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ORIGINAL RESEARCH ARTICLE

Growth and exploitation rate of Common cuttlefish, *Sepia officinalis* in Ghanaian Coastal Waters

Samuel K.K. Amponsah

Department of Fishereies and Water Resources, University of Energy and Natural Resources, Sunyani, Ghana

*Corresponding author: *samuel.amponsah@uenr.edu.gh*

ABSTRACT

This study presents a preliminary assessment of growth and mortality parameters for *Sepia officinalis* along the coasts of Tema, Sakumono, and Ningo-Prampram, Ghana. A total of 264 specimens were randomly purchased from fishermen between January and December 2020. Samples obtained were measured for mantle length and analyzed for growth and exploitation rates using TropFishR software. Mantle length ranged from 3 cm to 26.7 cm, with a mean of 12.4 ± 0.4 cm. Mantle length–frequency data fitted to the von Bertalanffy Growth Function yielded an asymptotic length (Linf) of 30.23 cm, a growth coefficient (K) of 0.57 $year^{-1}$, and a longevity of 5.0 years. Mortality estimates showed a total mortality rate (Z) of 1.14 $year^{-1}$, a natural mortality rate (M) of 0.89 $year^{-1}$, and a fishing mortality rate (F) of 0.25 $year^{-1}$, with an exploitation rate (E) of 0.22. The lower fishing mortality rate reflects low commercial demand for *S. officinalis* among artisanal fisherfolk in Ghana. The exploitation rate shows that the species along Ghana's coast is underexploited, though at a sustainable level. Nevertheless, as a precautionary management measure, fishing effort should be monitored to ensure that biological reference points for sustaining this species are not exceeded.

Keywords: *Cuttlefish, exploitation, Fisheries management, growth, mortality*

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INTRODUCTION

Cephalopods (Mollusca) are key ecosystem components of the World Ocean (e.g., Gasalla et al., 2010) because they occupy varying trophic positions in marine food webs and have a high production-to-biomass ratio (Bobowski et al., 2023). Cephalopod species diversity is relatively low, with about 800 pelagic and demersal species belonging to three main Orders: Teuthida (squid), Octopoda (octopuses), and Sepiida (cuttlefish and sepiolids). They have short lifespans, high metabolic rates, and rapid growth. Their growth rates, maturation, and life-cycle phenology vary widely (Vidal, 2014). Although much of this variation seems environmentally influenced, it also reflects phenotypic plasticity and possibly a genetic component (McKeown et al., 2019). As such, cephalopod abundance and distribution can vary widely year to year. Cephalopoda is the most advanced class of the phylum Mollusca adapted to a swimming existence (Luna et al., 2021). They are entirely marine, vary in form, size, and nature (Vidal and Shea, 2023), and occur in littoral, benthic, and pelagic environments in all world oceans.

Cephalopods are important as a food resource and for scientific investigation (Lefkaditou et al., 2003). Research on cephalopods is important for conservation because relatively little is known about their life history, development, and reproductive behaviour, particularly in deep-ocean species (Villanueva et al., 2016). Knowledge of their abundance and distribution is fundamental not only for fisheries but also for understanding their significance in energy and material flow in marine ecosystems (Piatkowski et al., 2001). They are abundant predators which are large, active, and voracious; conversely, they are essential as prey for many marine mammals, birds, and fishes, including economically important species. The life cycles of commercially exploited cephalopod species range from 6 months in small sepiolids and subtropical squids (Czudaj et al., 2012) to 2 years in the large-sized squids (Arkhipkin et al., 2021), large temperate sepiids (*Sepia officinalis*, Challier et al., 2005), and octopods (*Octopus tetricus*, Leporati et al., 2015). The short lifespan is a unique feature of tropical squids. Cephalopods contribute about 2.5% of global seafood production, with landings increasing by about 416% since 1961, peaking at nearly 4.9 million tonnes in 2014 before declining to about 3 million tonnes in 2019 (Ospina-Alvarez et al., 2022).

One of the most prevalent cephalopod genera in Africa is *Sepia*, distributed from Morocco to Namibia, with abundance varying by environmental conditions, population structure, and habitat (Djan et al., 2022). The common cuttlefish has a large head with relatively large eyes. The front of the head is tipped with eight arms and two tentacles, positioned radially around a forward-positioned mouth. The arms have rows of suckers, while the tentacles have suckers at their ends (Kimbara et al., 2022). The mouthparts form a structure resembling a bird's beak; directly behind the head is an oval-shaped body, fringed with a single fin on each side. The cuttlefish's skeletal mass consists of a single internal 'cuttlebone'. The cuttlebone is a porous structure made predominantly of aragonite, a type of calcium carbonate. The cuttlebone is important not only for structure but also for maintaining buoyancy (Arkhipkin et al., 2021). Despite their strong reliance on visual stimuli and high visual acuity, several studies have shown that cuttlefish are colour blind (Mäthger et al., 2006). Cuttlefish primarily propel themselves by pushing water out through their siphon (Mouritsen and Styrbæk, 2021). The siphon is a protruding tube structure situated beneath the head at the front of the body (Goulet et al., 2026). Cuttlefish control their vertical position by moving gas into and out of the internal cuttlebone, which affects buoyancy and position within the water column (Bloor et al., 2013). Common cuttlefish are intermittent terminal spawners; spawning occurs during the latter stages of their lives (Rocha et al., 2001). Females typically stop feeding during this time and do not grow somatically (Jahan and Mahmud, 2025).

After laying several batches of eggs over a few months, breeding cuttlefish undergo mass mortality (Rocha et al., 2001). The diet of adult cuttlefish includes a wide range of organisms, including crustaceans, molluscs, polychaete worms, and bony fish. Cuttlefish often prefer crustaceans such as mysids, shrimps, prawns, and crabs. Sandeels and gobies are among the fish cuttlefish eat most often. The most abundant molluscs in the diet of *S. officinalis* are sepiolids and sepiids (squids). Cuttlefish frequently exhibit cannibalistic tendencies, and larger individuals will attack and consume smaller members of the same and closely related species. Juvenile cuttlefish diets include a high percentage of small crustaceans (Bloor et al., 2013).

The natural range of common cuttlefish extends across the northeastern Atlantic continental shelves, from southern Norway and northern England south to the coasts of Senegal. They also occur throughout the Mediterranean Sea (Bello et al., 2020). They occur atdepths ranging from 1–2 m to 200 m, although they are common above 100 m (Pérez-Losada et al., 2007). Cuttlefish do not inhabit water deeper than 200 m because pressure on the internal shell may cause it to implode (Ward and Boletzky, 1984). Cuttlefish can tolerate a range of salinities and occur in the brackish waters of coastal lagoons (Fernandes Guerreiro et al., 2023). Adult cuttlefish move toward their inshore breeding grounds in early spring, with one of the main triggers being sea temperature (Wang et al., 2003). The breeding season extends from April to July (Bloor et al., 2013; Wang et al., 2003).

