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Mortality Rates, Relative Yield Per Recruit and Parasitic Infestations of Striped Piggy (*Pomadasys stridens*) from Lake Temsah, Egypt

Noha M. Eid and Mai Nashaat*
National Institute of Oceanography & Fisheries, (NIOF), Cairo, Egypt
***Corresponding Author: mainashat85@gmail.com**

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ABSTRACT
Striped piggy fish (*Pomadasys stridens*) were randomly collected from Lake Temsah by fishermen during the 2022 fishing season. Mortality rates and relative yield per recruit were calculated using the von Bertalanffy growth function method. The estimated length at first capture (Lc) was 9.32cm. The natural, total, and fishing mortality rates were estimated at 0.32, 1.70, and 1.42 year^{-1}, respectively. These findings indicate a high level of exploitation of the striped piggy population in Lake Temsah. Relative yield per recruit analysis confirmed that the population of *P. stridens* is overexploited. This highlights the urgent need for management measures to ensure the long-term sustainability of the fishery. Additionally, a subsample of 200 fish was examined for parasitic infestations. The prevalence of *Livoneca redmanii* Leach, 1818 (Isopoda, Cymothoida) was 15%. Infestation was higher in females (66.6%) compared to males (33.3%). These results suggest that parasitic infestations may contribute to the elevated mortality rates observed in the population. Further research is recommended to assess the parasitic impacts on other commercially important fish species in the Suez Canal region, given their ecological and economic significance.

INTRODUCTION

Fishery resources provide a crucial source of income and nutrition for millions of people worldwide, supporting livelihoods from collection to processing and marketing. For many coastal nations, fisheries are also a vital component of cultural identity. However, global fishery production faces multiple challenges, including overfishing, disease outbreaks, pollution, and more recently, the impacts of climate change **(Mehanna, 2022)**.

Food deficiency, particularly in animal protein, is one of the most pressing concerns globally. Developing countries such as Egypt face a continuous rise in population at alarming rates, intensifying the demand for sustainable food resources. In this context, fisheries represent one of the most significant renewable food sources and may be among the few viable solutions to protein deficiency **(Farrag, 2008)**.

The striped piggy (*Pomadasys stridens*), belonging to the family Haemulidae, is a benthic species commonly distributed in coastal waters worldwide. It is typically found at depths of 13.9– 75m, where it feeds on small fishes and crustaceans **(Yousif, 2004)**. In Egypt, the species is abundant along the Red Sea coast, where it is harvested primarily by trawl fisheries. It can also migrate into the Mediterranean through the Suez Canal **(Osman *et al.*, 2019)**. In the Gulf of Suez, *P. stridens* holds considerable economic importance, accounting for ~10% of total fishery production **(Mehanna, 2022)**. Beyond Egypt, the species is distributed across the western Indian Ocean, along the East African coast to Mozambique, and in the Arabian Gulf **(Safi *et al.*, 2014)**. Its first record in the Mediterranean dates back to 1968, when it was reported from the Gulf of Genoa **(Ben-Tuvia, 1977)**.

The Suez Canal ecosystem supports a rich diversity of fish species but also exposes them to increased interactions with aquatic pathogens, leading to heightened susceptibility to bacterial and parasitic infections, whether singular or mixed **(Qorany & Mansour, 2023)**.

Among parasites, members of the family Cymothoida (Leach, 1818) are widely distributed isopod ectoparasites found in marine, freshwater, and brackish environments. They pose significant problems for affected fish species due to their large size, strong attachment appendages, and site-specific infestations that cause severe damage to host tissues **(Tanrikul & Percin, 2012; Nashaat *et al.*, 2023)**. Cymothoids can attach to various body sites—including fins, skin, gills, and buccal cavities—depending on the host species **(Hoffman, 2019)**.

Livoneca redmanii is one of the most common cymothoid isopods, infesting multiple fish hosts in diverse aquatic habitats. In Egypt, it has been reported in the Suez Canal region from *Dicentrarchus punctatus* and *Dicentrarchus labrax* **(Eissa *et al.*, 2020)**, and from *Argyrosomus regius* in the northern Mediterranean lakes **(Fadel *et al.*, 2020)**. Due to taxonomic overlap among cymothoid species, accurate identification requires both morphological and molecular approaches. For instance, **Zayed *et al.* (2024)** emphasized the importance of complementary morphological descriptions, particularly of females, in distinguishing *L. redmanii*.

The present study aimed to assess the mortality rates, exploitation levels, and relative yield per recruit of *Pomadasys stridens* from Lake Temsah, in addition to conducting a laboratory survey of associated parasitic infestations. These findings will provide baseline parameters for fishery management and parasite control strategies.

MATERIALS AND METHODS

1. Study area

Lake Temsah is a shallow saline water body, considered the most extensive in Ismailia Governorate, with a total area of ~14 km². It lies between the southern side of Suez Governorate and the northern side of Port Said Governorate at coordinates 32°19′30.54″E and 30°35′46.55″N. The lake extends southward from the Gulf of Suez and northward toward the Mediterranean Sea, and its waters are supplied from the Red Sea as part of the Suez Canal system **(El-Serehy *et al.*, 2018)**.

2. Fish samples collection

The Striped piggy (*Pomadasys stridens*) were randomly collected from Lake Temsah during the 2022 fishing season through local fishermen. Samples were transported to the Fish Population Dynamics Laboratory at the National Institute of Oceanography and Fisheries (NIOF), Suez and El-Akaba branch, for morphometric measurements. A subsample of 200 fish was immediately transported on ice to the Aquatic Pathology Laboratory at the same institution for parasitological examinations.

3. Clinical and postmortem examinations

Fresh specimens of *P. stridens* were examined externally for clinical signs. Postmortem examinations were also conducted to detect internal abnormalities associated with parasitic infestations. The protocols followed were based on those outlined in the study of **Noga (2010)**.

4. Parasitological examinations and identification

Each specimen was placed in a Petri dish and was examined externally using a dissecting stereo microscope (OPTICA-Italy B-150) according to the methods described by **Amlacher (1970)**. Detected isopod parasites were rinsed in tap water, fixed in 70% ethanol, and stored until identification and scanning electron microscopy (SEM) processing. Identification was conducted using international taxonomic keys **(Hoffman & Sindermann, 1962; Paperna, 1996)**, with species-level confirmation based on morphological descriptions provided by **Qorany and Mansour (2023)**.

