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Age-based life-history traits of two filefish from the Solomon Islands: the honeycomb (*Cantherhines pardalis*) and the broom (*Amanses scopas*) filefishes

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This study investigates the age-based life-history traits of two filefish species from the Solomon Islands, the Honeycomb filefish (*Cantherhines pardalis*) and the Broom filefish (*Amanses scopas*). The research aims to fill a significant gap in our understanding of tropical monacanthid demography by providing an age-based life-history assessment for these species. A total of 201 *C. pardalis* and 60 *A. scopas* were collected from the reefs offshore Vavanga Village, Solomon Islands, between January 2016 and February 2017. Age determination was based on thin transverse sagittal otolith sections, revealing that *C. pardalis* reaches a maximum age of 9 years ($n=140$, $CV=6.7$, $APE=8.12$), while *A. scopas* of 12 years ($n=42$, $CV=2.5$, $APE=20.3$). The study found marked differences in life-history strategies between the two species, with *C. pardalis* exhibiting rapid early growth and early maturation within its first year, whereas *A. scopas* grows more slowly and reaches a larger asymptotic size later in life. Sex-specific patterns in growth and length-weight relationships were observed, indicating differential energy allocation strategies. Mortality estimates align with expectations for small-bodied reef fishes subjected to natural predation and artisanal harvesting. The findings highlight divergent growth and reproductive strategies within a single family in the same reef system, underscoring the ecological plasticity of monacanthids.

KEYWORDS

Monacanthidae, otolith, body size, growth, histology, reproductive biology, Pacific Ocean

Introduction

The Monacanthidae family, commonly referred to as filefish, comprise of 102 species across 27 genera, primarily found in tropical and subtropical regions (Matsuura, 2015; Bray, 2023). Of these, 58 species are found in Australian waters representing a major geographically constrained diversification (Gomon et al., 2008). The widespread distribution of monacanthids across the Pacific, Atlantic and Indian oceans have made them a popular target for subsistence fishing, the ornamental aquarium trade, and the focus of large-scale commercial fisheries (Wood, 2001; Miller and Stewart, 2009; Hinton et al., 2014; Moesinger, 2018). Monacanthids typically display a laterally compressed, slender, and elongated body with a distinctive flat head and snout (Nelson, 1994). They appear to be slow swimmers, have soft caudal and short pectoral fins, lack pelvic fins, and have a long, articulated, sharp spine on their crown (Harmelin-Vivien and Quéro, 1990). They also exhibit a variety of foraging behaviours, adapted to various habitats ranging from coral reefs, seagrass beds, sandy and muddy substrate to the open oceans (Clements and Livingston, 1984; Barlow, 1987; Hobson and Chess, 1996; Ballard and Rakocinski, 2012; Horinouchi et al., 2013; Miyajima-Taga et al., 2016).

Depending on the region, between 30 to 40 species of monacanthids can be globally found on coral reefs (Harmelin-Vivien and Quéro, 1990; Nelson, 1994), ranging from specialist obligate corallivores to generalist omnivores, detritivores, planktivorous and benthivores (Hobson and Chess, 1996; Prado and Heck, 2011; Brooker et al., 2013). In a study by Siqueira et al. (2023) reviewing the evolution of fish–coral interactions, members of the family Monacanthidae were identified as playing a critical functional role in coral reef ecosystems, owing to the strong associations exhibited by several species with coral habitats. A few recent demographic studies of Indo-Pacific coral reef species belonging to acanthurids, labrids and mullids, have also highlighted the importance of the age-based information derived from otoliths not only to inform fisheries managers but also to detect signals of environmental and climatic variability over latitudinal gradients (Pardee et al., 2025; Reed et al., 2025). However, despite the ecological role within coral reef ecosystems of monacanthids, the population dynamics and life history of several tropical species of this family have yet to be documented.