Within West Africa, Ghana is recognized as one of the leading producers and exporters of cuttlefish to Asian markets (Djan et al., 2022). Cuttlefish are the most heavily harvested cephalopods in Ghana, particularly adults (Akwetey et al., 2025; Djan et al., 2022).The dominant cuttlefish species harvested includes *Sepia officinalis* (Denechaud et al., 2025). Both artisanal and industrial fishers target this species; artisanal fishers commonly use beach seines, gill nets, and hook-and-line (single or multiple), while industrial operators rely on demersal trawls (Akwetey et al., 2025). Local coastal consumption and supermarket distribution rely on traditional processing methods for *Sepia officinalis* such as frying, smoking, or freezing, whereas industrial catches are largely exported (Kwei and Ofori-Adu, 2005). Cephalopods are among the major exploited resources in Ghanaian fisheries (Djan et al., 2022). Cephalopods account for about 15–20% of total industrial landings, of which cuttlefish (*Sepia* spp.) make up about 80% (Djan et al., 2022).

Ghana ranks among the chief exploiters and exporters of cuttlefish to Asian and European markets. Many landed cuttlefish result from bycatch in multi-species bottom trawl fisheries (Djan et al., 2022). However, cuttlefish account for a large proportion of the total catch (Vargheese et al., 2026). Frozen cephalopods (octopus, cuttlefish, and squid) represent the second-largest export fish chain by quantity (about 3,000 t to the European market) (Failler et al., 2014). Trawl catches of *Sepia* dominate the cuttlefish fisheries in Ghanaian waters (Failler et al., 2014). Beyond these exploitations, information on *Sepia* is limited to basic biology and ecology, as reported in FAO manuals and ICES reports. However, cuttlefish catches along the Ghanaian coast declined from 5,500 tonnes in 2003 to 4,814 tonnes in 2023 (FAO, 2025), reflecting the decline in Ghana's capture fisheries (Owusu and Andriesse, 2020). Despite the marginal decline of *S. officinalis* following the overexploitation of marine capture fisheries (Asiedu et al., 2023), studies of population dynamics are essential for conserving this species along Ghana's coast.

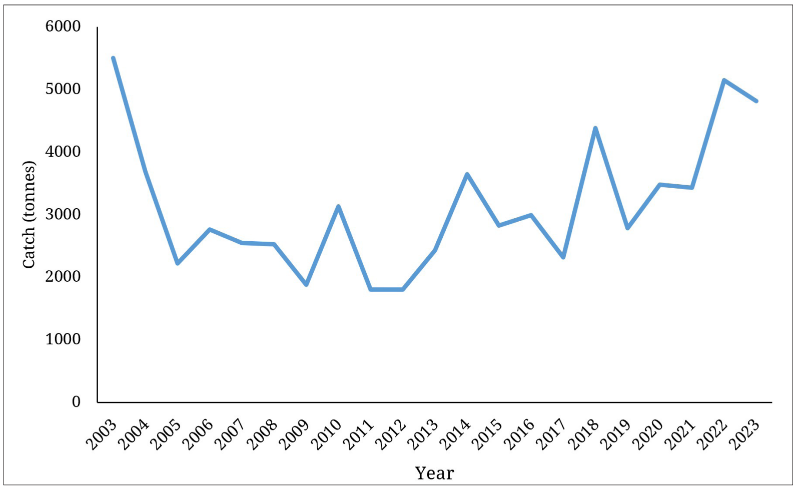

Figure 1. Catches of Cuttlefish from the coast of Ghana (2003 – 2023).

Population dynamics are the processes responsible for changes in a population's abundance or biomass over time and are a subset of possible population parameters (Anderson et al., 2008). Estimates of population dynamics can provide greater insight into fish populations than indices, which are a static portrayal of the population (Gebremedhin et al., 2021). Population dynamics estimates can indicate how a population reached its current state and how it might change in the future. Fish growth rates are associated with mortality and recruitment rates. Growth rate influences survival and age at sexual maturity (Weinstein et al., 2019). Fish growth is commonly indexed using coefficients of the von Bertalanffy growth model, which is widely used to describe the lifetime pattern of somatic growth in organisms such as fish with indeterminate growth (Lugert et al., 2016).

Mortality rates are important to fishery scientists in determining fish population dynamics (Shishitu, 2023). The total mortality coefficient (Z), natural mortality (M), fishing mortality (F), and the exploitation ratio (E) are vital for determining fishery status. These parameters are also used to establish the level of exploitation (Enin et al., 1996); therefore, we estimated Z, M, F, and E for the samples collected during the study. Mortality can result from several factors, including age, disease and pollution, predation, spawning stress, and lack of food (Punt et al., 2021). The exploitation ratio (E) helps assess whether a stock is overfished (high E-values), assuming the optimal value of E (Eopt) is about 0.5. This 0.5 value for Eopt assumes that sustainable yield is optimised when F = M (Gulland, 1971).

However, studies on cuttlefish population dynamics, particularly growth and mortality parameters, remain rarely explored in Ghana (Djan et al., 2022). The absence of robust scientific data poses a considerable risk of ineffective resource management for *S. officinalis*, potentially leading to population decline and severe economic repercussions for both local communities and the national economy (Mehanna and Makky, 2020). Accordingly, this study aimed to assess the growth, mortality, and exploitation rate of *S. officinalis* in Ghanaian coastal waters. The findings provide preliminary insights that can inform sustainable management of the species in Ghana.

MATERIALS AND METHODS

Description of the study area

The study selected three coastal fishing communities in Ghana's Greater Accra Region. We selected the three coastal fish landing sampling sites based on fishing activity levels and geographic isolation. These three coastal fish landing sampling locations were Sakumono, Tema, and Ningo-Prampram (Figure 2). Ningo-Prampram District is the largest in the Greater Accra Region, Ghana, with a coastline stretching over 37 km and a total land area of 1,442 km2. It is located at 5°42'53.75"N, 0° 7'55.24" E. The district's main occupations are salt mining and fishing. Anchovies (*Engraulis encrasicolus*), Sardinellas (*Sardinella aurita*), and mackerel (*Caranx chrysos*) are the major fish species caught in this district. Fishermen in Ningo-Prampram use purse seines, lines, and set nets (Dovlo et al., 2016). Tema is the administrative capital of the Tema Metropolitan Assembly and is located 25 km east of Accra, the national capital. It is located at 5°38'34.65"N, 0°1'4.76" E. Main occupations include commerce, tourism, hospitality, and fishing. At the Tema fishing community, several fish species belonging to various families, such as the Anchovy (*Engraulis encrasicolus*), Sardinella (*Sardinella aurita*), Bumper (*Chloroscombrus chrysurus*), Frigate Mackerel (*Caranx hippos*), and Chub Mackerel (*Scomber colias*), are landed in Tema due to its major infrastructure and proximity to the capital. Sakumono is a coastal community along Ghana's Accra-Tema coast. The Sakumono landing beach is located at (5°36'40.87"N, 0° 2'40.61" W). At Sakumono, species landed include Bigeye grunt, Lesser African threadfin, and others. The Sakumono fishing community uses lines, set nets, and beach seines (Dovlo et al., 2016). Most inhabitants in the three selected sampling sites rely primarily on fishing, along with other activities related to post-harvesting wild fish.