5. Scanning electron microscope (sem) processing

Preserved isopod parasites were prepared for SEM and imaged at magnifications of 15–25 kV using the electron microscopy unit at Assiut University. The procedures followed those outlined by **Colwell *et al.* (2007)**.

6. Critical lengths

Recruitment length (Lr) was estimated as the smallest specimen in the catch sample, while the length at first capture (Lc), corresponding to the size at which 50% of the population is retained by fishing gear, was calculated using the catch curve analysis method developed by **Pauly (1984)**.

7. Mortality, exploitation rates, and relative yield per recruit (Y/R′)

The following parameters were estimated:

- **Total mortality coefficient (Z)**
- **Natural mortality coefficient (M)**
- **Fishing mortality coefficient (F)**
- **Exploitation ratio (E)**
- **Relative yield per recruit (Y/R′)**
- **Relative biomass per recruit (B/R′)**

These were calculated using geometric mean methods as described in the literature. For example:

- **Total mortality coefficient (Z)** was estimated by applying the procedures of **Jones and Van Zalinge (1981)**, **Hoenig and Lawing (1982)** and **Pauly (1983)**.

This equation depends on the linear correlation between the natural log of cumulative frequency (CN) and the natural log of differences between the asymptotic length and the length ($L\infty$ - L) as:

$Ln (CN) = a + (Z/K) * \ln (L\infty - L)$

CN means: Cumulative frequency

Z means: Total mortality coefficient

K means: Growth coefficient

a means: Constant

The linear correlation was assessed ($Y = \ln (CN)$, $X = \ln (L\infty - L)$). Linear regression modeling is used to estimate the constant (a). The slope of the regression line model is equal to (Z/K), allowing Z to be calculated as:

$Z = K * slope$

Hoenig and Lawing (1982) method:

This method requires the maximum age (t.max), the first capture mean age (t.c) and the sample size (N) of large animals used to determine t.max. Total mortality (Z) is calculated as:

$Z = 1 / (c1 * (t.max – t.c))$

c1: A function of N

t.c: Age at first capture

t.max: Maximum age attained

3. **Pauly**’s **(1983)** method:

This method uses length-frequency data to catch curve constructions. Length is changed to age by using the growth model of von Bertalanffy. Estimation of the total mortality (Z) is evaluated using the following formula:

$\ln(N/\Delta t) = a + b * t$

N means: Frequency of each length class

Δt means: Time needed to grow from t1 to t2 of a given length class

T means: Relative age corresponding to the midpoint of the length class

a and b mean: Constants

Natural mortality coefficient (M): calculated by using the methods of **Taylor (1960)**, **Ursin (1967)** and **Rikhter and Efanov (1976)** as the geometric means; methods followed are explained in the lines to follow:

Taylor's method (1960):

M= 3/ t.max

t.max: means obtaining the maximum age

Ursin's method (1967)

M= W- 1/3

W: means total body weight

Rikhter and Efimov's **(1976)** Empirical Model:

M = ((1.52 / t. mass) 0.72) - 0.16

t. mass means age at the major maturity

The fishing mortality coefficient (F): calculated as:

F = Z – M

Z means: the total mortality coefficient

M means: the natural mortality coefficient

The exploitation ratio (E): calculated as the methods of **Gulland (1971)** as:

E= F/Z

Relative yield per recruit (Y/R)' and relative biomass per recruit (B/R): calculated following the method of **Beverton and Holt (1979)**, which is explained as follows:

(Y/R)' = E U M/K [1 - (3U/1+m) + (3U2/1+2m) - (U3/1+3m)]

(B/R)' = (Y/R)'/F

E: exploitation rate

U: 1 - (Lc / L∞)

M: natural mortality

K: growth parameter

F: fishing mortality coefficient

M: (1-E) / (M/K) = (K/Z)

RESULTS

1. Observed clinical signs of infested fish

Examination of freshly infested striped piggy fish (*Pomadasys stridens*) revealed moderate to severe clinical manifestations. The most severe sign was necrosis, with complete destruction of tissues at the sites of isopod attachment, including the gills, operculum, and external body surface. Postmortem examinations revealed slight shrinkage of the stomach and pale coloration of internal organs, indicating malnutrition associated with parasitic infestation (Plate 1a).

2. Parasitic infestation and prevalence

Of the 200 *P. stridens* examined, 30 individuals (15%) were infested with the isopod *Livoneca redmanii* Leach, 1818 (Isopoda: Cymothoida). Attachment sites varied, with the highest prevalence observed on the gills (20 specimens) (Plate, 1a), followed by infestations near the operculum on the ventral side (10 specimens) (Plate, 1b– d).

Sex-based prevalence indicated that females were more frequently infested (66.6%) compared to males (33.3%) (Plate, 1e). The total parasitic prevalence was calculated as: Total infestation × (100) ÷ Total examined (Table 1).

Plate (1) depicts the Striped piggy fish (*Pomadasys stridens*) infested with *Livoneca redmanii* isopods.

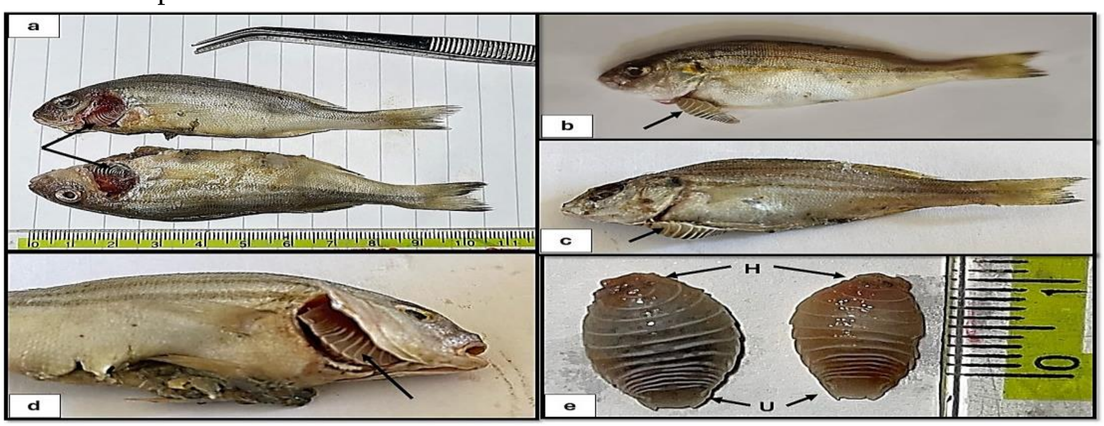

Plate 1. Photograph of striped piggy fish (*Pomadasys stridens*) showing shrinking stomach with attached *Livoneca redmanii* isopods to one-sided gills (a and d). *Livoneca redmanii* isopods attached to outer body ventral sided (b and c). *Livoneca redmanii* isopods males 10±1 (smaller size) and ovigerous females with total length 10±4 mm (e). (12-megapixel camera of iPhone 12 ProMax)

Table (1) shows the total fish examined (FE), the total fish infested (FI), the infestation prevalence (P%) and the parasite sex (P), males (M), females (F).

