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Length–weight relationships of 17 noncommercial fish species (Actinopterygii) sampled through bottom trawling in the waters of southwestern Taiwan

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Abstract

Although noncommercial species are generally smaller in body size, they hold considerable ecological value. Because they are often discarded at sea or cannot be collected, basic data on their biological features remain limited. In this study, we explored the length–weight relationships of 17 noncommercial fish species sampled through bottom trawling (16 trawling hauls) in the waters of southwestern Taiwan between 2019 and 2023. Sampling was performed using a bottom trawl with a net opening height of 2.5 m and a width of 30 m; the codend mesh size was 2 × 2 cm. Fork length and body weight measurements were obtained from randomly selected subsamples of the total catch. Twelve species exhibited isometric growth: *Ariosoma dolichopterum* Karmovskaya, 2015, *Crossorhombus kanekonis* (Tanaka, 1918), *Suezichthys gracilis* (Steindachner et Döderlein, 1887), *Jaydia truncata* (Bleeker, 1855), *Lepidotrigla punctipectoralis* Fowler, 1938, *Ophidion asiro* (Jordan et Fowler, 1902), *Ostorhinchus kiensis* (Jordan et Snyder, 1901), *Parapercis sexfasciata* (Temminck et Schlegel, 1843), *Rogadius asper* (Cuvier, 1829), *Synodus binotatus* Schultz, 1953, *Synodus fuscus* Tanaka, 1917, and *Synodus taiwanensis* Chen, Ho et Shao, 2007. Four species exhibited positive allometry—*Bleekeria mitsukurii* Jordan et Evermann, 1902, *Gonorynchus abbreviatus* Temminck et Schlegel, 1846, *Synodus tectus* Cressey, 1981, and *Trachinocephalus trachinus* (Temminck et Schlegel, 1846), whereas one species exhibited negative allometry—*Ratabulus megacephalus* (Tanaka, 1917). Overall, this study provides updated insights into the length–weight relationships of data-poor fish species. Our findings may guide studies determining resource status and investigating ecological dynamics in marine ecosystems.

Keywords

bycatch, commercial bottom trawling, fisheries assessment, growth types, length–weight relations, noncommercial species

Introduction

Taiwan is located in the western North Pacific Ocean, characterized by a complex hydrological environment influenced by seasonal interactions among a diverse range of water masses (Jan et al. 2002). The coastal waters of western Taiwan feature flat, shallow, and sandy seabeds (Lin 1996; Jan et al. 2002; Chen et al. 2022), forming a major trawling area (Kuo and Shao 1999). Bottom trawling hotspots are concentrated in the southwestern waters, particularly around Penghu Islands and Taiwan Banks (Lee et al. 2025). These areas are marked by topographically driven upwelling, low temperatures, and high chlorophyll-a concentrations, which enhance primary productivity, thereby making them key fishing grounds with abundant marine resources (Hong et al. 1991; Tang et al. 2002; Lan et al. 2009; Hsieh et al. 2023).

Studies have focused on the primary target species of commercial fisheries, which are typically large and commercially valuable, because these specimens are relatively easy to obtain. The remaining bycatch mainly consists of noncommercial, small-bodied species. Even commercially valuable taxa are often classified as noncommercial because of their small sizes (Jawad 2021). Such fish are frequently discarded at sea or used as trash fish for fishmeal (Nagamatsu 2009). Because these specimens are difficult to obtain, basic data on their biological features remain limited (Walker et al. 2017).

Trawl nets exhibit low fishing selectivity, resulting in a high proportion of bycatch fish, most of which are small-sized species (Kumar and Deepthi 2006; Volvenko et al. 2020). Documenting noncommercial fish species caught in trawl fisheries can enhance our understanding of fish populations and provide basic data for future research.

Although noncommercial species are generally smaller, they have considerable ecological value. Many noncommercial and small-bodied species serve as prey for commercially valuable fish and larger predators (Baran 2002; Dänhardt et al. 2011; Laptikhovsky et al. 2013; Jawad 2021). These small species play a crucial role in the ecosystem that they are a part of and can serve as keystone species when abundant, given that their mid-trophic position allows them to influence population sizes at both lower and higher trophic levels (Coll and Libralato 2012; Pockberger et al. 2014). Information on the length–weight relationships (LWRs) of fish can support assessments of growth patterns, population dynamics, stock status, ecosystem modeling, environmental change, and management strategies (Jellyman et al. 2013; Pauly et al. 2014; Heymans et al. 2016; Shubhadeep et al. 2022; Dikou 2023), particularly for data-poor species. The present study sought to uncover the LWRs of 17 noncommercial fish species caught through bottom trawling in the waters of southwestern Taiwan.

