Indian Journal of Geo Marine Sciences
Vol. 52 (10), October 2023, pp. 477-484
DOI: 10.56042/ijms.v52i10.11640

Length-weight relationship and condition factor of seven live bait fishes captured from the nearshore lagoon of Agatti Island (Lakshadweep), India

M U Rekha[a,b], T Haslamathbi[a,b], D S Deepa[a,b], T K Teena Jayakumar[a,b], T T Ajith Kumar*[,a] & K K Lal[a]

[a]ICAR-National Bureau of Fish Genetic Resources, Lucknow, Uttar Pradesh – 226 002, India

[b]Kerala University of Fisheries and Ocean Studies, Kochi, Kerala – 682 506, India

*[E-mail: ttajith87@gmail.com]

17 October 2022; revised 28 September 2023

The Length-Weight Relationships (LWRs) of seven live-bait fishes namely, *Rhabdamia gracilis*, *Zoramia leptacantha*, *Verulux cypselurus*, *Gymnocaesio gymnoptera*, *Chromis viridis*, *Chrysiptera brownriggii* and *Lutjanus kasmira* found in Lakshadweep waters were determined in the current study. The specimens were captured from Agatti Island lagoons, using lift nets and encircling nets at depths ranging from 2 to 10 m. This data collection spanned from January 2021 to March 2022. The estimated *b* values ranged from 3.09 to 3.38 for *G. gymnoptera* and *Z. leptacantha*, respectively. The coefficient of determination (r^2) ranged from 0.99 (*G. gymnoptera*) to 0.89 (*V. cypselurus*). The study provides insight into the biological details of these live bait fishes, which support traditional tuna pole and line fishing in Lakshadweep waters.

[**Keywords**: K-factor, Lagoon, LWR, Tuna pole and line fishery]

Introduction

The live bait-based tuna fishing in Lakshadweep holds a critical position in the local economy and the fisheries sector, building upon traditional practices by incorporating a sustainable element, the use of live bait. Fishermen strategically deploy live baitfish from specialized wells or tanks aboard fishing vessels to entice tuna schools, adopting a targeted pole and line approach that minimizes bycatch and reduces the fishery's ecological footprint. To maintain the ecological balance, it's crucial to manage the extraction of baitfish species and ensure their natural replenishment, contributing to the long-term health of the marine ecosystem in Lakshadweep.

The lagoons and shallow reef areas of Lakshadweep provide an ideal habitat for live baitfishes. Out of the 45 baitfish species documented in earlier studies[1], only 21 from five families are commonly captured. Key characteristics of a good live bait fish include a length below 15 cm, reflective lateral surface, a tendency to flee towards the surface, hardiness, and a tendency to return to the boat[2]. The live baits collection methods involve using two types of nets: an encircling net made of nylon mosquito net for catching schools of sprat, like *Spratelloides delicatulus* (Bennett, 1832), in shallow sandy areas, and a lift net made of 6 mm nylon netting for capturing colonies located with the help of a diver. However, practices such as harvesting live baits during spawning seasons, night-time fishing with torchlight assistance, and overharvesting have intensified fishing pressure, leading to a decline in wild stocks[3]. Current exploitation rates exceeding the Maximum Sustainable Yield (MSY)[4], necessitate urgent monitoring and intervention to sustain their wild population.

The availability and distribution of live bait species in Lakshadweep Islands is well-documented; however, there exists limited information on their biological details. The current study addresses this gap by presenting the Length-Weight Relationships (LWRs) and condition factor (K) of seven live baitfish species. Understanding LWRs is crucial for establishing the mathematical relationship between length and weight, enabling comparisons within and between different populations[5]. This mathematical relationship serves as a practical index for comprehending survival, growth, maturity, reproduction, and overall well-being, facilitating life history characterization and morphological comparisons between different fish species or populations[6]. Length-weight relationships offer valuable insights into biology, ecology, physiology, population dynamics, general conditions, etc.

Mathematically, LWR describes the relationship between fish length and body mass, facilitating the translation of length annotations into weight approximations for biomass measurement[7].

Fish condition is frequently assessed using the condition factor, where a heavier fish of a given length is considered to be in better physiological condition[8,9]. Studies on fish condition parameters serve as useful, inexpensive, and easy measurement tools for understanding fecundity, reproduction, growth, and mortality rates of fishes[10-13], as well as for monitoring fat levels in the body, gonadal development[14], and studying the reproductive status of fish.

In this context, the present study reports the LWR and condition factor of seven live baitfish species aiming to assist in live bait growth, biomass estimation, stock assessment models, and their population studies in Lakshadweep waters. Additionally, it facilitates comparisons between stocks, aiding in the live bait resource management in Lakshadweep waters. Notably, a previous study[15] reported the LWR of four live bait fishes, and this study builds on that knowledge by introducing seven more species *viz*. *Rhabdamia gracilis* (Bleeker, 1856), *Zoramia leptacantha* (Bleeker, 1856), *Verulux cypselurus* (Weber, 1909), *Gymnocaesio gymnoptera* (Bleeker, 1856), *Chromis viridis* (Cuvier, 1830), *Chrysiptera brownriggii* (Bennett, 1828), and *Lutjanus kasmira* (Fabricius, 1775).