Table 1. Parasitic prevalence of *Pomadasys stridens*

Parasite species	F E	F I	P %	Site of attachment	P. sex
Livoneca redmanii	200	30	15%	Ventrally (10) Gills (20)	M (33.3%) F (66.6%)

2. Morphological description of *Livoneca redmanii* isopods

Based on five specimens, the morphological characteristics of *L. redmanii* were recorded as follows:

The body is oval, dorsoventrally flattened, and bilaterally symmetrical. Average body length was 10 ± 4mm in females and 10 ± 1mm in males. The body is slightly curved laterally and covered with a segmented cuticle (Plate, 2a). The overall coloration of collected parasites ranged from yellowish to dark brown.

The cephalon (head) is rounded, non-segmented, and slightly pointed, bearing a pair of black simple eyes laterally. Ovigerous females were distinguished by ventral black patches, indicating the presence of immature mancae larvae (Plate, 2b). The dorsal surface is marked with chromatophores distributed along the segments (Plate, 2a, c).

The body consists of seven pereonites that narrow posteriorly toward the pleonites. The five pleonites are broader at the mid-body and progressively taper toward the posterior end, terminating in the pleotelson with paired uropods (Plate, 2c). The ventral pleopod appendages are unequal in size and length depending on the site of attachment. The uropodal rami extend beyond the posterior margin of the pleotelson (Plate, 2d). Plate (2) illustrates *Livoneca redmanii*, Leach 1818 (Isopoda, Cymothoida) morphological characters.

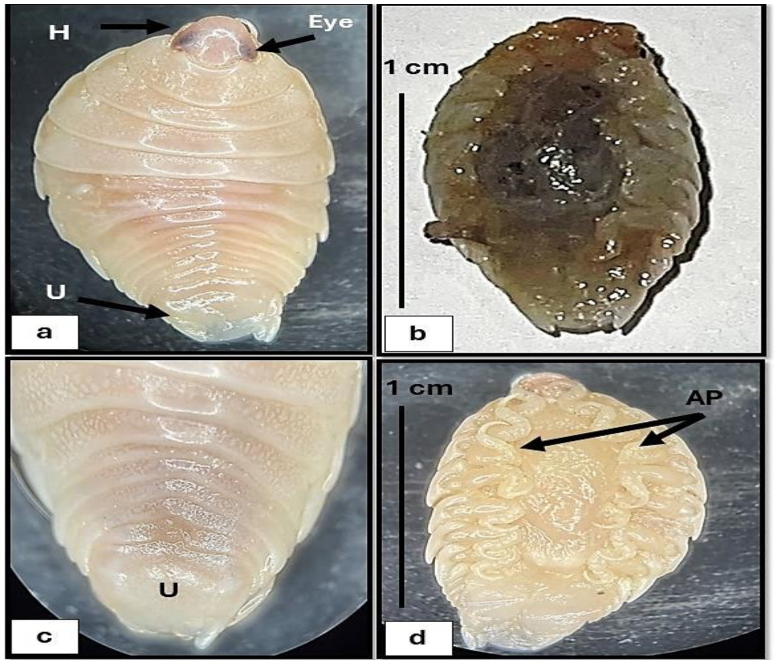

Plate 2. Dissecting microscope photograph of dorsal view of *L. redmanii* showing head (H) with large bilateral eyes, antenna, body with segmented cuticle (a) 10x. Ventral view of ovigerous female *L. redmanii* showing immature mancae larvae (b) 10x. Posterior pleonites with uropods (U) (c) 10x. Ventral view of *L. redmanii* showing pleopod appendages (AP) (d) 10x

3. Scanning electron microscope consequences

Following morphological identification, detailed examination of *L. redmanii* was performed using scanning electron microscopy (SEM).

As shown in Plate (3), the parasite was photographed from both dorsal and ventral perspectives. On the ventral side, the anterior head region consists of a non-segmented cephalon and associated mouthparts, including the maxilla and maxilliped. The anterior antennae and antennules serve sensory functions, while the frontal lamella and clypeus structure define the lower margin of the face (Plate, 3a– c).

The appendages of the pereonites displayed a distinct structural organization, including the basal segment and movable parts (ischium and propodus). The dactyl hook, which anchors the parasite to its host, was clearly visible and is responsible for significant tissue damage at the attachment site (Plate, 3d– e).

The ventral posterior region showed rami layers attached to the pleopods and pleotelson (Plate 3f). Adult females exhibited a marsupium on the ventral surface, formed from flap-like extensions of the coxae, which functions as a brood pouch for developing larvae until release into the water (Plate, 3g).

The dorsal view revealed a segmented cuticle, which provides structural protection for the parasite (Plate, 3h).

Plate (3) exhibits the SEM of *Livoneca redmanii*, Leach 1818 (Isopoda, Cymothoida).

