

Morphology of hybrid marine turtles *Caretta caretta* x *Chelonia mydas*

Patrick J. COUPER

Biodiversity and Geosciences Program, Queensland Museum, PO Box 3300, South Brisbane, Queensland, Australia.

Nancy N. FITZSIMMONS

Department of Environment and Science, Brisbane, Queensland, Australia.

Australian Rivers Institute, Griffith University, Nathan, Queensland, Australia.

Siobhan HOULIHAN

Sea World, Gold Coast, Queensland, Australia.

Andrew P. AMEY

Biodiversity and Geosciences Program, Queensland Museum, PO Box 3300, South Brisbane, Queensland, Australia.

Duncan J. LIMPUS

Colin J. LIMPUS

Department of Environment and Science, Brisbane, Queensland, Australia.

<https://doi.org/10.17082/j.2204-1478.64.2023.2023-02>

Citation: Couper, P.J., FitzSimmons, N.N., Houlihan, S., Amey, A.P., Limpus, D.J. & Limpus, C.J. (2023). Morphology of hybrid marine turtles *Caretta caretta* x *Chelonia mydas*. *Memoirs of the Queensland Museum | Nature* 64: 320–341. Brisbane ISSN 2204-1478 (Online), ISSN 0079-8835 (Print). Accepted: 23 June 2023. Published online: 30 October 2023.

Keywords:

Turtles | hybrid | *Caretta caretta* | *Chelonia mydas* | scalation | skeletal anatomy | Mon Repos | south-east Queensland | Australia.

ABSTRACT

We report on *Caretta caretta* × *Chelonia mydas* hybrid hatchlings that emerged from successive nests laid by a female Loggerhead Turtle (*C. caretta*) at Mon Repos, south-east Queensland, during the 1990–91 breeding season. We provide details of the parent female’s breeding history, which includes multiple paternity and genetic confirmation of her hybrid offspring. Three hybrid hatchlings were raised in captivity to assess whether scalation could be used to identify hybrid turtles in field studies. One captive hybrid died at 29 years of age, allowing an assessment of its reproductive status and examination of its skeletal anatomy. Two of the captive individuals were determined to be infertile. The reproductive status of the third individual was not determined. The external and skeletal morphology of the hybrids is discussed and illustrated. We show that atypical symmetrical scalation is diagnostic for *C. caretta* × *C. mydas* hybrids, as are various buccal and skeletal characters.

Hybridisation was first reported for marine turtles in 1888 (Garman 1888) and has been shown to occur intermittently over the past four decades from within the Pacific, Indian and Atlantic Ocean basins (reviewed in Bowen and Karl 2007). To date, hybrid combinations, involving all six cheloniid turtle species, have been reported: *Caretta caretta* × *Chelonia mydas* (James et al. 2004); *C. caretta* × *Eretmochelys imbricata* (Kamezaki 1983; Vilaça et al. 2012; Witzell and Schmid 2003); *C. caretta* × *Lepidochelys kempii* (Karl et al. 1995); *C. mydas* × *E. imbricata* (Wood et al. 1983; Seminoff et al. 2003); *Lepidochelys olivacea* × *C. caretta* (Vilaça et al. 2012); *L. olivacea* × *E. imbricata* (Vilaça et al. 2012); *Natator depressus* × *L. olivacea* (Waayers and Fitzpatrick 2012). Within the southern Great Barrier Reef (GBR) region of eastern Australia, *C. caretta* × *C. mydas*, *N. depressus* × *C. caretta* and *N. depressus* × *C. mydas* hybrid hatchlings have been observed. Sympatric nesting by all three species occurs at numerous beaches (Dept of Environment and Science 2022) and mating areas used by *C. caretta* and *C. mydas* overlap at several locations (Limpus pers. obs.).

Most reports of hybridisation are of isolated events within non-hybridised populations but there is also clear evidence of a high percentage (27–42%) of naturally occurring, reproductively functional hybrid turtles of *C. caretta* × *E. imbricata* and *C. caretta* × *L. olivacea* nesting along the north-eastern coast of Brazil (Lara-Ruiz et al. 2006, Reis et al. 2006, Soares et al. 2018, 2021). Hybridisation is occurring within the current generation in Brazil, but there is also evidence that hybridisation has been occurring across generations as indicated by the

presence of *E. imbricata* × *C. caretta* × *C. mydas* hatchlings (Vilaça et al. 2012). Using whole-genome resequencing data for five marine turtle species, Vilaça et al. (2021) investigated patterns of genetic diversity, population size dynamics and ancient hybridization between species. They concluded that hybridisation played a role in the evolutionary history of marine turtles. In contrast, prior to the availability of modern genetic testing for species identification, hybrid turtles have been mistakenly described as new species (Stuart and Parham 2007). Using genetic markers, Garofalo et al. (2012) were able to refute that a *C. caretta* exhibiting an atypical scale pattern was a hybrid.