Materials and methods

All specimens were collected seasonally from March 2019 to September 2023 across 16 trawling hauls. Due to weather and sea conditions, sample collection may not be possible in some seasons, such as the summers of 2021 and 2022, and the winter of 2023. Trawling was conducted in the waters of southwestern Taiwan by using commercial vessels (Fig. 1). The primary objectives of these surveys were to assess fish composition, diversity, and abundance and to obtain additional biological information from the investigated waters. Sampling was performed using a commercial bottom trawl. The net had an opening vertical height of approximately 2.5 m, a horizontal width of approximately 30 m, a total opening area of approximately 75 m^2, and a total length of 38 m. The codend mesh size of the bottom trawl net was 2 × 2 cm. Trawling hauls were typically conducted at night for 2–4 h (mean duration: 3 h) at a speed of 2.0–3.8 knots (mean speed: 3.3–3.4 knots). Each randomly selected sample weighed approximately one-third to one-seventh of the total catch. All samples were frozen on board and subsequently transported to our laboratory. After thawing, the specimens were identified, photographed, fixed in 75% ethyl alcohol, and deposited in the laboratory.

Morphometric identification of the specimens was performed to the species level, following the methods described by Nakabo (2013). Given the large number of specimens collected in this study, rapid determination of basic biological information, such as body length and weight, were required to ensure the integrity of all samples obtained. Furthermore, fish specimens collected by bottom trawling were often damaged due to compression during capture, particularly at the posterior tip of the caudal fin in species with forked tails. Using total length (TL) in such cases could result in an underestimation of body length. Therefore, fork length (FL) was used for species with forked caudal fins, while TL was measured for species with non-forked caudal fins in this study. The method of measuring FL was measured straight-line from the anterior end of the snout to the caudal fork, and TL was measured to the posterior tip of the caudal fin. For each individual, fork length and wet body weight (BW) were measured to the nearest 0.01 mm and 0.01 g by using digital calipers and a digital balance, respectively. The LWR was evaluated using the allometric equation developed by Le Cren (1951).

$$\mathrm{BW} = aL^b$$

where BW represents total wet body weight [g], L represents FL or TL [cm], a is a coefficient related to body shape, and b is an exponent indicating isometric growth. To calculate the coefficients a and b, 95% confidence intervals (CI), and coefficient of determination (R^2) values, statistical analyses and graph plotting were performed in R software environment (version 4.5.1).

Results

A total of over 35 000 specimens, with a total weight of 684 kg, were randomly collected during the 16 trawling hauls. The collection included elasmobranchs, teleost fish, shrimp, mantis shrimp, crabs, cephalopods, shells, and other benthic organisms. In this study, we examined 231 bony fish species belonging to 74 families, accounting for approximately 82% of the total catch weight. Of these species, 150 were classified as noncommercial, representing 32% of the total catch weight of these bony fish.