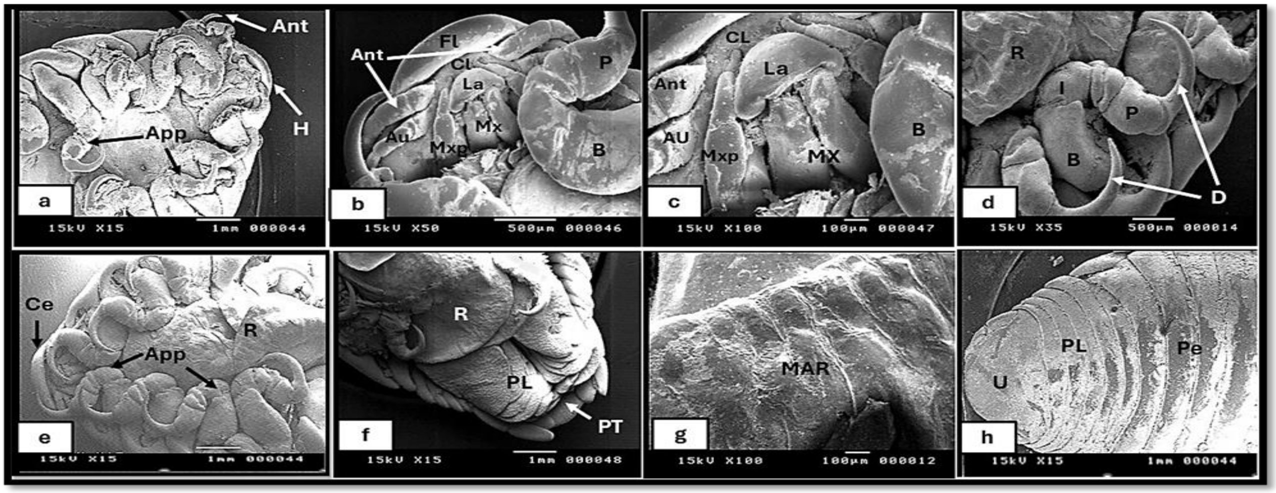

Plate 3. Scanning electron micrograph of *L. redmanii* isolated from *Pomadasys stridens* fish. Ventral view of anterior body showing cephalon the head region (H) with antenna (Ant) and pereopods appendages (App) (a) 1mm. Cephalon ventral view showing antenna (Ant), antennule (Au), mouth parts as: maxilliped (Mxp), maxilla (Mx), labrum (La), clypeus (Cl) and frontal lamina (Fl) also the first pairs of pereopod appendage structure as: base of the appendage (B), propodus (P) (b, 500µm and c 100µm). Detailed structure of pereonite appendages showing base of the appendage (B), ischium (I), propodus (P), dactyl hock (D), and abdominal rami (R) (d) 500µm. Cephalon (Ce) with anterior pereopods with rami (R) (e) 1mm. Posterior part of *L. redmanii* body showing posterior rami (R), pleopods (PL) and pleotelson (PT) (f) 1mm. Ventral body rami of female *L. redmanii* showing marsupium (MAR) (g) 100 µm. Dorsal view of *L. redmanii* showing segmented cuticle of the posterior body region showing pereopod segments (Pe), pleopod segments (PL) and uropod segments (U) (h) 1mm

4. Critical lengths

The recruitment length (Lr) of striped piggy at Lake Temsah was 7.5cm. The detected length at the first capture (Lc) was assessed as 9.3cm (Fig. 1). Fig. (1) shows the critical lengths of *Pomadasys stridens* at Lake Temsah.

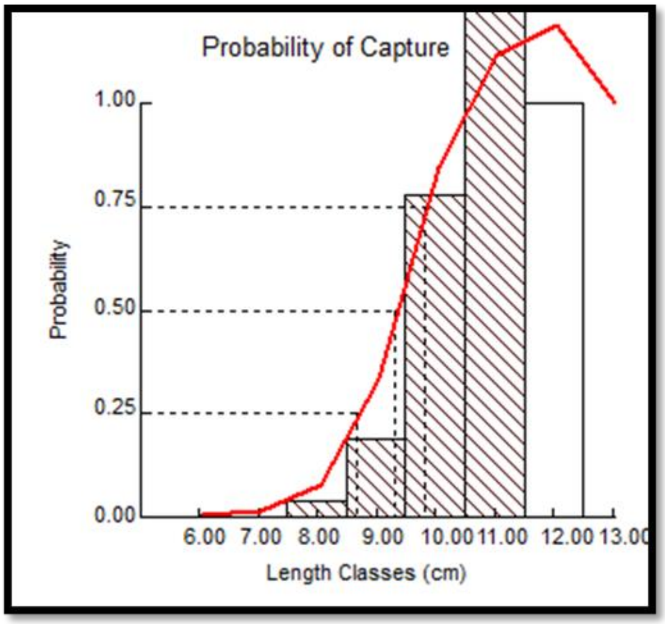

Fig. 1. Capture probability of *Pomadasys stridens* showing the relation between fish different length classes (cm) and capture probability

5. Mortality and exploitation rates findings

The total mortality coefficient (Z) was calculated using three different methods, and the results are summarized in Table (2) and illustrated in Figs. (2, 3). Estimates of natural mortality (M), derived using three geometric mean methods, are presented in Table (3). Based on these calculations, the fishing mortality (F) was estimated at 1.35 year^{-1}, while the exploitation rate (E) was assessed at 0.79 year^{-1}. This value is considerably higher than the optimal exploitation level (E = 0.5).

These results indicate that the striped piggy (*Pomadasys stridens*) population in Lake Temsah is subject to high levels of exploitation, primarily due to elevated fishing mortality and overexploitation rates.

Table 2. The total mortality coefficient (Z) calculations for *Pomadasys stridens* at Lake Temsah

Method	Z
Hoenig and Lawing (1982)	1.0
Jones and Van Zalinge (1981)	2.3
Pauly (1983)	1.4
GM	1.5

Note: data shows three scientists' methods of the total mortality coefficient (Z) with total geometric mean (GM).

Table 3. The natural mortality (M) calculations for *Pomadasys stridens* at Lake Temsah

Method	M
Rikhter and Efanov (1976)	0.3
Taylor (1960)	0.6
Ursin (1967)	0.4
GM	0.3

Note: Data refer to three scientists' methods of natural mortality (M) with total Geometric Mean (GM).

Fig. (2) illustrates the length-converted catch curve of *Pomadasys stridens* at Lake Temsah.