Herein, we report on the first records of hybrid *C. caretta* × *C. mydas* hatchlings for Australia. These were observed on the 16th January 1991 at Mon Repos Beach (near Bundaberg, south-east Queensland) and emerged from the first clutch laid for the season by an adult Loggerhead Turtle (*C. caretta*) T2625 (Table 1). The hybrid hatchlings superficially resembled Green Turtle (*C. mydas*) hatchlings in body shape and colouration and emerged alongside a larger number of normal-looking *C. caretta* hatchlings. Because a small number of *C. mydas* nest annually at Mon Repos, the hybrid hatchlings could easily have been overlooked if they had not been seen emerging simultaneously with *C. caretta* hatchlings. A closer examination showed that some of the hatchlings resembling *C. mydas* had five pairs of costal scales, a condition rarely seen in Green Turtles. Subsequent nests by T2625 in the 1990–91 breeding season were closely monitored, and all produced a mix of *C. caretta* and *C. caretta* × *C. mydas* hatchlings. This confirmed hybrid event

allowed us to address questions regarding our capacity to correctly identify large immature or adult-sized turtles. A series of voucher specimens for both *C. caretta* and *C. caretta* x *C. mydas* hybrid hatchlings from the second nest of female T2625 in the 1990–91 breeding season were deposited in the Queensland Museum (see **Material examined**).

METHODS

We initiated a long-term study to captive-rear a sample of these hatchlings to maturity, allowing us to assess external morphology as they aged and to genetically test their parentage. We transferred three hybrid hatchlings from T2625's second clutch for the season to Sea World (Gold Coast, Queensland) for captive rearing. The hatchlings were subsequently tagged for individual recognition with titanium flipper tags (T71784–86) that were positioned in the axillary area of a front flipper. PIT tags were injected under the carapace at the left shoulder. The captive rearing study concluded with the death of the last captive hybrid in 2020 at 29 years of age. We summarise the breeding history of the *C. caretta* parent turtle (T2625) and data recorded from the *C. caretta* x *C. mydas* hybrids that emerged from her successive clutches (1990–91 breeding season). We compared the hatchling hybrids to both *C. mydas* and *C. caretta* hatchlings and post-hatchlings of similar size and illustrate how they differ from their parent stock in colour pattern, size and scalation. Also, we provide data on the three captive-reared individuals and report on skeletal features of the hybrid turtles, some resembling *C. caretta*, others *C. mydas*, but many showing conditions intermediate to both. A skeletal comparison of adult-sized *C. caretta*, *C. mydas* and *C. caretta* x *C. mydas* turtles was possible from skeletal material held in the Queensland Museum and the prepared skeleton of the 29-year-old hybrid (QM J97245). The skeleton of a smaller *C. caretta* x *C. mydas* hybrid (QM J85544, CCL = 51 cm) was also available for comparison. Therefore, we were able to identify skeletal characters that were diagnostic for identifying *C. caretta* x *C. mydas* hybrids that were consistent across both juvenile and adult size classes.

Terminology:

Terminology largely follows that of Wyneken (2001) and Márquez (1990). Cranial and dentary measurements (straight-line) follow Kamezaki and Matsui (1995).

- *Cranial length*: anterior tip of premaxilla to posterior tip of supraoccipital
- *Cranial width*: distance between the outermost points of the squamosal bones
- *Dentary length*: anterior tip of dentary to posterior tip of articular
- *Dentary height*: tip of coronoid to ventral edge of dentary
- *Parietal notch*: posterodorsal emargination between the squamosal and supraoccipital bones
- *Tomium*: cutting edge of maxilla
- *Dentary midline*: anterior tip to mid-posterior edge (buccal surface)

Skeletal descriptions are from direct examination of specimens in Queensland Museum, identified by registration number. Measurements given for hatchling and adult *C. mydas* and *C. caretta* are from Limpus (1985) and Limpus et al. (1984, 2003).

Abbreviations: CCL: midline curved carapace length, SCL: straight carapace length, QM: Queensland Museum, GBR: Great Barrier Reef. **Note:** The skeletal images provided are not to scale and are intended as a visual aid for identifying specific morphological differences. The dimensions of individual turtles are provided in Table 3. Line drawings and images are by Patrick Couper QM, unless otherwise stated in figure captions.

RESULTS

Breeding biology of adult female Loggerhead Turtle

The history of a female *C. caretta* (T2625) across five recorded breeding seasons at Mon Repos Beach is summarised in Table 1. This turtle was first recorded during an unsuccessful nesting attempt at Wreck Rock Beach (24 Dec 1983). She then moved approximately 100 km south, laying her first recorded clutch at Mon Repos on 29 Dec 1983. At least three clutches of eggs were laid during the 1983–84 breeding season. Subsequently, she returned to Mon Repos for another four breeding seasons with two-, two-, three- and two-year intervals and laid five clutches of eggs in the first season and six for the remaining three. Just prior to her fourth breeding season, T2625 was caught as fishing bycatch at Byron Bay, northern New South Wales (15 Oct 1990), 520 km south of Mon Repos. Thirty-two days later, she came ashore at Mon Repos to lay her first clutch for the 1990–91 breeding season. Hatchling turtles were examined from her first, second, fifth and sixth clutches for this season, with each clutch containing a mix of morphologically normal *C. caretta* hatchlings and hatchlings that resembled *C. mydas* in body size and colour pattern.

