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Fast-Growing, Short-Lived, and Sex-Changing: Life History of the Blue-Barred Parrotfish (*Scarus ghobban*) From the Solomon Islands

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ABSTRACT

The population dynamics of the blue-barred parrotfish (*Scarus ghobban*) was examined to estimate key life-history traits of this important reef fishery species in the Solomon Islands. The population was dominated by individuals within the 220–239 mm size class, corresponding to a modal age of 1-year-olds. Maximum observed size and age were 350 mm (SL) and 5 years, respectively. von Bertalanffy growth parameters were estimated as an asymptotic length (L_{∞}) of 296.66 mm and a growth coefficient (k) of 1.06. Sex-specific growth trajectories revealed significant sexual dimorphism, with males attaining greater lengths than females at equivalent ages ($p < 0.05$). The relationship between length and weight was positively allometric ($b = 3.67$), indicating a preference for weight gain before somatic growth. Histological analyses of gonadal tissue provided evidence of sequential hermaphroditism. Dual male developmental pathways (diandry) were identified, consistent with both primary and secondary male formation. These findings highlight the rapid growth, early maturation and complex sexual ontogeny of *S. ghobban*, traits which likely underpin its ecological adaptability in coral reef environments.

1 | Introduction

Parrotfish are a conspicuous clade of coral reef fishes classified as scarine labrids (Streelman et al. 2002; Westneat and Alfaro 2005; Near et al. 2025). They play a key ecological role as bioeroders in coral reef ecosystems (Mumby et al. 2006; Bonaldo et al. 2014). Their grazing activity is fundamental to coral reef dynamics, and sustaining healthy, size-diverse populations is essential for preserving the overall ecosystem integrity (Shantz et al. 2020; Roos et al. 2020). To date, research on parrotfish population dynamics has yielded valuable insights into their population ecology, such as plasticity in demographic traits, the influence of fishing pressures on life history parameters and the identification of critical life history characteristics (Paddock et al. 2009; Kume et al. 2010; Taylor et al. 2014; Taylor and Pardee 2017). Their close association with

coral reefs makes parrotfishes easy targets in shallow water for subsistence, artisanal and commercial fishers (Aswani and Sabetian 2010; Roos et al. 2020; Callwood 2021). However, many species remain insufficiently studied, particularly in relation to location-specific age and growth patterns or reproductive life history inferred from histological analysis of the gonadal tissue. Such knowledge is essential for effective management and conservation strategies, as understanding spatial-specific life history traits enhances our broader grasp of fish ecology, where populations often exhibit dynamic demographic profiles with high life history plasticity (Gust et al. 2002; Taylor and Choat 2014; Rivera Hernández and Shervette 2025).

The blue-barred parrotfish (*Scarus ghobban*) has a near-circumtropical distribution and displays considerable latitudinal

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variation in growth trajectories (Grandcourt 2002; Taylor and Choat 2014; Ebisawa et al. 2016; Rakotonaivo et al. 2026). However, knowledge of its reproductive and sexual life-history traits remains limited. In this study, we examined key life-history characteristics for this important coral reef fishery species in the Solomon Islands.

2 | Materials and Methods

2.1 | Sample Collection

The specimens used in this study were not collected directly by the authors. A total of 115 fish were obtained between 2004 and 2006 through purchase or donation from subsistence and artisanal spearfishers operating in western Solomon Islands. As the samples were acquired post-capture and the authors were not involved in the harvesting, handling or targeting of animals, the work constitutes the secondary use of specimens. In accordance with institutional and regional guidelines applicable at the time of collection, formal animal ethics approval was therefore not required. For each specimen, total weight (g), standard length (mm) and colouration (initial or terminal) were recorded, followed by extraction of sagittal otoliths and gonads.

2.2 | Age Estimation

Sagittal otoliths were cleaned, dried and weighed (± 0.001 g). Transverse sections (~ 400 μ m) were prepared following standard ageing protocols (Secor et al. 1995; Choat and Axe 1996). Annuli were counted along the core–margin axis under reflected light at a 20 $\times$ magnification (Figure 1). Annual periodicity of opaque and translucent bands in parrotfishes, including *S. ghobban*, has been previously validated (Ebisawa et al. 2016; Jones et al. 2021; Hernandez and Shervette 2024). Each otolith was independently read twice by the same reader and assigned a readability score (1 = clear, 5 = unreadable). If counts disagreed, a third reading was performed; otoliths without agreement after three readings were excluded. After removing unreadable sections (score 5), 91 individuals were successfully aged.