Rhabdamia gracilis, *Z. leptacantha*, *V. cypselurus*, and *Taeniamia fucata*, collectively known as cardinal fishes in the Apogonidae family, thrive in Lakshadweep's lagoons and are often sighted among corals and rocks. These fishes are usually caught at night time, using lights. However, during the day, they are collected from lagoons at depths of 1 – 2 meters, using square lift nets. Renowned for their hardiness, these fishes show enhanced survival rates in live bait holding tanks, earning them the local name 'Bodhi'.

Gymnocaesio gymnoptera, a slender fusilier and the sole member of its genus in the Caesionidae family, swiftly moves in shoals within coral reefs and is captured with lift nets. It is commonly known as 'Mukram' and is seen at 5 – 6 m outside lagoons. These fishes display robust hardiness and high survival rates in bait tanks attached with the vessel making them ideal live bait for Yellowfin tuna and seer fish. These migratory fishes are temporarily associated with branched or massive coral colonies.

Chromis viridis, the blue-green damsel, congregates in groups over *Acropora* corals and represents resident forms. With a maximum length of 10 cm, these robust fish are excellent baits, uniquely used for catching Yellowfin tuna and lagoon fishes like trevally and groupers. Locally, these fishes are referred to as 'Pachachala'. *Chrysiptera brownriggii*, the surge damselfish in family Pomacentridae, primarily resides in rubble-strewn surge channels, outer reef flats, and the upper submarine terrace at 12 m. Displaying territorial behaviour, these fish often occur in groups and remain close to shelter. *Lutjanus kasmira*, known as 'Manja' locally, inhabits coral reefs in shallow lagoons and on outer reef slopes. Found in greater numbers in uninhabited island lagoons at depths of 1 to 2.5 m and are captured using an encircling net. *Lutjanus kasmira* serves as live bait for lagoon fishing, targeting larger groupers and snapper fishes at depths of 20 – 30 m.

Materials and Methods

Study area

The fish specimens were collected from the lagoons of Agatti Island of Lakshadweep (10°51'27.36" N, 72°11'36.24" E; Fig. 1) from January 2021 to March 2022 using encircling and lift nets having mesh sizes of 25 to 30 mm, operating at the depth of 2 – 10 m.

Methodology

Fish species were identified using standard identification keys and published documents[16-18], and the scientific names were validated by consulting Eschmeyer's Catalog of Fishes[19]. To establish the length-weight relationship, precise measurements of fish length to the nearest millimeter (mm) and total weight (W) to the nearest gram (g) were documented. A Vernier calliper (Mitutoyo, Japan) with an accuracy of 0.01 mm was employed for length measurements, while a digital balance (Sartorius, Germany) with an accuracy of 0.1 mg was used for weight measurements.

The LWR was determined using the formula $W = aL^b$, and the resulting data were transformed into a linear equation: $\text{Log } W = \text{Log } a + b \log L$[(ref. 14)]. In this equation, 'W' represents the total weight in grams, 'L' signifies the total length of the fish in centimetres, '*a*' denotes the intercept, and '*b*' represents the allometric coefficient or slope. Before the application of linear regression to