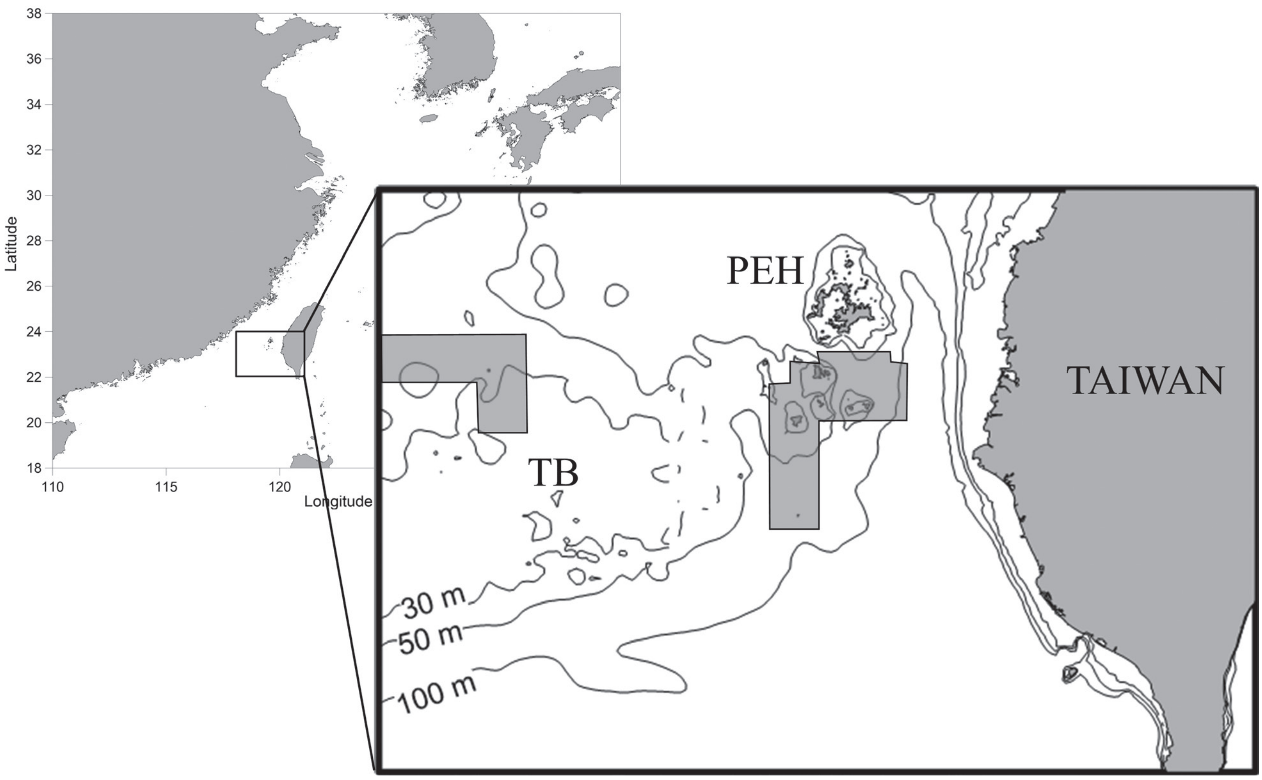

Figure 1. Sampling areas (gray square) in the waters of southwestern Taiwan. TB = Taiwan Banks, PEH = Penghu Islands.

Although length and BW data were collected from all 231 fish species, we focused on the 150 noncommercial species in this study. Specimens with surface damage or incomplete bodies, such as broken heads or tails, were excluded from the analysis. Only intact specimens were included. After data verification, we excluded 112 species with small sample sizes (n < 15) and 13 species with extensive records in FishBase (Froese and Pauly 2025). From the remaining 25 species, the following six were excluded because of abnormal b values ($2.5 < b < 3.5$): *Apogonichthyoides niger* (Döderlein, 1883), *Bregmaceros pescadorus* Shen, 1960, *Crossorhombus kobensis* (Jordan et Starks, 1906), *Engyprosopon multisquama* Amaoka, 1963, *Onigocia spinosa* (Temminck et Schlegel, 1843), and *Sunagocia arenicola* (Schultz, 1966). In addition, the following two species were excluded because of low R^2 values (<0.8): *Psettina tosana* Amaoka, 1963 and *Saurenchelys fierasfer* (Jordan et Snyder, 1901).

Finally, this study included 17 species belonging to 11 families (Table 1): *Ariosoma dolichopterum* Karmovskaya, 2015, *Bleekeria mitsukurii* Jordan et Evermann, 1902, *Gonorynchus abbreviatus* Temminck et Schlegel, 1846, *Jaydia truncata* (Bleeker, 1855), *Lepidotrigla punctipectoralis* (Fowler, 1938), *Ophidion asiro* (Jordan et Fowler, 1902), *Ostorhinchus kiensis* (Jordan et Snyder, 1901), *Ratabulus megacephalus* (Tanaka, 1917), *Synodus fuscus* Tanaka, 1917, *Synodus taiwanensis* Chen, Ho et Shao, 2007, *Synodus tectus* Cressey, 1981, *Crossorhombus kanekonis* (Tanaka, 1918), *Parapercis sexfasciata* (Temminck et Schlegel, 1843), *Rogadius asper* (Cuvier, 1829), *Suezichthys gracilis* (Steindachner et Döderlein, 1887), *Synodus binotatus* Schultz, 1953, and *Trachinocephalus trachinus* (Temminck et Schlegel, 1846). Notably, FishBase lacked data on the first 11 species and had a few or no records of the last 5 species in the waters surrounding Taiwan (Froese and Pauly 2025). *Trachinocephalus* specimens found in the region were previously recognized as *Trachinocephalus myops* (Forster, 1801), but recent evidence suggests that *T. myops* is an Atlantic species and specimens from the Indo-West Pacific Ocean should be identified as *T. trachinus* (see Polanco et al. 2016). Limited information is available for this species, and no LWR data are available in FishBase. Even LWR data for *T. myops* are restricted to Brazil. Our study appears to be the first to provide LWR data for *T. trachinus*, a noncommercial species in Taiwan.