2.3 | Histological Analysis

Gonads were weighed (± 0.001 g), fixed in 10% buffered formalin, processed using a LEICA ASP300S tissue processor, embedded in paraffin, sectioned at 5 μ m and stained with Mayer’s haematoxylin and Young’s eosin. Sex and reproductive phase were classified using established histological criteria for females, males and transitional individuals (Longenecker et al. 2020). To establish

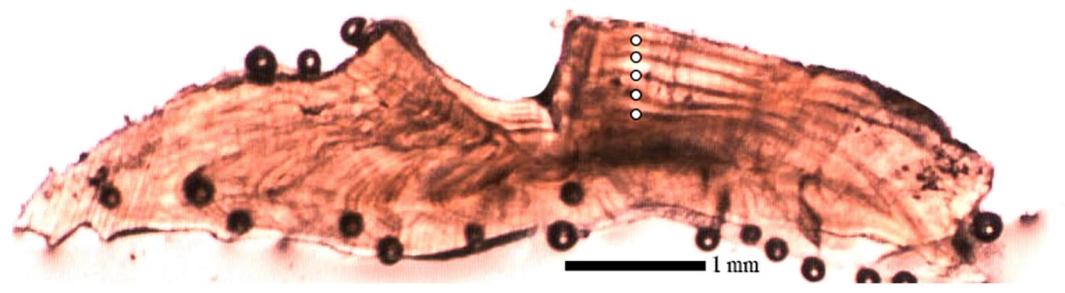


FIGURE 1 | Cross-sectioned sagittal otolith of *Scarus ghobban* viewed under transmitted light. Distinctive opaque growth increments selected as annual rings are marked.

TABLE 1 | Histological criteria used to categorise female, transitional and male gonad development stages.

Developmental Stage	Histological description
Immature female	No evidence of prior spawning. Ovary is small, with lamellae well packed with oogonia and pre-vitellogenic oocytes.
Mature female	Ovary is dominated by pre-vitellogenic oocytes. There may be indications of prior spawning, such as atretic vitellogenic oocytes and possible presence of brown bodies. The ovarian wall is thick, and the ovary is larger in diameter than that of an immature female.
Ripe female	Ripening or vitellogenic oocytes are present, and hydrated oocytes may also be observed. Indications of prior spawning may be evident, such as ‘spent’ oocytes undergoing atresia.
Transitional	Pre-vitellogenic oocytes and degenerating oocytes are present, alongside primary and secondary spermatocytes.
Primary male	Proliferating testicular tissue is present in a gonad similar in appearance to an immature ovary, where spermatogenesis has progressed at least to the secondary spermatocyte stage. Ovarian tissue still dominates the lamellae, which have not yet developed the typical lobular form of mature testes. No signs of prior spawning as a female are present.
Secondary male	Gonads are dominated by testicular tissue, which may contain spermatogonia and germinal cells at various stages of development. Evidence of thick ovary wall, indicating previous female history.

a diandry, primary and secondary males were identified following the criteria outlined by Shapiro and Rasotto (1993). The developmental stages used to assign sex classes are summarised in Table 1. In total, 69 individuals were successfully classified.

2.4 | Population Demography

Growth parameters were estimated from size- and age-frequency data. The length–weight relationship was modelled as $W = a \times L^b$ (Ricker 1973), where b describes allometric growth ($b \approx 3$ isometric; $b < 3$ negative; $b > 3$ positive). Length-at-age data were fitted to the von Bertalanffy growth function (VBGF) (Kimura 1980): $L(t) = L_{\infty} [1 - \exp^{-K(t - t_0)}]$, where L_{∞} , K and t_0 are the asymptotic length, growth coefficient and theoretical age at zero length,

respectively. Because young juveniles were absent in this dataset, t_0 was not constrained. Sex-specific growth models were compared using likelihood ratio tests (LRTs) following Kimura (1980) and Cerrato (1990) at $\alpha = 0.05$, with degrees of freedom equal to the number of constrained parameters.

