Research Article

Reproductive Biology of Hamri Fish (*Carasobarbus luteus*) from Al-Chibyesh Marsh, South of Iraq

Faleh Musa Al-Zaidy, Abdul Hussein Jaafer Abdullah*, Falah Maarouf Mutlak and Ali Taha Yaseen

[1]*Department of Marine Vertebrate, Marine Science Center, University of Basrah, Iraq.*

Abstract | Due to the large reduction in the stock of Hamri fish, *Carasobarbus luteus* stock, the present research highlighted the most important aspects of reproductive biology of these fish from January to December 2021 in the Al-Chibyesh Marsh, southern Iraq. The work dealt with gonadosomatic index (GSI), fecundity, the relationship between reproductive and morphometric variables, and the length-weight equation of species. The study discussed the reasons that led to the dropping of the abundance and presence of current species in the marsh. A total of 686 fish (307 males and 379 females) were monthly collected from the study region. The total length of individuals differs from 13 cm in June to 26.20 cm in January. Gonadosomatic index (GSI) in the females was 5.51 in February and attained a peak of 11.96% in March, whereas the males fluctuated from 3.13 in February and attained a peak of 3.76 in March 2021. The absolute fecundity ranged from 2325 eggs at a total length of 24.50 cm and body weight of 238.70 g to 8702 eggs at a total length of 26.20 cm and body weight of 305 g. Weak relationships were detected between reproductive and morphometric variables, except the relation between total length and weight was strong (r = 0.912). Spawning season happened in March and was prolonged to April in two batches. The sex ratio attained 1:1.23 male to female. The present study concluded there were no variations in the fecundity of species, but the hydrological changes and habitat deterioration caused a decline in the species stock.

Received | September 14, 2025; **Accepted** | April 9, 2026; **Published** | August 13, 2026
***Correspondence** | Abdul Hussein Jaafer Abdullah, Department of Marine Vertebrate, Marine Science Center, University of Basrah, Iraq; **Email:** abdulhassain.abdulah@uobasrah.edu.iq
Citation | Al-Zaidy, F.M., A.H.J. Abdullah, F.M. Mutlak and A.T. Yaseen. 2026. Reproductive biology of hamri fish (*Carasobarbus luteus*) from al-chibyesh marsh, South of Iraq . *Sarhad Journal of Agriculture,* 42(4): 1325-1336.
DOI | https://dx.doi.org/10.17582/journal.sja/2026/42.4.1325.1336
Keywords | Fecundity, Spawning, Gonadosomatic index, weight, Length

Introduction

Fish are a primary source of nutrition for humans, providing them with healthy, easily digestible protein that helps build the body and repair damaged parts (Phogat *et al*., 2022). This species is an important commercial fish in southern Iraq and is highly sought after by the local population, its traps are widespread in the marshes and in the Tigris and Euphrates rivers and their tributaries (Jawad, 2021).

The reproductive biology of the freshwater species Hamri *Carasobarbus luteus*, especially fecundity, is essential to determining the stability of fish assemblages and their survival. Fecundity represents some important reproductive traits, which means the number of mature oocytes released from the females during the spawning season (Abdullah

and Al-Zaidy, 2022). Studying the reproductive features is fundamental and has an essential role in evaluating the status of species, discovering the effects of environmental shifts on the assemblage of fish, and examining the functioning of the ecosystem (Chakraborty, 2021).

There are several types of fecundity: batch fecundity, relative fecundity, annual population fecundity, total fecundity, potential annual fecundity, and annual realized fecundity (Jansen *et al*., 2021). Deferent factors can affect fish fecundity, which involves the reproductive timing, age, and size of the female and the environmental condition. Generally, in fish, the mature individuals represented by older and larger fish can have more fecundity than young or moderate-sized fish (He *et al*., 2023). These features enhanced the size and age composition in maintenance populations of fish, in addition to the availability of suitable environmental conditions of salinity, temperature, foods, and lotic freshwater habitats that can determine the success of reproduction (Koch and Narum, 2021). Moreover, the hydrological variations in the Al-Chibyesh marsh have a critical role in obstructing the reproductive cycles that cause a significant consequence on the success of the reproductive strategy of species (Hasan *et al*., 2022; Lianthuamluaia *et al*., 2024). The achievement of species' reproductive strategies is dependent on the transfer of genetic traits to the next offspring to create new generations possessing the ability to reproduce and recruit new individuals to maintain the continuity of the species (Abdullah and Al-Zaidy, 2022; Domínguez-Petit *et al*., 2022). Fish reproduction is critical to the survival and sustainability of species communities. Damages caused by increased exploitation, resulting in fishing mortality, must be repaired to maximize yield and stock conservation (Hilborn *et al*., 2020; Mignien and Stoll, 2024). The study of the reproduction of fish species has an important role in comparing the productivity of species in different periods, gaining knowledge of the range of influences, the changes, and in the conditions, and examining the reasons causing varying productivity.

Several studies on the reproductive biology of Hamri fish *C. luteus* were carried out to examine the reproduction cycle of present species (Bhatti and Al-Daham, 1978; Al-Daham and Bhatti, 1979; Ahmed *et al*., 1984; Epler *et al*., 1996; Abdullah and Al-Noor, 2015; Bilici *et al*., 2016).

The present study aims to gain insight into the reproductive biology of *Carasobarbus luteus* in the Al-Chibyesh marsh for investigating and assessing the fecundity of females, Gonaddosomatic index (GSI), relative fecundity, the relationship between reproductive metrics, and morphometric parameters to enhance the optimal understanding of the fish reproductive cycle that can contribute to better conservation plans of species and examine the stability of ecosystems over long-term time.