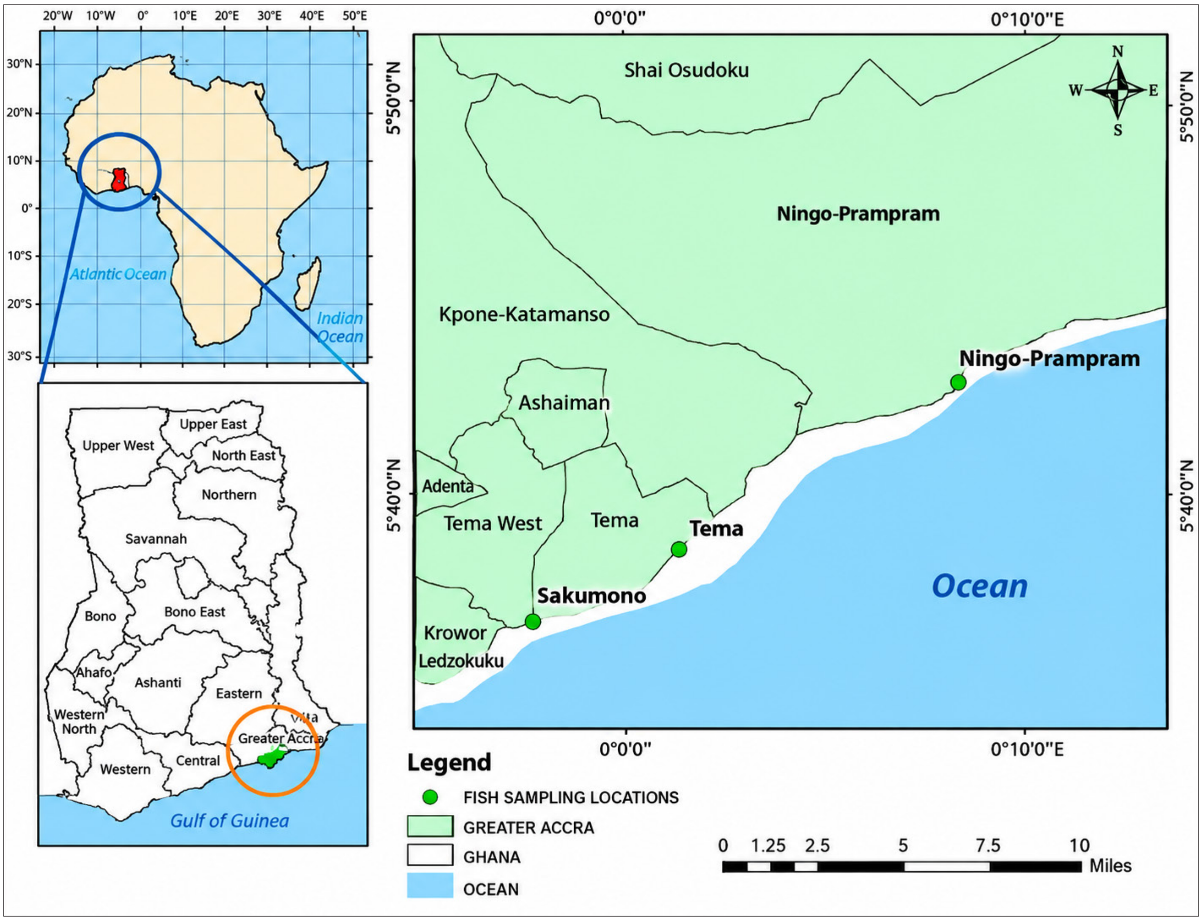

Figure 2. Map showing the fish sampling locations for the study.

Data Collection

The author purchased *Sepia officinalis* samples monthly from fishermen along the coast at the three sampling locations. The collected 264 specimens from January to December 2020, measured mantle length to the nearest 0.1 cm, and recorded body weight to the nearest 0.1 g. We identified all samples to species level using the identification key by Kwei and Ofori-Adu (2005). The measured mantle length and body weight using a 100 cm graduated measuring board and an electronic weighing scale. Figure 3 shows the number of specimens and corresponding average weight sampled from each of the three fish sampling locations each month.

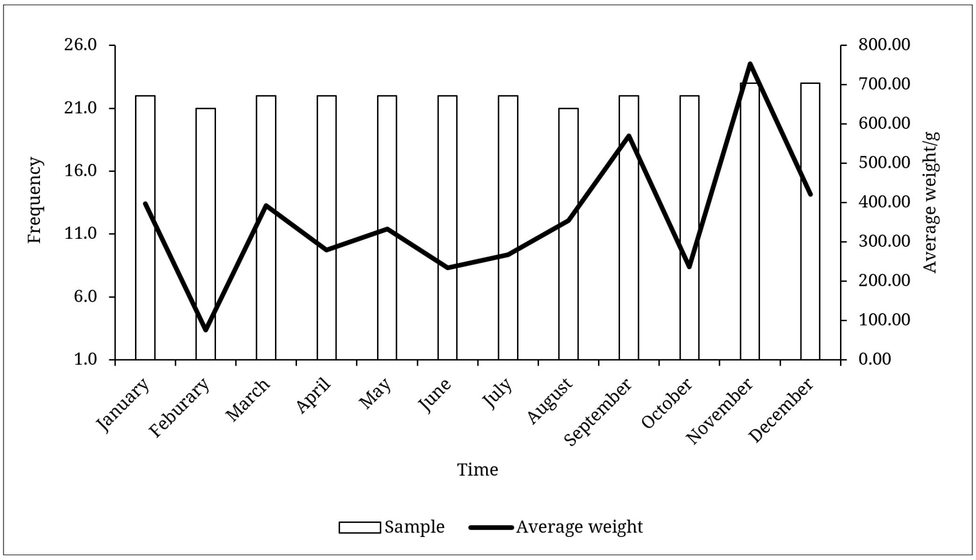

Figure 3. Number of specimens and corresponding average weight sampled monthly between January and December, 2020 from the coast of Ghana.

Methods

Growth parameters

We estimated growth parameters using the von Bertalanffy Growth Function (VBGF) with Electronic Length Frequency Analysis (ELEFAN). We used ELEFAN_SA to optimise all parameters simultaneously; it uses simulated annealing and is preferable to exact algorithms. We conducted a sensitivity analysis to evaluate the accuracy of VBGF parameter estimates using a moving-average setting and a fixed Linf (Zhou et al., 2022).

The von Bertalanffy Growth Function (VBGF) is given as follows:

$$L_t = L_{inf} [1- e^{-K (t- t0)}] \text{ (Pauly, 1984),}$$

where Lt is the average length at time (or age) t, Linf is the asymptotic length, K is the growth rate, and t represents the age when the average length was zero.

The theoretical age at length zero (t0) followed the equation:

$$Log_{10} (-t_0) = -0.3922 – 0.2752 \log_{10} L_{inf} - 1.038 \log_{10} K \text{ (Lessa and Duarte-Neto, 2004)}$$

Estimation of longevity (tmax) of the species was done using the formula:

$$3/K + t_0 \text{ (Anato, 1999)}$$

The growth performance index was calculated using the formula:

$$2\log_{10} L_{inf} + \log_{10} K \text{ (Pauly, 1998)}$$

Mortality parameters

The total mortality rate (Z) was estimated using the length-converted catch curve (Liang and Pauly, 2017). approach. This involved converting length-frequency data into a relative age-frequency distribution based on growth parameters. The regression line was fitted only to the descending right arm of the catch curve, with the length classes included in the regression being determined interactively (Mainguy and Moral, 2021). Smaller length groups which formed the ascending left arm of the catch curve were excluded (Sparre and Venema, 1999).

The natural mortality rate (M) was estimated using Then et al. (2015):

$$M = 4.118 \times K^{0.73} \times L_{inf}^{-0.33}$$

where Linf is the asymptotic length, M is the natural mortality and K is growth coefficient After M and Z were estimated, fishing mortality was determined employing the following relationship:

$$F = Z – M$$

where Z is the total mortality, F is the fishing mortality, and M is th e natural mortality.