3 | Results

The population was dominated by the 220–239 mm size class (Figure 2), and the age distribution peaked at 1 year (Figure 3). The oldest and largest specimen reached 5 years of age and 350 mm standard length. There was a strong relationship between otolith weight and age ($R^2 = 0.74$) and an asymptotic relationship between age and size. The length (L_{∞}) and rate (k) at which the

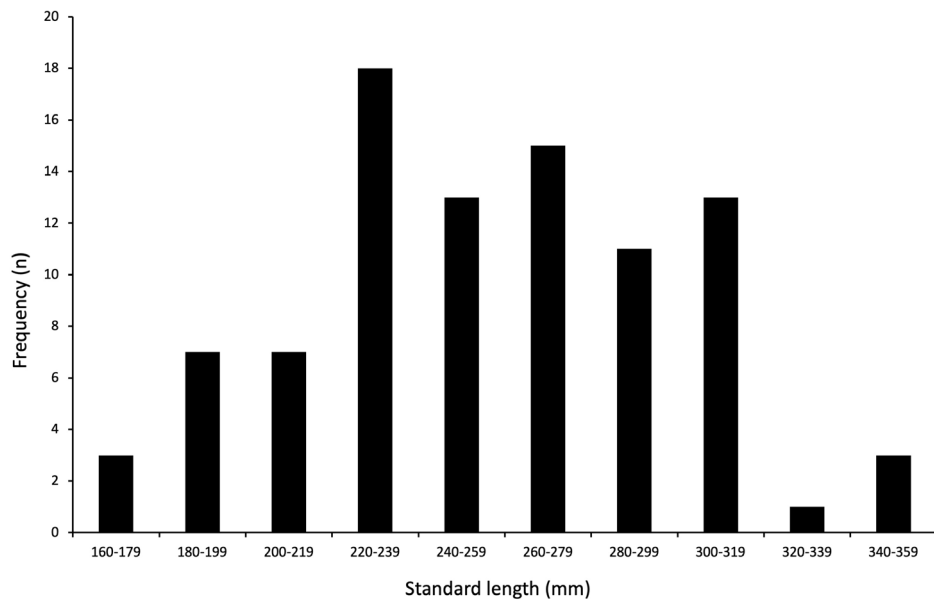


FIGURE 2 | Size distribution of *Scarus ghobban* from the Solomon Islands.

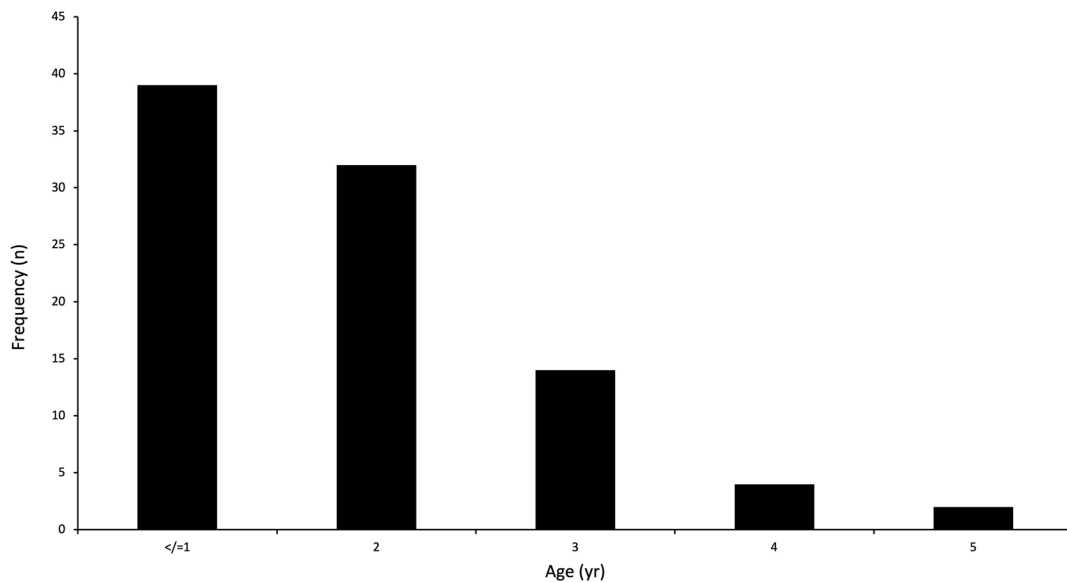


FIGURE 3 | Age distribution of *Scarus ghobban* from the Solomon Islands.