The FL, TL, BW, LWR, and R^2 values for the 17 species are presented in Table 1 and Fig. 2. Samples for each species were collected over multiple seasons and years; therefore, the parameters a and b should be treated as mean values. In this study, isometric growth (95%CI for b including 3) was observed in 12 species, negative allometric growth (b < 3; 95%CI not including 3) in one species, and positive allometric growth (b > 3; 95%CI not including 3) in four species (Bagenal and Tesch 1978). LWRs were strongly correlated for the majority of species (R^2 value > 0.95), with only three species exhibiting lower correlations ($0.83 < R^2 < 0.89$).

Table 1. Length–weight relationships of 17 noncommercial fish species sampled through trawling in the waters of southwestern Taiwan.

Family	Species	*n*	Fork / Total length [cm]	Body weight [g]	LWR parameters *a* [95%CI]	LWR parameters *b* [95%CI]	R^2
Ammodytidae	*Bleekeria mitsukurii*	401	6.75–15.99 (FL)	1.01–14.70	0.0018 [0.0015–0.0022]	3.288 [3.212–3.364]	0.9478
Apogonidae	*Jaydia truncata*	36	3.59–8.75 (TL)	0.69–8.48	0.0115 [0.0072–0.0185]	3.058 [2.804–3.311]	0.9464
	Ostorhinchus kiensis	41	2.65–7.69 (FL)	0.28–8.99	0.0176 [0.0102–0.0303]	2.829 [2.427–3.231]	0.8386
Bothidae	*Crossorhombus kanekonis*	72	3.83–13.01 (TL)	0.49–23.50	0.0097 [0.0071–0.0133]	3.016 [2.864–3.167]	0.9576
Congridae	*Ariosoma dolichopterum*	17	18.37–42.13 (TL)	4.77–78.66	0.0007 [0.0002–0.0022]	3.165 [2.804–3.526]	0.9588
Gonorynchidae	*Gonorynchus abbreviatus*	180	8.37–17.96 (FL)	1.60–25.03	0.0017 [0.0013–0.0022]	3.327 [3.226–3.427]	0.96
Labridae	*Suezichthys gracilis*	78	6.54–12.51 (TL)	2.35–21.82	0.0051 [0.0028–0.0094]	3.267 [2.999–3.534]	0.8862
Ophidiidae	*Ophidion asiro*	56	6.25–12.33 (TL)	0.78–6.84	0.0038 [0.0019–0.0073]	3.037 [2.721–3.354]	0.8728
Pinguipedidae	*Parapercis sexfasciata*	263	3.53–14.37 (TL)	0.46–38.03	0.0133 [0.0116–0.0152]	3.0001 [2.933–3.067]	0.9673
Platycephalidae	*Ratabulus megacephalus*	36	3.71–23.92 (TL)	0.49–120.46	0.0153 [0.0124–0.0188]	2.845 [2.756–2.934]	0.9921
	Rogadius asper	85	3.56–21.33 (TL)	0.34–79.10	0.0116 [0.0085–0.0159]	2.881 [2.751–3.011]	0.959
Synodontidae	*Synodus binotatus*	40	8.41–14.17 (FL)	5.65–27.60	0.0075 [0.0045–0.0125]	3.138 [2.923–3.353]	0.9583
	Synodus fuscus	193	3.16–23.33 (FL)	0.20–102.19	0.0058 [0.0047–0.0072]	3.022 [2.931–3.112]	0.958
	Synodus taiwanensis	26	4.18–16.23 (FL)	0.42–27.04	0.0064 [0.0046–0.0088]	2.969 [2.832–3.106]	0.9882
	Synodus tectus	29	5.56–14.12 (FL)	1.16–21.33	0.0048 [0.0035–0.0065]	3.225 [3.073–3.376]	0.9861
	Trachinocephalus trachinus	162	4.51–35.70 (FL)	0.52–350.12	0.0043 [0.0038–0.0049]	3.251 [3.198–3.305]	0.989
Triglidae	*Lepidotrigla punctipectoralis*	24	3.20–7.38 (FL)	0.39–5.90	0.0067 [0.0041–0.0109]	3.254 [2.95–3.559]	0.9572

The species are listed in alphabetical order by family.
n = sample size, FL = fork length, TL = total length, *a* = body shape coefficient, *b* = allometric growth parameter, R^2 = coefficient of determination, CI = confidence interval.