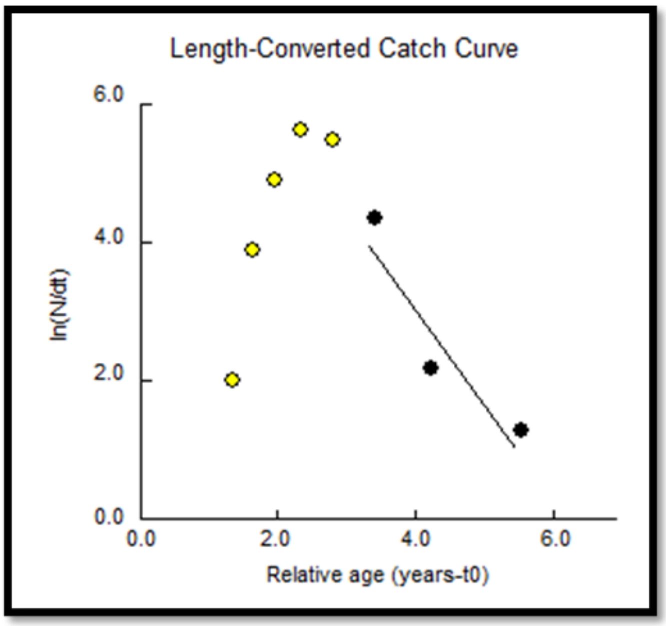

Fig. 2. Length-converted catch curve of *Pomadasys stridens* showing relation between relative age (years) and its natural logarithm (ln)

Data presented in Fig. (3) show the cumulated-catch curve of *Pomadasys stridens* at Lake Temsah.

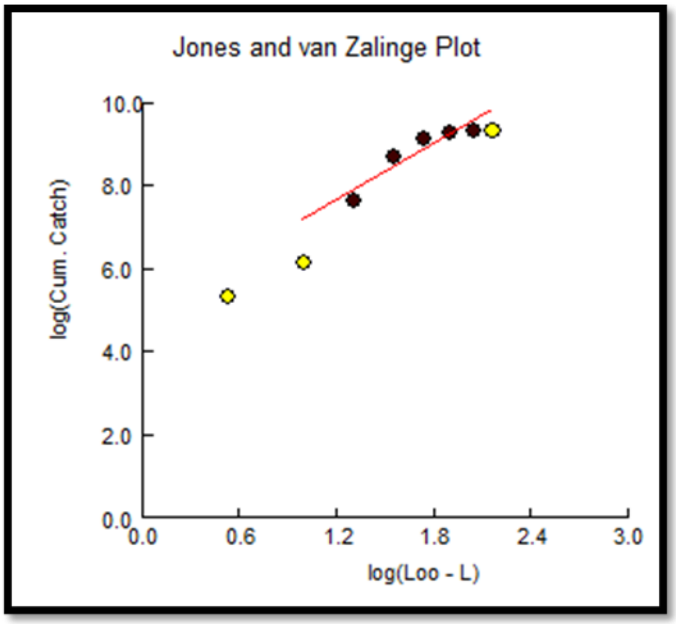

Fig. 3. Cumulated-catch curve of *Pomadasys stridens* showing Jones and Van Zalinge Plot with natural log values

6. Relative yield per recruit (Y/R)'

The relative yield-per-recruit (Y/R′) of *Pomadasys stridens* in Lake Temsah was estimated as shown in Fig. (4). The analysis revealed that the current exploitation rate (E) was 0.79, the length at first capture (Lc) was 9.32cm, and the natural mortality coefficient (M) was 0.32 year^{-1}. These values did not correspond to the maximum yield-per-recruit. The highest Y/R′ was achieved at an exploitation rate of 0.75, indicating that the present fishing mortality (F = 1.20 year^{-1}) exceeded the level that maximizes yield.

Two key reference points were also calculated:

- **$E_{0.5}$ = 0.41**, the exploitation rate that reduces unexploited biomass by 50%.
- **$E_{0.1}$ = 0.66**, the exploitation rate at which any further increase yields only 1/10 of the marginal increase.

The current exploitation rate (E = 0.79) was substantially higher than both $E_{0.5}$ and $E_{0.1}$. This suggests that the striped piggy stock is experiencing overexploitation and that fishing effort should be reduced by approximately 48.2% to maintain stock sustainability. Fig. (4) presents the results of the relative yield per recruits (Y/R)'of *Pomadasys stridens* at Lake Temsah.

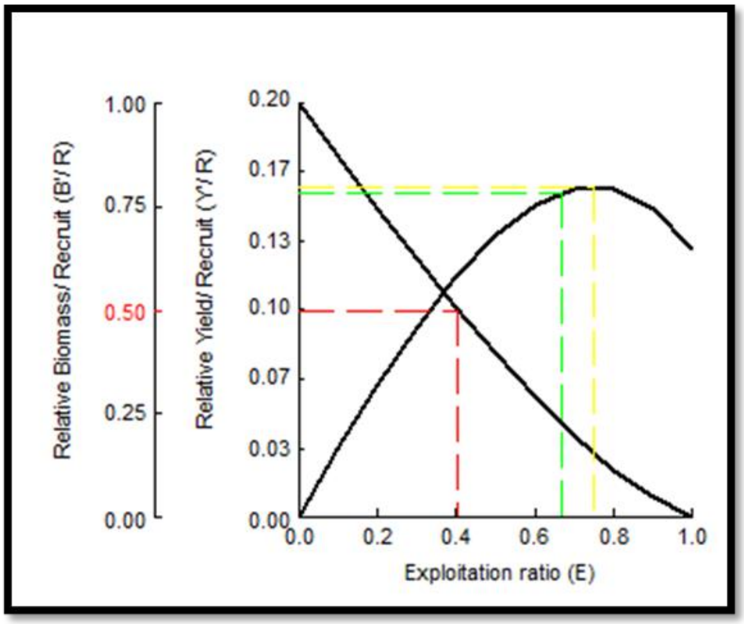

Fig. 4. Relative Yield per-Recruit analysis of *Pomadasys stridens* showing the relation between the exploitation rate and the relative biomass/ recruit.

DISCUSSION

This study revealed parasitic infestation of the striped piggy (*Pomadasys stridens*) in Lake Temsah by *Livoneca redmanii* Leach, 1818 (Isopoda: Cymothoida), which may represent one of several contributing factors to the observed mortality of this species. The prevalence rate was 15% (30 infested out of 200 examined), aligning with previous reports of low prevalence in the Mediterranean coastal fishes including Alexandria (4%), Matruh (3.13%), and Port Said (9%) **(Badawy, 1994; Eman *et al.*, 2014; Abdel-Latif, 2016)**. However, other studies have documented much higher rates, such as 46.7% in *Mugil cephalus* **(Helal & Yousef, 2018)** and 66% in *Tilapia zillii* **(Mohammed-Geba *et al.*, 2019)**.