This provided evidence that T2625 was inseminated by at least one *C. caretta* male and one *C. mydas* male at a breeding ground enroute to Mon Repos. Genetic analyses of 27 hatchlings from the 1990–91 clutches identified 14 *C. caretta* individuals and 13 *C. caretta* × *C. mydas* hybrids, based on microsatellite analyses. These analyses used the Cm3 and Cm58 microsatellites that are not variable in this *C. caretta* population and the Ei8 and Cc141 microsatellites that are not variable in the *C. mydas* southern GBR population (FitzSimmons et al. 1995, and FitzSimmons unpubl. data). The three captive tagged individuals (T71784–86) sampled in Mar 1996 were also confirmed as *C. caretta* × *C. mydas* hybrids.

Table 1 (next page). Summary of breeding history of adult female *C. caretta*, T2625: resident in Byron Bay, Northern New South Wales waters, and nesting on the Woongarra Coast. First recorded ashore attempting to nest at Wreck Rock (WR) in the 1983–84 breeding season. After one unsuccessful nesting attempt, she changed nesting beach to Mon Repos (MR), where she laid three additional clutches for the season. She continued to breed successfully at Mon Repos across five breeding seasons.

Other genetic studies have shown that some female *C. caretta* nesting at Mon Repos mated with multiple males and stored sperm to fertilise their successive clutches (Harry and Briscoe 1988, Howe et al. 2018). Multiple paternity within a clutch of eggs or hatchlings is common in this population. There was no evidence of hybridisation in the first two clutches T2625 laid during her fifth breeding season. Over the nine years (1983–84 to 1992–93 breeding seasons) that T2625 was recorded, her CCL increased by 4.3 cm.

Colour pattern and morphology of hatchlings from eastern Australia

***C. caretta*. Dorsal surface** (Fig. 1a): Carapace mid-dark brown, generally a little paler at edges; flippers uniformly chocolate brown to black. Head uniformly greyish brown. Eyelids and jaw sheath dark. **Ventral surface:** Plastron with medial dark zone extending from anal to humeral scutes, paler at edges. Chin, throat, and flippers dark chocolate brown to black. **Size:** Mean SCL = 43.3 mm, SD = 0.141, range 39.0–46.9, n = 710; mean weight = 20.9 g, SD = 1.680, range 14.6–26.4, n = 690. Mon Repos (Limpus 1985).

***C. mydas*. Dorsal surface** (Fig. 1b): Carapace predominantly dark, dusky grey but brown towards centre and bearing a paler vertebral streak. Marginals with narrow cream outer edge; flippers dark, dusky grey with distinct cream margin. Head dark above. Scales on postorbital region dark, with narrow pale margins. Eyelids pale. Upper jaw sheath with pale lower edge. **Ventral surface:** Plastron, chin, throat, proximal half of flippers and tail pale cream. Distal half of flippers darkly pigmented. **Size:** Mean SCL = 48.9 mm, SD = 0.19, range 45.5–53.5, mean weight = 24.93 g, SD = 2.36, range 19–30.5, n = 220. Heron Is. 1980–81 (Limpus et al. 1984).

Season	Beach records	Breeding season	CCL (cm)	Remigration interval (yr)	Clutches per year	Clutch no. for year	Date	Clutch data
1983–84	WR x1	First	96.0			0	24 Dec	Unsuccessful attempt
						1	29 Dec	
	2		11 Jan					
	3		24 Jan					
1985–86	MR x6	Second	96.0	2	5	1	03 Dec	Hatch success = 94.4 %
						2	16 Dec	
						3	27 Dec	
						4	08 Jan	
						5	19 Jan	
1987–88	MR x7	Third	97.5	2	6	1	29 Nov	140 eggs; Hatch success = 84.8%
						2	13 Dec	133 eggs
						3	26 Dec	114 eggs
						4	07 Jan	
						5	20 Jan	
						6	02 Feb	
<p>Captured while foraging at Byron Bay in northern New South Wales on 15 Oct 1990, 32 days prior to being recorded ashore at Mon Repos on 16 Nov 1990 for her first nesting for the 1990–91 breeding season, having migrated a minimum distance of 530 km.</p>								
1990–91	MR x12	Fourth	98.5	3	6	1	16 Nov	156 eggs; emerged 16–17 Jan. <i>Caretta</i> and hybrid <i>C. caretta</i> x <i>C. mydas</i> hatchlings
						2	01 Dec	Emerged 23 Jan; <i>Caretta</i> and hybrid <i>C. caretta</i> x <i>C. mydas</i> hatchlings
						3	15 Dec	149 eggs; Hatchlings not examined
						4	26 Dec	130 eggs; Clutch lost with TC Joy erosion
						5	08 Jan	133 eggs; <i>Caretta</i> and hybrid <i>C. caretta</i> x <i>C. mydas</i> hatchlings
						6	21 Jan	<i>Caretta</i> and hybrid <i>C. caretta</i> x <i>C. mydas</i> hatchlings
1992–93	MR x10	Fifth	99.8	2	6	1	28 Nov	149 eggs; Hatch success = 95.3%, no hybrid hatchlings
						2	12 Dec	No hybrid hatchlings
						3	25 Dec	
						4	08 Jan	
						5	20 Jan	
						6	01 Feb	