Discussion

The LWR is a common parameter in fisheries management and fisheries biology. A *b* value of 3 indicates isometric growth, where fish increase in length and *BW* proportionally. A *b* value of < 3 indicates negative allometric growth, with larger specimens increasing more in length than in *BW*. Finally, a *b* value of > 3 indicates positive allometric growth, with larger specimens increasing more in BW than in length (Bagenal and Tesch 1978; Froese 2006).

In this study, six species were excluded from the results due to abnormal *b* values at first. Among them, four species had *b* values higher than 3.5, while two species had *b* values lower than 2.5. Strong allometric trends ($b > 3.5$ or $b < 2.5$) are generally rare in fish, likely as a result of incomplete sampling, in which certain size classes are overrepresented in the sample (Carlander 1977). Most fishes in our study had body sizes ranging from 4 to 8 cm, which may be attributable to the trawl net used. Although trawls can capture smaller-bodied samples, they often fail to capture species capable of attaining larger sizes. Similarly, limitations in how fine the mesh could be constrained the collection of very small specimens.

Only *Ratabulus megacephalus* exhibited negative allometric growth. Fish typically grow in body size more rapidly in earlier stages of development (Fulton 1904), resulting in *b* values of < 3. Our samples for *R. megacephalus* were mostly 4–8 and 14–18 cm in TL, substantially smaller than the species' typical maximum length of 30 cm (Knapp 1999), which may explain this result. In the future, larger specimens should be collected to update the LWR data. Four species exhibited positive allometric growth patterns, characterized as elongated. Other elongated species, such as *Synodus binotatus* and *Parapercis sexfasciata*, exhibited isometric growth. Sampling across multiple seasons and years suggests that the reported *b* values represent long-term averages. Although factors such as body size range, growth, spawning season, feeding, body shape, and environmental conditions can influence the *b* value (Le Cren 1951; Sparre 1992;