Materials and Methods

The Hamri fish *C. luteus* were monthly caught from Al-Chibyesh marsh from January to December 2021. The specimens were caught at the sites (N 31° 01′ 48", E 47° 04′ 12"). Different methods were used to capture samples of fish, including electro-fishing, gill nets (20×20, 24×24, 26×26, and 50×50mm mesh size, 25m long), and cast nets used in the deep rivers inside the marsh. The samples were preserved in the ice box and carried to the laboratory for the next work to conduct further measurements for mature specimens. Fish are classified according to Fricke *et al*. (2024). The body weight was measured to the nearest 0.1 g, the total length measured to the nearest 0.1 cm, the gonad length to the nearest 0.1 cm, the gonad weight to 0.1 g, and the egg dimeters estimated in microns (μ). The GSI index was measured three times in the month and accounted for in the present equation:

GSI index = gonad weight (g) / Body weight(g) *100

GSI represented the gonadosomatic index for fish. The number of eggs (absolute fecundity) was estimated by applying the gravimetric method (Bagenal, 1978). The ripe gonads of females were removed. Three secondary samples were taken from the gonads and counted from different sites of gonads, and then the average was calculated as the absolute fecundity. To estimate the relative fecundity, we should use the following equation:

Relative fecundity = Absolute fecundity/body weight (g)

A micrometer (μ) was utilized to measure the eggs' diameters. The reproductive and morphometric parameters were done by using the correlation between length (cm) and weight (g), and the equation was shifted to a linear equation by using log form:

The successive equation determined relative fecundity:

$$W = a L^{b}$$ (Le Cren, 1951)

W is weight L represented length where (a) and (b) represented constants.

Log W= log a +b log x

The relative condition factor (Kn) was calculated using the below equation:

Relative condition factor $Kn = W_O / Wc$

Moreover, the calculated weight (Wc) is measured by the above length-weight equation, but the observed weight is addressed as (W_O).

The sex ratio was determined monthly for all samples, with an analysis of variance between the number of females and males. Determining age as in Gokçek and Akyurt, (2008) and Baboli and Sayahi, (2014) using scales taken from the dorsal area of the right side of the body of the sample that was examined. The scales were washed with 5% KOH and dried, then put between two glasses for a microscopic exam and read by projectina CH-9435 Heerbrugg, manufactured in Switzerland, to estimate the age group. The diagrams were drawn in Excel 2016.

Statistical analysis

The SPSS program version 20 was used to analyze the raw data. The analysis of variance (ANOVA) application was utilized to discover the significant differences between females and males in the gonadosomatic index (GSI). The same program examined the correlations among reproductive and morphometric characteristics of fish. Due to negative allometry growth (b< 3), test of student (t-test) utilized to analyze the algometric of (b) coefficient.

Results

Distribution length and weight of fish

A total of 686 specimens of Hamri *Carasobarbus luteus* sampled from Al-Chibyesh marsh south of Iraq from January to December 2021 differs from 33 individuals in December to 85 fish in May.

The fish's total length ranged from 13 cm in June to 26.20 cm in January. The total length means varied from 18.54 in November to 22.08 in March. The specimen's weight fluctuated from 53 g in November to 317.60 g in October, whereas the mean weight varied from 118.40 g in December to 184.31 g in March (Table 1).

Table 1: *The total length and weight, ranges and means of Carasobarbus luteus from Al-Chibyesh marsh from January to December.*

Month	No. of Fish	Total length (cm)		Weight (g)	
		Range	Mean ± SD	Range	Mean ± SD
January 2021	48	22.80 - 26.20	21.83 ± 1.20	135.30 - 205.00	177.37 ± 35.29
February	60	16.50 - 23.80	20.13 ± 0.98	121.20 - 210.90	147.79 ± 22.32
March	73	18.20 - 26.10	22. 08 ± 1.41	110.00 - 295.20	184.31 ± 37.66
April	68	14.00 - 24.00	20.09 ± 3.64	97.00 - 231.40	178.85 ± 127.99
May	85	15.50 - 25.00	21.29 ± 1.48	104.00 - 214.00	164.00 ± 36.94
June	44	13.00 - 24.00	19.39 ± 2.49	116.00 - 205.00	174.21 ± 93.29
July	47	17.00 - 25.30	20.84 ± 2.51	86.00 - 240.11	189.55 ± 61.55
August	37	19.00 - 23.00	20.12 ± 2.53	106.00 - 209.70	173.66 ± 70.99
September	71	19.50 - 26.20	20.87 ± 2.84	99.00 - 305.00	197.58 ± 145.84
October	70	19.00 - 25.00	21.80 ± 4.04	98.00 - 317.60	167.77 ± 100.91
November	50	14.00 - 22.00	18.54 ± 3.04	53.00 - 177.23	121.84 ± 104.41
December	33	15.00 - 22.50	18.89 ± 2.43	74.00 -185.00	118.40 ± 88.16

Gonadosomatic index (GSI)

Male and female gonads begin to appear and become distinct in November in the mature fish, and get a gradual development with a clear increase in weight and size. In April, they started to decline (Figure 1). The GSI values in the females continued to grow to a recoded 5.51 in February and attained the peak of 11.96 in March, then dropped to 6.07 in April and to the next months. The values of gonadosomatic index in the males exhibited a steady increase from November to reach 3.13 in February and attained the peak 3.76 in March, then declined in April (2.77) and the rest of the months.

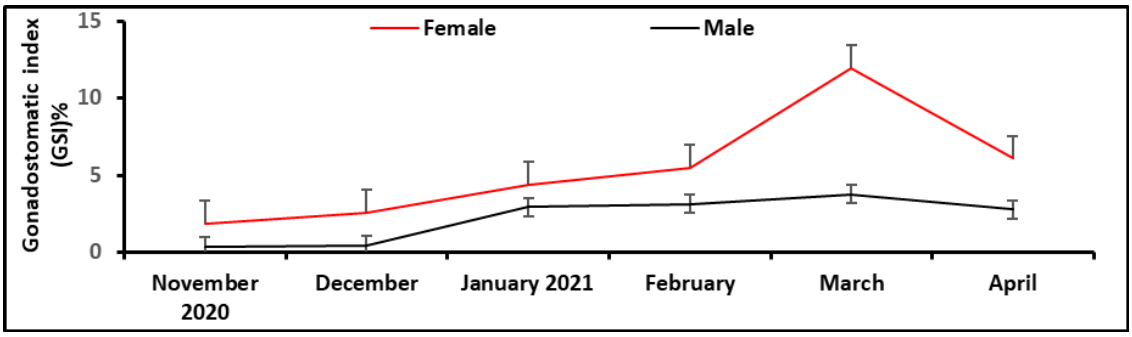


Figure 1: *Monthly changes in gonadosomatic index (GSI) of Carasobarbus luteus collected from Al-Chibyesh marsh. Error bars are represented standard deviation.*

Table 2: *Morphometric and reproductive parameters of the female hamri carasobarbus luteus fish total length (TL), absolute fecundity (AF), fish weight (W), gonad weight (GW), gonad length (GL), gonadosomatic index (GSI), relative fecundity (RF), and fish egg diameter (ED) were sampled from Al-Chibyesh marsh from January to December 2021.*