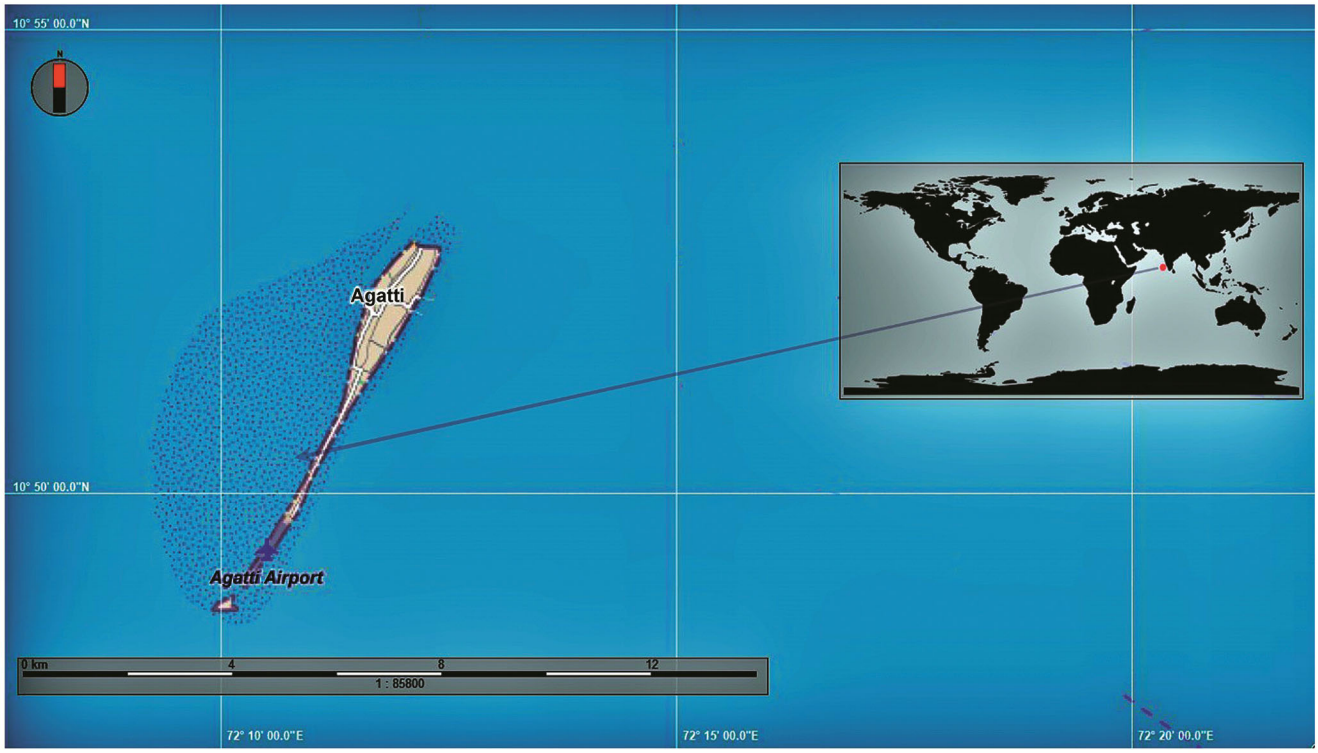

Fig. 1 — Layout of the sampling sites, Agatti Island, Lakshadweep

Table 1 — Number of live bait fishes collected from the lagoon of Agatti Island, Lakshadweep, India from January 2021 to March 2022

Species	*n*	Jan-21	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-22	Feb	March
Rhabdamia gracilis	138	-	-	54	-	-	-	-	12	-	30	14	-	-	-	28
Zoramia leptacantha	126	34	-	-	18	-	-	-	-	48	-	-	-	-	-	26
Verulux cypselurus	58	-	-	-	-	-	-	-	-	58	-	-	-	-	-	-
Gymnocaesio gymnoptera	128	-	-	20	-	-	-	-	-	-	-	-	-	-	-	108
Chromis viridis	176	-	32	-	-	-	-	31	32	35	-	-	46	-	-	-
Chrysiptera brownriggii	102	-	-	-	-	-	-	-	-	42	-	-	-	22	-	38
Lutjanus kasmira	52	-	-	-	-	-	-	-	-	39	-	-	-	-	13	-

log-transformed data, careful identification and removal of outliers were conducted[20]. Condition factor (K) was calculated using the formula $K = 100 \times (W/L^3)$, where 'W' is the total weight and 'L' is the total length in centimeters (cm)[21]. All subsequent statistical analyses were carried out using MS Excel 2010.

Results and Discussion

The study presents the first documentation of the Length-Weight Relationship (LWR) for *Z. leptacantha*, *V. cypselurus*, *G. gymnoptera*, and *C. brownriggii*. The number of fishes captured from Agatti Island, Lakshadweep from January 2021 to March 2022 is given in the Table 1. Due to the rough seas during the monsoon season, no live bait fishes were caught in May and June. Detailed information on each species, including scientific name, sample size (n), ranges of total length (cm), body weight (g), growth parameters '*a*' and '*b*', 95 % confidence limits (CL) of '*a*' and '*b*', and the coefficient of determination (r^2), are provided in Table 2. In this study, the LWRs for all seven species exhibited high significance, with

Table 2 — Descriptive statistics and estimated length-weight relationship parameters of seven live bait fishes collected from the lagoon of Agatti Island, Lakshadweep, India from January 2021 to March 2022