The exploitation rate (E) was calculated by the Gulland (1971) formula:

$$E=F/Z.$$

RESULTS

Length distribution

The length–frequency distribution was unimodal, with one major peak; the modal size was 6.4 cm, and the mean, maximum, and minimum mantle lengths were 12.4 ± 6.8 cm, 26.7 cm, and 3.0 cm, respectively (Figure 4). The skewness of the distribution was 0.21, indicating approximately a normal distribution (Figure 4)

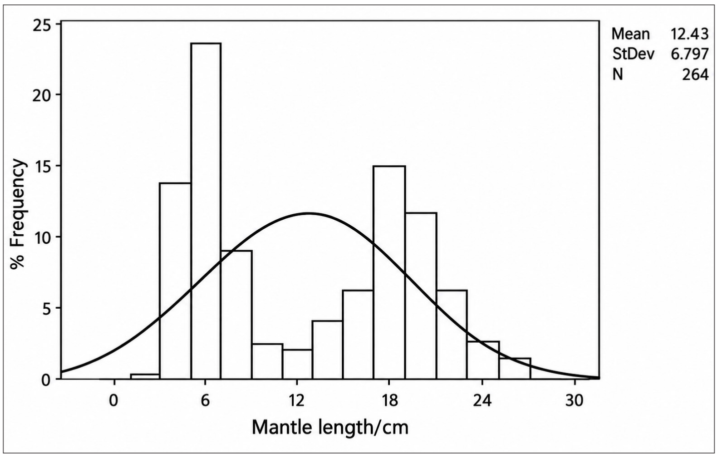

Figure 4. The bar chart shows the length–frequency of *Sepia officinalis* from the coast of Ghana.

Growth parameters

The estimated von Bertalanffy growth parameters were 30.23 cm TL for L∞ and 0.57 year−1 for growth coefficient K (Figure 5). The growth performance index was 2.72 with a goodness-of-fit value (Rn) of 0.40, which is considered a strong, highly acceptable fit between K and Linf (Mildenberger et al., 2017). The theoretical age at length zero was -0.29 years with a longevity of 5.0 years.

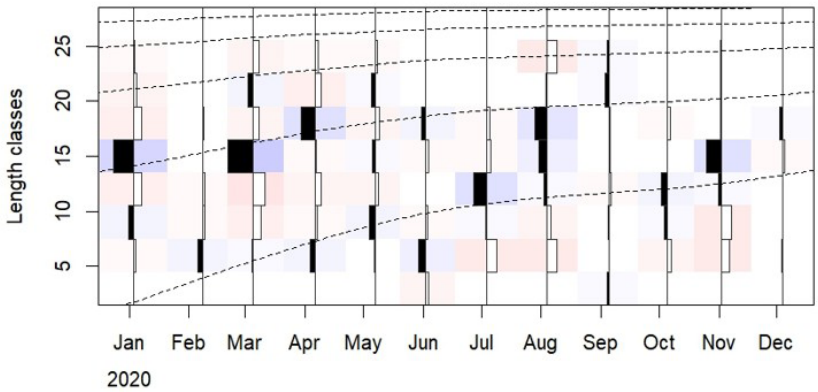

Figure 5. Reconstructed length frequency distribution of *Sepia officinalis* superimposed with growth curves.

Mortality and exploitation

Based on a linearised length-converted catch curve, we estimated total mortality (Z) at 1.14 ± 0.19 year^{-1} (Figure 6). We estimated natural mortality (M) at 0.887 year^{-1} and calculated fishing mortality (F) at 0.253 year^{-1}. The present exploitation rate (E) was 0.22.

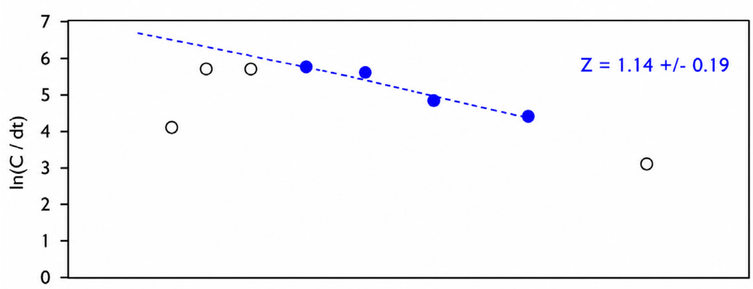

Figure 6. Linearized length-converted catch curve for estimating total mortality coefficient of *Sepia officinalis* from the coast of Ghana.

DISCUSSION

Scholars such as Bhendekar et al. (2018) have extensively examined the population dynamics of short-lived species, particularly squids and cuttlefish. Several factors strongly influence estimates of growth and natural mortality coefficients for tropical species, including short lifespan, multiple breeding seasons, and intra-annual variation in growth (Sparre and Venema, 1999; Pauly, 1980). Studies on the population dynamics of *Sepia officinalis* along the coast of Ghana are currently non-existent; therefore, we compared estimates from different geographical locations.

In the present study, mantle length ranged from 3.0 cm to 26.7 cm. This range was broader than that reported by Saddikioui et al. (2017; ML = 6.5–23.8 cm) and Yesilyurt et al. (2019; ML = 2.2–15.5 cm) from the coasts of Algeria and Turkey. Akyol et al. (2011) observed mantle lengths of 5.5-22.4 cm in Izmir Bay, while Duysak et al. (2014) reported 4.8–19.2 cm in

Iskenderun Bay. In the northern Adriatic Sea, Bettoso et al. (2015) documented mantle lengths spanning 3.5–18.0 cm. The size structure of *Sepia officinalis* observed in Ghana reflects a wider catch-length distribution and includes nearly all size categories, including juveniles. Comparatively, the wider mantle length range of cuttlefish sampled along the coast of Ghana may suggest reduced fishing pressure on the stock (Ostman et al., 2023).

The asymptotic length (Linf) represents the largest theoretical mean length that a species could attain in its habitat, given ecological peculiarities. At the same time, the growth coefficient (K) reflects the rate at which the species approaches this final size (Sparre and Venema, 1999). Comparing growth parameters across populations and species is essential in fisheries science and ecology for management and academic purposes (Taylor and Mildenberger, 2017). The growth rate and asymptotic length estimated in the present study were (K = 0.57 per year) and (Linf = 30.23 cm), respectively. The growth rate was comparable to the estimate by Mehanna and Haggag (2011) from the coast of Egypt (K = 0.58 per year), but lower than the values reported by Saddikioui et al. (2017; K = 0.68 per year) and Yesilyurt et al. (2019; K = 0.90 per year) from Algeria and Turkey. The asymptotic length obtained in this study exceeded estimates by Mehanna and Haggag (2011; 25.2 cm), Yesilyurt et al. (2019; 19.54 cm), and Saddikioui et al. (2017; 24.64 cm). These differences in asymptotic length may reflect variations in environmental conditions, fishing pressure, sampling methods, and the length classes obtained (Moreno et al., 2007). The growth rate fell within the range for fast-growing species, as defined by Amponsah et al. (2021), who reported fast growth as K > 0.5 per year. This suggests that the species sampled along the coast of Ghana exhibits intermediate growth characteristics. Fast growth combined with small asymptotic length indicates that species in these waters mature early and have short lifespans (Sparre and Venema, 1999). Sparre and Venema (1999) further noted that higher K values are linked to higher metabolic rates, which are highly influenced by temperature. Consequently, tropical species tend to exhibit higher (K) values than cold-water species. Growth parameter values may vary due to collection methods, stomach fullness, gonadal maturity, food availability, and spawning conditions (Ogunola et al., 2018). Environmental factors also play a significant role: differences in water temperature can affect cuttlefish growth and development, while pollution can increase mortality rates, lowering survival and altering population dynamics (Mustafa et al., 2024). Thus, differences in ecological conditions such as temperature regimes, pollution levels, and resource availability likely contribute to the observed variability in growth parameters across geographical locations (Huang et al., 2021).

