The lowest condition factor occurred in April (0.837) and the highest was recorded in February (1.171) and September (1.16).

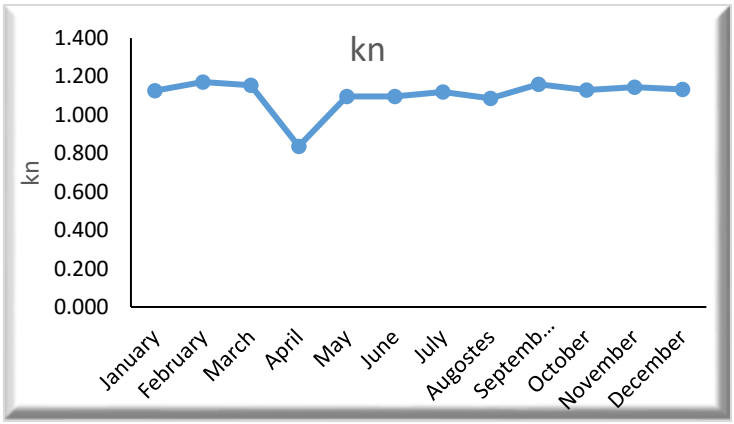

Fig.(6) Monthly Relative condition factor based on length frequency of *E. affinis*

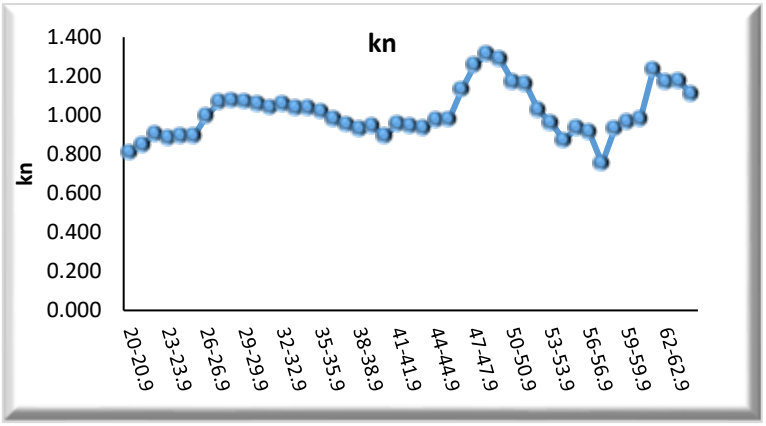

Fig. (7) Relative condition factor based on length frequency of *E. affinis*

3.3 Age determination

Using the FiSAT II program based on length frequencies by Bhattacharya (1967) method five age groups were determined in *Euthynnus affinis* in the present study (fig 8). About 5 % of the total catch of *E. affinis* was belonging to age group (I) with individuals of 22.62 cm mean total length. Age group (II) represented about 59.3 % of an individual's average length of 37.56 cm. Age group (III) average length of 52.28 cm represented by 30.3% of *E. affinis*. Age group (IV) was represented by 3.1% of *E. affinis* with an average length of 59.21 cm and Age group (V) was represented by 2.1% with an average length of 62.85 cm (Fig. 9). The corresponding average weights of age groups from one to six were 138.9, 592.2, 1524.4, 2176.1 and 2580.9 g respectively (Fig. 10).

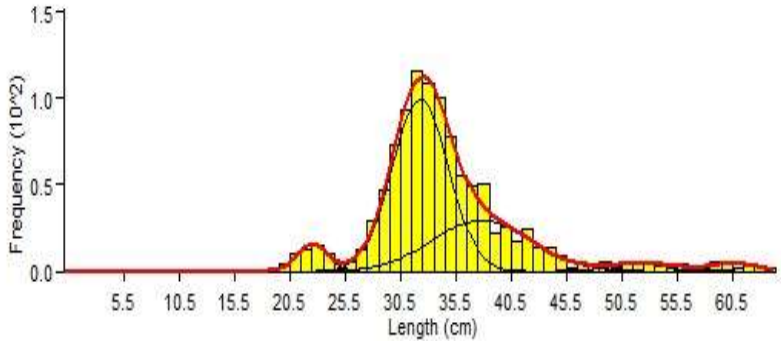

Fig (8) Decomposition of *E. Affinis* length frequency distribution into its normal components

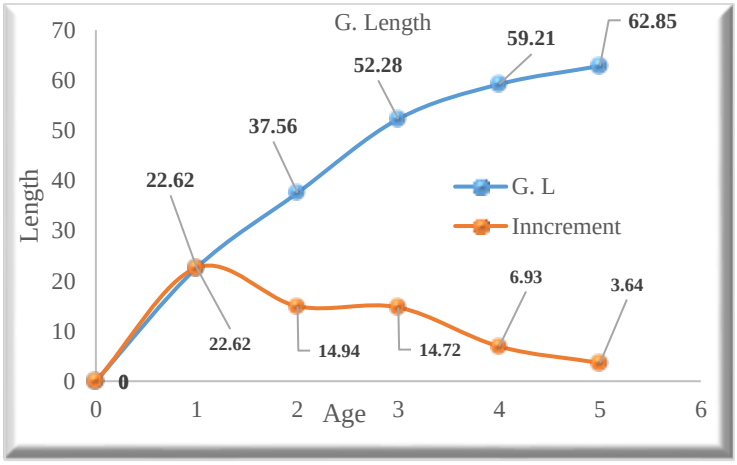

Fig (9) The length at the end years life and Increment of the length of *E. affinis* in the eastern Mediterranean coast of during 2020

