Indian J. Anim. Res., 52(12) 2018: 1790-1796
Print ISSN:0367-6722 / Online ISSN:0976-0555

AGRICULTURAL RESEARCH COMMUNICATION CENTRE
www.arccjournals.com/www.ijaronline.in

Estimating some population parameters and stock assesment of spiny butterfly ray, *Gymnura altavela* (Linnaeus, 1758) the Levant Basin coast (Northeastern Mediterranean)

Hacer Yeldan*

Fisheries Faculty,
Cukurova University, 01330, Adana, Turkey.
Received: 15-02-2018 Accepted: 11-04-2018 DOI: 10.18805/ijar.B-917

ABSTRACT

The purpose of this study was to investigate the morphometric characteristics, growth, mortality and exploitation rate of the spiny butterfly ray (*Gymnura altavela* Linnaeus, 1758). The study was conducted using 284 specimens from the coastal waters of the Levant Basin (the northeastern Mediterranean). Samples were collected monthly between July 2014 and June 2015 using a bottom trawl from the following depth strata: 0-10m, 10-20m, and 20-50m. The following measurements were taken total length (TL), disc length (DL), disc width (DW) distance from nose tip to eye (NE), nose tip to mouth (NM, cm), width of mouth (MW, cm) where Y is the various dimensions (TL; W; DL; DW; NE; NM; MW, respectively) and X is the total length estimated by linear regression analysis. Length-weight and disc width-weight relationships were $W = 0.097 * TL^{3.2070}$ and $W = 0.084 * DW^{3.169}$ for total individuals. The von Bertalanffy growth function contained in DW was $DW\infty = 136.50cm$ $K = 0.230\ year^{-1}$ $t_0 = -0.492year^{-1}$ for total individuals. The total mortality (Z) was $0.91year^{-1}$, the natural mortality (M) was $0.41year^{-1,}$ and the fishing mortality (F) was estimated to be $0.51year^{-1}$. The exploitation rate (E) was calculated as $0.55\ year^{-1}$ for all obtained individuals.

Key words: Exploitation rate, *Gymnura altavela*, Mortality rate, Population parameters.

INTRODUCTION

The butterfly *Gymnura altavela*, (spiny butterfly ray) was abundant, and catches were possible in the Mediterranean region. The Chondrichthyan species accounted for 51% of the discard catch biomass while *G. altavela* was dominant in the bottom trawl (Yeldan *et al.* 2013; Yemişken *et al.* 2014). The spiny butterfly ray has been recorded in the Atlantic Ocean, including the Mediterranean Sea, the Black Sea and the waters around the Madeira and Canary Islands into the warm continental shelf waters (Serena 2005). *G. altavela* are classified as "vulnerable" on the IUCN list (IUCN 2013). It is a demersal species found on sandy and muddy bottoms from shallow waters to approximately 100m. *G .altavela* feeds on all kinds of animals that live the depths but favors fish and cephalopods (Bauchot 1987). This species is known throughout the Turkish seas of the northeastern Mediterranean (Başusta and Erdem, 2000; Yeldan and Avşar, 2007; Yemişken *et al.* 2014; Ozbek *et al.* 2016); its presence has been reported in the Levant Basin, and it has been captured in abundance in the northeastern Mediterranean. Data on the age, growth, feeding, reproduction, and fundamental biological processes of a population of this species from other regions were reported in some research studies (Wigley *et al*. 2003; Filiz and Bilge 2004; Yeldan and Avşar 2007; Başusta *et al*. 2012; Eronat and Ozaydın 2014; Ozbek *et al*. 2016; Parsons *et al*. 2018). The spiny ray is not a target species of commercial fisheries, but caught as by-catch of the demersal trawl, gillnet, trammel net, and bottom longline fisheries (Serena 2005), and data on its biology are inadequate.

Chondrichthyan fish have an important ecological role because they are located in the uppermost part of the food chain. The lack of commercial value and non-targeted status, mean that their numbers are decreasing every day. In addition, they have often had pessimistic outcomes in stock assessments over the past decade due to their slow growth, late sexual maturity, low reproduction and long lifespan. Therefore, the sustainability of many chondrichthyan stocks over the coming years has been skeptical. *G. altavela* is in second place among the chondrichthyan biomass caught in the Levant Basin (northeastern Mediterranean) through bottom trawl hunting (Yeldan *et al*. 2013). In this context, morphometric characteristics and population dynamics parameters such as growth, mortality rates, and stock utilization level were estimated foi the Levant Basin coast (northeastern Mediterranean) Thus, through these determined parameters, it is thought that it will contribute to preservation, stock management, and sustainability.