TABLE 2 | Population parameter values of best-fit models for *Scarus ghobban*; growth parameters of von Bertalanffy growth function (VBGF) showing overall and sex-specific growth characteristics, length–weight relationship fitted to a power curve, otolith weight–age relationship fitted to a linear regression and sex ratio.

Function	Parameters	<i>S. ghobban</i>
VBGF, $n = 91$	L_{∞}	296.66(mm)
	K	1.06
	t_0	−0.34
Male VBGF, $n = 38$	L_{∞}	308.43(mm)
	K	1.21
	t_0	−0.05
Female VBGF, $n = 29$	L_{∞}	256.26(mm)
	K	1.54
	t_0	0.15
Length–weight relationship	n	91
	b	3.67
	R^2	0.62
Otolith weight–age relationship	R^2	0.74
Sex ratio	F:M	1:1.3

population reached asymptote were 296.66 mm and 1.06, respectively (Table 2). Comparisons of VBGF growth trajectories partitioned by sex for *S. ghobban* show that males are larger than females at equivalent ages (Figure 4). LRTs for overlapping age groups (1–3 years) confirmed this difference ($p < 0.05$). Analysis of the length–weight relationship revealed positive allometric growth ($b = 3.67$), with body weight increasing disproportionately relative to length. The distribution of gonadal reproductive characteristics by age (Figure 5) and size (Figure 6) indicated a clear

demographic pattern, with females concentrated among younger and smaller individuals and males spanning the complete range of recorded ages and sizes. Histological analysis identified evidence of sex change and dual male development pathways in *S. ghobban* (Figure 7).

4 | Discussion

Despite the limited sample size and the associated uncertainty in life-history parameter estimates, our study provides valuable insights into the population dynamics of *S. ghobban* in the Solomon Islands. The species in this location appears to be short-lived, fast-growing and to exhibit a diandric protogynous sexual development pathway. Our estimated longevity and asymptotic length were predominantly shorter and smaller than values reported elsewhere, indicating substantial geographic variation in growth and life-history traits across the species' latitudinal range. Our estimate of $L_{\infty} = 296.66$ mm (SL) was lower than the $L_{\infty} = 485$ mm fork length (FL) reported from Japan (Ebisawa et al. 2016) but was comparable to the $L_{\infty} = 274.9$ mm (FL) estimated for the Seychelles (Grandcourt 2002). In contrast, markedly larger asymptotic lengths (743 to 752 mm FL) were reported from Madagascar using a length-based Bayesian biomass model (Rakotonaivo et al. 2026). However, these comparisons should be interpreted with caution given the limited number of published populations, differences in length metrics (SL vs. FL), sex and colour-phase composition of sampled individuals, sampling selectivity and variation in growth modelling approaches and parameter estimation procedures.

The observed truncated age and size structure of *S. ghobban* in this study may reflect the effects of chronic fishing pressure (Fidler et al. 2018). For example, Cuetos-Bueno et al. (2019) documented declines in mean size and biomass of the Pacific longnose parrotfish (*Hipposcarus longiceps*) under long-term fishing pressure in the