Cymothoid isopods are chronic ectoparasites inhabiting marine, brackish, and freshwater environments. They cause harm either directly through attachment and tissue damage, or indirectly by predisposing hosts to secondary bacterial or fungal infections. Their persistence and permanent attachment classify them as chronic pathogens **(Bunkley-Williams & Williams, 1998; Mahmoud *et al.*, 2017)**. Comparable effects have been reported for other cymothoid species such as *Norileca orbignyi*, which infested *T. zillii* in Lake Qarun with a prevalence of 25% **(Abdel-Latif, 2016)**. Likewise, **Shaheen *et al.* (2017)** observed high infestation rates in *M. capito* (80.9%), *T. zillii* (33.5%), and *Solea solea* (41.1%). The most recent findings by **Qorany and Mansour (2023)** reported a prevalence of 48.75% of *L. redmanii* in *P. stridens* from the Suez Canal region, suggesting regional variation in parasite pressure.

Infected fish in this study displayed moderate to severe clinical signs, ranging from pale gill arches and shrunken stomachs to necrosis at attachment sites. These observations agree with reports by **Helal and Yousef (2018)**, who described hypoxia, gasping, and flaring opercula due to isopod pressure on gill filaments, which shortened lamellae, ruptured epithelial tissues, and increased mucus production, impairing respiration. Similarly, **Mahmoud *et al.* (2017)** and **Abdallah and Hamouda (2022)** documented bilateral opercular protrusion in infested *P. stridens*. Severe gill tissue destruction has also been attributed to isopod feeding, which involves hematophagy (blood feeding) and leads to lamellar atrophy **(Thamban *et al.*, 2015; Ali & Aboyadak, 2018; Elgendy *et al.*, 2022)**.

Morphological identification remains the primary method for distinguishing cymothoid parasites. The present findings are consistent with the morphological and genetic identification of *L. redmanii* in *P. stridens* by **Qorany and Mansour (2023)**. Similarly, the current outcomes coincide with earlier reports on other Egyptian fish hosts **(Helal & Yousef, 2018; Mohammed-Geba *et al.*, 2019; Fadel *et al.*, 2020)**. Scanning electron microscopy (SEM) provided detailed visualization of diagnostic features, supporting identification accuracy. This approach has been applied successfully in previous studies to confirm cymothoid identity, including *L. redmanii* infestations in *Dicentrarchus labrax* from the Mediterranean with 23% prevalence **(Abdallah & Hamouda, 2022)**.

Attachment sites of cymothoids vary with host species, and infestations have been reported in gills, fins, buccal cavities, and skin **(Hoffman, 2019)**. In the present study, *L. redmanii* was observed mainly in the gills and branchial cavity of *P. stridens*. This agrees with the study of **Rameshkumar and Ravichandran (2014)**, who isolated the parasite detected between gill arches and the operculum, whereas **Ugbomeh and Nwosu (2016)** and **Wonodi *et al.* (2019)** reported prevalence in the mouths and fins of pomadasyid hosts.

Mortality and exploitation estimates provide further evidence of stock vulnerability. Natural mortality (M), calculated using the method of **Hoenig and Lawing (1982)**, reflected typical values for tropical and subtropical fish populations **(Jørgensen & Holt, 2013)**. The low recruitment length (Lr) suggests that very small mesh sizes are in use, preventing escapement and reducing the likelihood that individuals spawn before capture **(Pauly, 1984)**.

The present results also revealed overfishing of *P. stridens* in Lake Temsah. Current exploitation rates (E = 0.79) greatly exceed the optimal reference point ($E_{0.5}$ = 0.41), requiring a reduction of ~48.2% to ensure sustainable spawning biomass. Similar findings were reported by **Mehanna (2022)** addressing the Gulf of Suez. On the other hand, **Avşar *et al.* (2021)** estimated lower mortality (Z = 1.14 $year^{-1}$, M = 0.66 $year^{-1}$, F = 0.48 $year^{-1}$, and E = 0.42), indicating less intense exploitation in other regions.

Management actions are therefore urgently needed to mitigate overfishing. Strategies could include reducing trawler numbers, limiting fishing duration, or modifying gear selectivity to allow escapement of smaller individuals. Such measures would help stabilize production, preserve spawning biomass, and support the long-term sustainability of the striped piggy stocks **(Osman *et al.*, 2019)**.

CONCLUSION

This study assessed mortality rates, relative yield-per-recruit, and parasitic infestations of the striped piggy (*Pomadasys stridens*) in Lake Temsah, Egypt. The isopod parasite *Livoneca redmanii* Leach, 1818 (Isopoda: Cymothoida) was identified, with a prevalence of 15% among examined specimens, and is considered one of the contributing factors to fish mortality.

Population dynamics analysis indicated that the stock of *P. stridens* in Lake Temsah is overexploited, with the current exploitation rate (E = 0.79) exceeding the optimum level ($E_{0.5}$ = 0.41). To achieve sustainable management, fishing pressure must be reduced by approximately 48.2%, thereby preserving adequate spawning biomass and ensuring long-term stock productivity.

RECOMMENDATIONS

Based on the present findings, it is recommended that exploitation levels of *Pomadasys stridens* in Lake Temsah be reduced to sustainable limits in order to preserve stock productivity and ensure effective fisheries management. In parallel, greater attention should be directed toward monitoring and controlling parasitic infestations, particularly those caused by *Livoneca redmanii*, as they represent an additional cause of mortality. Combining stock regulation with parasite management will be essential for sustaining the striped piggy population and maintaining the ecological and economic value of Lake Temsah fisheries.

Author Declaration

Conflicts of interest

The authors declare that they have no competing financial interests or personal relationships that could influence the work reported in this paper.

Data availability

Data and findings are available on reasonable requests and require permission from the corresponding author. No datasets were generated or analyzed during the current study.

Consent for publication
Not applicable.

Consent to participate
Not applicable.

Ethical permission
All reported procedures including samples collection, measurements and examinations were proceeded based on the committee of the National Institute of Oceanography and Fisheries for ethical care and use of animals and aquatic animals (NIOF/ IACUC) with approval number: NIOF-AQ2-F-24-R-035.