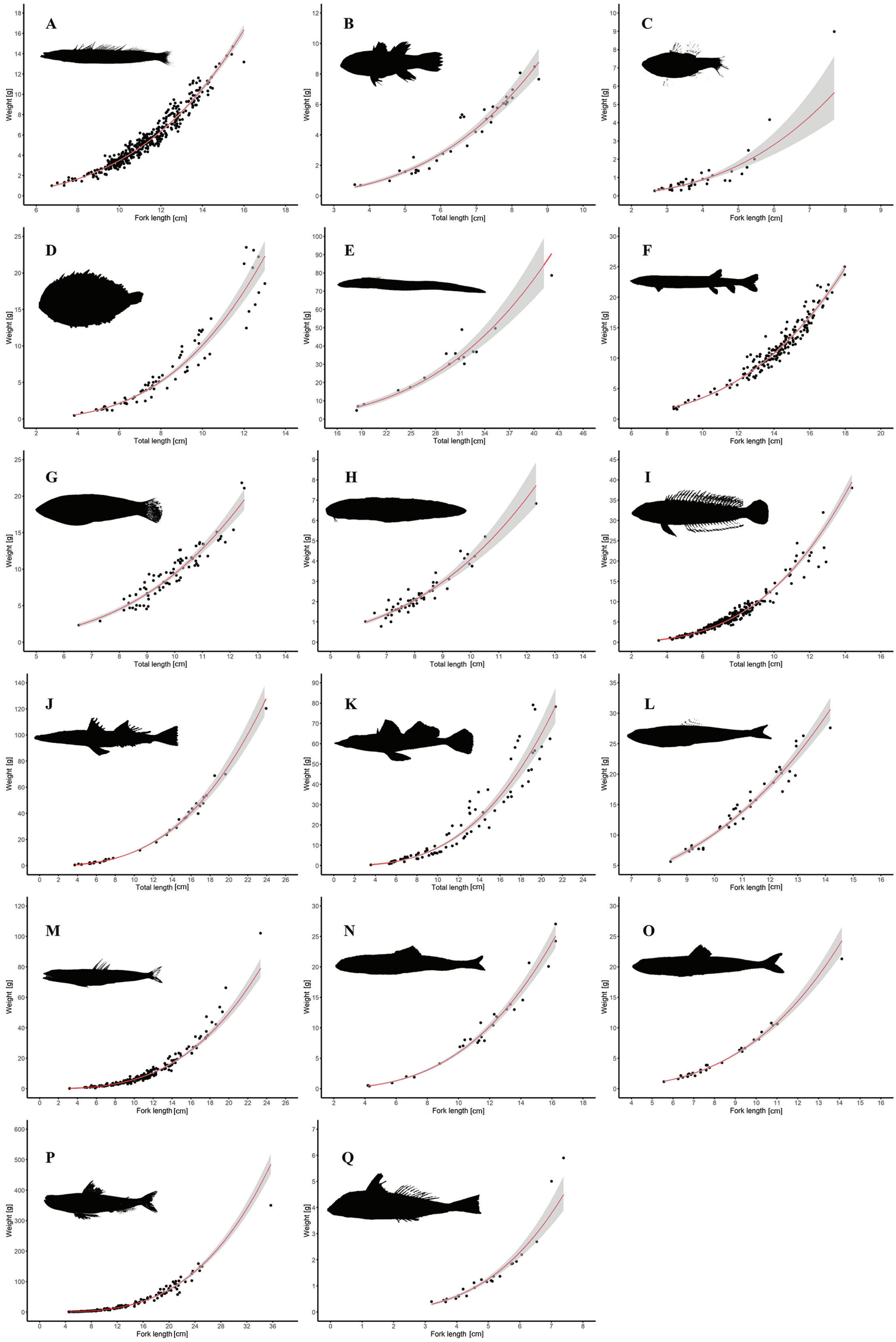

Figure 2. Fork length–body weight relationships of 17 noncommercial fish species. Black dots represent the actual measured values, red lines represent estimated trend lines, and shaded areas represent 95% confidence intervals. (**A**) *Bleekeria mitsukurii*, (**B**) *Jaydia truncata*, (**C**) *Ostorhinchus kiensis*, (**D**) *Crossorhombus kanekonis*, (**E**) *Ariosoma dolichopterum*, (**F**) *Gonorynchus abbreviatus*, (**G**) *Suezichthys gracilis*, (**H**) *Ophidion asiro*, (**I**) *Parapercis sexfasciata*, (**J**) *Ratabulus megacephalus*, (**K**) *Rogadius asper*, (**L**) *Synodus binotatus*, (**M**) *Synodus fuscus*, (**N**) *Synodus taiwanensis*, (**O**) *Synodus tectus*, (**P**) *Trachinocephalus trachinus*, and (**Q**) *Lepidotrigla punctipectoralis*.

Froese 2006; Kuriakose 2017; Jisr et al. 2018; López-Pérez et al. 2020), our results are most likely attributable to specimen body size. Many of the four specimens approached or exceeded the maximum FL values reported in FishBase (Froese and Pauly 2025). At sexual maturity and near maximum body size, these fish typically increase in BW more rapidly than in length (Ilhan et al. 2010; Jisr et al. 2018; Rodríguez-García et al. 2023), consistent with the observed *b* values of > 3.

In this study, five species—*Crossorhombus kanekonis*, *Suezichthys gracilis*, *Parapercis sexfasciata*, *Rogadius asper*, and *Synodus binotatus* — have only one or two records of LWR available in FishBase (Froese and Pauly 2025). The study areas of these records are far from the present study area or do not specify the study area. Comparing the *b* values in this study with those reported in Fishbase, the results for *R. asper* differ significantly, with the previous study's *b* = 3.355 being higher than ours (*b* = 2.881). The results for the remaining four species were not significantly different. For *C. kanekonis* and *P. sexfasciata*, the previous study's *b* = 3.111 and 3.138 were higher than ours (*b* = 3.016 and 3.0001); for *S. gracilis* and S. *binotatus*, the presently reported study's (*b* = 3.267 and 3.38) were higher than the previous study results (*b* = 3, 3). The deviation may be caused by various environmental, biological, and human sampling factors, including sample numbers, body size range, seasonal differences, gonad maturity, growth, and feeding (Le Cren 1951; Sparre 1992; Froese 2006; Kuriakose 2017; Jisr et al. 2018; López-Pérez et al. 2020).

The *b* values for the 17 species fell within the expected range of 2.5–3.5 (Froese 2006), with highly significant linear regression results (R^2 value > 0.83). In spite of its small sample size, this study improves our knowledge of noncommercial fish species in the waters of southwestern Taiwan, which have been rarely studied and lack LWR data. Our findings may support future research on non-economic and small fish species in this region—for example, studies calculating fish biomass and those assessing ecological dynamics.

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References

Bagenal TB, Tesch FW (1978) Age and growth. In: Bagenal TB (Ed.) Methods for assessment of fish production in fresh waters (3rd ed.). Blackwell Scientific Publications, 101–136.

Baran E (2002) The importance of non-commercial fish. Fisheries and aquaculture: Towards sustainable aquatic living resources management. UNESCO Encyclopedia of Life Support Systems, 1– 7.

Carlander KD (1977) Handbook of freshwater fishery biology. Vol. 2. Iowa State University Press, Ames, 431 pp.