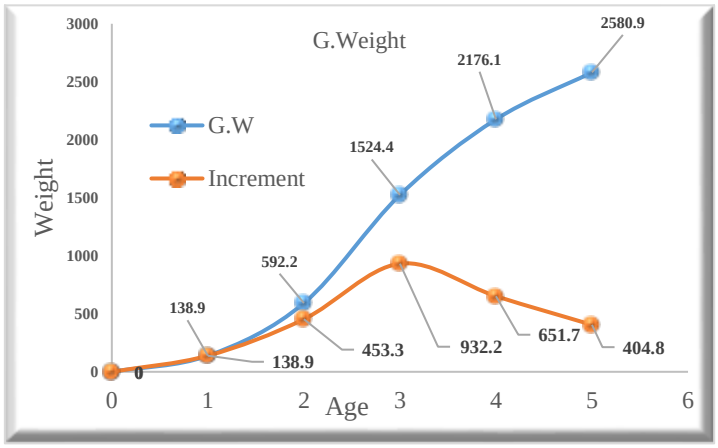

Fig (10): The weight at the end of years live and Increment of the weight of *E. affinis* on the Mediterranean coast during 2020

Discussion

The present study revealed that the common size of *E. affinis* in commercial catches from the Eastern Mediterranean in Egypt ranged from 20-46.5 Cm TL. The average length of the fish in the catch is 35.1 cm, and **(Ekawaty and Jatmiko 2018**) indicated that the length at sexual maturity is 48.4 cm, which indicates that most fish are caught in small sizes before sexual maturity . Earlier studies on the growth of *E. affinis* from different regions have indicated that growth as in most tuna species is fast with the fish having longevity of 2 to 8 years **(Pratibha *et al.*, 2012**). The length-weight relationship of kawakawa *E. affinis* caught from different regions has been estimated by several earlier studies and the values of 'a' and 'b' obtained are as in Table 2. For the present study, kawakawa in North Sinai coastal waters allometric

growth with the 'b' value lower than 3 (b=2.8595). According to **Mulfizar *et al.*, 2012** the factors that affect 'b' are physiological conditions and environments such as sampling techniques, location geography, temperature, salinity, development gonads and food availability.

The condition factor of kawakawa value ranging from 0.79-1.42 showed good fatness or obesity conditions. According to (**Effendie, 2002**), whether the fish condition is good or not can be seen from the value of the condition factor. Condition factor value <1, classified as flatfish, and values 1-3 as fish with a less flat body shape.

This statement is confirmed by **(Ndimele *et al*., 2010),** who stated that the condition factor is a useful index for looking for age, growth rate, and feeding intensity. Then, the feeding intensity and growth rate will explain the age groups divided into juvenile, immature, mature, and old groups. In addition, the condition factor value can also be affected by the density of population, food sex, age, and level of gonad maturity (**Effendie, 2002**). Condition factors indicate whether or not a fish's weight is good in terms of its physical ability to survive and reproduce (**Effendie, 1997**). According to **Wujdi *et al.*, 2012**, more than one condition factor value also indicated that the observed fish samples are in good environmental conditions and can be used for consumption.

Hasibuan *et al.*, 2022 reported that the kawakawa *Euthynnus affinis* has a good growth with condition factor (Kn) > 1.

Growth parameters in the von Bertalanffy equation as estimated by earlier studies in different regions of the world are given in Table 3. Kawakawa is a fast-growing fish attaining a maximum length of around 64.5 cm (in North Sinai coastal waters). However, the L∞ estimated from other regions are much higher ranging from 81.0 – 89.0 cm, than the estimated value obtained in the present study. The 'K' value obtained from this study also revealed a lower value than earlier studies in other regions. This can be attributed to the fact that *E. affinis* is an Indo-pacific species that migrated recently to the Mediterranean Sea through Suez Canal. Differences in growth patterns may be the result of differences in genetic structure and or differences in temperature, the density of food and diseases (**Pauly, 1994 and Wootton, 1998). Pratibha *et al.*, (2012)** reported, that the difference in growth rate can be attributed to several reasons including prevailing eco-biological conditions of the habitat from time to time.