The genus *Amanes* contains a single Indo-Western Pacific species, *A. scopas*, whereas the genus *Cantherhines* comprises 12 tropical species (Matsuura, 2015). Both species are widely distributed across the Indo-Pacific and are typically observed in pairs on outer reef slopes at depths ranging from 2 to 20 meters. *Amanes scopas* shows a preference for coral-rich areas, reflecting its diet of primarily coral polyps, whereas *C. pardalis* predominantly feeds on benthic organisms (Harmelin-Vivien and Quéro, 1990; Gomon et al., 2008). The maximum recorded total length (TL) is 25 cm for *C. pardalis* and 20 cm for *A. scopas* (Harmelin-Vivien and Quéro, 1990; Hutchins, 2001). *Cantherhines pardalis* exhibits a range of colour patterns, varying from mottled grey and brown to dark brown, or grey with a network of polygonal spots that confer a leopard-like (pardus) appearance. Despite this variation, a

distinctive white spot at the rear base of the second dorsal fin remains a consistent feature that facilitates underwater identification. In contrast, *A. scopas* displays a more uniform brown body colouration, typically marked by up to 12 narrow dark brown crossbars. Sexual dimorphism can be distinguished by examining the area in front of the caudal peduncle: males possess several long spines, while females display a toothbrush-like mass of setae. *Cantherhines pardalis* is the only one for which embryonic development has been briefly described from wild-captured eggs (Kawase and Nakazono, 1994), and gonadal and larval development has been examined in captivity, albeit under hormonal induction (Shadrin and Emel'yanova, 2022).

To the best of our knowledge, there are no comprehensive studies on the age-based life-history traits of monacanthids with the exception four species: *Meuschenia scaber*, *Meuschenia australis*, *Nelussetta ayraudi* and *Penicipelta vittiger* (Barrett, 1995a; Miller et al., 2010; Visconti et al., 2018b). In this context of minimal biological data available for the monacanthid family, we provide the first age-based life-history study of two common coral reef monacanthids from the Solomon Islands: the honeycomb filefish (*Cantherhines pardalis*) and the broom filefish (*Amanes scopas*).

Materials and methods

Sample collection

A total of 201 *C. pardalis* and 60 *A. scopas* were collected between January 2016 and February 2017 from the reefs of Vavanga Village, located on the southwest coast of Kolombangara Island, Western Province, Solomon Islands (8°03'41" S, 156°58'05" E). Samples were collected from artisanal indigenous spearfishers with no control over the selectivity of size or sex, therefore the age structure presented here is likely to reflect the population in the area sampled. Total length (TL), standard length (SL) and body depth (BD) were recorded to the nearest mm, and total weight (TW) and gutted weight (WG) were measured to the nearest mg. The sex of each specimen was determined during dissection based on external characteristics and macroscopic examination of the gonadal tissue. Both sagittal otoliths were extracted from each specimen (Figures 1A, C), rinsed in 70% ethanol and stored dry in 96-well plates.

Age determination

For each fish, one otolith from the paired sagittal set was randomly selected and used to prepare a thin transverse section, following the methodology described by Visconti et al. (2018b). Otoliths were ground from the posterior and anterior margins to obtain a thin transverse section through the nucleus of approximately 200µm using a combination of Carbimet Silicon carbide P2500 and FiberMet 0.3 µm (Buehler, <http://www.buehler.com>). Otolith thin sections were subsequently covered with a clear low viscosity epoxy resin (RT310, Resintech,

<http://www.resintech.co.uk>). Otolith sections were viewed under reflected light against a black background with a Leica DM2000 compound microscope (www.leica.com) at $\times 100$ magnification, and pictures were taken for each sample with a GT Vision GXCAM-U3PRO camera (www.gtvision.co.uk) for subsequent analyses. Age determination was conducted using ObjectJ software (www.simon.bio.uva.nl/object) by examining the alternation of opaque and translucent zones along a linear path from the otolith core to its distal edge. The assumption of annual periodicity in the formation of these zones in monacanthid otoliths has been previously proposed (Rogers et al., 2001; Visconti et al., 2020). Each otolith section was read twice by the expert reader (V.V.), with the number of opaque zones counted to estimate age in years. If the two independent counts were identical, the reading was accepted as the final age estimate; otherwise, the individual was excluded from subsequent age-based analyses. A standard birthday of 1 July was assigned to all individuals, based on the assumption of year-round spawning and following the approach of Proctor et al. (2021). In order to examine the precision of the reading, the coefficient of variation (CV) and the average percentage error (APE) were calculated amongst readings (Beamish & Fournier 1981; Campana, 2001). A total of 140 *C. pardalis* and 42 *A. scopas* individuals were successfully aged (Figure 1).