*Corresponding author's e-mail: hacyel@gmail.com

MATERIALS AND METHODS

Samples were collected from commercial bottom trawl nets in Iskenderun Bay which is located in the Levant Basin coastal area (northeastern Mediterranean) between longitudes 36°43'283''N, 34°53'674''E and latitudes 36°49'161''N, 35°52'134''E. Monthly surveys (July 2014-June 2015) were conducted with a deep trawl net for 45 minutes in three different tree trassects (0-10m (36°43' 928'' N - 35°42' 754'' E; 36°45' 250'' N - 35°41' 208'' E), 10-20m (36°41' 195'' N - 35°42' 484'' E; 36°38' 955'' N - 35°40' 878'' E) and 20-50m (36°40' 300'' N - 35°43' 181'' E; 36° 41' 736'' N - 35°45' 823'' E)). The species obtained were measured for total length (TL), disc length (DL), disc width (DW), nose to eye (NE), mouth width (MW), and nose to mouth (NM) to the nearest 0.5 cm immediately after capture and were weighed (Weight, W: ±1.0 g). Disc width (DW) was used instead of total length (TL) because of the breakage of their tails during hunting during the growth studies made with the ray individuals (Girgin and Basusta 2016; Parsons *et al*. 2018). In this context, DW was used in the study and the tail was not taken into account in the total length measurements. The TL-W and DW-W relationships were determined according to the equation given by Sparre and Venema (1992), Where $W = a*TL^b$ and $W= a*DW^b$, respectively. In the age determination, the Electronic Length Frequency Analyzes (ELEFAN) method was applied to indirect age determination methods (Hemida *et al.* 2016; Haihua and Yanping *et al.* 2017). In the application of length-frequency analysis and other specified equations, the package program FAO-ICLARM Stock Assessment Tools (FISAT I), which includes the ELEFAN program, was used (Gayanilo *et al*. 1995).

Growth parameters (K) and length infinity (DW∞) were estimated using the ELEFAN I module of FISAT-II software. The von Bertallanffy growth coefficients were estimated from the length-frequency analysis with the assistance of the equation:

$$DW_t=DW\infty*[1-e^{(-k(t-t_0)\ -(CK/2\pi(\sin(2\pi(t-t_s)))}]$$

Where D_t is the length at age t, the DW∞ parameter is known as the asymptotic length, K is the growth coefficient C is a parameter that exposes the intensity of the seasonal growth oscillation ($0<C<1$), and t_s is the start of sinusoid growth, and where growth is slowest (*WP*). The ELEFAN estimates only two-growth parameters DW∞; K respectively.

The theoretical age parameter (t_0) was estimated using the empirical equation:

Log $(-t_0)$= - 0.3922-0.2752 Log (DW∞) - 1.038 log K as proposed by (Pauly 1984)

Where: DW∞ = asymptotic length

K = coefficient of growth

t_0 = theoretical age at zero length

Sea surface temperatures (SST) were measured with a probe of YSI® model (±1°C).

For estimating the total mortality (*Z*) length-converted catch curves were developed from the length frequencies (Gayanilo *et al*. 1995). Natural mortality (*M*) was calculated using Pauly's formula (Pauly *et al.* 1984).

Log M= (0.0066) - 0.279 logDW∞ + 0.643logK + 0.463logT (T temperature)

The exploitation rate (E) was computed from E=F/Z (Sparre and Venema 1992).

RESULTS AND DISCUSSION

In total, 284 spiny butterfly rays were measured for the morphometric characteristics of *G. altavela* in the habitats located in the northeastern Mediterranean. An independent t-test (H_0: $\mu_M= \mu_M$) with a ±95% confidence level (α=0.05) was applied to confirm whether the mean values of the morphometric characters were significantly different between males and females. All *P* values were zero and < 0.05. Apart from the observed variability, species differences in the morphometric (TL, W, DL, DW, NE, NM, MW) means were significantly different between the sexes (Fig1).

In this study, the graphs show that there is a strong linear relationship between all morphometric TL-DL, TL-DW, TL-NE, TL-NM, and TL-MW. The strongest relationship is between TL-DL and TL-DW sex groups.

The total length of all individuals was in the range 17.70-92.90cm. Furthermore, the 150 females (52%) ranged 19.90-92.40cm TL, and the 134 males (48%) ranged from 17.7-76.5cm (Fig 2).

Fig 3 shows the relationships between total length (cm) and total weight (g) values for all samples.