Family	Species	*n*	Total length (cm)		Total weight (g)		*a*	95 % *CI* of *a*	*b*	95 % *CI* of *b*	r^2
			Min	Max	Min	Max					
Apogonidae	*Rhabdamia gracilis* (Bleeker, 1856)	138	4	5.5	0.69	1.92	0.01	0.0055 – 0.0086	3.298	3.162 – 3.434	0.938
	Zoramia leptacantha (Bleeker, 1856)	126	3.5	5.2	0.61	2.53	0.01	0.0067 – 0.0115	3.383	3.212 – 3.454	0.926
	Verulux cypselurus (Weber 1909)	58	3.3	4.4	0.24	0.61	0.01	0.0022 – 0.0111	3.192	2.891 – 3.511	0.891
Caesionidae	*Gymnocaesio gymnoptera* (Bleeker, 1856)	128	5.2	11	1.2	11.5	0.01	0.0062 – 0.0076	3.092	3.044 – 3.139	0.992
Pomacentridae	*Chromis viridis* (Cuvier 1830)	176	4.9	10.1	1.76	14.8	0.01	0.0096 – 0.0138	3.132	3.055 – 3.244	0.961
	Chrysiptera brownriggii (Bennet 1828)	102	2.7	3.7	0.57	1.6	0.02	0.0154 – 0.0231	3.371	3.192 – 3.553	0.966
Lutjanidae	*Lutjanus kasmira* (Fabricius, 1775)	52	11.6	16.6	22.7	64.4	0.01	0.0087 – 0.0149	3.189	2.711 – 3.215	0.975

$p < 0.001$. An isometric growth was observed in *G. gymnoptera* ($b = 3.09$, $t = -97.30$, $p < 0.001$). Positive allometric growth was reported for *Z. leptacantha* ($b = 3.38$, $t = -34.97$, $p < 0.001$), *V. cypselurus* ($b = 3.19$, $t = -13.09$, $p < 0.001$), *R. gracilis* ($b = 3.30$, $t = -45.04$, $p < 0.001$), *C. brownriggii* ($b = 3.37$, $t = -39.85$, $p < 0.001$), *C. viridis* ($b = 3.13$, $t = -48.20$, $p < 0.001$) and *L. kasmira* ($b = 3.19$, $t = -4.74$, $p < 0.001$). Among them, *Z. leptacantha* demonstrated the highest '*b*' value (3.38), while *G. gymnoptera* exhibited the lowest (3.09). Notably, the coefficient of determination (r^2) exceeded 0.9 for all species, except for *V. cypselurus* (0.89). *Gymnocaesio gymnoptera* showcased the highest r^2 value (0.99), followed by *L. kasmira* (0.98), *C. brownriggii* (0.97), *C. viridis* (0.96), *R. gracilis* (0.94), and *Z. leptacantha* (0.93). The scatter diagram illustrating the LWRs of the studied species is depicted in Figure 2(a – g).

The allometric coefficient (*b*) values presented in this study for *R. gracilis*, *Z. leptacantha*, *V. cypselurus*, *G. gymnoptera*, *C. viridis*, *C. brownriggii*, and *L. kasmira* fall within the widely accepted range of 2.5 – 3.5[ref. 20]. However, it is crucial to note the absence of prior estimates for *Z. leptacantha*, *V. cypselurus*, *G. gymnoptera*, and *C. brownriggii*, hindering direct comparisons and validation of their respective *b* values. For *C. viridis*, the reported *b* value of 2.79 in Lakshadweep lagoons differs from the earlier study[22], which is possibly attributable to variations in specimen numbers and distinct oceanographic features. Furthermore, the exclusion of various biotic and abiotic factors in this study necessitates consideration of their potential influence on *b* values. The determination of LWRs is influenced by a myriad of factors including habitat, season, sex, gonad maturity, stomach fullness, diet, and overall health[23-25]. Previous investigations on *C. viridis* have reported *b* values of 2.52 and 2.90 from New Caledonia[26,27]. In the case of *R. gracilis*, there are no prior studies available in India, but a reported *b* value of 3.09 originates from Marudu Bay, Malaysia[28]. For *L. kasmira*, a species with varying *b* values, previous studies indicate 2.98 from Southern Africa[29], 3.01 from American Samoa[30], 3.12 from Guam[31], 3.14 and 3.15 from Mariana Archipelago[26,32], and 3.25 from New Caledonia[27]. These diverse findings underscore the need for further research to comprehend the factors influencing the observed variability in *L. kasmira* '*b*' values.

In the realm of fisheries science, LWRs serve as a fundamental tool for deriving quantitative measures related to crucial factors such as growth patterns, population dynamics, stock assessment, and biomass[33]. In the context of the present study, new length and weight ranges are presented for *Z. leptacantha* (3.5 to 5.2 cm, 0.6 to 2.5 g) and *G. gymnoptera* (5.2 to 11 cm, 1.2 to 11.5 g). Additionally, the LWRs of *V. cypselurus*, *Z. leptacantha*, *G. gymnoptera* and *C. brownriggii* are reported for the first time along with updated length and weight ranges for *C. viridis* (TL: 4.9 to 10.1 cm; W: 1.76 to 14.8 g) and a smaller length and weight (11.6 cm and 22.7 g) for *L. kasmira*.