Chen MH, Lai CC, Chen TC, Ho CW, Meng PJ, Chen KS, Hung TH, Chang CW (2022) Seasonal variations in the trawling marine organism community at the Changyun Rise off central western Taiwan from spring to autumn 2020. Marine Research 2(2): 25–42. https://doi.org/10.29677/MR.202212_2(2).0002

Coll M, Libralato S (2012) Contributions of food web modelling to the ecosystem approach to marine resource management in the Mediterranean Sea. Fish and Fisheries 13(1): 60–88. https://doi.org/10.1111/j.1467-2979.2011.00420.x

Dänhardt A, Fresemann T, Becker PH (2011) To eat or to feed? Prey utilization of common terns *Sterna hirundo* in the Wadden Sea. Journal of Ornithology 152(2): 347–357. https://doi.org/10.1007/s10336-010-0590-0

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

Froese R (2006) Cube law, condition factor and weight–length relationships: History, meta-analysis and recommendations. Journal of Applied Ichthyology 22(4): 241–253. https://doi.org/10.1111/j.1439-0426.2006.00805.x

Froese R, Pauly D (Eds.) (2025) FishBase. [Version 04/2025] http://www.fishbase.org

Fulton TW (1904) The rate of growth of fishes. Twenty-second Annual Report, Part III. Fisheries Board of Scotland, Edinburgh, 141–241.

Heymans JJ, Coll M, Link JS, Mackinson S, Steenbeek J, Walters C, Christensen V (2016) Best practice in Ecopath with Ecosim food-web models for ecosystem-based management. Ecological Modelling 331: 173–184. https://doi.org/10.1016/j.ecolmodel.2015.12.007

Hong HS, Qiu SY, Ruan WQ, Hong QC (1991) [Minnan-Taiwan Bank fishing ground upwelling ecosystem study.] Science Publishing House, Beijing, China, 1–18. [In Chinese]

Hsieh HY, Lee MA, Chiu WL, Meng PJ (2023) Comparison of abundance and structure of larval fish assemblages between autumn and spring in the waters surrounding Taiwan Bank, western North Pacific. Fishes 9(1): 16. https://doi.org/10.3390/fishes9010016

Ilhan D, Akalin S, Tosunoglu Z, Özaydin O (2010) Growth characteristics and reproduction of comber, *Serranus cabrilla* (Actinopterygii, Perciformes, Serranidae), in the Aegean Sea. Acta Ichthyologica et Piscatoria 40: 55–60. https://doi.org/10.3750/AIP2010.40.1.07

Jan S, Wang J, Chern CS, Chao SY (2002) Seasonal variation of the circulation in the Taiwan Strait. Journal of Marine Systems 35(3–4): 249–268. https://doi.org/10.1016/S0924-7963(02)00130-6

Jawad LA (2021) The importance of non-commercial and small-sized fish species: A proposal for an additional revenue to Iraq. In: Jawad LA (Ed.) Tigris and Euphrates rivers: Their environment from headwaters to mouth. Springer International Publishing, Cham, 1611–1623. https://doi.org/10.1007/978-3-030-57570-0_84

Jellyman P, Booker D, Crow S, Bonnett M, Jellyman D (2013) Does one size fit all? An evaluation of length–weight relationships for New Zealand's freshwater fish species. New Zealand Journal of Marine and Freshwater Research 47(4): 450–468. https://doi.org/10.1080/00288330.2013.781510

Jisr N, Younes G, Sukhn C, El-Dakdouki MH (2018) Length–weight relationships and relative condition factor of fish inhabiting the marine area of the Eastern Mediterranean city, Tripoli-Lebanon. Egyptian Journal of Aquatic Research 44(4): 299–305. https://doi.org/10.1016/j.ejar.2018.11.004

Knapp LW (1999) Platycephalidae. Flatheads. In: Carpenter KE, Niem VH (Eds) FAO species identification guide for fishery purposes. The living marine resources of the Western Central Pacific. Volume 4. Bony fishes part 2 (Mugilidae to Carangidae). FAO, Rome, 2385–2421.

Kumar AB, Deepthi GR (2006) Trawling and by-catch: Implications on marine ecosystem. Current Science 90(8): 922–931.

Kuo SR, Shao KT (1999) Species composition of fish in the coastal zones of the Tsengwen estuary, with descriptions of five new records from Taiwan. Zoological Studies (Taipei, Taiwan) 38(4): 391–404.

Kuriakose S (2017) Estimation of length weight relationship in fishes. Summer School on Advanced Methods for Fish Stock Assessment and Fisheries Management. Lecture Note Series No. 2/2017. CMFRI, Kochi, Kochi, 215–220.