Figure 1. Hatchling turtles **A** *C. caretta* **B** *C. mydas* **C** *C. caretta* x *C. mydas* hybrid, showing a distinctive pale edge to carapace and flippers. Hatchlings **A** and **C** are from the second clutch of *C. caretta* T2625 during the 1991–92 nesting season. (image 1b © Colin Limpus. Image 1c © Queensland Museum, Lily Kumpe).

***C. caretta* x *C. mydas* hatchlings from *C. caretta* female T2625: Dorsal surface** (Fig. 1c): Carapace predominantly greyish brown with a brown vertebral streak. Marginals with narrow cream outer edge; flippers dark, dusky grey with distinct cream margin. Head dark above. Eyelids and scales on postorbital region dark. Upper jaw sheath with pale lower edge. **Ventral surface:** Plastron, chin, throat, proximal half of flippers and tail pale cream. Distal half of flippers darkly pigmented. **Size:** Mean SCL = 48.6 mm, SD = 0.10, mean weight = 23.03 g, SD = 0.86, n = 10 (first clutch); mean SCL = 48.1 mm, SD = 0.12, mean weight = 24.17 g, SD = 1.28, n = 23 (second clutch). *C. caretta* hatchlings emerging from T2625's second clutch had a mean SCL of 44.4 mm, SD = 0.11, mean weight = 22.04 g, SD = 0.95, n = 50 (Table 2). The hybrid hatchlings distinctly resemble *C. mydas* in both size and colour pattern.

Scalation: Despite variation in the scalation of the hybrid hatchlings (Table 2), some scale traits predominantly resembled *C. caretta*. These include the presence of five pairs of costal scutes (vs. four in *C. mydas*), first pair of costal scutes in contact with precentral scute (vs. not in contact in *C. mydas*); two pairs of large prefrontal scales (Fig. 2c vs. a single pair in *C. mydas* Fig. 2b), a partially divided frontoparietal (at times partially or fully divided in *C. caretta* vs. usually undivided in *C. mydas*), three postorbital scales (Fig. 2d vs. four or more in *C. mydas*) and two claws on the front and hind flippers (vs. one claw in *C. mydas*). The hybrids resembled *C. mydas* in predominantly having four enlarged inframarginal scales on the plastron/carapace bridge (vs. three in *C. caretta*) and two temporal scales (vs. usually three in *C. caretta*). Twenty seven of the 28 hybrid hatchlings examined had a divided intergular scale, an unusual condition for both the parent species.

Table 2 (next page). Summary of measurements and scute patterns of hatchling turtles from clutches of eggs laid by female Loggerhead Turtle (*C. caretta*) T2625 at Mon Repos beach during the 1990–91 summer breeding season. Hatchlings from this female during this season included morphologically normal *C. caretta* and morphologically abnormal hatchlings for *C. caretta*. The morphologically abnormal hatchlings showed a strong resemblance to Green Turtle (*C. mydas*) hatchlings in colour and shape. Though there were variation in character states, the presumed hybrid hatchlings predominantly resembled *C. caretta* regarding the number of costal scutes (usually five), the number of prefrontal scales (two or more pairs) and the number of postocular scales (usually three). The hybrids resembled *C. mydas* in the number of inframarginal scales on the carapace/plastron bridge. The number of prefrontals shown in the table is the total number of scales sitting between the nasal and frontal scales. Both the *C. caretta* and *C. caretta* x *C. mydas* hatchlings generally have four enlarged prefrontals with a varying number of smaller, supernumerary scales sitting between the prefrontals, or resulting from fragmentation of the prefrontals.