Length-weight relationship analysis is crucial for understanding population dynamics and fisheries

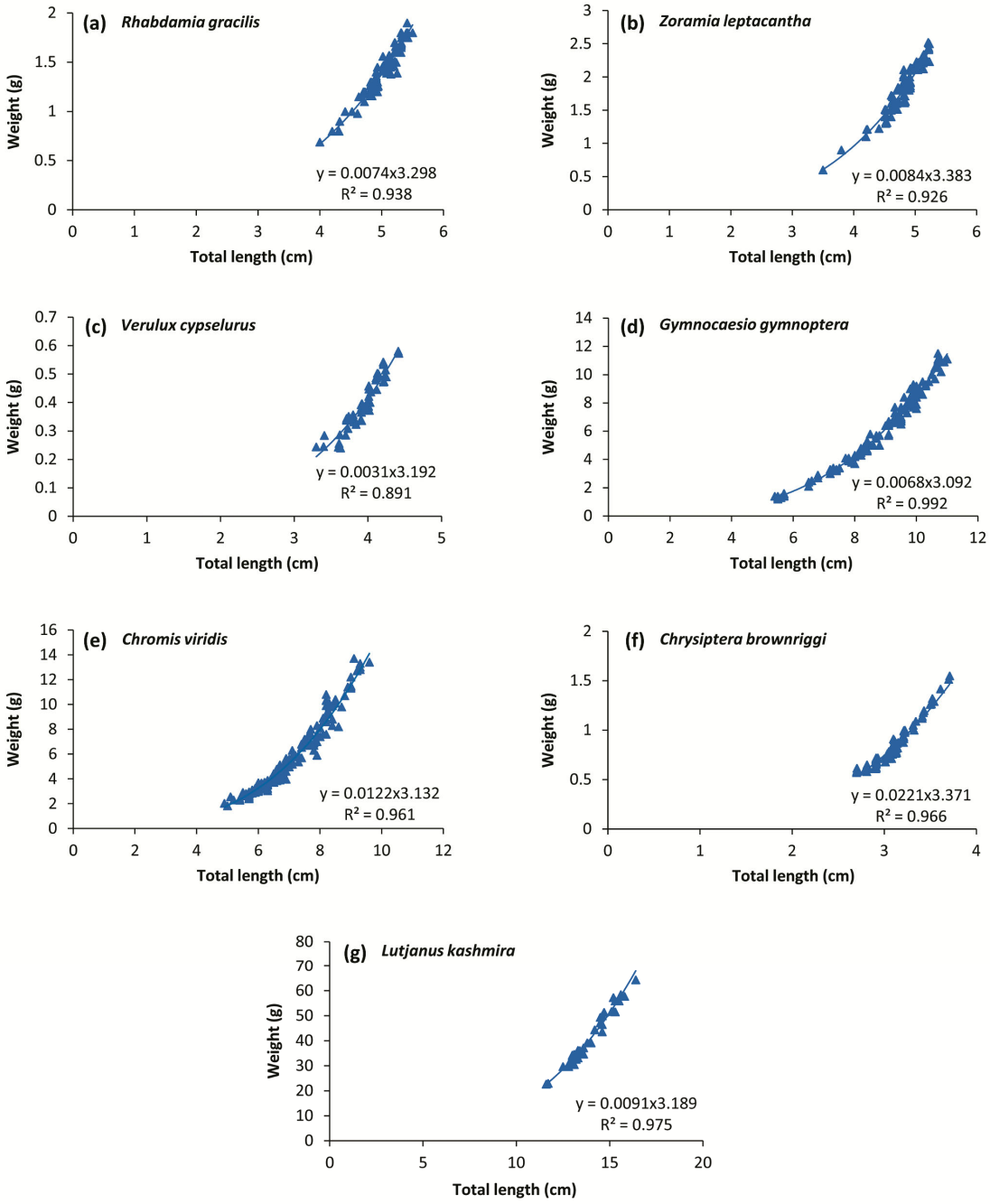

Fig. 2 — Scatter plot of LWRs: a) *R. gracilis*, b) *Z. leptacantha*, c) *V. cypselurus*, d) *G. gymnoptera*, e) *C. viridis* f) *C. brownriggii*, and g) *L. kasmira*

science, especially when direct weight measurements in the field are time-consuming. This analytical approach has diverse applications, such as calculating weight-at-age, evaluating fish condition, and comparing life history patterns across regions. Establishing a strong mathematical correlation between length and weight is essential, enabling the calculation of weight variations based on individual or group lengths. In fisheries science, this correlation reveals vital trends in fish life history, providing valuable insights for effective population management and conservation strategies[34-38].