The growth performance index (ϕ') is a useful tool for comparing the growth curves of different populations of the same species and/or different species within the same order (Valeri et al., 2016). The growth performance index (φ') in the current study was 2.72, similar to estimates by Mehanna and Haggag (2011; φ' = 2.57) and Yesilyurt et al. (2019; φ' = 2.53). The values reported by Sanreported79; ϕ' = 3.2) and ϕ' = 3.2 Amad et al. (2004; ϕ' = 3.00) ϕ' = 3.00 cfor *Sepia* in the Gulf of Aden and India, respectively. Abdul et al. (2012) emphasised that the index is ecosystem-dependent. Therefore, variation in ecological conditions across locations may have accounted for the observed differences, favouring this species' growth (Abdul et al., 2012; Yesilyurt et al., 2019). A higher growth performance index value indicates that fish can grow faster and larger (Pauly, 1980).

As a general rule, if Z/K = 1, the stock is considered mortality-dominated, whereas values less than 1 indicate growth dominance. In mortality-dominated populations, if Z/K ≥2, the stock is regarded as highly exploited (Azrie et al., 2026). The total mortality-to-growth ratio (Z/K = 2.00) further suggests that mortality processes dominated the population. The M/K ratio is commonly used to validate estimates of M and K obtained by different methods, and it typically ranges between 1 and 2.5 (Edmond et al., 2017). The M/K ratio obtained in the present study (1.65) falls well within this expected range.

In the present study, natural mortality (M = 0.94 year-1) exceeded fishing mortality (F = 0.38 year-1), which may suggest a stock imbalance. Natural mortality rates vary across life stages, with maximum values occurring during larval and juvenile phases and later in life, particularly after spawning (Lorenzen, 2022). In general, natural mortality remains relatively constant when species longevity is stable under natural conditions. Shorter lifespans are typically associated with higher natural mortality, especially among tropical species (Kenchington, 2014). Comparatively, the increased natural mortality may result from faster growth, cannibalism, and post-spawning mortality (Zhang and Megrey, 2006). Sparre and Venema (1999) noted that higher K values are linked to higher metabolic rates, which are temperature-dependent, with tropical species exhibiting higher K values than cold-water species.

Natural mortality contributed more to the total mortality rate (Z) than fishing mortality, indicating that naturally induced conditions were primarily responsible for population decline along the coast of Ghana (Campos et al., 2024). The fishing mortality rate estimated in this study was lower than the rate reported by Mehanna and Haggag (2011; F=0.73year−1), implying that fishing pressure on *S. officinalis* along the Egyptian coast is greater than in Ghanaian waters. Furthermore, because the natural mortality rate exceeded the fishing mortality rate in the present study, *S. officinalis* along the coast of Ghana may be underutilised. This may be due to the low-mobility fishing gear employed by local fishers.

Chakraborty et al. (2013) emphasised that equal rates of natural and fishing mortality denote a healthy stock. In the present study, the exploitation rate (E = 0.22) was lower than Mehanna and Haggag's estimate (2011; E = 0.71), supporting the assertion that *S. officinalis* along the Ghanaian coast is experiencing less fishing pressure. According to Gulland (1971), yield is optimised when F = M; therefore, when E > 0.5, the stock is considered over-fished. According to Choudhary et al. (2026), the optimal exploitation level for fish stocks is approximately 0.5, which is higher than the value estimated in the study. This suggests that the species in Ghanaian waters is underexploited. The exploitation ratio below 0.5 also suggests that the stock in Ghanaian waters is considered sustainable (Asiedu et al., 2023). The lower fishing mortality and exploitation ratio observed in the present study may signal low commercial demand for this species in Ghana. However, higher landings levels in previous years (Figure 1) may be partially attributed to increased fishing effort in the trawl fishery. This finding also implies that the current level of utilisation could be sustainable without disrupting population structure (Bramantio et al., 2026). Therefore, to improve exploitation of the sampled species, the length-at-capture should be revised and increased.

CONCLUSION

The current study assessed the mantle length frequency for growth and mortality rates of cuttlefish, *Sepia officinalis,* from the coast of Ghana. Species along the Ghanaian coast exhibited fast growth, with natural mortality as the primary contributor to population decline. In contrast, low fishing mortality and exploitation rates indicated reduced fishing pressure and underutilization of the species along the Ghanaian coast. As part of the recommendations, continuous monitoring of fishing effort, catch composition, size structure, and mortality indicators along the Ghanaian coast is essential. Relevant fishery managers should also implement stricter controls on discarding small fish, regulate by-catch, and enforce measures such as seasonal closures and appropriate mesh sizes. In addition, develop and promote specialised fishing gear among fishers who rely on cephalopods for their livelihood.

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AUTHOR CONTRIBUTIONS

SKKA: Conducted the fieldwork and curated the data; performed analyses and species identification; prepared the draft manuscript; revised manuscript drafts; and approved the final version for publication.

DECLARATION

Informed consent statement

Specimen collection did not require institutional animal ethics approval.

Conflicting of interests

The author has no conflict of interest related to this study.

AI Declaration

The authors declare that no Artificial Intelligence (AI) or AI-assisted technologies were used in the preparation of this manuscript.

REFERENCES

Abdul, W. O., Omoniyi, I. T., Akegbejo-Samsons, Y., Akinyemi, A. A., Agbon, A. O., and Adeosun, F. I. (2012). Management indicators and growth performance index of *Tilapia zillii* in a tropical coastal estuary. *Journal of Agricultural Science*, 4(11), 66. DOI:10.5539/jas.v4n11p66

Abdussamad, E. M., Meiyappan, M. M., and Somayajulu, K. R. (2004). Fishery, population characteristics and stock assessment of cuttlefishes, *Sepia aculeata* and *Sepia pharaonis* at Kakinada along the east coast of India. *Bangladesh Journal of Fisheries Research*, 8(2), 143-150.

Akwetey, M. F. A., Faseyi, C. A., Mensah, P. K., Abrokwah, S., Gator, G., Wiredu, G., and Pauly, D. (2025). Juvenile species in beach Seine bycatch along the Coast of Ghana: Any implications for fisheries? Marine Ecology,46(2), https://dx.doi.org/10.1111/maec.70014

Akyol, O., Tellibayraktar, B., and Ceyhan, T. (2011). Preliminary results on the cuttlefish, *Sepia officinalis*, reproduction in Izmir Bay (Aegean Sea). *Journal of Fisheries Sciences.com*, 9, pp. DOI: 10.3153/jfscom.2011015

Amponsah, S. K., Avornyo, S. Y., Ofori-Danson, P., Henneh, S. and Afranewaa, N. A. B. (2021). Assessing the population characteristics of Carangids in the coast of Ghana, West Africa. *Research in Marine Sciences* 6 (2), 965-976.