Hatchlings		Normal <i>C. caretta</i>				Abnormal					
		Clutch 2 n = 50		Clutch 6 n = 78		Clutch 1 n = 10		Clutch 2 n = 23		Clutch 6 n = 5	
SCL ± SD (cm)		4.44 ± 0.11				4.86 ± 0.10		4.81 ± 0.12			
Weight ± SD (g)		22.04 ± 0.95				23.03 ± 0.86		24.17 ± 1.28			
Scute name	Number										
Nuchal	1	50		78		9		23		5	
	2					1					
Vertebral	5	50		78		9		23		4	
	6										
	7					1				1	
Supracaudals	2	50		78		10		23		5	
Costal, left/right	4					6	6	10	6	1	2
	5	49	49	76	74	4	4	13	17	3	3
	6	1	1	2	4					1	
Marginal, left/right	11	4	4	2	7	4	3	13	13	3	3
	12	45	45	71	66	5	6	10	10	2	2
	13	1	1	5	5	1	1				
Post ocular, left/right	3	50	50	76	73			17	19	4	2
	4			2	5			6	4	1	3
Prefrontal	2							1			
	3							2			
	4	7		15				19		5	
	5	25		28							
	6	11		17				1			
	7	5		8							
	8	2		10							
Post-parietal	1			2							
	2	2		3				4		1	
	3	18		15				5		1	
	4	19		28				13		3	
	5	10		28				1			
	6	1		2							
Infra-marginal, left/right	3	31	31	63	68					1	3
	4	19	19	15	20			23	23	4	2
Intergular	0	26		17							
	1	24		60						1	
	2			1				23		4	

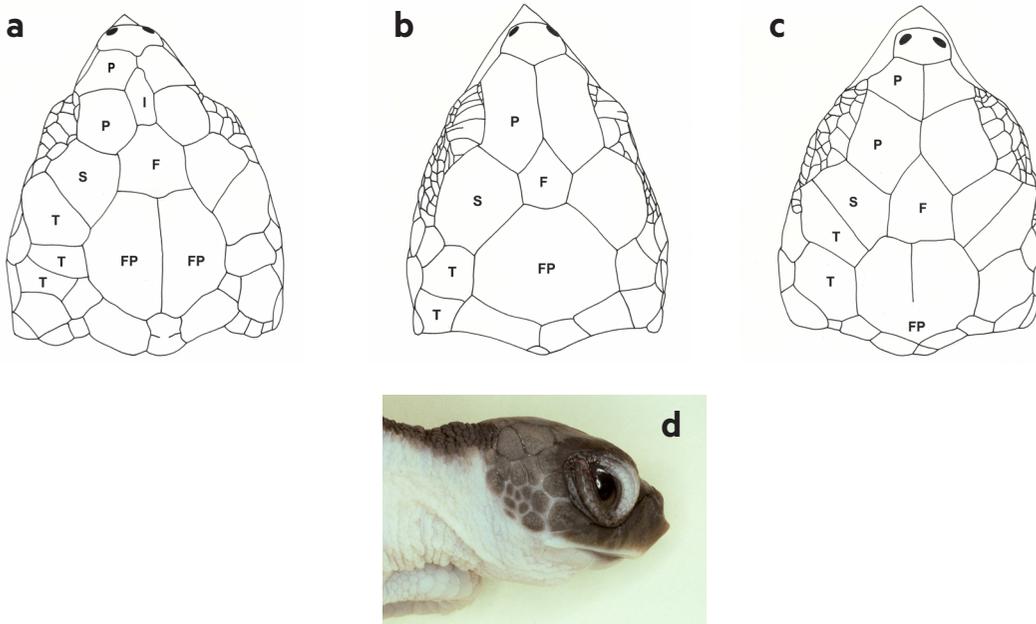


Figure 2. Dorsal head scales of hatchlings. P = prefrontal, F = frontal, S = supraocular, FP = frontoparietal, T = temporal, I = supernumerary scale sitting between the prefrontals (this scale is not always present in *C. caretta*). **A** *C. caretta* QM J97708, **B** *C. mydas*, QM J57289 **C** *C. caretta* x *C. mydas* hybrid QM J97712 **D** hybrid hatchling. The hybrid hatchling resembles *C. mydas* in the number of temporal scales (two pairs). It exhibits the *C. caretta* condition for the number of prefrontals (two pairs) and postorbitals (three pairs). The partially divided frontoparietal scale, a common condition in *C. caretta*, is less frequently seen in *C. mydas*. (image 2d © Colin Limpus).

Notes on the captive-reared *C. caretta* x *C. mydas* hybrids

Three sibling hybrid hatchlings from the second clutch laid by *C. caretta* T2625 (laid 1 Dec 1990, emerged 23 Jan 1991; Table 1) were raised at Sea World. The following summaries were compiled from Sea World husbandry records of these turtles and observations during their growth by CJL and DJL (Appendix).

T71784. This hybrid (Fig. 3a and b) was assigned a female status given the general ovarian-like structure of the gonad and the development of an enlarged, adult-sized oviduct. Although the ovary did not display normal development of ovarian follicles, its endocrine system is presumed to have developed to adult function because she was reproductively attractive to the adult male *C. caretta*, identified as *Big Guy*, that occupied the same pool in the summer of 2011–12. *Big Guy* mounted T71784 (age

20.8 years, CCL = >110 cm) in courtship in Nov 2011. *Big Guy* engaged her in courtship again in Sep 2015 (age 24.7 years) and in Aug 2019 (age 28.6 years). We presume that T71784 reached adult status in 2011 and her endocrine system gave off potential breeding readiness signals at four yearly intervals that resemble the natural adult female *Caretta* and *Chelonia* remigration interval. When T71784 died from multi-systemic malignant cancer in July 2020, aged 29 years (CCL = 111 cm) she was regarded as an infertile adult based on her ovarian and oviduct development and her participation in courtship behaviour (Fig. 3c). Following necropsy, the specimen was prepared as a skeleton and is now housed in the Queensland Museum’s (QM) herpetological collection (QM J97245).