The condition factor (K) serves as a crucial metric for evaluating feeding intensity, age, and growth rates

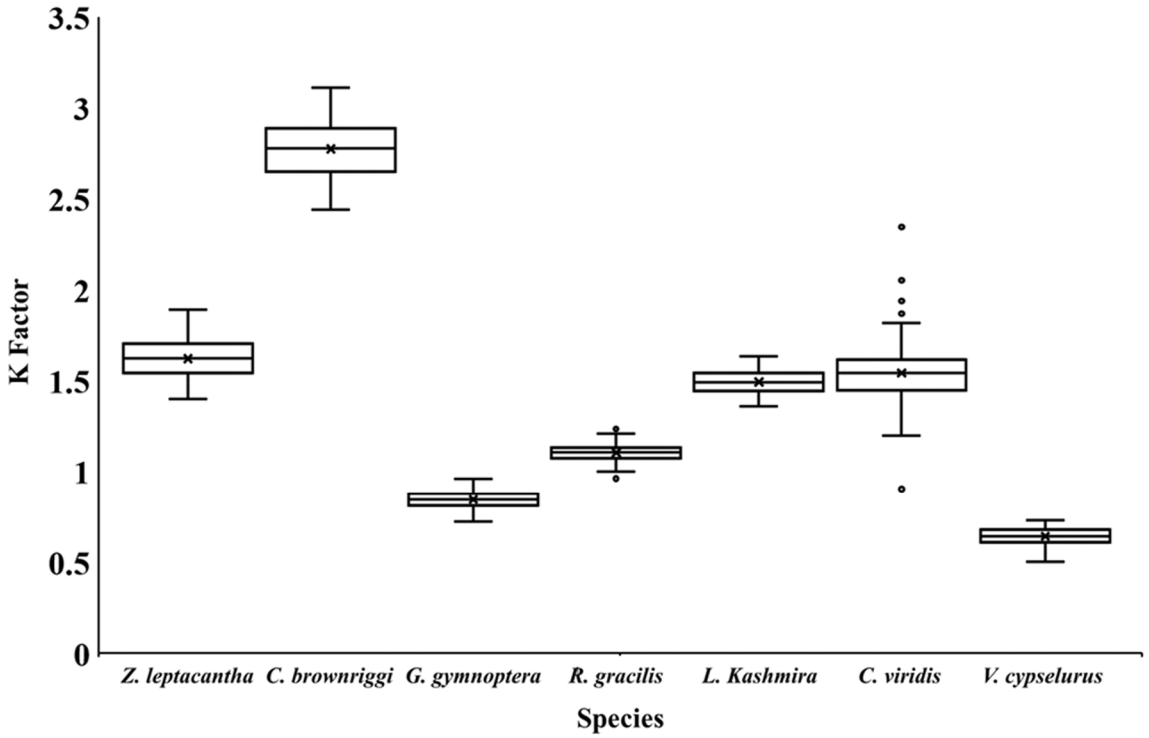

Fig. 3 — Condition factor (K value) of different live bait fish species

in fish. Pooled data were considered for K factor calculation, which revealed favourable relative K values for *C. brownriggii* (2.76), followed by *Z. leptacantha* (1.62), *C. viridis* (1.54), *L. kasmira* (1.49), *R. gracilis* (1.10), *G. gymnoptera* (0.84), and *V. cypselurus* (0.64) (Fig. 3). Conditions indicative of excellent fish growth are reflected when the K value approaches or exceeds one. The condition factor is further influenced by sexual dimorphism and seasonal fluctuations. Earlier studies underscore a significant decline in the K values among females during reproduction and spawning, attributed to diminished feeding and substantial energy loss[39]. As both biotic and abiotic environmental variables influence

K value, it serves as a measure to assess the integrity of the aquatic ecosystem. Factors such as sex, maturation stages, stomach condition, growth rate, distribution area, and differences between males and females can impact a fish's well-being, contributing to variations from previous reports.

The present study provides fundamental information on seven live bait fishes, establishing a valuable baseline for future biological comparisons. Additionally, this data aids in the effective conservation/management plan for live bait fish resources in Lakshadweep waters, complemented by the inclusion of various other biological parameters.

Conclusion

The comprehensive study conducted on seven live bait fish species from Agatti, Lakshadweep, focusing on length, weight, and condition factors, has contributed to understanding the morphometric variations among the studied species and shed light on their overall health and well-being. The examination of length and weight parameters has revealed important information about the growth patterns and size distribution of these live bait fish species. Moreover, the calculation of condition factors has offered a holistic perspective on the overall fitness and health status of the fish populations. Continued monitoring of these live bait fish species is essential for maintaining the delicate balance of the marine ecosystem and ensuring the sustainability of the fisheries industry at Lakshadweep as well as in India.

Acknowledgments

The authors thank the Director, ICAR-National Bureau of Fish Genetic Resources, for providing financial support (under the institute project

FISHNBFGRSIL 202100300229 at Lakshadweep), guidance, and encouragements.

Conflicts of Interest

The authors declare no conflict of interest.

Ethical Statement

Freshly deceased fish specimens were gathered directly from the traditional fishermen of Agatti Island, Lakshadweep. No animals were stressed or killed during the research and the study was carried out following the current animal welfare laws of India. The provisions of the Government of India's Wildlife Protection Act of 1972 do not apply to the studied fish species as they are not on the scheduled list.