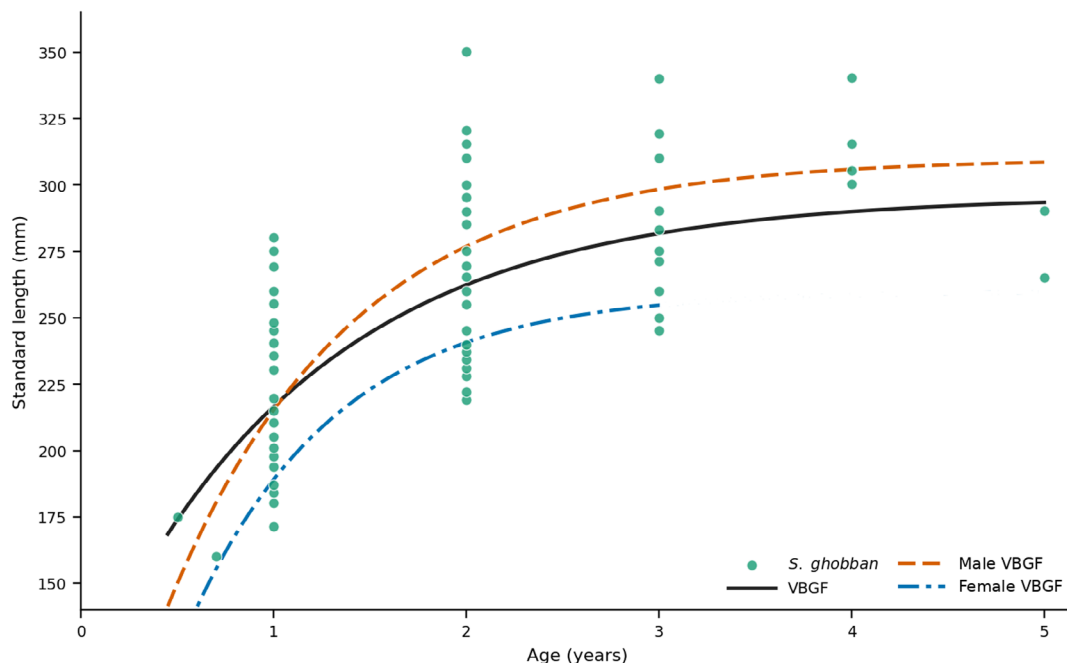


FIGURE 4 | Overall and sex-specific von Bertalanffy growth trajectories of *Scarus ghobban*. Parameters are presented in Table 2.

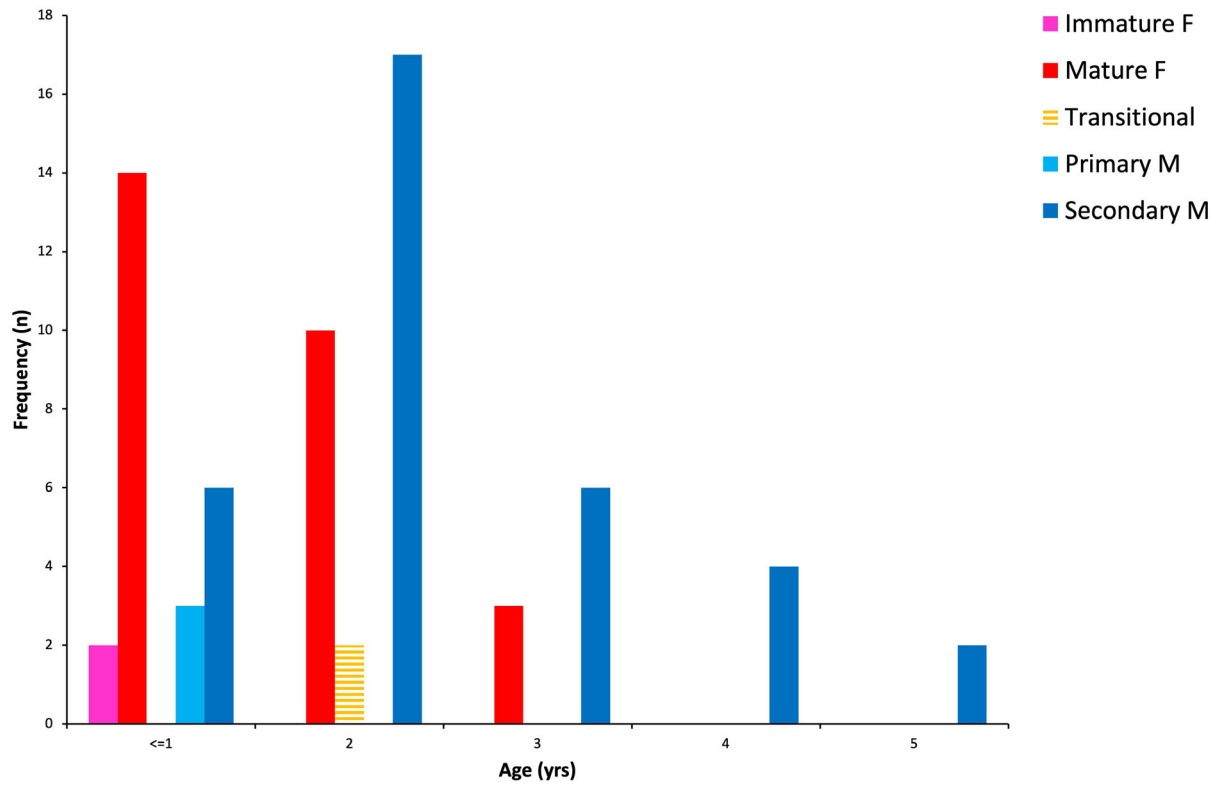


FIGURE 5 | Age-frequency distribution of *Scarus ghobban* partitioned by gonad development stage.