Table 2: The value of 'a' and 'b' of kawakawa *E. affinis* in the length-weight relationship

Reference	'a'	'b'	Region
Present study	0.0186	2.8595	Mediterranean coast, North Sinai, Egypt
AL Kamel *et al.* (2020)	0.0332	2.706	Red sea, Yemen
Herath *et al.* (2019)	0.132	3.115	Sri Lanka
Vinod *et al.* (2018)	0.0286	2.857	India
Paighambari *et al.* (2018)	0.001	3.22	Iran
Saberi *et al.* (2017)	0.009	3.04	Iran
Sallehudin *et al.* (2016)	0.000062	2.776	Kuala Perlis, Malaysia
Sallehudin *et al.* (2016)	0.000013	3.058	Tok Bali, Malaysia
Ahmed *et al*. (2014)	0.0254	2.889	Karachicoast
Umi Chodrijah *et al.* (2013)	0.000001	3.1253	Java Sea waters
Kaymaram & Darvishi (2012)	0.0186	2.87	Iran
Pratibha *et al*. (2012)	0.0254	2.889	Indian waters
Ghosh *et al*. (2010)	-1.9313	3.056	Veraval, India
Al-Zibdah & Odat (2007)	-2.11	3.1399	Red sea
Khan (2004)	-1.432	2.786	India
James *et al*. (1993)	0.0191	2.95	Indian waters
Williamson (1970)	0.0885	2.5649	South China Sea
Silas (1967)	0.0138	3.0287	Indian Ocean
Ronquillo (1963)	0.0334	2.838	Philippines waters

Table 3: Estimates of growth parameters of *E. affinis* from earlier and present studies in the regions.

Reference	L_∞	K	t_o	ϕ	Region
Present study	67.2	0.24	-0.56008	3.0349	Mediterranean coast North Sinai Egypt
Sallehudin *et al.* (2016)	60.4	0.26	-0.55	4.98	Kuala Perlis, Malaysia
Sallehudin *et al.* (2016)	53.0	0.19	-0.39		Tok Bali, Malaysia

Umi Chodrijah *et al.* (2013)	59.63	0.91	-0.178		JAVA SEA WATERS
Jatmiko *et al.* (2013)	63.53	0.63			Indonesia
Pratibha *et al*. (2012)	81.9	0.56	-0.0317		India
Kaymaram & Darvishi (2012)	95.06	0.67		8.7	Iran
Ghosh *et al*. (2010)	72.5	0.56	0.0327		Veraval, India
Taghvai *et al.*, (2010)	87.7	0.51	-0.23	8.28	Persian Sea of Oman
Khan (2004)	81.7	0.79	-0.0227		Maharashtra, India
Kasim & Abdus Samad (2003)	87.5	1.5	-0.003		India
Dayaratne & Silva (1991)	76.8	0.52		8.87	Sri Lanka
Pillai *et al.* (2002)	81	0.9		8.87	India
Talebzadeh *et al.* (1997)	86	0.69		8.5	India
James *et al*. (1993)	83.5	0.42	-0.044		Indian waters
Yesaki (1989)	76	0.96			Thailand
Joseph *et al.* (1987)	59.5	.69			Sri Lanka
Silas *et al.* (1985)	81	0.365	-0.3438	7.79	India
Yesaki (1982)	76	0.46		7.8	Thailand

Conclusion

The present study revealed that the common size of E. affinis in commercial catches from the Eastern Mediterranean in Egypt ranged from 20-64.5 Cm TL. The average length of the fish in the catch is 35.1 cm, which indicates that most fish are caught in small sizes before sexual maturity. Therefore, to preserve the fish stocks of kawakawa Euthynnus affinis fish in the study region, the fishing methods should be regulated to catch fish longer than 48 cm to give the fish a chance to spawn even once.

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علاقة الطول والوزن معامل الحاله وقياسات النمو لاسماك البلاميطه (*Euthynnus affinis*) في المياه الساحلية لساحل البحر المتوسط بشمال سيناء مصر.

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الملخص

استخدمت بيانات الطول الكلى والوزن الكلى لاسماك البلاميطه (Euthynnus affinis) بالبحر المتوسط ساحل شمال سيناء مصر التي تم جمعها من ميناء العريش شهريا (مناطق انزال) في الفترة من يناير الى ديسمبر ٢٠٢٠ لتقدير علاقة الطول والوزن. ,, ومعامل الحاله والنمو. حيث كانت العلاقة بين الطول والوزن من المعادله ($W = 0.0186\ L^{2.8595}$) وكان متوسط معامل الحال ١,١٢ ومعامل الحال النسبى ١,٠١ تم تحديد العمر بشكل غير مباشر من خلال تحليل بيانات طول التردد باستخدام الطريقة الإحصائية القياسية لـ Bhattacharya المشاركة في FiSAT II. تم العثور على خمس مراحل عمرية وكان الطول في نهاية كل عمر ٢٢,٦٢ و ٣٧,٥٦ و ٥٢,٢٨ و ٥٩,٢١ و ٦٢,٨٥ أونصة للسنوات ١ و ٢ و ٣ و ٤ و ٥ على التوالي. تم تقدير معلمات النمو لمعادلة فون برتالانفي على أنها $L\infty = 0.67.2$ سم ، $K = 0.24$ سنويًا و $to = -0.56$ في السنة.

أوصت الدراسة بعدم صيد الأسماك الصغيرة التي يقل طولها عن ٤٨ سم