T71785. This hybrid was also assigned a female status given the general ovarian-like structure of the gonad but did not display normal development of ovarian follicles. At her death in Mar 2001

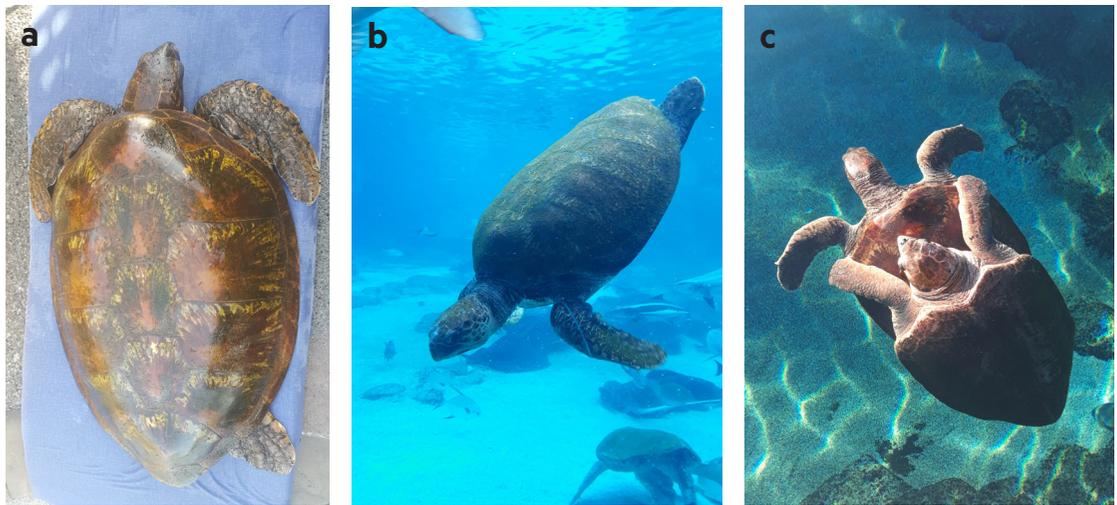


Figure 3. Adult-sized *C. caretta* x *C. mydas* hybrid (T71784/QM J97245) **A** recently deceased, showing proportionately small head and distinctive carapace pattern (features of *C. mydas*). **B** In life. **C** mating with adult male *C. caretta* at Sea World, Gold Coast, Queensland (images: © Siobhan Houlihan).

(age = 10.2 years, CCL = 94 cm), she was regarded as an infertile, prepubescent immature female based on her ovarian and oviduct development. The carapace of this individual is now on display at the Mon Repos Conservation Park Research Base and exhibits the typical five costal scales of *C. caretta*.

T71786. Based on the superficial resemblance of its gonad to a testis, T71786 was regarded as a male. In Aug 2003 (age = 12.7 years, CCL = 99.8 cm), he was considered adult, with a tail length extending 29 cm beyond the carapace edge. This is longer than the tail length of wild adult male *C. caretta* in eastern Australia. Fertility status was not established for this turtle.

Adult colour pattern and size comparisons

C. caretta. Brown above. Carapace reddish-brown, relatively uniform in colour. Top of head brown, side of face often pale with some dark blotching. Mean CCL = 95.76 cm, SD = 4.42, range 80–113.5, n = 2,207, Mon Repos (Limpus 1985). Weight mean = 100.65 kg, SD = 13.99, range 70.3–146.1, n = 112, Mon Repos (Limpus 1985).

C. mydas. Olive-green to brown above. Carapace variegated with shades of beige, brown, reddish-brown, and black. Sometimes with remnants of a sunray pattern that is characteristic of smaller size classes. Pale sutures present between scales on side of face. Mean CCL = 106 cm, SD = 5.14, range 86.0–130.1, n = 20,947, Raine Island. (Limpus et al. 2003). Weight mean = 126.2 kg, SD = 13.9, range 101–154, n = 24 (Limpus et al. 2003).

C. caretta* x *C. mydas. Reddish-brown above. Carapace with distinct patterning, costal and vertebral scutes with a posterior, reddish-brown blotch, jagged at edges and interdigitating with a beige outer margin (sunray effect) (Fig. 3a). Pale sutures present between scales on side of face. The hybrid adult (skeletonised and registered as QM J97245) was consistent in scalation with the hatchling illustrated in Figs. 2c) and d). It had five costal scutes (right side only), two pairs of prefrontal scales, two temporal scales and three postorbital scales. The number of inframaginal scales on the carapace/plastron bridge was not assessed prior to skeletonisation. CCL = 111 cm, weight = 128 kg, age 29 years.