Reproductive parameters

All specimens were eviscerated upon capture, and each pair of gonads was photographed (Supplementary Figure S1), weighed to the nearest 0.01 g, stored in 10% buffered formalin, and histologically processed within six months. All the tissues were processed following Visconti et al. (2018a) where one of the two gonad lobes for each gonad was embedded in paraffin wax, sectioned at 7 μm , and stained using a combination of Ehrlich's and Gill's haematoxylin and eosin (H&E). All the gonad sections were observed using a Leica DMRE upright microscope equipped with a colour camera (Leica DC500), and digital images were captured using AnalySIS LifeScience software. Macroscopic and microscopic developmental stages were identified and assigned according to Trip et al. (2011a) and Visconti et al. (2018a) (Supplementary Figure S2).

Population parameters

The distribution of size and age class frequency was analysed to understand the growth and longevity of both species. Instantaneous total mortality rates (Z) were derived from age-based catch curves. A linear regression was applied to the natural logarithm of the descending frequency of individuals per age class, starting from the modal age class (i.e., the age with the highest abundance) and extending to the oldest age class showing a consistent decline in abundance. This included ages 3–9 for *C. pardalis* and 6–12 for *A. scopas*.

The relationship between weight and length was described following equation (Ricker, 1973):

$$W = aL^b$$

where W denotes total weight (g), L represents standard length (mm), 'a' is the y-intercept or initial growth coefficient, and 'b' is the slope or growth coefficient. For most fish species, growth is isometric, with 'b' typically around 3.0. A 'b' value less than 3.0 indicates negative allometric growth, while a value greater than 3.0 signifies positive allometric growth.

The relationship between size and age was modelled using the von Bertalanffy growth function (VBGF), fitted for combined sexes, and for males and females separately for both species, following the equation:

$$L_t = L_{\infty}[1 - e^{-K(t-t_0)}]$$

where L_t is the estimated mean size-at-age t , and L_{∞} represents the mean asymptotic size or the maximum average length a fish would theoretically reach if it lived indefinitely. K is the growth coefficient, reflecting the steepness of the ascending portion of the growth curve and indicating how rapidly the fish approaches its asymptotic length, and t_0 denotes the theoretical age at which the fish's length would be zero. t_0 is not always an actual observable point but rather a parameter that shapes the growth curve, especially if sufficient young and smaller samples are available. The VBGF was fitted by constraining the curve to a length-at-settlement of 10 mm TL according to previous studies on the Monacanthidae family (Kingsford and Milicich, 1987; Visconti et al., 2020). VBGF growth trajectories were compared between the two species using 95% confidence ellipses surrounding the traditional VBGF estimates of parameters L_{∞} and K (Kimura, 1980). Mean maximum age T_{max} and mean maximum body size L_{max} were calculated for each species as the average age (in years) of the 15% oldest individuals, and as the average body size (total length, in mm) of the 15% largest individuals found within each species (Beverton, 1992; Trip et al., 2008).

Age and size at sexual maturity were determined for *C. pardalis* using immature and mature females collected between 2016 and 2017 (Supplementary Figure S2). Size at maturity was estimated from the size at which 50% of females were sexually mature (L_{50}) and the size at which 95% of females were sexually mature (L_{95}) (Trip et al., 2011b; Visconti et al., 2018a). Age at maturity was estimated from the age at which 50% and 95% of females were sexually mature (T_{50} and T_{95} , respectively) following Trip et al. (2011b) and Visconti et al. (2018a). The logistic function (the maturity ogive) was fitted to the proportion of mature fish in each year class that were sampled during the spawning season and the ogive was fitted to the mid-point of each age class. The best-fit logistic function was estimated by minimizing the negative \log_{10} of the likelihood based on a probability density function with a binomial distribution (Haddon, 2001). No immature females were present among the *A. scopas* sampled, which prevented us from calculating the logistic functions and estimating size- and age-at-maturity for this species.