Total length Tl(cm)	Body weight	Gonad weight	Gonad length GL(mm)	GSI	Absolute fecundity	Relative fecundity	Egg diameter ED (µ)
	W(g)	GW(g)			AF	RF	
20.50	130.40	7.50	7.86	5.75	3988	30.58	591
20.80	136.30	11.10	8.30	8.14	5006	36.73	603
22.20	160.00	8.00	8.00	5.00	3777	23.61	607
22.50	191.60	12.40	10.00	6.47	4193	21.89	679
22.80	186.90	10.00	9.00	5.35	4297	22.99	665
23.00	211.90	8.00	8.00	3.78	2787	13.15	723
23.20	198.30	9.50	9.00	4.79	2692	13.57	694
23.20	186.90	12.00	9.00	6.42	7728	41.35	745
23.50	203.70	9.00	9.00	4.42	3516	17.26	641
24.00	210.90	8.00	9.00	3.79	2387	11.32	784
24.00	244.70	9.00	9.00	3.68	7744	31.65	821
24.50	238.70	10.00	10.00	4.19	2325	9.74	805
24.90	229.40	13.00	9.50	5.67	9125	39.78	768
25.00	234.40	9.00	9.00	3.84	3211	13.70	636
26.20	305.00	10.00	10.00	3.27	6231	20.38	790
26.00	295.20	13.70	10.50	4.64	8702	29.48	898
Mean 23.59	210.31	9.80	10.80	4.90	4857	23.57	715.63
S.D 1.74	1.56	1.56	0.72	1.37	2311.64	10.01	87.51

The present results noticed that all fish of this species appear to be single-spawning in two batches in March and prolonged to April, but some individuals tend to be in a partial spent in April. Generally, and at the same time, the male in spent status and gonads seem empty. The analysis of Variance analysis papers no significant difference in GSI ($P > 0.05$) between females and males (Sig. = 0.075, F = 3.939), in the present study area.

Reproductive and morphometric parameters

The measurements of the total length of the Hamri brooder fluctuated between 20.50 cm and 26.20 cm. The weight of the body ranged from 130.40g to 305.00g. Gonad weight differs from 7.50g at a total length of 20.50cm, body weight 130.40g to 13.70g at a total length of 26.00cm, and body weight 295.20g. Gonads length varied from 7.86mm at a total length of 20.50cm and a body weight of 130.40g to 10.50mm at a total length of 26.20cm and a body weight of 295.20g. The gonadosomatic index (GSI) ranged from 3.27 at a total length of 6.50 cm and body weight of 305.00 g to 8.14 at a total length of 20.80 cm and body weight of 136.30g. The absolute

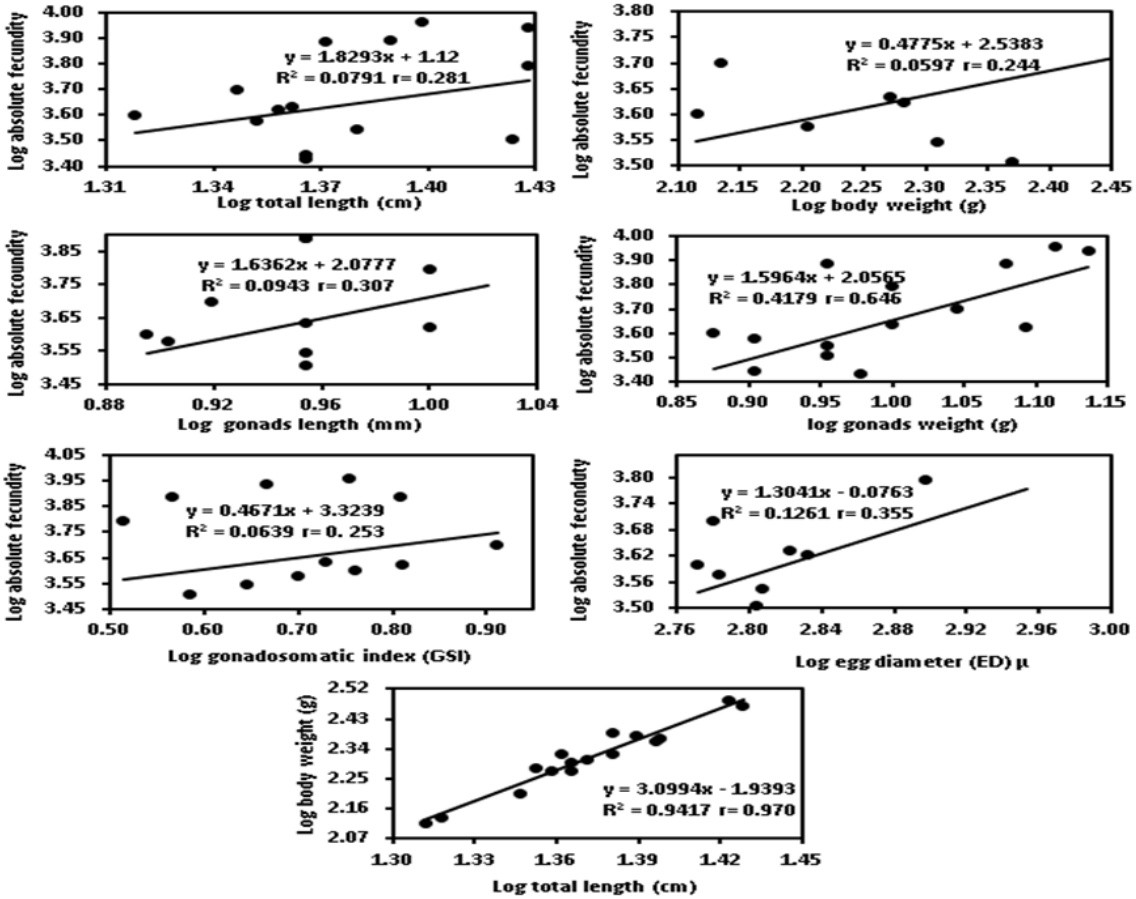


Figure 2: *The correlations between absolute fecundity and the total length, body weight, gonad length, gonad weight, egg diameter, GSI, body weight, and total length of Carasobarbus luteus females from Al-Chibyesh marsh.*

fecundity ranged from 2325 eggs at a total length of 24.50 cm and body weight of 238.70 g, to 8702 eggs at a total length of 26.20 cm and body weight of 305 g, with a mean of 197.58 ± 145.84. Relative fecundity fluctuated from 9.74 at a total length of 24.50 cm and body weight of 238.70 g to 41.35 at a total length of 23.20 cm and body weight of 186.90 g. The egg diameter ranged from 591 µ at a total length of 20.50 cm and body weight of 130.40 g to 898 µ at 6.80 cm and body weight of 295.20 g (Table 2).