Anderson, C. N. K., Hsieh, C., Sandin, S. A., Hewitt, R., Hollowed, A., Beddington, J., May, R. M., and Sugihara, G. (2008). Why fishing magnifies fluctuations in fish abundance. *Nature*, 452 (7189), 835–839. https://doi.org/10.1038/nature06851

Arkhipkin, A. I., Hendrickson, L. C., Payá, I., Pierce, G. J., Roa-Ureta, R. H., Robin, J. P., and Winter, A. (2021). Stock assessment and management of cephalopods: advances and challenges for short-lived fishery resources. *ICES Journal of Marine Science*, 78(2), 714-730. https://doi.org/10.1093/icesjms/fsaa038

Asiedu, B., Iddrisu, S., and Failler, P. (2023). Yesterday, today, and tomorrow's fish consumption: Analysis of present and prospective fish consumption in Ghana by 2030.*Cogent Food & Agriculture*, 9 (1).doi.org/10.1080/23311932.2023.2224603

Azrie, N., Amin, S. N., Arshad, A., Kamarudin, M. S., Yusoff, F. M., and Majeed, S. (2026). Stock Assessment and Management Recommendations for the Sustainable Fishery of Tropical Shad (Terubok), Tenualosa toli, in Sarawak Waters, Malaysia. *Conservation*, 6(3), 110. https://doi.org/10.3390/conservation6030110

Bello, G., Andaloro, F., and Battaglia, P. (2020). Non-indigenous cephalopods in the Mediterranean Sea: A review. Acta Adriatica, 61(2), 113-134. https://doi.org/10.32582/aa.61.2.1

Bettoso, N., Borme, D., Faresi, L., Aleffi, I., Orlando-Bonaca, M., and Lipej, L. (2015). New insights on the biological parameters of the exploited cuttlefish *Sepia officinalis* L. (Mollusca: Cephalopoda) in the northern Adriatic Sea in relation to the main fishing gears employed. Mediterranean *Marine Science*, 17(1), 152–162. https://doi.org/10.12681/mms.1311

Bhendekar, S. N., Mohamed, K. S., Shenoy, L., Dineshbabu, A. P., Jayasankar, J., Jaiswar, A. K., and Chellappan, A. (2018). Spatial variability and abundance pattern of Indian squid off Maharashtra coast, India. *Journal of the Marine Biological Association of India*, 60(2), 47–52. https://doi.org/10.6024/jmbai.2018.60.2.2073-07

Bloor, I. S. M., Wearmouth, V. J., Cotterell, S. P., McHugh, M. J., Humphries, N. E., Jackson, E. L., Attrill, M. J., and Sims, D. W. (2013). Movements and behaviour of European common cuttlefish *Sepia officinalis* in English Channel inshore waters: First results from acoustic telemetry. *Journal of Experimental Marine Biology and Ecology*, 448, 19–27. https://doi.org/10.1016/j.jembe.2013.06.013

Bobowski, B. T. C., Power, A. M., Pierce, G. J., Moreno, A., Iriondo, A., Valeiras, J., Sokolova, I. M., and Oesterwind, D. (2023). Cephalopods, a gap in the European Marine Strategy Framework Directive and their future integration. *Mar. Biol.*, 170, 26. https://doi.org/10.1007/s00227-022-04148-2

Bramantio, B. D., Wijayanto, D., and Wahyuningsih, S. M. (2026). Analysis of growth parameters and exploitation level of rabbitfish (Siganus virgatus) in Karimunjawa Islands. AACL *Bioflux*, 19(3), 1184-1193.

Campos, C. P., Inomata, D. O., Inomata, S. O., Bitar, S., and Freitas, C. E. C. (2024). Natural mortality of fish: a review. *Brazilian Journal of Biology*, 84. https://doi.org/10.1590/1519-6984.288214

Challier, L., Dunn, M. R., and Robin, J. P. (2005). Trends in age-at-recruitment and juvenile growth of cuttlefish, *Sepia officinalis*, from the English Channel. *ICES Journal of Marine Science*, 62(8), 1671–1682. https://doi.org/10.1016/j.icesjms.2005.06.006

Choudhary, S., Devadas, D., Lata, T., Monalisha, S., Mandal, S., Bhakta, D., Chakraborty, S. K., Kumar, R., and Bhushan, S. (2026). Population parameters and exploitation status of endemic Garra mullya (Sykes, 1839) in relation to environmental variables, in a tropical river of Western Ghats, India. *Environmental Monitoring and Assessment*, 198(9), 971. https://doi.org/10.1007/s10661-026-15808-x

Czudaj, S., Pereira, J., Moreno, A., Costa, A. M., Saint-Paul, U., and Rosa, R. (2012). Distribution, abundance, reproduction and ageing of the common bobtail squid Sepietta oweniana (Sepiolidae, Cephalopoda) from the Portuguese Coast. *Marine Biology Research*, 8(1), 74–86. https://doi.org/10.1080/17451000.2011.594892

Denechaud, C., Dovlo, E., Joanny, T., Osei, V. S., Buhl-Mortensen, L., and Staby, A. (2025). Spatial environmental variability shapes the diversity of bottom ecosystems on the western Gulf of Guinea shelf. *African Journal of Marine Science*, 47(2),191-205.https://doi.org/10.2989/1814232X.2025.2526707

Djan, P. S., Fynn, J. A., and Lazar, N. (2022). Habitat distribution, growth and mortality of giant African cuttlefish *Sepia hierredda* (Rang, 1835) in Ghana waters. *Journal of Fisheries and Coastal Management,*3(1), 1-1. doi: 10.5455/jfcom.20190318121213

Dovlo, E., Amador, K., Nkrumah, B., and Fisheries Scientific Survey Division. (2016). Report on the 2016 Ghana Marine Canoe Survey (Information Report No. 36). Fisheries Scientific Survey Division, Fisheries Commission, Ministry of Fisheries and Aquaculture Development.

Duysak, Ö., Özcan, G., Çek, Ş., and Türeli, C. (2014). Reproductive biology of the common cuttlefish (*Sepia officinalis*, Linnaeus, 1758) in Iskenderun Bay (Northeastern Mediterranean Sea). *Indian Journal of Geo-Marine*, 43(9), 1689–1694.

Enin, U. I., Lowenberg, U., and Kunzel, T. (1996). Population dynamics of the estuarine prawn (Nematopalaemon hastatus Aurivillius 1898) off the southeast coast of Nigeria. *Fisheries Research*, 26(1–2), 17–35. https://doi.org/10.1016/0165-7836(95)00411-4

Failler, P., Beyens, Y., and Asiedu, B. (2014). Value chain analysis of the fishery sector in Ghana. Mission Report, Trade Capacity Building Project for Ghana, UNIDO/MOTI TCB Project, Accra, Ghana, 106 p.

Fernandes Guerreiro, M., Oliveira Borges, F., Pereira Santos, C., and Rosa, R. (2023). Future distribution patterns of nine cuttlefish species under climate change. *Marine Biology*, 170(12), 159. https://doi.org/10.1007/s00227-023-04310-4

Food and Agriculture Organization. (2025). FishStatJ – Software for Fishery and Aquaculture Statistical Time Series.