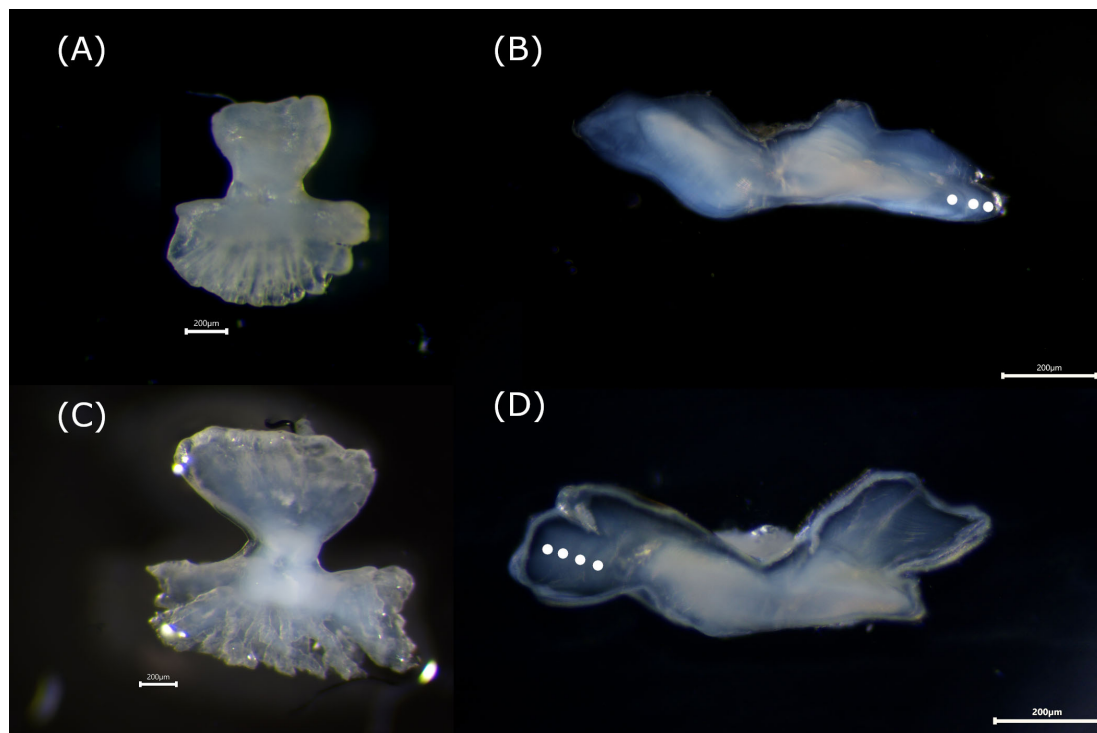


FIGURE 1

Whole and sectioned otoliths of *Cantherhines pardalis* (A, B) and *Amanes scopas* (C, D), viewed under reflected light. Distinct opaque growth increments, interpreted as annual rings, are marked with white dots.

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Results

Size, age and growth parameters

The transverse sectioned otoliths showed clear alternating patterns of opaque and translucent zones, with *C. pardalis* exhibiting better reading patterns (Figure 1B) than *A. scopas* (Figure 1D). *C. pardalis* ranged in total length (TL) from 104 mm to a maximum of 163 mm, while *A. scopas* exhibited a broader size range, from 110 mm up to 188 mm TL (Figure 2A). In terms of age distribution, *C. pardalis* reached a maximum age of 9 years while *A. scopas* attained 12 years (Figure 2B). The ageing precision for both species resulted similar to those published for other monacanthids (Visconti et al., 2018a; Miller et al., 2010), with *C. pardalis* (n=140) scoring a CV=6.7% and APE=8.12, and *A. scopas* (n=42), a CV=2.5%, APE=20.3.

Mortality estimates for *C. pardalis* and *A. scopas* based on age-based catch curves revealed annual mortality rate of 39.25% (yr^{-1}) and 47.74% (yr^{-1}), respectively, reflecting their relatively short life spans (Table 1).