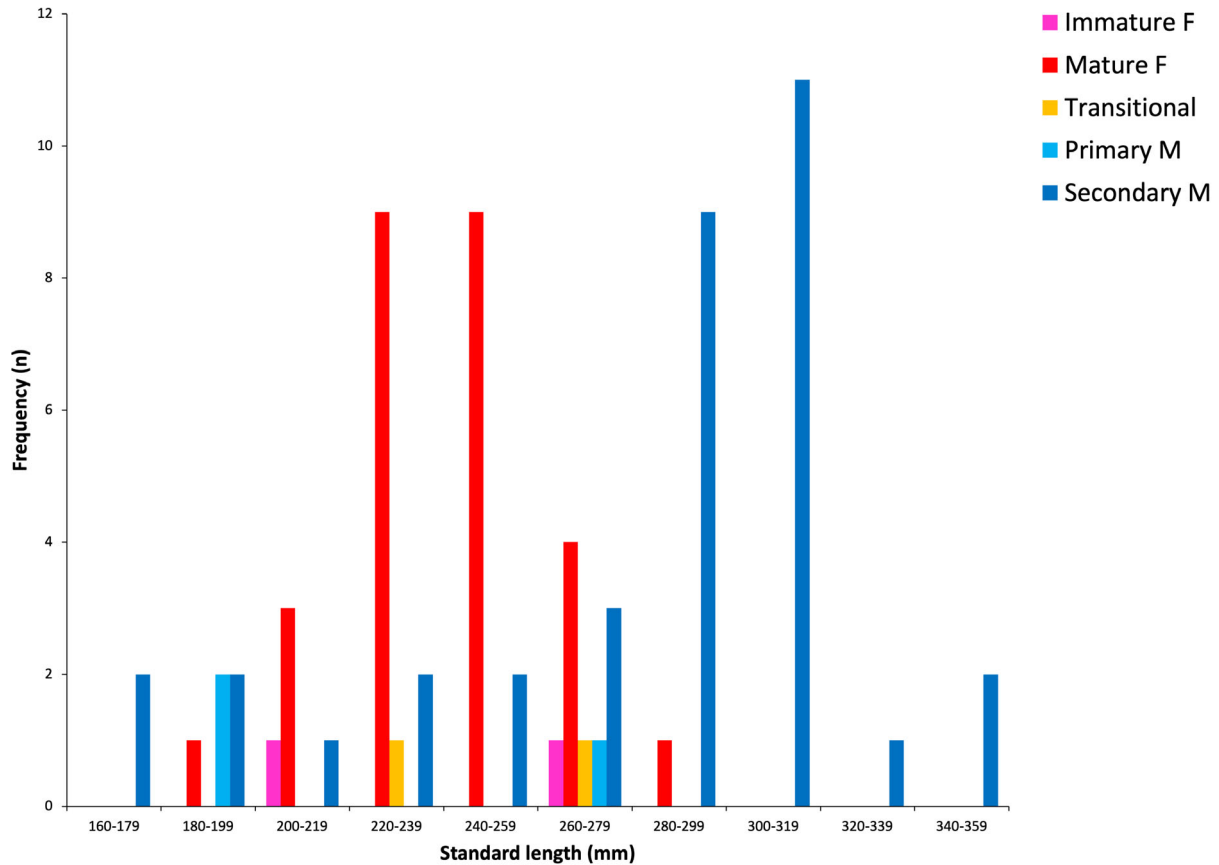


FIGURE 6 | Size-frequency distribution of *Scarus ghobban* partitioned by gonad development stage.