The abbreviations inserted below can be used to express the equations as follows: AF = absolute fecundity, TL = total length, BW = fish body weight, GW = gonad weight, GL = gonad length, GSI = gonadosomatic index, ED = egg diameter.

A weak positive correlation coefficient (r = 0.281) was observed between absolute fecundity and total length; the equation is shown as: Log AF = 1.12 + 1.8293 log TL (Figure 2; Table 3).

A positive relationship was detected between the absolute and body weight of fish (r = 0.244), and we can record the equation as: Log AF = 2.5383 + 0.4775 log BW.

Table 3: *The correlations between reproductive and morphometric parameters of Hamri Carasobarbus luteus female from Al-Chibyesh marsh.*

Relationship		a	b	r
Y	X			
Absolute fecundity	Total length	1.12	1.83	0.281
Absolute fecundity	Body weight	2.54	0.47	0.244
Absolute fecundity	Gonad weight	2.06	1.59	0.646
Absolute fecundity	Gonad length	2.07	1.63	0.307
Absolute fecundity	GSI	3.32	0.46	0.253
Absolute fecundity	Egg diameter	- 0.07	1. 30	0.35
Body weight	Total length	-1.93	3.09	0.970

A weak positive relationship was noticed between absolute fecundity and fish gonad length coefficient (r = 0.307), and the equation can be addressed as: Log FA = 2.0777 +1.6362 log GL.

A strong positive correlation was found between absolute fecundity and gonads weight (r = 0.646);

the equation can be inserted as: Log FA = 2.0565 +1.5964 log GW.

A positive weak relationship coefficient (r = 0.233) was found between absolute fecundity and GSI; the equation has been addressed as: Log AF = 3.3239 + 0.4671 log GSI. A weak positive correlation coefficient (r = 0.355) was detected between absolute fecundity and the egg diameter; the equation has been inserted as: Log AF = -0.0763 +1.3041 log ED (μ).

A very positive forceful relationship coefficient (r = 0.970) was observed between body weight (g) and the fish's total length (cm), the equation addressed as: Log BW = -1.9393 + 3.0994 log TL.

Weight- length equation

The general relationship of weight-length of Hamri *C. luteus* in Al-Chibyesh marsh as in the express allometric coefficient figure (3), is as follows:

$$W = 0.0194\ L^{2.9442}$$

The exponent (b) in these equations appears to have fluctuated values during the different months of length groups of the fish community, which ranged between 19 and 26 cm, and body weight differed from 91 to 385 g. The exponent (b) was noted down 3 in December, January, and February, 2. 53, 2. 82, and 2.91, respectively, then increased to record 3.07 in March and dropped to 2.97 in April. The allometric coefficient in the present relationship refers to negative allometry for all fish (males and females) due to b < 3 (b < 3, t-test P < 0.05). A very strong correlation was found between weight and total length (r = 0.912) (Figure 3).

Relative condition factor (Kn)

There are obvious oscillations in Kn values of Hmri *C. luteus* in the study region during the study period, with a total length range of 19 to 26 cm and a weight range of 91 to 385 g. The present results show a gradual increase in the Kn values from January (0.91), February (0.95), and March (0.96), then started to drop in April and the lowest in May to record 0.95 and 0.78, respectively. The values peaked at 1.04 in September and then decreased to the lowest of 0.83 in December (Figure 4).

Sex ratio

A total of 686 specimens of Hamri *C. luteus* (307 males and 379 females) were sampled from Al-Chibyesh Marsh south of Iraq, from January to December 2021; the ratio of sex attained 1:1.23 males to females. The age group ratio differs from 1:0.00 in age group VII to 1:1.47 in age group IV. Analysis of variance announces the nonexistence of clear variations (P > 0.05) (Sig. = 0.952, F = 0.004) between the number of females and males (Table 4).

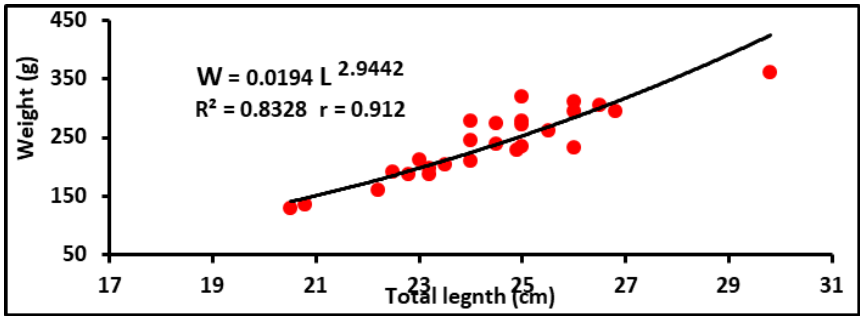
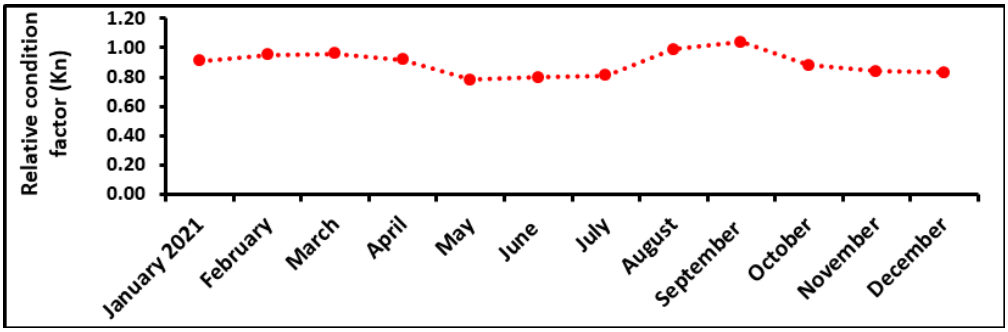