Analysis of the length (L) and weight (W) relationship for *C. pardalis* revealed a negatively allometric L-W growth coefficient of

2.75, which indicates a species that prioritises growth over condition (Table 1; Supplementary Figure S3). When partitioned by sex, females exhibited a stronger negative growth coefficient ($b=2.52$) compared to males ($b=2.80$), suggesting a behavioural dominance of males over females. The negative allometric relationship between length and weight was the same for *A. scopas* ($b=2.79$), however, when partitioned by sex the growth coefficient was similar between males ($b=2.85$) and females ($b=2.90$).

Given the 1:1 sex ratio for both species, the length-weight relationships provide an interesting insight into the growth vs condition strategy of this species, which coincides with the results of the VBGF analysis. *C. pardalis* (Figure 3; Table 1) exhibited fast early growth ($K=1.06$) in the first two to three years of life, before reaching an asymptotic length of 145.68 mm (TL). In contrast, *A. scopas* showed comparatively slower and more gradual growth ($K=0.63$), reaching an asymptotic length of 159.02mm (TL) later in life (Figure 3; Table 1). The comparison of combined growth curves of both species showed *C. pardalis* to grow faster in their first 3 years of life while *A. scopas* grow relatively slower but attain bigger asymptotic lengths and older ages. These differences were confirmed by plotting the 95% confidence ellipses surrounding the VBGF estimates of parameters L_{∞} and K (Figure 3). When partitioned by sex, *C. pardalis* males grew slower early on but reached a larger asymptotic length (151.60 mm TL) compared to females (135.32 mm TL) (Supplementary Figure S4; Table 1). When partitioned by sex, *A. scopas* males grew faster than females, and males reached a comparatively larger asymptotic