Gasalla, M. A., Rodrigues, A. R., and Postuma, F. A. (2010). The trophic role of the squid Loligo plei as a keystone species in the South Brazil Bight ecosystem. *ICES Journal of Marine Science*, 67(7), 1413-1424. https://doi.org/10.1093/icesjms/fsq106

Gebremedhin, S., Bruneel, S., Getahun, A., Anteneh, W., and Goethals, P. (2021). Scientific methods to understand fish population dynamics and support sustainable fisheries management. Water, 13(4), 574. https://doi.org/10.3390/w13040574

Goto, D., Phillips, E., Phillips, G. A. C., Zimmermann, F., Carleton, L., and Hold, N. (2025). Progress toward sustainable management of marine crustacean fisheries. *EcoEvoRxiv.* https://doi.org/10.32942/X2BD2M

Goulet, D., Pauls, A., True, A., and Crimaldi, J. (2026). Flow structure and volume capture in idealized stereo inhalation flows at low-intermediate Reynolds number. Physical Review Fluids, 11(3), 033102. DOI: https://doi.org/10.1103/9v66-vk6q

Gulland, J. A. (1971). The effect of exploitation on the numbers of marine animals. Dynamics of populations, 450-67.

Huang, M., Ding, L., Wang, J., Ding, C., and Tao, J. (2021). The impacts of climate change on fish growth: A summary of conducted studies and current knowledge. Ecological Indicators, 121, 106976. https://doi.org/10.1016/j.ecolind.2020.106976

Jahan, R., and Mahmud, M. N. (2025). Length-weight relationship, condition factors and reproductive biology of the spineless cuttlefish Sepiella inermis (Ferussac & d'Orbigny, 1848) in the southeastern regions of the Bay of Bengal, Bangladesh. *Heliyon*, 11(3). 10.1016/j.heliyon.2025.e42338

Kenchington, T. J. (2014). Natural mortality estimators for information-limited fisheries. *Fish and Fisheries,* 15(4), 533-562. https://doi.org/10.1111/faf.12027

Kimbara, R., Kohtsuka, H., Abe, S., Oguchi, K., and Miura, T. (2022). Sucker formation in a bigfin reef squid: comparison between arms and tentacles. *Journal of Morphology,* 283(2), 149-163. https://doi.org/10.1002/jmor.21434

Lefkaditou, E., Peristeraki, P., Bekas, P., Tserpes, G., Politou, C. Y., and Petrakis, G. (2003). Cephalopods distribution in the southern Aegean Sea. Mediterranean *Marine Science,* 4(1), 79–86. https://doi.org/10.12681/mms.243

Leporati, S. C., Hart, A. M., Larsen, R., Franken, L. E., and de Graaf, M. (2015). Octopus life history relative to age, in a multi-geared developmental fishery. *Fisheries Research,* 165, 28–41. https://doi.org/10.1016/j.fishres.2014.12.017

Lessa, R., and Duarte-Neto, P. (2004). Age and growth of yellowfin tuna (Thunnus albacares) in the western equatorial Atlantic, using dorsal fin spines. *Fisheries Research*, 69(2), 157-170. https://doi.org/10.1016/j.fishres.2004.05.007

Liang, C., and Pauly, D. (2017). Growth and mortality of exploited fishes in China's coastal seas and their uses for yield-per-recruit analyses. *Journal of Applied Ichthyology,* 33(4), 746-756. https://doi.org/10.1111/jai.13379

Lorenzen, K. (2022). Size-and age-dependent natural mortality in fish populations: Biology, models, implications, and a generalized length-inverse mortality paradigm. *Fisheries Research*, 255, 106454. https://doi.org/10.1016/j.fishres.2022.106454

Lugert, V., Thaller, G., Tetens, J., Schulz, C., and Krieter, J. (2016). A review on fish growth calculation: multiple functions in fish production and their specific application. Reviews in aquaculture, 8(1), 30-42. https://doi.org/10.1111/raq.12071

Luna, A., Rocha, F., and Perales-Raya, C. (2021). A review of cephalopods (Phylum: Mollusca) of the canary current Large marine ecosystem (Central-East Atlantic, African coast). *Journal of the Marine Biological Association of the United Kingdom*, 101(1), 1-25. https://doi.org/10.1017/S0025315420001356

Mainguy, J., and Moral, R. D. A. (2021). An Improved method for the estimation and comparison of mortality rates in fish from catch-curve data. *North American Journal of Fisheries Management*, 41(5), 1436-1453. https://doi.org/10.1002/nafm.10665

Mäthger, L. M., Barbosa, A., Miner, S., and Hanlon, R. T. (2006). Color blindness and contrast perception in cuttlefish (*Sepia officinalis*) determined by a visual sensorimotor assay. *Vision Research*, 46(11), 1746–1753. https://doi.org/10.1016/j.visres.2005.09.035

McKeown, N. J., Arkhipkin, A. I., and Shaw, P. W. (2019). Genetic analysis reveals historical and contemporary population dynamics in the longfin squid Doryteuthis gahi: implications for cephalopod management and conservation. *ICES Journal of Marine Science,* 76(4), 1019-1027. https://doi.org/10.1093/icesjms/fsz009

Mehanna, S. F., and Haggag, H. M. (2011). Stock assessment of the common cuttlefish, *Sepia officinalis*, in the southeastern Mediterranean, Egypt. *Egyptian Journal of Aquatic Biology & Fisheries*, 15(3), 277–284.

Mehanna, S. F., Desouky, M. G., and Makky, A. F. (2020). Growth, mortality, recruitment and fishery regulation of the Nile *Tilapia Oreochromis niloticus* (Teleostei: Cichlidae) from Manzala Lake, Egypt. *Iranian Journal of Ichthyology*, 7(2), 158 – 166.

Mildenberger, T. K., Taylor, M. H., and Wolff, M. (2017). TropFishR: an Rpackage for fisheries analysis with length-frequency data. *Methods in Ecology and Evolution*, 8(11), 1520-1527. doi: 10.1111/2041-210X.12791

Misra, R. K. (1986). Fitting and comparing several growth curves of the generalized von Bertalanffy type. *Canadian Journal of Fisheries and Aquatic Sciences*, 43(8), 1656-1659. https://doi.org/10.1139/f86-204

Moreno, A., Azevedo, M., Pereira, J., and Pierce, G. J. (2007). Growth strategies in the squid Loligo vulgaris from Portuguese waters. *Marine Biology Research*,3(1), 49-59. https://doi.org/10.1080/17451000601129115

Mouritsen, O. G., and Styrbæk, K. (2021). Cephalopod Anatomy. In *Octopuses, Squid & Cuttlefish: Seafood for Today and for the Future* (pp. 27-70). Cham: Springer International Publishing. DOI: 10.1007/978-3-030-58027-8

Mustafa, S. A., Al-Rudainy, A. J., and Salman, N. M. (2024). Effect of environmental pollutants on fish health: An overview. *Egyptian Journal of Aquatic Research*, 50(2), 225-233. https://doi.org/10.1016/j.ejar.2024.02.006

Ogunola, O. S., Onada, O. A., and Falaye, A. E. (2018). Preliminary evaluation of some aspects of the ecology (growth pattern, condition factor and reproductive biology) of African pike, Hepsetus odoe (Bloch 1794), in Lake Eleiyele, Ibadan, Nigeria. *Fisheries and Aquatic Sciences*, 21(1), 12. https://doi.org/10.1186/s41240-018-0087-y

Ospina-Alvarez, A., de Juan, S., Pita, P., Ainsworth, G. B., Matos, F. L., Pita, C., and Villasante, S. (2022). A network analysis of global cephalopod trade. *Scientific Reports*, 12(1), Article 322. https://doi.org/10.1038/s41598-021-03777-9

Owusu, V., and Andriesse, E. (2020). From open access regime to closed fishing season: Lessons from small-scale coastal fisheries in the Western Region of Ghana. *Marine Policy*, 121, 104162. 10.1016/j.marpol.2020.104162

Pauly, D. (1980). On the interrelationships between natural mortality, growth parameters, and mean environmental temperature in 175 fish stocks. *ICES journal of Marine Science*, 39(2), 175-192. https://doi.org/10.1093/icesjms/39.2.175

Pauly, D. (1998). Tropical fishes: patterns and propensities. *Journal of Fish Biology*, 53, 1-17. https://doi.org/10.1111/j.1095-8649.1998.tb01014.x59.