The length-weight relationship among the butterfly rays is as given in Fig 3. Analysis of the length-weight relationships of female, male, and both sexes showed an allometric growth pattern.

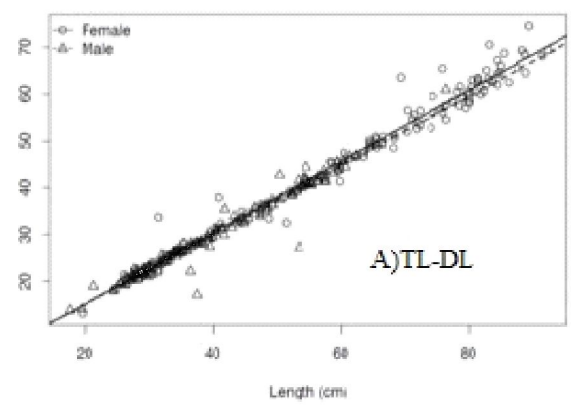
The monthly length-frequency distribution and the von Bertalanffy's DW growth curves for sexes of *G.altavela* are as given Fig 5.

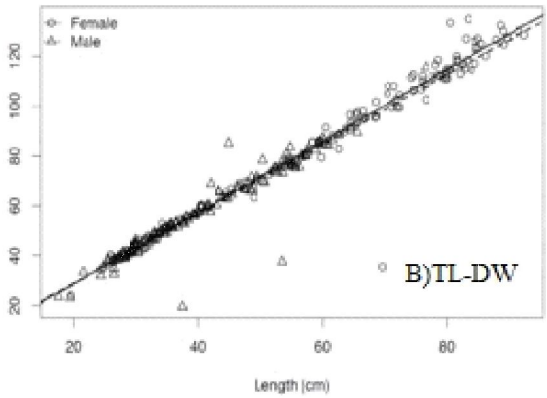
As seen in Fig 4, the DW frequency distributions of total individuals clearly show that new participation in the stock started in June and that three formations were added to the stock.

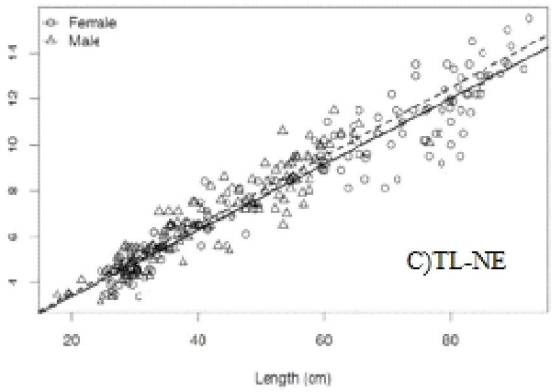
The von Bertalanffy growth equation was used to calculate the growth parameters in a dataset of 284 for each sex and combined data (Table 1).

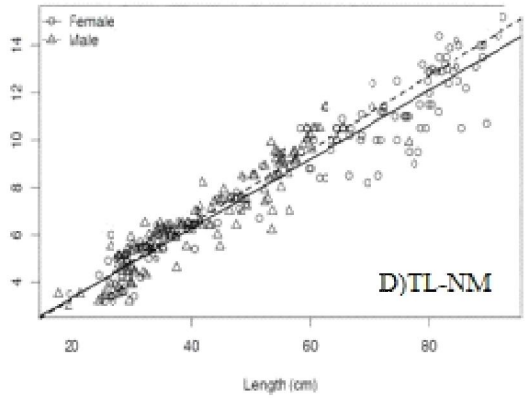
The asymptotic length (DW∞) values were 136.25cm for males and 131.25cm for females. The DW∞ was higher for females than males (Table 1).

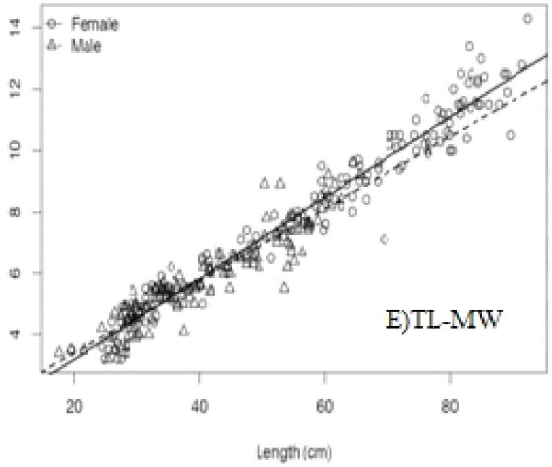
The total mortality rates (*Z*), natural mortality rates (*M*), and fishing mortality rates (*F*) are given in Fig 6 as totals and for both sexes separately.











