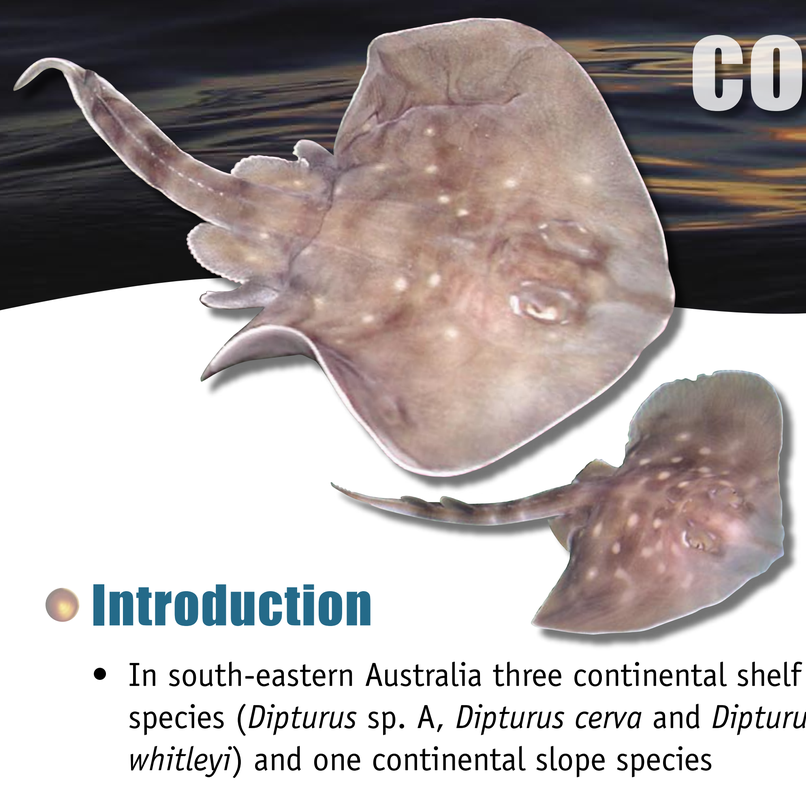
Age and growth of four skates commonly caught as by-catch in the southeast Australian fisheries



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Introduction

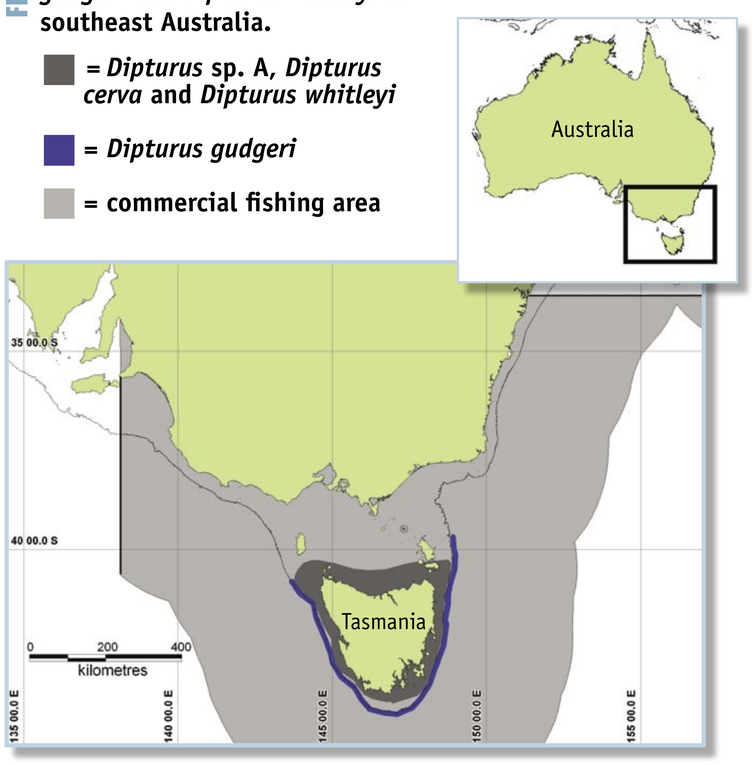
- In south-eastern Australia three continental shelf species (*Dipturus* sp. A, *Dipturus cerva* and *Dipturus whitleyi*) and one continental slope species (*Dipturus gudgeri*) are frequent bycatch of trawl, dropline and gillnet fisheries (Figure 1).
- The aim of this study was to obtain age and growth estimates of these commercially exploited species of skates and to compare different ageing techniques and growth models to best describe the species growth.