Figure 3: *Weight-length relationship of Hamri Carasobarbus luteus from Al-Chibyesh marsh south of Iraq.*



Figuer 4: *Monthly variations in the relative condition factor (Kn) values of Hamri Carasobarbus luteus from Al-Chibyesh marsh south of Iraq.*

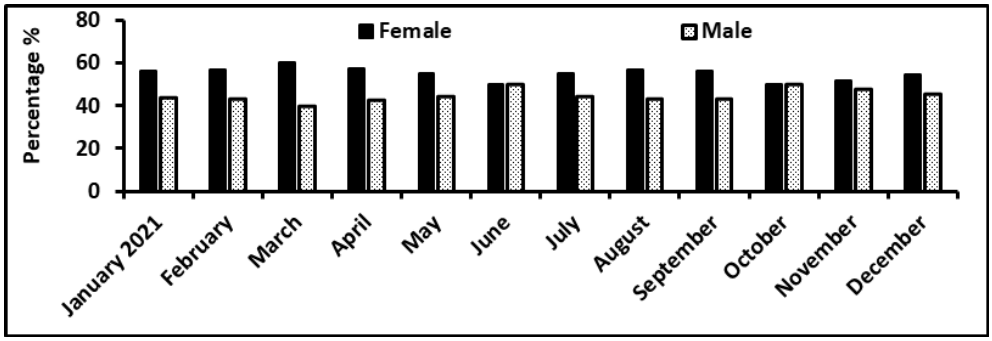


Figure 5: *Monthly variations in the sex-ratio of Hamri Carasobarbus luteus in from January to December 2021.*

The percentage of females varied from 50.00% in June and October to 60.27% in March. In the males, the percentage ranged from 39.73% in March to 50.00% in June and October (Figure 5).

Table 4: *The sex ratio of Hamri Carasobarbus luteus with age groups in the Al-Chibyesh marsh from January to December 2021.*

Number		Ratio	Age group
Females	Males	Female/males	
0	0	-	I
127	107	1:1.19	II
114	101	1:1.13	III
78	53	1:1.47	IV
38	29	1:1.31	V
21	17	1:1.24	VI
1	0	1:0.00	VII
379	307	1:1.23	Total

Discussion

Weight and length are very important parameters; they have a critical role in calculating the growth pattern of fish species, environmental conditions, and the health status of fish (Famoofo and Abdul, 2020). These parameters are widely applied in biological studies for fish and the management of fisheries. We can also extract one of these measures by using the other in the length-weight equation (Froese *et al.*, 2014). The weight-length relationship can be used as an indicator for discovered environmental conditions, pressures of fishing, and food availability; these equations vary with the seasons and life cycle stage (Karadurmuş, 2022; Nur *et al.*, 2023). The two parameters are mostly utilized in estimating the condition factor (K), which refers to the health status of fish populations and the suitability of habitats for the species (Ondemo *et al.*, 2022; Faruque and Das, 2024). The length-weight distribution data shows that large fish were caught in February and March for both males and females, which indicates reproductive migration and spawning operations, the results corresponding (Abdullah and Al-Noor, 2015; Abdullah and Al-Zaidy, 2022). Examined and noticeable size distribution of males and females during spawning season showed that males were slightly smaller than females in *C. luteus*. These consequences agreed with Abdullah and Al-Zaidy (2022) when they studied the fecundity of the Bunni *Mesopotamichthys sharpeyi* and found that males tend to be slightly smaller in size than females.

Values of GSI in the present study increased gradually in December to reach a peak in March; these signals indicate the development of gonads and maximum maturity in March, and a few individuals prolonged to April. Fish species maturity differs due to the differences in temporal and spatial in the geographical region; therefore, maturity differs with the diverse spatial distribution of fish (Werner *et al.*, 2016). Ahmed (1984) found that GSI in Hamri for females and males in Al-Hammar marsh took place in April, while Abdullah and Al-Noor (2015) mentioned that GSI values of Hamri reached maximum in April in both females and males (11.99% in females and 4.63% in males) in the north part of the Shatt Al-Arab River. Bilici *et al.* (2016) pointed out that the GSI of Hamri attained a peak in May (6.44% in females and 7.98% in males) in the Tigris River in Turkey. These differences in fish GSI values are due to fish status and distributions in the different geographical regions (Ahammad *et al.*, 2021).

Fecundity is a common phenomenon, and it varies according to the species and individuals and exhibits many changes due to weight, length, age, type of fish, season, and food availability (Abdullah and Al-Zaidy, 2022). The mean absolute fecundity in the present results ranged from 2325 to 8702 eggs; it seems less

than that of Abdullah and Al-Noor (2015), when they recorded the mean from 2098 to 14147 eggs. Bilici *et al*. (2016) found that the mean of absolute fecundity varied between 1672 and 14678 eggs; these results did not coincide with the current study; the differences may be due to spatial and temporal variations, water quality, food available, and fish status (Kumari *et al*., 2021; Chen and Lin, 2022). Generally, and about fish fecundity, increasing the length, body weight, and length and weight of the gonad enhances fertility and contributes to the success of the reproduction process and the transfer of genetic traits to subsequent generations of fish. Egg diameter (egg size) plays a critical role in the success of reproductive strategy. Large eggs have a large amount of yolk, which produces a large larvae brooder that gives the larvae more opportunity to pass the difficult conditions and possess a high chance of survival (Blaxter, 2023). However, the consequences indicate that spawning occurs during March in Al-Chibyesh marsh, when temperature and light periods are suitable for hatching. These factors play a critical role in determining the spawning time to allow the young larvae to feed and grow under optimal conditions (Li *et al*., 2021).

The reproductive and morphometric parameters refer to weak relationships between absolute fecundity and the total length, body weight, gonad length, and egg diameters. These poor correlations may be due to rising concentrations of salinity, habitat degradation, and anthropogenic effects that lead to limited growth, which determines the growth and dwarfism of fish (Ugrin *et al*., 2023; Zhang *et al*., 2023). The present study recorded a low correlation between fecundity and total length, body weight, gonads weight and length, and egg diameters compared to Ahmed *et al*. (1984); Al-Hazzaa (2005); Abdullah and Al-Noor (2015), while the study agrees with Bilici *et al*. (2016) in the values of correlations among reproductive and morphometric parameters.