A) $y=0.739X+0.258$ $R^2=0.958$ (M)
$y=0.760X+0.075$ $R^2=0.982$ (F)

B) $y=1.395X+1.002$ $R^2=0.976$ (M)
$y=1.442X-0.222$ $R^2=0.988$ (F)

C) $y=0.144X+0.532$ $R^2=0.858$ (M)
$y=0.149X+0.543$ $R^2=0.925$ (F)

D) $y=0.157X+0.149$ $R^2=0.871$ (M)
$y=0.146X+0.400$ $R^2=0.925$ (F)

E) $y=0.118X+1.030$ $R^2=0.883$ (M)
$y=0.131X+0.544$ $R^2=0.955$ (F)

Fig 1: Regression relationships plots and formulas.

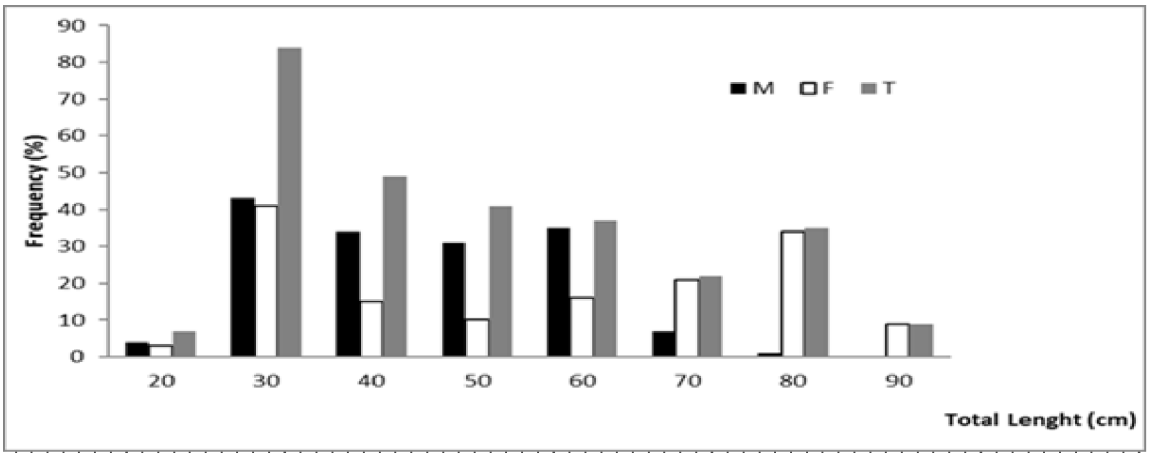


Fig 2: Length frequency distribution for *G .altavela.*

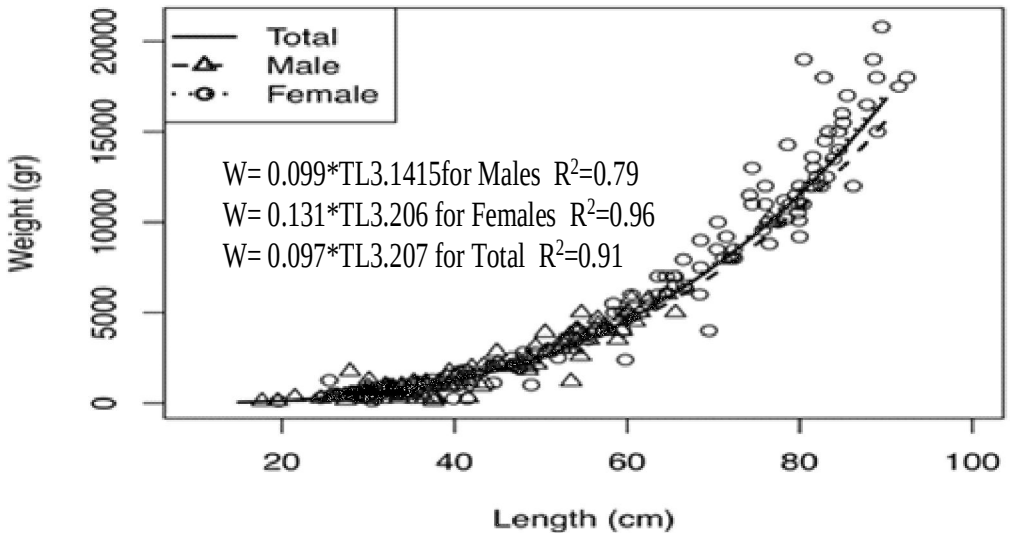


Fig 3: The length-weight relationships of each sex and their totals for *G. altavela*.