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REFERENCES

Abdallah, E.S.H. and Hamouda, A.H. (2022). *Livoneca redmanii* Leach, 1818 (Cymothoidae) a parasitic isopod infesting the gills of the European seabass, *Dicentrarchus labrax* (Linnaeus, 1758): morphological and molecular characterization study. *BMC Veterinary Research*, 18(1): 330. doi: https://doi.org/10.1186/s12917-022-03405-2.

Abdel-Latif, H. (2016). Cymothoid parasite, *Nerocila orbigni* inflicts great losses on *Tilapia zilli* in Lake Qarun at El-Fayoum Province. *International Journal of Innovative Studies in Aquatic Biology and Fisheries*, 2(3): 1-9.

Ali, N.G. and Aboyadak, I.M. (2018). Histopathological alterations and condition factor deterioration accompanied by isopod infestation in *Tilapia zilli*, *Mugil capito* and *Solea aegyptiaca* from Lake Qaroun. *Egyptian Journal of Aquatic Research*, 44(1): 57-63. doi: https://doi.org/10.1016/j.ejar.2018.03.001.

Amlacher, E. (1970). *Textbook of fish diseases*. T.F.H. Publications.

Avşar, D.; Mavruk, S.; Yeldan, H. and Manaşirli, M. (2021). Population dynamics of an emergent invasive fish, striped piggy, *Pomadasys stridens* (Actinopterygii, Perciformes, Haemulidae) in the Gulf of İskenderun, north-eastern Mediterranean. *Acta Ichthyologica et Piscatoria*, 51(1): 13-21. doi: 10.3897/aiep.51.63320.

Badawy, G. (1994). *Some studies on ectoparasites infecting marine fish in Egypt*. Ph.D. Thesis, Parasitology Department, Faculty of Veterinary Medicine, Zagazig University.

Ben-Tuvia, A. (1977). New records of Red Sea immigrants in the eastern Mediterranean. *Cybium*, 3: 95-102.

Beverton, R.J. and Holt, S.J. (1979). *Manual of methods for fish stock assessment. Pt. 2: Tables of yield functions* (Vol. 1).

Bunkley-Williams, L. and Williams, E.H. (1998). Ability of Pederson Cleaner Shrimp to Remove Juveniles of the Parasitic Cymothoid Isopod, *Anilocra haemuli*, from the Host. *Crustaceana*, 71(8): 862-869. doi: http://www.jstor.org/stable/20106067.

Colwell, M.A.; Hurley, S.J.; Hall, J.N. and Dinsmore, S.J. (2007). Age-Related Survival and Behavior of Snowy Plover Chicks. *The Condor*, 109(3): 638-647. doi: https://doi.org/10.1093/condor/109.3.638.

Eissa, I.; Ismail, M.M.; Abd El-Wahab, M.M.; Dessouki, A.A.; Abdel-Mawla, H.I. and Qorany, R.A. (2020). Mixed parasitic infestation in *Dicentrachus labrax*, *Dicentrachus punctatus* and *Sparus aurata* in Suez Canal. *International Journal of Fisheries and Aquatic Research*, 5(3).

El-Serehy, H.; Abdallah, H.; Al-Misned, F.; Alfarraj, S. and Al-Rasheid, K. (2018). Assessing water quality and classifying trophic status for scientifically based managing the water resources of the Lake Timsah, the lake with salinity stratification along the Suez Canal. *Saudi Journal of Biological Sciences*, 25(25): 1247-1256. doi: https://doi.org/10.1016/j.sjbs.2018.05.022.

Elgendy, M.Y.; Shaalan, M.; Abdelsalam, M.; Eissa, A.E.; El-Adawy, M.M. and Seida, A.A. (2022). Antibacterial activity of silver nanoparticles against antibiotic-resistant *Aeromonas veronii* infections in Nile tilapia, *Oreochromis niloticus* (L.), in vitro and in vivo assay. *Aquaculture Research*, 53(3): 901-920. doi: https://doi.org/10.1111/are.15632.

Eman, M.Y.; Nahla, H.S.; Eissa, I. and Mona, S.Z. (2014). Parasitological studies on the isopoda (Cymothoidae) parasites infesting some marine fishes at Suez Canal area at Ismailia Province, Egypt with a key to the cymothoid genera. *Life Sciences*, 11(1): 227-231.

Fadel, A.; Bessat, M. and Abdel-Aziz, M. (2020). *Livoneca redmanii* (Isopoda, Cymothoidae) in meagre *Argyrosomus regius*: parasitological and molecular diagnosis and proposed control measure. *Diseases of Aquatic Organisms*, 140: 13-24. doi: https://doi.org/10.3354/dao03490.

Farrag, E. (2008). *Population dynamics and management of some sparid fish species in Abu Qir-Bay*. M.S. thesis, AlAzhar University, Cairo, Egypt.

Gulland, J. (1971). *The Fish Resources of the Ocean*.

Helal, A.M. and Yousef, O.E.A.Y. (2018). Infestation Study of *Livoneca redmanii* (Isopoda, Cymothoidae) on *Mugil cephalus* in Lake Qarun, Egypt. *Egyptian Academic Journal of Biological Sciences*, 10(1): 1-17. doi: 10.21608/eajbsz.2018.13425.

Hoenig, J. and Lawing, W. (1982). Estimating the total mortality rate using the maximum-order statistic for age. *International Counc. Exploration Sea. CM/D*, 7: 13.

Hoffman, G.L. (2019). *Parasites of North American freshwater fishes*. Cornell University Press.

Hoffman, G.L. and Sindermann, C.J. (1962). Common parasites of fishes. *Circular*, 0-17.

Jones, R. and Van Zalinge, N. (1981). Estimates of mortality rate and population size for shrimp in Kuwait waters. *Kuwait bulletin of marine science*, 2: 273-288.

Jørgensen, C. and Holt, R.E. (2013). Natural mortality: Its ecology, how it shapes fish life histories, and why it may be increased by fishing. *Journal of Sea Research*, 75: 8-18. doi: https://doi.org/10.1016/j.seares.2012.04.003.

Mahmoud, N.E.; Abd Elwahab, A.M.; Abouwarda, M.M.; Khattab, M.S. and Ramadan, R.M. (2017). Further studies on Cymothoid isopods of some fish species from lake Qarun, Egypt. *Egyptian Veterinary Medical Society of Parasitology Journal (EVMSPJ)*, 13(1): 15-24. doi: 10.21608/evmspj.2017.37456.