Generally, fish size increases in weight and length from growth and exhibit development; these factors can evolve and progress via optimal temperature, food availability, suitable oxygen concentrations, and other environmental factors (Verberk *et al*., 2021). The weight-length equation is a standard relationship that provides reliable biological information used in assessing fisheries and biomass calculating of fish populations to use for comparing populations between regions and years (Dash *et al*., 2023; Dikou, 2023). The weight-length relationship is specific to species; it differs between geographical regions, species, and populations (Mahe *et al*., 2023). The values of (b) coefficients 3 (b =3) refer to allometric growth when b is larger than 3 (b >3), indicating isometric growth, and the fish became deeper and thicker bodies. The fish in thin elongated bodies have (b < 3) values less than 3 and have negative allometry (Ubong *et al*., 2023). The value of (b) in the present study is less than 3 (b = 2.9442), indicating negative allometric growth. Al-Hazzaa (2005) found an isometric pattern of growth (b) values ranging between 2.98 and 3.05. However, the values of (b) in fish can express growth patterns and sometimes refer to fish status from the development of gonads, feeding intensity, and fish health (Agumassie, 2018). The relative condition factor (Kn) measures the diversion of the individual from the mean weight and length (Suyani *et al*., 2021). Ogunola *et al*. (2018) pointed out that the relative condition factor is widely used in fish quantitative scale well-being status and expresses feeding condition. The relative condition factor shows the differences in the values of Kn in stages of life cycles, such as feeding intensity and the interaction between biotic and abiotic factors. Broadly, Kn values in the present study raised in two peaks, the first from January to March (0.91, 0.95, 0.96) respectively, which could be due to the development of gonads, while the second peak from August and September (0.99 to 1.04), attributed to increased feeding intensity (Abdullah and Al-Zaidy, 2022). Abdullah and Al-Noor (2015) mentioned the Kn of Hamri *C. luteus* caught in the northern part of the Shatt Al-Arab River differed from 0.74 in December to 1.24 in March, the differences due to fish status and feeding intensity. Mohamed's (2014) results, when he studied *C. luteus* in Al-Huwaiza marsh, Kn=1.00, correspond to the present finding and also converged with those of Mohamed and Al-Jubouri (2019), Kn values ranged from 0.82 to 1.05 when they studied the second type of Hamri *Carasobarbus sublimes* in the Al-Diiwanea, southern Iraq.

The status of the sex ratio indicates that the ratio of females/males shows few differences in the results compared with the previous studies such as those (Al-Hazzaa, 2005; Bilici *et al*., 2016), despite temporal and spatial variations, the difference in the populations, habitat, and condition factors.

The present consequences are that the reproductive time of Hamri *C. luteus* in the Al-Chibyesh marsh

was during March for most females. Still, a few individuals were prolonged to April in two batches, and all populations were found in a spent stage in May. Whatever the study found, there is a bad pattern of growth in the marsh, and the fish did not reach a large size due to habitat deterioration, increased fishing pressure, and a decline in water levels, so the study noticed a large reduction in the stock of this important commercial fish species.

Conclusions and Recommendations

The results showed no reduction in the fecundity of this species. Nevertheless, hydrological and environmental variables can negatively affect the presence of current species in the marsh, in addition to anthropogenic impacts and elevated pollutant levels. All these impacts have negative interactions on this fish species' life cycle.

Acknowledgment

The authors introduce the thanks and gratitude of the Marine Vertebrates Department, Marine Science Center, and Basrah University for supporting and declining the difficulties in completing the research.

Novelty Statement

The findings of this paper will contribute to new knowledge on the spawning behavior, gonadal development, and fertility of *Carasobarbus luteus*. Through this research, the current reproductive methods used by the red snapper in response to environmental change can be identified, which will help in managing the fisheries industry.

Author's Contribution

Faleh Musa Al-Zaidy: Designed the experimentation
Abdul Hussein Jaafer Abdullah: Wrote the first draft of the manuscript and wrote the manuscript
Falah Maarouf Mutlak: Wrote the first draft of the manuscript and wrote the manuscript
Ali Taha Yaseen: Analyzed the data

Generative AI and AI-assisted technology statement
The authors declare that no generative AI and AI assisted technology was used in the creation of this manuscript.

Conflict of interest
The authors have declared no conflict of interest.

References

Abdullah, A.H. J. and F. M. Al-Zaidy. 2022. Reproductive Biology of the Bunni *Mesopotamichthys sharpeyi* (Gunther, 1874) from Southern Missan Province Marshes, Southern Iraq. Egypt. J. Aquat. Biol. Fisher., 26(3): 347-358. https://ejabf.journals.ekb.eg/article_241691.html

Abdullah, A.H.J. and S.S. Al-Noor. 2015. Observations on some reproductive features of *Carasobarbus luteus* (Heckel, 1843) from the Shatt Al-Arab River, Southern Iraq. Mesopot. J. Mar. Sci., 30(2): 142 – 151. https://doi.org/10.58629/mjms.v30i2.116

Agumassie, T. 2018. Overview of length-weight relationship, condition factor and size at first maturity of Nile tilapia *Oreochromis niloticus* (L.) in different water bodies of Ethiopia: a review. Green. J. Biolog. Sci., 8(3): 21-28. http://doi.org/10.15580/GJBS.2018.3.060618077

Ahmed, H.A., M.A. Al-Mukhtar, and H.Y. Al-Adhub. 1984. The reproductive biology of *Carasobarbus luteus* (Pisces, Cyprinidae) in Al-Hammar Marsh, Iraq Cybiu., 8 (4): 69-80. https://api.semanticscholar.org/CorpusID:89432877

Ahammad, A.S., N.A. Hasan, M.M. Haque, A. Bashar, M.B.U. Ahmed, M.A. Alam, and Y. Mahmud. 2021. Environmental factors and genetic diversity as drivers of early gonadal maturation: a gonadosomatic index based investigation on Indian Shad, *Tenualosa ilisha* Population of Bangladesh. Front. Mar. Sci., 8: 758868. https://doi.org/10.3389/fmars.2021.758868

Al-Daham, N.K. and M.N. Bhatti. 1979. Annual changes in the ovarian activity of the freshwater teleost *Barbus luteus* (Heckel) from Southern Iraq. J. Fish Biol., 14 (4): 381-387.