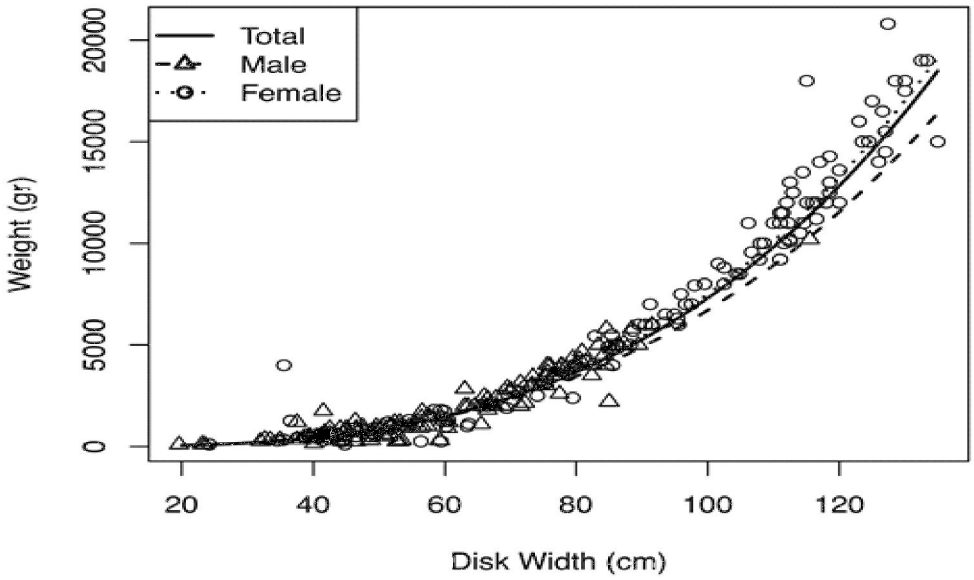


Fig 4: Disc width-weight relationships for each sex and their total.

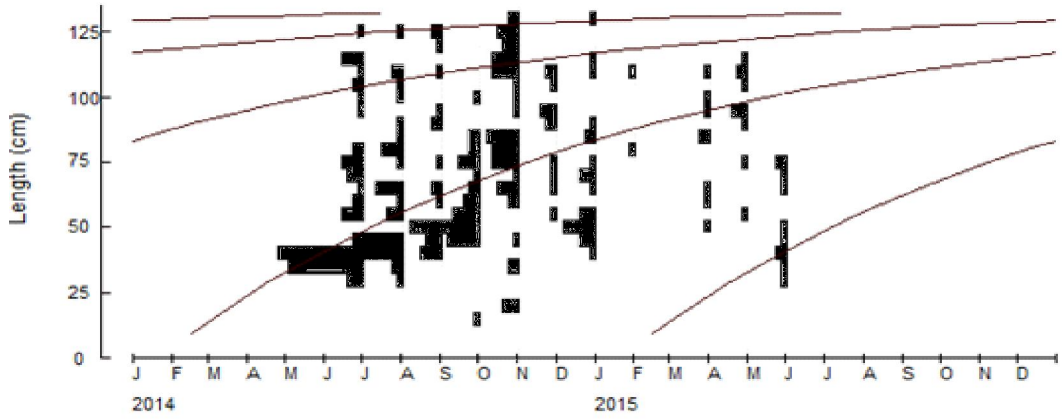


Fig 5: The monthly length-frequency distribution and the von Betalanffy's DW growth curves for combined sex.