Author Contributions

RMU: Design and implementation of the research, analysis of the results, and writing of the manuscript. HT & DDS: Measurements and data collection. TKTJ: Taxonomic identification of fishes and manuscript editing. TTAK & KKL: Planning and supervision of work.

References

1 Jones S, A preliminary survey of the common tuna live bait fishes of Minicoy and their distribution in the Laccadive Archipelago, In: *Proceedings of the Symposium on Scombroid Fishes*, Part 2, 12 – 15 January 1962, (Marine Biological Association of India, Mandapam, India), 1964, pp. 643-680.

2 Gopakumar G, Pillai P P & Koya K P, Said Population characteristics of tuna live baits in Lakshadweep, *J Mar Biol Assoc India*, 33 (1991) 255-277. http://eprints.cmfri.org.in/1194/

3 Koya M, Abdul A P, Rohit P, Sreenath K R, Rajesh K M, *et al.*, *Lakshadweep Live bait Fisheries Management Plan*, ICAR-CMFRI Marine Fisheries Policy Series No. 12, (ICAR-CMFRI, Kochi), 2019, pp. 56.

4 Sivadas M & Nasser A K V, Tuna Live baits, In: *Marine Fisheries Research and Management*, edited by Pillai V N & Menon N G, (CMFRI, Kochi), 2000, pp. 468-478.

5 Lagler K F, Bardach J E & Miller R R, *Ichthyology*, 1st Edn, (John Willey & Sons Inc, New York), 1962, pp. 546.

6 Jennings S, Kaiser M & Reynolds J D, *Marine fisheries ecology*, (John Wiley & Sons), 2009, pp. 417.

7 Froese R, Cube law, condition factor and weight-length relationships: History, meta-analysis and recommendations, *J Appl Ichthyol*, 22 (2006) 241-253. https://doi.org/10.1111/j.1439-0426.2006.00805.x

8 Bagenal J B & Tesch F W, Age and growth, In: *Methods for assessment of fish production in freshwaters*, 3rd edn, IBP Handbook 3, edited by Bagenal T, (Blackwell Scientific Publications, Oxford), 1978, pp. 101-136.

9 Bhakta D, Meetei W A, Vaishak G, Kamble S P, Solanki J K, *et al.*, Season-wise length-weight relationship and relative condition factor of *Tenualosa ilisha* (Hamilton, 1822) at Narmada estuary, Gujarat, India, *Indian J Geo-Mar Sci*, 48 (05) (2019) 635-638.

10 Bhakta D, Das S K, Das B K, Nagesh T S, Behera S, *et al.*, Length-weight relationship and condition factor of *Otolithoides pama* (Hamilton, 1822) from Hooghly-Matlah estuarine system of West Bengal, India, *Indian J Fish*, 66 (4) (2019) 51-59.

11 Bhakta D, Das S K, Das B K, Behera S & Nagesh T S, Relationship between otolith morphometry and fish size of *Otolithoides pama* (Hamilton, 1822) from Hooghly-Matlah estuary, India, *Indian J Geo-Mar Sci*, 49 (10) (2020) 1636-1642.

12 Khongngain O, Das S K & Bhakta D, Studies of biological parameters of *Trichogaster fasciata* (Bloch and Schneider, 1801) from a lentic water body Shanti Jheel, West Bengal, *J Indian Fish Assoc*, 43 (2) (2016) 01-06.

13 Chakraborty R, Das S K & Bhakta D, Length-weight relationship, relative condition factor and food and feeding habits of *Channa striata* from wetlands of Nadia district, West Bengal, *J Inl Fish Soc India*, 49 (2) (2017) 22-26.

14 Le Cren E D, The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (Perca fluviatilis), *J Anim Ecol*, 20 (2) (1951) 201-219. https://doi.org/10.2307/1540

15 Rekha M U, Kodeeswaran P, Abhilash C P, Dhinakaran A, Ajith Kumar T T, *et al*., Length-weight relationships of indigenous live baitfish captured in nearshore lagoons of Agatti Island (Lakshadweep), India, *J Appl Ichthyol*, 38 (2022) 123-125. https://doi.org/10.1111/jai.14250

16 Carpenter K E, *The Living Marine Resources of the Western Central Pacific, FAO Species Identification Guide for Fishery Purposes*, Vol. 5, (FAO, Rome, Italy), 2001.

17 Fraser T H & Lachner E A, A revision of the cardinalfish sub-genera *Pristiapogon* and *Zoramia* of the Indo-Pacific region (Teleostei: Apogonidae), *Smith Contr Zool*, 412 (1985) 1-47. https://doi.org/10.5479/si.00810282.412

18 Yoshida T, Mabuchi K & Motomura H, *Rhabdamia novaluna*, a new species of cardinalfish (Perciformes: Apogonidae) from the western Pacific Ocean, with comments on the synonymy of *Rhabdamia gracilis*, *Ichthyol Res*, 66 (2019) 129-139. https://doi.org/10.1007/s10228-018-0664-1

19 Fricke R, Eschmeyer W N & Fong J D, *Species by family/sub family*, Available online at: http://researcharchive.calacademy.org/research/ichthyology/catalog/SpeciesByFamily.asp (Accessed on September 2021).