Al-Hazzaa, R. 2005. Some biological aspects of the himri barbel, *Barbus luteus*, in the intermediate reaches of the Euphrates River. Turk. J. Zool., 29(4): 311-315. https://journals.tubitak.gov.tr/zoology/vol29/iss4/4/

Bagenal, T. 1978. Methods for the assessment of fish production in freshwaters, 3rd ed. Blackwell Sci. Publ. Oxford, pp. 365.

Baboli, M.I. and A. Sayahi. 2014. Age and growth of *Carasobarbus luteus* in Karkheh River, Southwestern Iran. Environm. and Experim. Biol., 12: 107-111.

Bhatti, M.N. and N.K. Al-Daham. 1978. Annual cyclical changes in the testicular activity of the freshwater teleost, *Barbus luteus* (Heckel) from Shatt Al-Arab, Iraqi J. Fish Biol., 13: 321-326. https://scite.ai/reports/annual-cyclical-changes-in-the-Ar1Pb3

Bilici, S., E. Unlu, T. Çiçek, and O. Satici. 2016. The reproductive biology of *Carasobarbus luteus* and *Capoeta trutta* in the Tigris River, Turkey. Cyb., 40(2): 147-153. https://doi.org/10.26028/cybium/2016-402-006.org/10.26028/cybium/2016-402-0

Blaxter, J.H.S. 2023. Development: eggs and larvae. In Fish Physiology. 40: 483-556. Academic Press. DOI: https://doi.org/10.1016/bs.fp.2023.09.011

Chakraborty, S.K. 2021. Ecology of Fishes of Rivers: Functional Roles. Riverine Ecology Volume 2: Biodiversity Conservation, Conflicts and X., B. Liu, and D. Lin, 2022. Sexual maturation, reproductive habits, and fecundity of fish. Biol. Fisher. Resour., 2: 113-142. https://colab.ws/articles/10.1007%2F978-981-16-6948-4_5

Chen, X., B. Liu, and D. Lin. 2022. Sexual maturation, reproductive habits, and fecundity of fish. In Biology of fishery resources (pp. 113-142). Singapore: Springer Nature Singapore . DOI: https://doi.org/10.1007/978-981-16-6948-4_5

Dash, G., S. Sen, R.K. Pradhan, S. Ghosh, J. Josileen and J. Jayasankar, 2023. Modeling framework for establishing the power law between length and weight of fishes and a meta-analysis for validation of LWRs for six commercially important marine fishes from the northwestern Bay of Bengal. Fisher. Resear., 257: 106496. https://eprints.cmfri.org.in/16301/

Dikou, A. 2023. Weight–length relationship in fish populations reflects environmental regulation on growth. Hydrobiol., 850(2): 335-346. https://doi.org/10.1007/s10750-022-05072-8

Domínguez-Petit, R., C. García-Fernández, E. Leonarduzzi, K. Rodrigues and G.J. Macchi, 2022. Parental effects and reproductive potential of fish and marine invertebrates: Cross-generational impact of environmental experiences. Fish., 7(4): 188. https://doi.org/10.3390/fishes7040188

Epler, P., M. Sokolowska-Mikolajczyk, W. Popek, K. Bieniarz, D.E. Kime, and R. Bartel, 1996. Gonadal development and spawning of *Barbus sharpeyi*, *Barbus luteus* and *Mugil hishni* in fresh and saltwater lakes in Iraq. Archiw. Rybact. Polsk., 4(1): 113-124.

Famoofo, O.O. and W.O. Abdul. 2020. Biometry, condition factors and length-weight relationships of sixteen fish species in Iwopin fresh-water ecotype of Lekki Lagoon, Ogun State, Southwest Nigeria. Heliy., 6(1): e02957. https://doi.org/10.1016/j.heliyon.2019.e02957

Faruque, M.H. and R. Das. 2024. Size-specific variations in the length-weight relationship and relative condition factor of Hilsa shad (*Tenualosa ilisha*) across its habitats in Bangladesh. Heliy., 10(13) e33586. https://doi.org/10.1016/j.heliyon.2024.e33586

Fricke, R., W.N. Eschmeyer and R. Van der Laan (eds). 2024. Eschmeyer's Catalog of Fishes: Genera, Species, References. (http://researcharchive.calac ademy.org/research/ichthyology/ catalog/fishcatmain.asp). Electronic version accessed dd mmm. http://researcharc hive.calacademy.org/research / ichthyology/catalog/fishc atmain.asp

Froese, R., J.T. Thorson and R.B. Reyes Jr. 2014. A Bayesian approach for estimating length-weight relationships in fishes. J. Appl. Ichthyol., 30(1): 78-85. https://doi.org/10.1111/jai.12299

Gokçek, K. and I. Akyurt, 2008. Age and growth characteristics of himri barbel *Barbus luteus* in Orontes River, Turkey. Turk. J. Zool., 32(4): 461- 467. https://journals.tubitak.gov.tr/zoology

Hasan, M.R., M.Y. Hossain, Z. Mawa, and M.A. Hossain. 2022. Reproductive biology of *Heteropneustes fossilis* in a wetland ecosystem (Gajner Beel, Bangladesh) in relation to eco-climatic factors: Suggesting a sustainable policy for aquaculture, management, and conservation. Saudi J. Biolog. Sci., 29(2): 1160-1174. https://doi.org/10.1016/j.sjbs.2021.09.050

He, W., H. Gao, C. Zhou, W. Wang, and Y. Liu. 2023. A Review of the Age, Growth Characteristics, and Population Resources of *Ptychobarbus dipogon* in the Middle and Upper Reaches of the Yarlung Zangbo River.