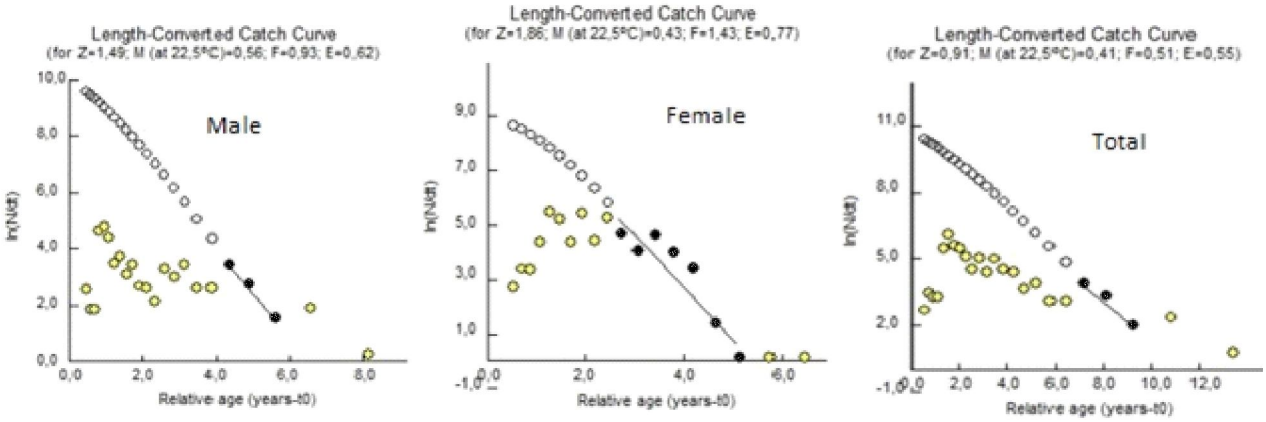


Fig 6: Mortality rates (year^{-1}) and explotation for each sex and their totals.

Table 1: The von Bertalanffy growth parameters for *G. altavel*a from length data of males and females as well as both sexes combined.

Sexes	von Bertalanffy growth constants for sexes					
	DW∞	**K (year)$^{-1}$**	**C**	**WP**	**t_0(year)$^{-1}$**	**R_n**
Males	131.25	0.250	0.00	0.00	-0.491	0.325
Females	136.25	0.380	0.00	0.00	-0.580	0.546
Total	136.25	0.230	0.00	0.00	-0.728	0.492

As can be seen in Fig 6, death rates from natural causes for females (0.43 year^{-1}) and the total (0.41 year^{-1}) were similar, while that for males (0.56 year^{-1}) was found to be higher. While all death rates were high for female individuals; they were found to be lower in male subjects. The levels of exploitation for both sexes and their totals were determined to be greater than the ideal level of stock retention E= 0.5 year^{-1}.

This study, determined that *G. altavela* female individuals were larger than males in both size and weight. The observed, species differences in the morphometric (TL, W, DL, DW, NE, NM, MW) mean was significantly different between the sexes. In Elasmobranchs, the sexes were different from each other and females were usually bigger. Alkusairy *et al*. 2014; As reported by researchers such as Ozbek *et al*. 2016 and Parsons *et al*. 2018, it is obvious that there is sexual dimorphism in individuals. The morphometric analysis of fish is an important aspect in the study of their biology (Qadri *et al*. 2017; Sangün and Güney, 2017).

In previously performed studies, the DW lengths (min-max) for the total individuals varied in the range 20-217cm (Wigley *et al* 2003), 30-127cm (Başusta *et al*. 2012), 39-165cm (Ozbek *et al*. 2016) are were measured as 19.60-135cm in this study. Parsons *et al*. (2018) examined and found western North Atlantic coasts and found DW∞ =128.54cm for males and DW∞=217.35cm for females, while this study determined DW∞=131.25cm for males and DW∞=136.25cm for females. Upon comparing these values, it was determined that DW∞ of male individuals was smaller than the DW∞ of female individuals. Table 2 presents the

Table 2: The length-weight achieved from various regions.

Sexes	a	b	R^2	Area	Autor	Growth type
M+F	0.364	3.306	0.99	Northeast coast of the United States	Wigley *et al.* 2003	Allometric (+)
M+F	0.127	3.178	0.99	Northeast coast of the United States	Wigley et *al.* 2003	Allometric (+)
M+F	0.027	2.960	0.98	North Aegen Sea	Filiz and Bilge 2004	Isometric
M	0.006	3.358	0.97	Cilician coast basin Northeaster Mediterranean	Yeldan and Avşar 2007	Allometric (+)
F	0.001	3.208	0.97	Cilician coast basin Northeaster Mediterranean	Yeldan and Avşar 2007	Allometric (+)
M+F	0.009	3.234	0.98	Cilician coast basin Northeaster Mediterranean	Yeldan and Avşar 2007	Allometric (+)
M	0.017	2.794	0.73	East coast of Iskenderun Bay	Başusta *et al.* 2012	Isometric
M+F	0.147	3.090	0.98	North Aegen Sea	Akalın *et al.* 2015	Allometric (-)
M	0.099	3.145	0.91	Levant basin coast water (Northeastern Mediterranean)	This study	Allometric (+)
F	0.173	3.206	0.94	Levant basin coast water (Northeastern Mediterranean)	This study	Allometric (+)
M+F	0.097	3.2070	0.90	Levant basin coast water (Northeastern Mediterranean)	This study	Allometric (+)

b values reported by various researchers for length and weight are given in Table 2.