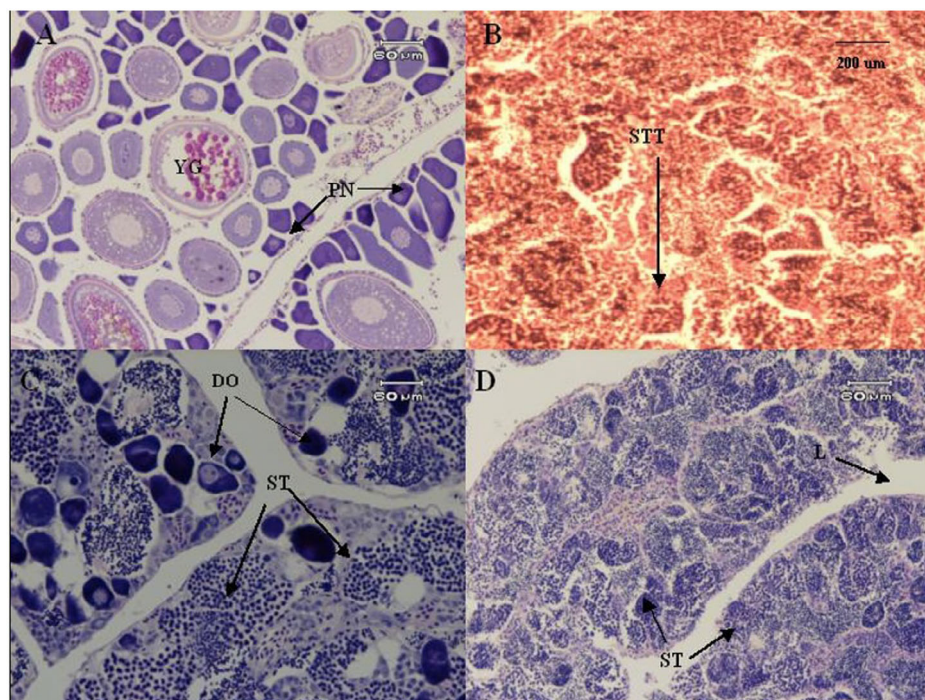


FIGURE 7 | Evidence of sex change and dual male development pathway in *Scarus ghobban*. (A) Mature resting female with oocyte development. (B) Mature male (IP colouration) with no prior sign of female function. (C) Transitional male. (D) Mature male with ovarian features. DO, degenerative oocyte; L, ovary lumen; PN, perinucleolar stage oocytes; ST, spermatids; STT, spermatogenic tissue; YG, yolk globule stage oocyte.

Northern Mariana Islands. Similarly, Hawkins and Roberts (2004) reported reduced size structure across several parrotfish species in the Caribbean, consistent with the selective removal of larger individuals by fishing pressure.

Histological evidence supported a protogynous hermaphroditic pathway, consistent with the findings by Ebisawa et al. (2016). However, the identification of three primary males in our samples indicates a diandric developmental strategy. While Grandcourt (2002) also alluded to a diandric pathway in Seychelles populations of *S. ghobban*, the criteria used to distinguish primary males from secondary males were not explicitly described. The presence of unequivocal transitional specimens in our study corroborates the classification of *S. ghobban* as a sequential hermaphrodite. Histological analysis of sexual development across age and size classes also revealed a notable absence of immature females, alongside the presence of young and small secondary males. Hawkins and Roberts (2004) proposed that increased fishing pressure on larger individuals may induce sex change in initial-phase parrotfish at smaller body sizes. However, the early maturation and sex change observed in *S. ghobban* from the Solomon Islands may also reflect intrinsic life-history characteristics, including genetic predisposition and a naturally short lifespan. A similar mechanism was proposed by Claro et al. (2001) for the Caribbean hogfish (*Lachnolaimus maximus*), in which sex change at relatively small body sizes may have a genetic basis rather than representing a compensatory response to fishing pressure. Moreover, early sexual maturation among small-bodied parrotfishes is not unprecedented (Taylor and Choat 2014), suggesting that accelerated reproductive potential may represent a recurring life-history strategy in short-lived scarines.

While this study contributes valuable baseline information on the ecology and population dynamics of *S. ghobban*, it also highlights the need for broader, spatially explicit and comparative investigations. Such efforts are essential not only to clarify reproductive pathways within scarine labrids but also to quantify variability in life-history traits across oceanographic regimes and latitudinal gradients. Encouragingly, the ability to derive robust demographic insights from a relatively small sample size suggests that such research may be both feasible and informative.

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The authors have nothing to report.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are openly available in Figshare at <https://doi.org/10.6084/m9.figshare.31062127>, reference number 31062127.

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