Wat., 15(9): 1713. https://doi.org/10.3390/w15091713

Hilborn, R., R.O Amoroso, C.M. Anderson, J.K. Baum, T.A. Branch, C. ostello, and Y. Ye. 2020. Effective fisheries management instrumental in improving fish stock status. Proceed. Nation. Acad. Sci., 117(4): 2218-2224 https://doi.org/10.1073/pnas.1909726116

Jansen, T., A. Slotte, T.C. dos Santos Schmidt, C.R. Sparrevohn, J.A. Jacobsen and O.S. Kjesbu. 2021. Bioenergetics of egg production in Northeast Atlantic mackerel changes the perception of fecundity type and annual trends in spawning stock biomass. Progr. Oceanograp., 198: 102658. https://doi.org/10.1016/j.pocean.2021.102658

Jawad, L.A. 2021. Freshwater fish biodiversity in Iraq: importance, threats, status, and conservation challenges. In Tigris and Euphrates Rivers: Their Environment from Headwaters to Mouth (pp. 479-497). https://doi.org/10.1007/978-3-030-57570-0

Karadurmuş, U. 2022. Length–weight relationship and condition factor of sixteen demersal fish species from the Southern part of the Marmara Sea, Turkey. J. Ichthyol., 62(4): 543-551. DOI: https://doi.org/10.1134/S0032945222040105

Koch, I.J. and S.R. Narum. 2021. An evaluation of the potential factors affecting lifetime reproductive success in salmonids. Evolution. Applicat., 14(8): 1929-1957. https://doi.org/10.1111/eva.13263

Kumari, S., U.K. Sarkar, G. Karnatak, S.K Mandhir, L. Lianthuamluaia, V. Kumar, and B.K. Das. 2021. Food selectivity and reproductive biology of small indigenous fish Indian river shad, *Gudusia chapra* (Hamilton, 1822) in a large tropical reservoir. Environm. Sci. Pollu. Resear., 28(9): 11040-11052. https://doi.org/10.1007/S11356-020-11217-W

Le Cren, E.D. 1951. The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). J. Anim. Ecol., 20: 201-219.

Li, T., K. Mo, J. Wang, Q Chen, J. Zhang, C. Zeng and P. Yang 2021. Mismatch between critical and accumulated temperature following river damming impacts fish spawning. Sci., Tot. Environ., 756: 144052. https://doi.org/10.1016/j.scitotenv.2020.144052

Lianthuamluaia, L., B.K. Das, P.K. Parida, G. Karnatak, A. Roy, A.K. Das, and S. Bhattacharya. 2024. Fish Production Patterns, Indigenous Fish Diversity, and Environmental Influences in a Tropical Floodplain Wetland: Implications for Livelihood and Nutrition. Sustain., 16(24): 11146. https://doi.org/10.3390/su162411146

Mahe, K., J. Baudrier, A. Larivain, S. Telliez, R. Elleboode, E. Bultel, and L. Pawlowski. 2023. Morphometric Relationships between Length and Weight of 109 Fish Species in the Caribbean Sea (French West Indies). Anim., 13(24): 3852. https://doi.org/10.3390/ani13243852

Mignien, L. and S. Stoll 2024. Reproductive success of stream fish species in relation to high and low flow patterns: The role of life history strategies and species traits. Sci. Tot. Environ., 946, 174366 https://doi.org/10.1016/j.scitotenv.2024.174366

Mohamed, A.R.M. and M.O. Al-Jubouri. 2019. Observations on biological properties of the cyprinid fish, *Carasobarbus sublimus* in the Al-Diwaniya River, Middle Euphrates, Iraq. J. Agricult. Veterin. Sci., 12(1): 38- 44. DOI: https://doi.org/10.9790/2380-1201013844

Mohamed, A.R.M. 2014. The status of Himri fish, *Barbus luteus* (Heckel) population in the Al-Huwazah marsh, south Iraq. J. Zankoy Sulaimani- Part A, 16(special): 303-314. DOI: https://doi.org/10.17656/jzs.10333

Nur, M., T. Tenriware and A.F.A. Nasyrah. 2023. Length-weight relationship and condition factor of bullet tuna (*Auxis rochei Risso*, 1810) in the waters of Mamuju District, West Sulawesi Province, Indonesia. Biodiversitas J. Biologl. Divers., 24(10): 5253-5259. https://doi.org/10.13057/biodiv/d241005

Ogunola, O.S., O.A. Onada, and A.E. Falaye. 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. Fisher. and Aquatic. Sci., 21(1): 1-15. https://doi.org/10.1186/s41240-018-0087-y

Ondemo, F.M.E., A. Getabu, Z. Gichana and J.O. Omweno 2022. Length-weight relationships (LWRs) and condition factor of seven fish species in River Nyangweta Tributary, Kenya. J. Engineering Resear. Sci., 1(3): 193-199. https://dx.doi.org/10.55708/js0103020

Phogat, S., T. Dahiya, M. Jangra, A. Kumari, and

A. Kumar. 2022. Nutritional benefits of fish consumption for humans: A review. Internat. J. Environm. and Climate Chan., 12(12): 1443-1457. https://doi.org/10.9734/ijecc/2022/v12i121585.

Suyani, N.K., M. Rajesh, K.M. Rajesh, M.M. Meshram and K. Vandana. 2021. Morphometry, length-weight relationship and relative condition factor of red-toothed trigger fish, *Odonus niger*. J. Environm. Biol., 42(4): 1026-1032. http://eprints.cmfri.org.in/id/eprint/13911

Ubong, G., A. Nsikak Okon and U. John Etitigwun. 2023. Assessment of Length-Weight Relationship of Nile Tilapia *Oreochromis niloticus* (Linnaeus 1758) from Qua Iboe River Estuary, Southeastern, Nigeria Asian J. Biol., 17(2): 21-33. DOI:https://doi.org/10.9734/ajob/2023/v17i2318

Ugrin, N., A. Paladin and S. Krstulović Šifner. 2023. Fecundity, Length at First Sexual Maturity and Gonadal Development of *Lepidorhombus boscii* in the Eastern Adriatic Sea. Biol., 12(1): 131(1-15). https://doi.org/10.3390/biology12010131

Verberk, W.C., D. Atkinson, K.N. Hoefnagel, A.G. Hirst, C.R. Horne, and H. Siepel. 2021. Shrinking body sizes in response to warming: explanations for the temperature-size rule with special emphasis on the role of oxygen. Biolog. Rev., 96(1): 247-268. DOI: https://doi.org/10.1111/brv.12653

Werner, K.M., A. Staby, and A.J. Geffen 2016. Temporal and spatial patterns of reproductive indices of European hake (*Merluccius merluccius*) in the northern North Sea and Norwegian coastal areas. Fisher. Resear., 183: 200-209. https://doi.org/10.1016/j.fishres.20

Zhang, T., N. Du, Z. Geng, S. Wang, Y. Gao, G. Yang, and F. Zhao. 2023. Estimation of estuarine habitat degradation and its influence on the reproduction process of the crab *Eriocheir sinensis* in the Yangtze River Estuary. Ecolog. Process., 12(1): 59. https://doi.org/10.1186/s13717-023-00473-6