Table 2, clearly shows that the dimension to weight relationship constant b varies in the range between 2.794-3.358. In similar studies performed by researchs, Filiz and Bilge 2004; and Başusta *et al*. 2012 demonstrated negative allometric growth while others demonstrated pessimistic allometric growth and the study by Akalın *et al.* (2015) demonstrated isometric growth. It is thought that the differences in the studies may have been caused by several factors such as the working region, water temperature, salinity, amount of food, sex and maturity period (Pauly 1984).

Yeldan (2005) in Iskenderun and Mersin Bays (Northeastern Mediterranean) demonstrated that respective death rates for males, females, and their totals were 0.27 $year^{-1}$ 0.30 years and 0.29 $year^{-1}$ in total deaths (Z). These were respectively 0.11 $year^{-1}$, 0.16 $year^{-1}$, and 0.13 $year^{-1}$, for the fishery cause (F); and respectively 0.41 $year^{-1}$, 0.53 $year^{-1}$ and 0.45 $year^{-1}$,for stock benefit (E). The mortality rates for males, females, and their totals in this study were respectively 1.49 $year^{-1}$, 1.86 $year^{-1}$ and 0.91 $year^{-1}$ for the total death (Z), and deaths with natural causes (M) were 0.56 $year^{-1}$, 0.43 $year^{-1}$ and 0.41 $year^{-1}$, respectively; 1.93 $year^{-1}$, 1.43 $year^{-1}$, and 0.51 $year^{-1}$, respectively, for the fishery cause (F) and 0.62 $year^{-1}$, 0.77 $year^{-1}$ and 0.55 $year^{-1}$, respectively for stock benefit (E). Compared with other studies, it can be said that the *G. altavela* population in the Northeastern Mediterranean has been exploited extensively between 2005 and 2018.

Thus, adequate information about chondrichthyan populations, lack of research, and the data are in question. In this context, more research is needed on the populations of these species. In this study, population dynamics parameters such as growth, mortality and stock the benefit level of *G. altavela* in the Levant Basin (northeastern Mediterranean) were estimated. Thus, these parameters are considered to contribute to sustainability and future research.

REFERENCES

Akalın, S., İlhan, D., Özaydın, O. (2015). Length-weıght relatıonshıps for 30 demersal fısh specıes from çandarlı bay (north aegean sea, turkey). C*roatian Journal of Fisheries, 2015, **73**, 73 – 76*

Alkusairy, H., Ali, M., Saad, A., Reynaud, C., Capapé, C. (2014). Maturity, reproductive cycle, and fecundity of spiny butterfly ray, *Gymnura altavela* (Elasmobranchii: Rajiformes: Gymnuridae), from the coast of Syria (Eastern Mediterranean). *Acta Ichthyologica et Piscatoria **44** (3): 229-240.*

Başusta, A., Başusta, N., Sulikowski, J.A., Driggers, W.B., Demirhan, S.A., Cicek, E. (2012). Length–weight relationships for nine species of batoids from the Iskenderun Bay, Turkey. *Journal of Applied Ichthyology **28**(5): 850-851*.

Başusta, N., Erdem, Ü. (2000). A study on the pelagic and demersal fishes of Iskenderun Bay. *Turkish Journal of Zoology **24**: 1-19.*

Bauchot, M.L. (1987). Raies et autres batoides. In: Fiches FAO d'identificationpour les besoins de la pêche. (rev. 1). (eds.,W. Fischer, M.L. Bauchot and M. Schneider). Mèditerranée et mer Noire. Zone de pêche 37. **Vol. II.** Commission des Communautés Européennes and FAO, Rome, pp. 845-886.

Eronat, E. G. T., Özaydın, O. (2014). Length-weight relationship of cartilaginous fish species from Central Aegean Sea (Izmir Bay and Sığacık Bay). *Ege J Fish Aqua Sci* 31*(3): 119-125.*

Filiz, H., Bilge, G. (2004). Length–weight relationships of 24 fish species from the North Aegean Sea, Turkey. *Journal of Applied Ichthyology, **20** (5), 431-432.*

Gayanilo, F.C., Sparre, J.R. and Pauly, D. (1995). The FAO-ICLARM stok assessment tools (FISAT) User's Guide. FAO Computerized Information Series (Fisheries) No: 8. Rome, FAO, 126P.

Girgin, H., Baºusta, N. (2016). Testing staining techniques to determine age and growth of Dasyatis pastinaca (Linnaeus, 1758) captured in Iskenderun Bay, Mediterranean. *J. Appl. Ichthyol. 32(3):* 595-601.