Adult-sized skeletal comparisons

Cranium

C. caretta. (Figs. 4a, 5a, 6a, 7a) *C. caretta* has a broadly triangular skull that tapers anteriorly, forming a wide V-shaped upper jawline. There are no alveolar ridges on palatal surface, the maxillary edge (tomium) is heavy and strong with no fluting on its lingual face. The maxillaries are in contact behind the premaxillaries, and a lateral process is present on the pterygoid (Fig. 7a). The parietal notch forms a deep, U-shaped emargination and curves smoothly at the squamosal–parietal junction. In profile, the jawline curves downwards anteriorly at the maxilla–premaxillary junction (Fig. 6a).

C. mydas. (Figs. 4b, 5b, 6b, 7b) *C. mydas* has a rounded or bullet-shaped skull (longer than wide), with a short snout and U-shaped upper jawline. The maxillary edge (tomium) is narrow and fluted on its lingual face. A pair of U-shaped, serrated ridges are present on the palatal surface (alveolar ridges). The maxillary bones do not meet behind the premaxillaries (separated by the vomer), and the pterygoid is without a lateral process (Fig. 7b). The parietal notch is relatively shallow and generally angular at the squamosal–parietal junction. In profile, the jawline is relatively straight, curving slightly upwards at the maxilla–premaxillary junction (Fig. 6b).

C. caretta x C. mydas. Ventral view (Fig. 4c): The secondary palate, although V-shaped like *C. caretta*, exhibits character states that are intermediate between *C. caretta* and *C. mydas*. The alveolar ridges, though present, are less pronounced than in *C. mydas* and lack the serrations seen in this species. The maxillary edge (tomium) is relatively narrow (intermediate thickness to those of the parent species), with only subtle fluting on the lingual face and, like *C. mydas*, the maxillary bones do not meet behind the premaxillaries but are separated by the vomer. The presence of a pterygoid process (Fig. 7c) distinctly resembles *C. caretta* and is a feature not seen in *C. mydas*.

Dorsal view (Fig. 5c): The skull most resembles *C. mydas* in its narrow, bullet-shaped appearance (63 % width / length vs 70–80% for *C. caretta*) but is more elongate: 18% longer than the largest *C. mydas* skull examined and comparable in length to the

skull of a mature *C. caretta* (Table 3). The parietal notch resembles *C. caretta*, being deep and U-shaped with the emargination curving smoothly at the squamosal–parietal junction. **Lateral view** (Fig. 6c): In profile, the skull resembles *C. caretta* with a more pronounced snout than *C. mydas*, which exhibits a distinctly snub-nosed appearance (Fig. 6b). There is a downward curve on the anterior jawline similar to *C. caretta*, giving a ‘hooked-beak’ appearance. When placed on a flat surface, the hybrid skull, like most *C. caretta* skulls, rests only on the quadrate and premaxilla. The skull of *C. mydas* has a broader contact with the surface, resting on both the quadrate and maxilla, but no contact with the premaxilla.

Dentary

C. caretta. (Fig. 8a) Robust (dentary height ~ 30% dentary length), sloping steeply from dorsal tip of coronoid to articular. Buccal surface broadly concave, lacking both ridges and cusps. Dentary midline ~ 35% lower jaw length.

C. mydas. (Fig. 8b) relatively slender (dentary height ~ 26% dentary length), sloping gently from dorsal tip of coronoid to articular. Outer, cutting edge serrated. A U-shaped ridge follows the inner curve of the buccal surface. At its apex, it joins a short, forward-projecting ridge that is bordered by a depression on either side. Mid-dentary tip bearing a small, beak-like projection. Dentary midline ~ 21% of lower jaw length.

C. caretta x C. mydas. (Fig. 8c) Robust (dentary height ~ 30% dentary length). Resembles *C. caretta*, sloping steeply from coronoid to articular. The buccal surface is broadly concave like *C. caretta* but, like *C. mydas*, has a U-shaped ridge following the inner curve of the dentary. At its apex, it joins a forward projecting midline ridge that is bordered by a shallow depression on either side. Dentary midline ~ 28% lower jaw length (Table 3).