FIGURE 1 **Sample collection sites of *Dipturus* sp. A, *Dipturus cerva, Dipturus gudgeri* and *Dipturus whitleyi* in southeast Australia.**

= *Dipturus* sp. A, *Dipturus cerva* and *Dipturus whitleyi*

= *Dipturus gudgeri*

= commercial fishing area



Methods

- From each skate, vertebral centra and caudal thorns were removed and frozen.
- Vertebrae were examined by two independent readers and average percent error index (IAPE index) (Beamish and Fournier 1981) and Chang's coefficient of variance equation (CV) (Chang 1982) evaluated (Table 1).
- Verification methods included marginal increment analysis, edge analysis and comparisons of sectioned, whole centra and thorns (Figure 2).
- von Bertalanffy (VBGM) and the reparameterised VBGM equation derived by Francis (1988) were used for comparisons of *Dipturus* sp. A and *D. cerva*.

TABLE 1 **Average percent error index and Chang's coefficient of variance equation for the four skate species.**

	Dipturus sp. A	*Dipturus cerva*	*Dipturus gudgeri*	*Dipturus whitleyi*
IAPE	5.94%	7.22%	7.52%	13.45%
CV	5.05%	6.35%	15.20%	19.07%

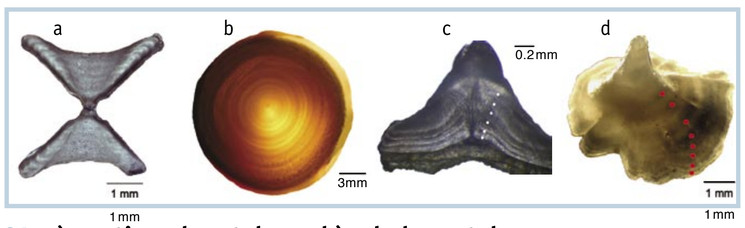
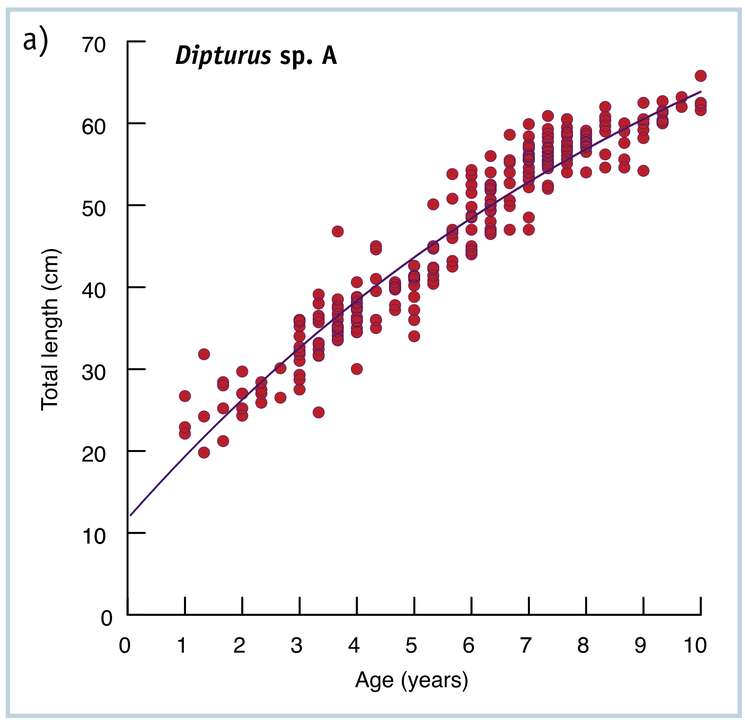


FIGURE 2 **a) sectioned vertebrae b) whole vertebrae c) sectioned thorn d) whole thorn.**

Results

- Growth curves were not constructed for *D. whitley* or *D. gudgeri* due to low sample sizes or incomplete representation of the size range.
- Caudal thorn and vertebral readings were similar for *Dipturus whitleyi*, but *D. gudgeri* caudal thorns were unreliable. The whole and sectioned vertebrae comparisons showed good agreement in the larger skates *D. gudgeri* and *D. whitleyi*.
- Sexes were pooled for both growth models as χ^2 tests on likelihood ratios (Kimura 1980) indicated no significant difference between them (P>0.05).
- There was little difference between the two growth models used (Figure 3).
- An extrapolated growth curve *Dipturus cerva* suggested a positive t_0 (Table 2, Figure 3b).