Pérez-Losada, M., Nolte, M. J., Crandall, K. A., and Shaw, P. W. (2007). Testing hypotheses of population structuring in the Northeast Atlantic Ocean and Mediterranean Sea using the common cuttlefish *Sepia officinalis*. *Molecular Ecology*, 16(13), 2667–2679.https://doi.org/10.1111/j.1365-294X.2007.03333.x

Piatkowski, U., Pierce, G. J., and Morais da Cunha, M. (2001). Impact of cephalopods in the food chain and their interaction with the environment and fisheries: An overview. *Fisheries Research*, 52(1–2), 5–10. https://doi.org/10.1016/S0165-7836(01)00226-0

Punt, A. E., Castillo-Jordán, C., Hamel, O. S., Cope, J. M., Maunder, M. N., and Ianelli, J. N. (2021). Consequences of error in natural mortality and its estimation in stock assessment models. *Fisheries Research*, 233, 105759. https://doi.org/10.1016/j.fishres.2020.105759

Rocha, F., Guerra, A., and González, Á. F. (2001). A review of reproductive strategies in cephalopods. *Biological Reviews*, 76(3), 291–304. https://doi.org/10.1017/S1464793101005681

Saddikioui, L., Mazouz, M., and Abi-Ayad, S. M. E. A. (2017). First data on reproduction and growth parameters of the cuttlefish (*Sepia officinalis* L.) in Oran Bay (western Algeria coast). *International Journal of Biosciences*, 10 (5), 75-84. http://dx.doi.org/10.12692/ijb/10.5.75-84

Sanders, M. J. (1979). Preliminary stock assessment for the cuttlefish *Sepia pharaonis* taken off the coast of the People's Democratic Republic of Yemen. UNDP/FAO, RAB/77/008/6.56 pp.

Shishitu, B. (2023). Population dynamics and yield estimation of Common Carp (Cyprinus carpio, Linnaeus, 1758) in Ayalew reservoir, Gamo Zone, Southern Ethiopia. *East African Journal of Biophysical and Computational Sciences*, 4(1), 28-41. https://doi.org/10.4314/eajbcs.v4i1.3S

Sparre, P., and Venema, S. C. (1999). Introduction to tropical fish stock assessment. Part 2: Exercises (FAO Fisheries Technical Paper No. 306/2, Rev. 2). Food and Agriculture Organization of the United Nations.

Taylor, M. H., and Mildenberger, T. K. (2017). Extending electronic length frequency analysis in R. Fisheries Management and Ecology, 24(4), 330-338. https://doi.org/10.1111/fme.12232

Then, A. Y., Hoenig, J. M., Hall, N. G., and Hewitt, D. A. (2015). Evaluating the predictive performance of empirical estimators of natural mortality rate using information on over 200 fish species. *ICES Journal of Marine Science*, 72(1), 82-92. DOI: 10.21276/haya.2016.1.4.4

Thorson, J. T. (2014). Standardizing compositional data for stock assessment. *ICES Journal of Marine Science*, 71(5), 1117-1128. https://doi.org/10.1093/icesjms/fst224

Valeri, A. E., Mamadou, K., Irene, K. F. K., and Atcho, O. (2016). Population Dynamics of the Common Cuttlefish *Sepia Officinalis* from the Coastal Water of Côte d'Ivoire. *Haya: The Saudi Journal of Life Sciences*, 1(4), 141-147. DOI: 10.21276/haya.2016.1.4.4

Vargheese, S., Ameri, S., and Basheer, V. S. (2026). Mitochondrial marker-based studies of Indian ocean cuttlefish species resolve taxonomic ambiguities and provide new systematic insights. *Marine Biodiversity*, 56(5), 99. https://doi.org/10.1007/s12526-026-01707-4

Vidal, E.A.G. (Ed.). (2014). Advances in cephalopod science: biology, ecology, cultivation and fisheries (Vol. 67). Academic Press. DOI: 10.1016/B978-0-12-800287-2.09992-3

Vidal, E. A., and Shea, E. K. (2023). Cephalopod ontogeny and life cycle patterns. *Frontiers in Marine Science*, 10, 1162735. https://doi.org/10.3389/fmars.2023.1162735

Villanueva, R., Vidal, E. A., Fernández-Álvarez, F. Á., and Nabhitabhata, J. (2016). Early mode of life and hatchling size in cephalopod molluscs: influence on the species distributional ranges. *PLoS One*, 11(11), e0165334. https://doi.org/10.1371/journal.pone.0165334

Wang, J., Pierce, G. J., Boyle, P. R., Denis, V., Robin, J.-P., and Bellido, J. M. (2003). Spatial and temporal patterns of cuttlefish (*Sepia officinalis*) abundance and environmental influences: A case study using trawl fishery data in French Atlantic coastal, English Channel, and adjacent waters. *ICES Journal of Marine Science*, 60(5), 1149–1158. https://doi.org/10.1016/S1054-3139(03)00118-8

Ward, P. D., and Von Boletzky, S. (1984). Shell implosion depth and implosion morphologies in three species of *Sepia* (Cephalopoda) from the Mediterranean Sea. *Journal of the Marine Biological Association of the United Kingdom*, 64(4), 955-966. DOI: https://doi.org/10.1017/S0025315400047366

Weinstein, M., Liotta, M. N., Solitt, A., Hunt, A., Abbott, J. K., Rios-Cardenas, O., and Morris, M. R. (2019). Selection on growth rates via a trade-off between survival to sexual maturity and longevity in the swordtail fish Xiphophorus multilineatus. *Evolutionary Ecology*, 33(4), 549-566. https://doi.org/10.1007/s10682-019-09989-w

Yesilyurt, İ. N., Türeli, C., and Duysak, Ö. (2019). Growth parameters of the cuttlefish, *Sepia officinalis* Linnaeus, 1758 from the Karataş coasts of the Mediterranean Sea, Turkey. 3rd International Congress on Advances in Bioscience and Biotechnology (ICABB), July 10-14, 2019 Kiev, Ukraine. pp. 25–36

Zhang, C. I., and Megrey, B. A. (2006). A revised Alverson and Carney model for estimating the instantaneous rate of natural mortality. Transactions of the American Fisheries Society, 135(3), 620-633. https://doi.org/10.1577/T04-173.1

Zhou, S., Hutton, T., Lei, Y., Miller, M., van Der Velde, T., and Deng, R. A. (2022). Estimating growth from length frequency distribution: comparison of ELEFAN and Bayesian approaches for red endeavour prawns (Metapenaeus ensis). *ICES Journal of Marine Science*, 79(6), 1942-1953. https://doi.org/10.1093/icesjms/fsac131

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