20 Froese R, Cube law, condition factor and weight-length relationships: History, meta-analysis and recommendations, *J Appl Ichthyol*, 22 (4) (2006) 241-253. https://doi.org/10.1111/j.1439-0426.2006.00805.x

21 Fulton T W, *The rate of growth of fishes*, Twenty-second annual report, Part III, (Fisheries Board of Scotland, Edinburgh), 1904, pp. 141-241.

22 Murty V S, *Marine ornamental fish resources of Lakshadweep*, CMFRI Special Publication 72, (CMFRI, Kochi), 2002, pp. 1-134.

23 Jisr N, Younes G, Sukhn C & El-Dakdouki M H, Length-weight relationships and relative condition factor of fish inhabiting the marine area of the Eastern Mediterranean city, Tripoli-Lebanon, *Egypt J Aquat Res*, 44 (4) (2018) 299-305. https://doi.org/10.1016/j.ejar.2018.11.004

24 Rekha M U, Tomy S, Sukumaran K, Vidya R, Kailasam M, *et al.*, Comparison of the reproductive biology of two stocks of Indian continental *Mugil cephalus* with special reference to reproductive isolation and philopatry, *Indian J Geo-Mar Sci*, 50 (2) (2021) 130-140. https://doi.org/10.56042/ijms.v50i02.66087

25 Quasim S Z, Some implications of the problem of age and growth in marine fishes from the Indian waters, *Indian J Fish*, 20 (1973) 351-371.

26 Letourneur Y, Michel K & Labrosse P, Length-weight relationship of fishes from coral reefs and lagoons of New Caledonia: An update, *The ICLARM quarterly*, (1998) 39-46.

27 Kulbicki M, Guillemot N & Amand M, A general approach to length-weight relationships for New Caledonian lagoon fishes, *Cybium*, 29 (3) (2005) 235-252.

28 Siddique M A M, Arshad A & Amin S M N, Length-weight and length-length relationships of two tropical fish *Secutor megalolepis* (Mochizuki & Hayashi, 1989) and *Rhabdamia gracilis* (Bleeker, 1856) from Sabah, Malaysia, *J Appl Ichthyol*, 31 (3) (2015) 574-575. https://doi.org/10.1111/jai.12752

29 Torres Jr F, Tabular data on marine fishes from Southern Africa, Part 1: Length-weight relationships, *Fishbyte*, 9 (1991) 50-53.

30 Matthews T, Ochavillo D, Felise S, Letalie T, Letuane M, *et al*., *Length-weight relationships for 71 reef and bottomfish species from Tutuila and Aunu'u, American Samoa*, Pacific Islands Fish, Sci. Cent., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96818-5007, Pacific Islands Fish. Sci. Cent. Admin. Rep. H-19-03, (NOAA, Hawaii), 2019, pp. 9. https://doi.org/10.25923/r3wq-ax31

31 Kamikawa K T, Cruz E, Essington T E, Hospital J, Brodziak J K T, *et al.*, Length–weight relationships for 85 fish species from Guam, *J Appl Ichthyol*, 31 (6) (2015) 1171-1174. https://doi.org/10.1111/jai.12877

32 Ralston S, Length-weight regressions and condition indices of lutjanids and other deep slope fishes from the Mariana Archipelago, *Micronesica*, 21 (1988) 189-192.

33 Anderson R O & Neumann R M, Length, weight, and associated structural indices, In: *Fisheries techniques*, 2nd edn, edited by B R Murphy & D W Willis, (American Fisheries Society, Bethesda, Maryland), 1996, pp. 447-481.

34 Erzini K, An empirical study of variability in length-at-age of marine fishes, *J Appl Ichthyol*, 10 (1994) 17-41.

35 Ricker W E, Computation and interpretation of biological statistics of fish populations, *Bull Fish Res Board Can*, 191 (1975) 383-415.

36 Sinovcic G, Franicevic M, Zorica B & Ciles-Kee V, Length-weight and length-length relationships for 10 pelagic fish species from Adriatic Sea (Croatia), *J Appl Ichthyol*, 20 (2004) 156-158.

37 Petrakis G & Stergiou K I, Weight-length relationships for 33 fish species in Greek waters, *Fish Res*, 21 (1995) 465-469.

38 Ferdaushy M H & Alam M M, Length-length and length-weight relationships and condition factor of nine freshwater fish species of Nageshwari, Bangladesh, *Int J Aquat Biol*, 3 (2015) 149-154.

39 Barnham C & Baxter A, Condition Factor, K, for Salmonid Fish, *Fisheries Notes*, (1998) 1-3.