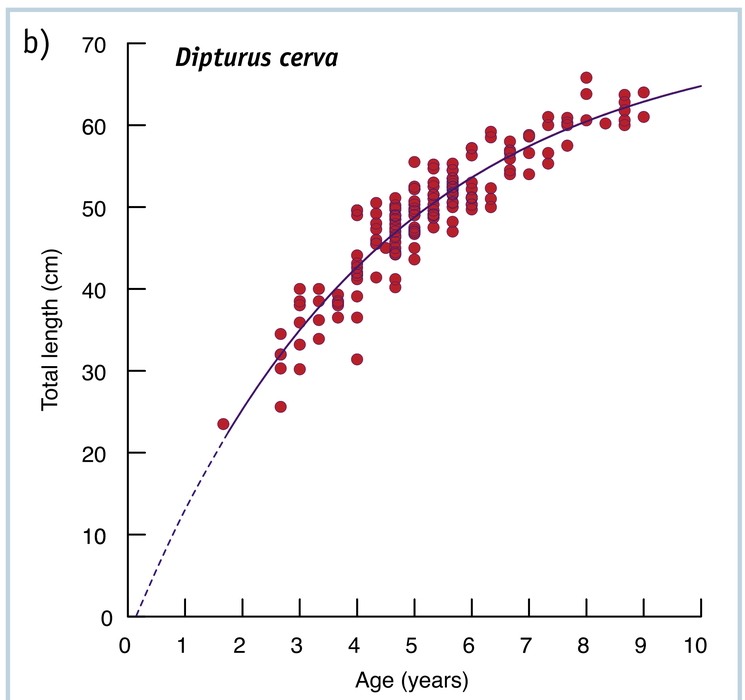


FIGURE 3 **Comparison of the von Bertalanffy ● and the Francis reparameterised VBGM ○ for a) *Dipturus* sp. A and b) *Dipturus cerva*.**

TABLE 2 **Growth parameters for *Dipturus* sp. A and *Dipturus cerva* (sexes combined). VBGM = von Bertalanffy (von Bertalanffy 1938) growth model and Francis = reparameterised model from Francis (Francis 1988).**

Species	Parameter	VBGM	Parameter	Francis
Dipturus sp. A	r^2	0.996	r^2	0.996
	$L\infty$	98.922	l_2	72.328
	k	0.091	$l_{4.5}$	87.134
	t_0	-1.388	l_7	98.922
Dipturus cerva	r^2	0.997	r^2	0.997
	$L\infty$	72.039	l_1	27.652
	k	0.233	l_4	57.287
	t_0	0.142	l_7	72.039

Discussion

- CV scores showed greater precision variance in larger bodied species, suggesting more errors in ageing the larger individuals.
- Longevity estimates for most skate species worldwide are between 9 and 24 years (Francis *et al*. 2001). The oldest aged *Dipturus cerva* was estimated at 9 years while the large deepwater species *Dipturus gudgeri* was estimated at 21 and 20 years for females and males, respectively (Table 3).
- *Dipturus* sp. A and *Dipturus cerva* growth did not reach an asymptote. Their oviparous reproduction may be less energy demanding than viviparous species, allowing more continual energy for growth.

TABLE 3 **Maximum length and oldest aged individuals for the four skate species.**

Species	L_{max} (cm)		Longevity (years)	
	Male	Female	Male	Female
Dipturus sp. A	66.0	66.8	12	11
Dipturus cerva	61.0	64.0	9	9
Dipturus gudgeri	155.6	184.4	20	21
Dipturus whitleyi	135.5	197.7	13	18

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