Mehanna, S.F. (2022). Chapter four - Egyptian Marine Fisheries and Its Sustainability. In C.M. Galanakis (Ed.), *Sustainable Fish Production and Processing* (pp. 111-140). Academic Press. doi: https://doi.org/10.1016/B978-0-12-824296-4.00010-4.

Mohammed-Geba, K.; Sheir, S.K.; Aguilar, R.; Ogburn, M.B.; Hines, A.H.; Khalafallah, H.J.; El-Kattan, A.; Hassab El-Nabi, S.E. and Galal-Khallaf, A. (2019). Molecular and morphological confirmation of an invasive American isopod; *Livoneca redmanii* Leach, 1818, from the Mediterranean region to Lake Qaroun, Egypt. *Egyptian Journal of Aquatic Biology and Fisheries*, 23(4): 251-273. doi: 10.21608/ejabf.2019.54062.

Nashaat, M.; Sabrah, M.M.; Shaaban, A.M.; Osman, H.M.; Geneid, Y.A. and AbouElmaaty, E.E. (2023). Morphological and SEM identification for mixed parasitic infestations in *Nemipterus japonicus* from the Western Gulf of Suez, Red Sea, Egypt. *Egyptian Journal of Aquatic Research*, 49(1): 67-73. doi: https://doi.org/10.1016/j.ejar.2022.10.004.

Noga, E.J. (2010). *Fish disease: diagnosis and treatment*. John Wiley & Sons.

Osman, H.M.; Saber, M.A. and El Ganainy, A.A. (2019). Population structure of the striped piggy *Pomadasys stridens* in the Gulf of Suez. *Egyptian Journal of Aquatic Research*, 45(1): 53-58. doi: https://doi.org/10.1016/j.ejar.2019.02.002.

Paperna, I. (1996). *Parasite infection and diseases of fish in Africa: An update*. Technical Paper 31. Food and Agriculture Organization, United Nations.

Pauly, D. (1983). Length-converted catch curves: a powerful tool for fisheries research in the tropics (part 1). *Fishbyte*, 1(2): 9-13.

Pauly, D. (1984). Length-converted catch curves: a powerful tool for fisheries research in the tropics (part 2). *Fishbyte*, 2(1): 17-19. doi: https://hdl.handle.net/20.500.12348/3577.

Qorany, R.A.M. and Mansour, S.M. (2023). Recent Advances in Diagnosis of Pseudomonas Septicemia in Relation to Isopods Infestation in *Pomadasys stridense*. *Egyptian Journal of Aquatic Biology and Fisheries*, 27(6): 297-316. doi: www.ejabf.journals.ekb.eg.

Rameshkumar, G. and Ravichandran, S. (2014). Problems caused by isopod parasites in commercial fishes. *Journal of Parasitic Diseases*, 38(1): 138-141. doi: https://doi.org/10.1007/s12639-012-0210-4.

Rikhter, V. and Efanov, V. (1976). On one of the approaches to estimation of natural mortality of fish populations. *International Commission for the Northwest Atlantic Fisheries*.

Safi, A.; Khan, M.A. and Khan, M.Z. (2014). Study of some morphometric and meristic characters of striped piggy fish, *Pomadasys stridens* (Forsskal, 1775) from Karachi Coast, Pakistan. *Journal of Zoological studies*, 1(4): 1-6. doi: https://www.researchgate.net/publication/277713267.

Shaheen, A.; Abd El Latif, A.; Elmadawy, R. and Eldeen, N.A. (2017). Isopodiosis in some fishes from Egyptian Qaroun Lake: prevalence, identification, pathology and in vitro trials to get rid of it. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, 8(1): 1971.

Tanrikul, T.T. and Percin, F. (2012). Ectoparasitic sea lice, *Caligus minimus* (Otto 1821, Copepoda: Caligidae) on Brawn wrasse, *Labrus merula* L., in Izmir Bay, Aegean Sea. *Italian Journal of Animal Science*, 11(2): e38. doi: https://doi.org/10.4081/ijas.2012.e38.

Taylor, C.C. (1960). Temperature, growth, and mortality–the pacific cockle. *ICES Journal of Marine Science*, 26(1): 117-124.

Thamban, A.P.; Kappalli, S.; Kottarathil, H.A.; Gopinathan, A. and Paul, T.J. (2015). *Cymothoa frontalis*, a cymothoid isopod parasitizing the belonid fish *Strongylura strongylura* from the Malabar Coast (Kerala, India): redescription, description, prevalence and life cycle. *Zoological Studies*, 54(1): 42. doi: https://doi.org/10.1186/s40555-015-0118-7.

Ugbomeh, A. and Nwosu, O. (2016). Survey of cymothoid parasites associated with some estuarine fishes (Actinopterygii) from the upper reaches of the Bonny Estuary, Nigeria: their use in ecotoxicological studies. *Research journal of biological sciences*, 4(2): 34-41.

Ursin, E. (1967). A Mathematical Model of Some Aspects of Fish Growth, Respiration, and Mortality. *The Journal of the Fisheries Research Board of Canada*, 24(11): 2355-2453. doi: https://doi.org/10.1139/f67-190.

Wonodi, G.; Ugbomeh, A.P. and Gabriel, U.U. (2019). Determination prevalence of cymothoid parasite fish families in Iwofe (Port Harcourt) Rivers state. *African Journal of Biological Sciences*, 1(4): 58-67. doi: https://ssrn.com/abstract=3467474.

Yousif, A. (2004). Abundance of the striped piggy (*Pomadasys stridens*) in the Northwest Red Sea, Egypt. *Egyptian Journal of Aquatic Biology and Fisheries*, 8(3): 139-158.

Zayed, O.E.-S.; Hellal, A.M.; Zeina, A.F.; Tayel, S.I. and El-Tabakh, M.A.M. (2024). Morphological and molecular assessment of *Livoneca redmanii* Leach, 1818, and *Anilocra alloceraea* Koelbel, 1878 (Isopoda: Cymothoidae) from Egyptian waters. *Bulletin of the National Research Centre*, 48(1): 3. doi: https://doi.org/10.1186/s42269-023-01158-y.