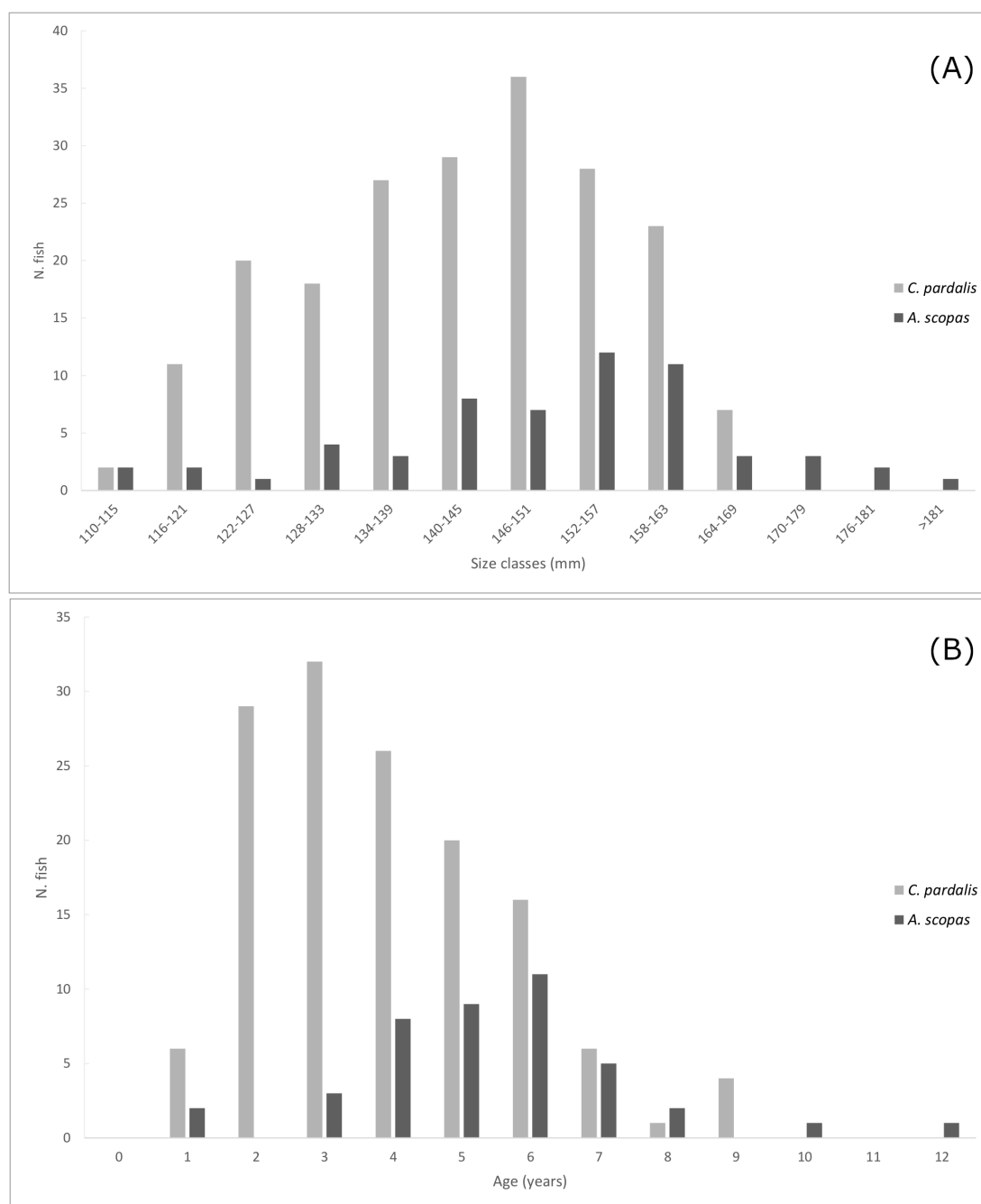


FIGURE 2
Age (A), and size distribution (B) of *Cantherhines pardalis* and *Amanes scopas* from the Solomon Islands.

length (159.37 mm TL) than females (149.38 mm TL) (Supplementary Figure S4; Table 1).

Reproductive parameters

Histological analysis identified six reproductive stages that were assigned to females to the gonad histological sections of both species, following the criteria published in Visconti et al. (2018a) (Supplementary Figure S2). Inactive ovaries showed immature

characteristics with chromatin nucleolar stage of primary growth cells (pre-vitellogenic oocytes) organised in a compact grid of ovigerous lamellae surrounded by a thin ovarian wall. Ripening ovaries exhibited the developing features during the secondary growth and were divided into two sub-stages: the first (ripening1) displaying early-stage cortical alveolar and primary vitellogenic oocytes, and the second (ripening2) displaying secondary (Vtg2) and tertiary (Vtg3) vitellogenic oocytes. Spawning ovaries contained several full yolk granule oocytes, with most undergoing germinal vesicle migration and breakdown, fully hydrated oocytes were

TABLE 1 Population parameter estimates for *Cantherhines pardalis* and *Amanses scopas* from the Solomon Islands.

Function	Parameters	<i>Cantherhines pardalis</i>	<i>Amanses scopas</i>
VBGF	L_{∞}	145.68	159.02
	K	1.06	0.63
	t_0	-0.07	-0.06
	SS	15010.20	4467.03
	SE	0.88	1.50
VBGF (male)	L_{∞}	151.60	159.37
	K	0.87	1.06
	t_0	-0.08	-0.06
	SS	7962.56	1685.40
	SE	1.98	1.91
VBGF (female)	L_{∞}	135.32	149.38
	K	1.95	0.88
	t_0	-0.04	-0.08
	SS	5854.05	2165.66
	SE	1.13	1.98
Length-Weight relationship	b	2.75	2.79
	R^2	0.87	0.87
Length-Weight relationship (male)	b	2.80	2.85
	R^2	0.88	0.84
Length-Weight relationship (female)	b	2.52	2.90
	R^2	0.77	0.89
Mortality (yr^{-1})	Z (%)	39.25	47.74
T_{\max}	Age (years)	9	12
L_{\max}	Total length (mm)	163	188
Size-at-maturity	L_{50} (TL, mm +/- SE)	110.80 +/- 0.27	–
	L_{95} (TL, mm +/- SE)	123.54 +/- 0.33	–
Age-at-maturity	T_{50} (years +/- SE)	0.92 +/- 0.01	–
	T_{95} (years +/- SE)	1.09 +/- 0.01	–
Sex ratio	F:M	1:1	1:1