Lan KW, Kawamura H, Lee MA, Chang Y, Chan JW, Liao CH (2009) Summertime sea surface temperature fronts associated with upwelling around the Taiwan Bank. Continental Shelf Research 29: 903–910. https://doi.org/10.1016/j.csr.2009.01.015

Laptikhovsky V, Arkhipkin A, Brickle P (2013) From small bycatch to main commercial species: Explosion of stocks of rock cod *Patagonotothen ramsayi* (Regan) in the Southwest Atlantic. Fisheries Research 147: 399–403. https://doi.org/10.1016/j.fishres.2013.05.006

Le Cren ED (1951) The length–weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). Journal of Animal Ecology 20(2): 201–219. https://doi.org/10.2307/1540

Lee YJ, Hsu WWY, Lee HT, Liao CH (2025) Enhancing the resolution of fishing dynamics in Taiwan's mixed-trawl fisheries: Investigating gear type operation patterns through vessel tracks. Regional Studies in Marine Science 81: 103928. https://doi.org/10.1016/j.rsma.2024.103928

Lin JC (1996) Coastal modification due to human influence in south-western Taiwan. Quaternary Science Reviews 15(8–9): 895–900. https://doi.org/10.1016/S0277-3791(96)00060-1

López-Pérez C, Olivar MP, Hulley PA, Tuset VM (2020) Length–weight relationships of mesopelagic fishes from the equatorial and tropical Atlantic waters: Influence of environment and body shape. Journal of Fish Biology 96(6): 1388–1398. https://doi.org/10.1111/jfb.14307

Nagamatsu K (2009) By-catch discards from a bottom trawl in the East China Sea. Suisan Daigakko Kenkyu Hokoku 58(1): 73–127.

Nakabo T (2013) [Fishes of Japan with pictorial keys to the species.] 3rd ed. Tokai University Press, Tokyo, Japan, 2530 pp. [In Japanese]

Pauly D, Froese R, Palomares ML, Stergiou K, Apostolidis C (2014) Fish online a guide to learning and teaching Ichthyology using the FishBase information system. Version 3. www.fishbase.in/FishOnLine/English/index.htm

Pockberger M, Kellnreitner F, Ahnelt H, Asmus R, Asmus H (2014) An abundant small sized fish as keystone species? The effect of *Pomatoschistus microps* on food webs and its trophic role in two intertidal benthic communities: A modeling approach. Journal of Sea Research 86: 86–96. https://doi.org/10.1016/j.seares.2013.11.008

Polanco FA, Acero PA, Betancur-R R (2016) No longer a circumtropical species: Revision of the lizardfishes in the *Trachinocephalus myops* species complex, with description of a new species from the Marquesas Islands. Journal of Fish Biology 89(2): 1302–1323. https://doi.org/10.1111/jfb.13038

Rodríguez-García C, Castro-Gutiérrez J, Domínguez-Bustos ÁR, García-González A, Cabrera-Castro R (2023) Every fish counts: Challenging length–weight relationship bias in discards. Fishes 8(5): 222. https://doi.org/10.3390/fishes8050222

Shubhadeep G, Loveson E, Muktha M, Indira D, Behera PR, Jasmin F, Manas HM, Phalguni P, Madhumita D, Gourisankar R, Satishkumar M, Dineshbabu AP, Gopalakrishnan A (2022) Length–weight relations for finfish species landed as trawl by-catch from north-western Bay of Bengal. Journal of Applied Ichthyology 38(6): 621–623. https://doi.org/10.1111/jai.14357

Sparre P (1992) Introduction to tropical fish stock assessment. Part I. Manual. FAO Fishery Technical Paper. 306/1. Rev. I, FAO, Rome.

Tang D, Kester DR, Ni IH, Kavamura H, Hong HS (2002) Upwelling in the Taiwan Strait during the summer monsoon detected by satellite and shipboard measurements. Remote Sensing of Environment 83: 457–471. https://doi.org/10.1016/S0034-4257(02)00062-7

Volvenko IV, Gebruk AV, Katugin ON, Ogorodnikova AA, Vinogradov GM, Maznikova OA, Orlov AM (2020) Commercial value of trawl macrofauna of the North Pacific and adjacent seas. Environmental Reviews 28(3): 269–283. https://doi.org/10.1139/er-2019-0073

Walker ND, Maxwell DL, Le Quesne WJ, Jennings S (2017) Estimating efficiency of survey and commercial trawl gears from comparisons of catch-ratios. ICES Journal of Marine Science 74(5): 1448–1457. https://doi.org/10.1093/icesjms/fsw250