Haihua, W.B and Yanping, Z. H. F. (2017). Estimating some population parameters and stock assessment of Dark Sleeper *Odontobutis potamophila* in the Gaosha River, Wuyuan County, Jiangxi Province, China. *Indian J. Anim. Res.*, DOI: 10. 18805/ijar.v0iOF.9113.

Hemida, F., Filali, T and Capape, C. (2016). analyse des structures de taille de *Squalus blainvillei* (chondrichthyes: squalidae) dans la région est du bassin algérien. Rapp. Comm. int. Mer Médit., 41, 2016.

IUCN,. (2013). The IUCN Red List of Threatened Species. Version 2013. 2. http://www.iucnredlist. org Downloaded on 21 November 2013.

Ozbek, E.O, Çardak, M., Kebapçıoğlu, T. (2016). Spatio-temporal patterns of abundance, biomass and length-weight relationships of *Gymnura altavel*a (Linnaeus, 1758) (Pisces: Gymnuridae) in the Gulf of Antalya, Turkey (Levantine Sea). J. *Black Sea/ Mediterranean Environment*, Vol. **22**, No. 1: 16-34.

Parsons. K.T., Maisano.J., J. Gregg., C., Cotton C.F and R. J. Latour.R.J. (2018). Age and growth assessment of western North Atlantic spiny butterfly ray *Gymnura altavel*a (L. 1758) using computed tomography of vertebral centra. *Environ Biol Fish* 101:137–151 https://doi.org/10.1007/s10641-017-0687-x.

Pauly, D. (1984). Fish Population Dynamics in Tropical Waters: a Manual for Use with Programmable Calculators. ICLARM Studies and Reviews 8. International Center for Living Aquatic Resources Management, Manila, Philippines, 325 pp.

Qadri, Sauliheen., Shah, Tasaduq H., Balkhi, M. H., Bhat, Bilal., Bhat, F., Najar, A. M., Asmi, Oyas., Farooq, Iram., Alia, Syed. (2017). Morphometrics and length-weight relationship of *Schizothorax curvifrons* Heckel 1838 in River Jhelum, Kashmir, India. *Indian J. Anim. Res., **51** (3) 2017: 453-458.*

Sangün, L., Güney .O.İ. (2017). Application of multiple regression analysis to morphometric characters obtained from Serranus cabrilla (Linnaeus, 1758) by using stepwise method. *Indian J. Anim. Res*., DOI:10.18805/ijar.v0iOF.9147.

Serena, F., Barone M., Mancusi C. and Abella A.J. (2005). Reproductive biology, growth and feeding habits of *Raja asteria*s (Delaroche, 1809), from the North Tyrrhenian and South Ligurian Sea (Italy), with some notes on trends in landing. Theme Session on Elasmobranch Fisheries Science CM2005/N:12. 2005 ICES Annual Science Conference 20–24 September 2005.

Sparre, P., Ursin, E., Venema, S. C. (1992). Introduction to Tropical Fish Stock Assessment, Part I, Manual. FAO Fisheries Techn Paper No. 306, 337pp.

Wigley SE, Mc Bride HM, McHugh NJ. (2003). Length-weight relationships for 74 fish species collected during NEFSC research vessel bottom trawl surveys, 1992-9. NOAA Tech Memo NMFS NE 171; 26 p

Yeldan, H. (2005). Identification of bioecological, characteristics of some rays caught (*Raja clavata* (Linnaeus, 1758) *Raja asterias* (Delaroche, 1809), *Raja radula* (Delaroche,1809), *Dasyatis pastinaca* (Linnaeus, 1758), *Gymnura altavel*a (Linenaeusi 1758) from Iskenderun and Mersin bays. Sc. thesis. Cukurova Universty Instıtute of Natural and Applied Science University of Cukurova¨.

Yeldan, H., Avşar, D. (2007). Length–weight relationship for five elasmobranch species from the Cilician Basin shelf waters (Northeastern Mediterranean). *Journal of Applied Ichthyology* **23** (6): 713-714.

Yeldan, H., Avşar, D., Mavruk, S., Manaşırlı, M. (2013).Temporal changes in some Rajiformes species of cartilaginous fish (Chondrichthyes) from the west coast of Iskenderun Bay (northeastern Mediterranean). *Turkish Journal of Zoology* **37**(6): 693-698.

Yemişken, E., Dalyan, C., Eryılmaz, L. (2014). Catch and discard fish species of trawl fisheries in the Iskenderun Bay (Northeastern Mediterranean) with emphasis on lessepsian and chondricthyan species. *Mediterranean Marine Science* **15**(2): 380-389.