The table includes von Bertalanffy Growth Function (VBGF) parameters fitted to combined and sex-specific data, length–weight relationships (power function), age-based mortality estimates (Z), and mean maximum age (T_{\max}) and length (L_{\max}) calculated from the oldest and largest 15% of individuals. Size-at-maturity (L_{50} , L_{95}) and age-at-maturity (T_{50} , T_{95}) are reported for *C. pardalis* only. Sex ratios are also provided.

abundant in the central lumen, and postovulatory follicles (POFs) and atretic oocytes were observed in the ovarian tissue. Post-spawning ovaries showed atretic hydrated oocytes and signs of previous spawning (post-ovulatory follicles, intra-lamellar muscle bundles). Resting ovaries (reproductively inactive) had numerous primary growth cells kept together in the lamellae by thick interlamellar muscle bundles and a thick ovary wall (Supplementary Figure S2).

The logistic function for size-at-maturity for *C. pardalis* showed that maturity is reached at 110mm of FL (L_{50}) with the 95% of the individuals being mature at 123.5mm (L_{95}). The logistic function for age-at-maturity for *C. pardalis* revealed an early maturation in females at just 1 year of life, with 50% of females becoming mature and active spawners by 0.92 years, 95% of females becoming mature by 1.09 years, and 100% of the individuals becoming mature and active spawners by the second year of life (Supplementary Figure S5). The youngest and smallest *A. scopas* female (1 year old and 110 mm TL) was diagnosed as being sexually mature with ripened ovaries, suggesting early sexual maturation (in age and body size) in *A. scopas*, which was also observed in *C. pardalis*.

Discussion

This study provides the first age-based life-history assessment for *C. pardalis* and *A. scopas* from the Solomon Islands, filling a significant gap in our understanding of tropical monacanthid demography. Despite their widespread occurrence and ecological relevance in coral reef habitats, detailed biological data for these species have been absent in the literature to date. Our findings indicate marked differences in life-history strategies between the two species. *C. pardalis* exhibits rapid early growth, matures within its first year, and reaches a maximum observed age of 9 years. In contrast, *A. scopas* grows more slowly ($K = 0.63$), attains a larger asymptotic size, and reaches an older maximum age of 13 years. Sex-specific patterns in growth and length-weight relationships were observed in both species. In *C. pardalis*, males achieved larger asymptotic lengths but grew more slowly than females, suggesting differential energy allocation strategies—potentially reflecting reproductive roles or territorial behaviours (Afeworki et al., 2014; Olsson and Gislason, 2016). The lack of immature *A. scopas* females in our sample along with the imbalanced sample-size presented in this study (i.e. *C. pardalis* $n=201$ vs *A. scopas* $n=60$) complicates direct comparisons, but the presence of mature females at small sizes supports early maturation in this species as well.

The observed negative allometric growth in both species ($b < 3$) implies prioritisation of somatic growth in length over weight, which may confer hydrodynamic or ecological advantages in structurally complex reef environments (Gust et al., 2002; Dunic and Baum, 2017). Similar patterns have been documented in other monacanthids and may be adaptive for manoeuvrability or habitat use (Ballard and Rakocinski, 2012; Visconti et al., 2020). Mortality estimates ($Z = 39.25\%$ for *C. pardalis*; $Z = 47.74\%$ for *A. scopas*) align with expectations for small-bodied reef fishes subjected to

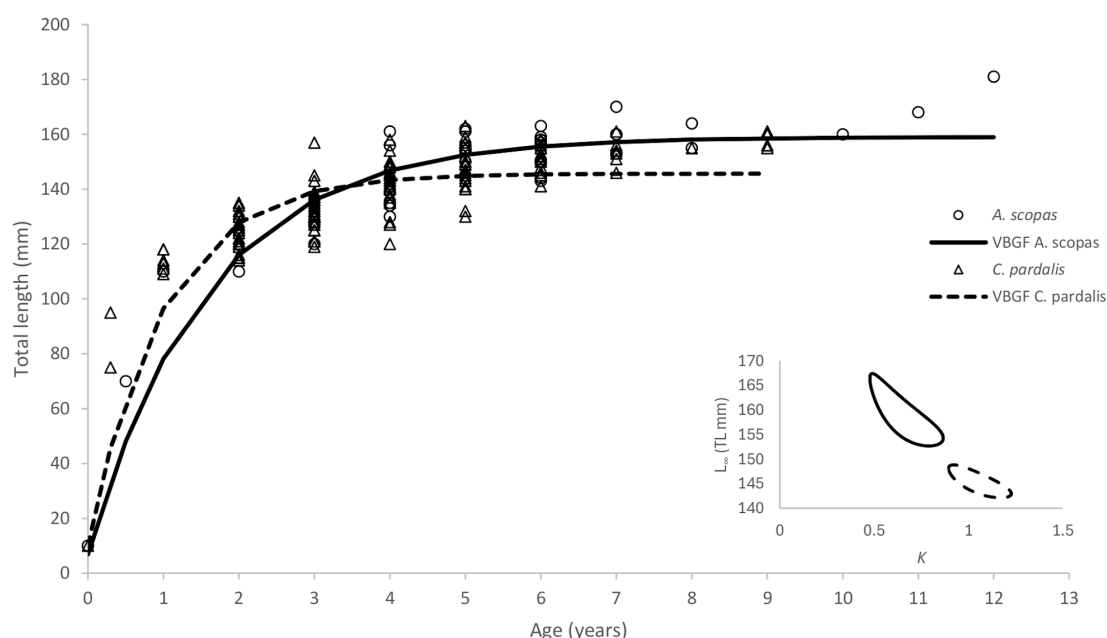


FIGURE 3

Von Bertalanffy growth trajectories of *Cantherhines pardalis* (dashed line) and *Amanses scopas* (continuous line) in the Solomon Islands, and comparison of VBGF parameters K and L_{∞} using 95% confidence ellipses (inset). Results of VBGF parameter values are presented in Table 1.

natural predation and artisanal harvesting. Monacanthids have been observed to display a variety of mating behaviours (Kawase, 1998, 2002), and are generally gonochoristic in their reproductive dynamics, with some sex-changing exceptions (Yamaguchi et al., 2013). In our study, both species displayed near 1:1 sex ratios, and gonochorism is consistent with previous reports for monacanthids.

Collectively, these findings support the hypothesis of divergent growth and reproductive strategies within a single family in the same reef system and, particularly, the ecological plasticity of monacanthids. Recent studies and observations have highlighted some peculiar ecological aspects of monacanthids in the coral reef system; an *A. scopas* individual was recorded to be anchored at the same *Acropora* spp. colony for several days after a severe storm (Eyal et al., 2011). While this sleeping behaviour reiterates the strong association with coral reef habitats (recently highlighted in Siqueira et al., 2023), on the other hand this species has been seen primarily feeding on coral polyps. If its diet was confirmed, *A. scopas* could be threatened by the current increase of habitat loss and forced to switch diet towards alternative resources as already documented for another monacanthid, the harlequin filefish *Oxymonacanthus longirostris* (Hobbs, 2013).

Given their role in reef trophodynamics, further research on their diet, habitat use, and responses to environmental stressors would enhance our understanding of the functional role of monacanthids in Pacific coral reef ecosystems.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The animal study was approved by the University of Auckland Animal Ethics for the collection of another monacanthid species and the same guidelines and protocols were used for the collection of the species in this study. The study was conducted in accordance with the local legislation and institutional requirements.

Author contributions

VV: Project administration, Data curation, Writing – original draft, Formal Analysis, Visualization, Investigation, Resources, Conceptualization, Writing – review & editing, Funding acquisition, Supervision. IW: Writing – review & editing, Investigation, Methodology. ET: Writing – review & editing, Validation, Formal Analysis, Supervision, Visualization, Methodology. AS: Resources, Writing – review & editing, Supervision, Investigation, Funding acquisition.

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Conflict of interest

Author ET was employed by HalieuMer.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fmars.2025.1634488/full#supplementary-material>

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