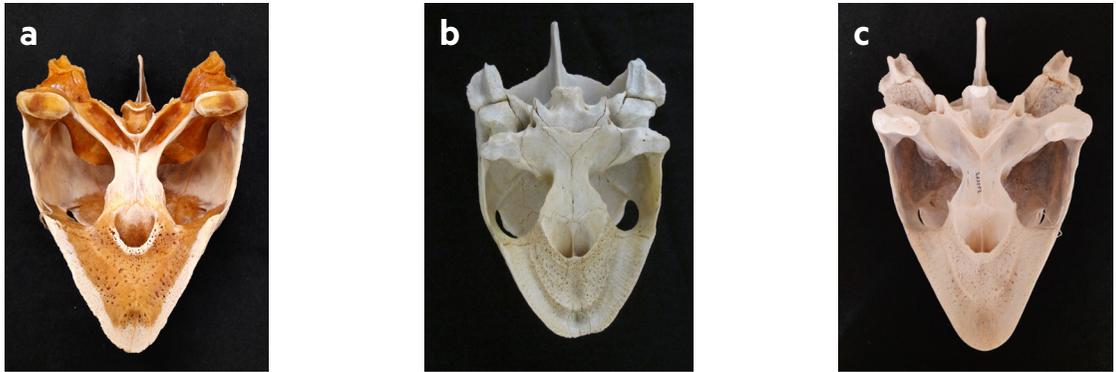


Figure 4. Ventral view of skulls showing differences in palatine region of **A** *C. caretta* QM J48380 **B** *C. mydas* QM J23029 **C** *C. caretta* x *C. mydas* hybrid QM J97245. The hybrid resembles *C. mydas* in having alveolar ridges on the maxilla and palatine bones (though somewhat reduced) and in the maxillary bones being separated by the vomer. The hybrid has a V-shaped jawline resembling *C. caretta* that lacks distinct fluting on its lingual face. It also has a lateral process on the outer edge of the pterygoid, not present in *C. mydas*.

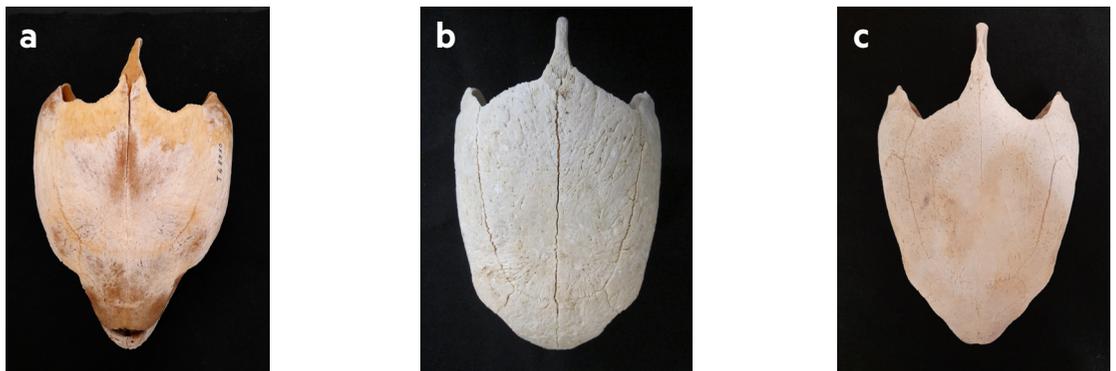


Figure 5. Dorsal view of skulls **A** *C. caretta* QM J48380 **B** *C. mydas* QM J23029 **C** *C. caretta* x *C. mydas* hybrid QM J97245. The hybrid and *C. mydas* both have bullet-shaped skulls. The hybrid skull, like that of *C. caretta*, has a smoothly curved parietal notch.



Figure 6. Lateral view of skulls **A** *C. caretta* QM J48380 **B** *C. mydas* QM J23029 **C** *C. caretta* x *C. mydas* hybrid QM J97245. The hybrid and *C. caretta* share a distinct downward curve to the anterior jawline.

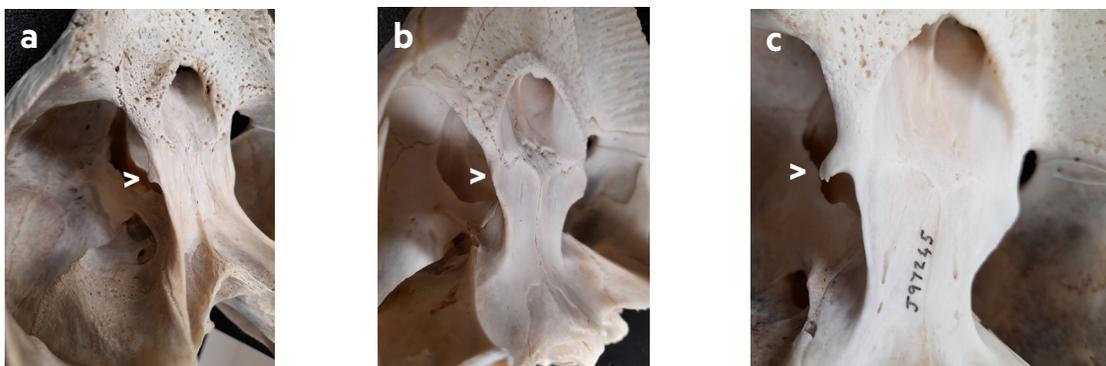


Figure 7. Ventral view of pterygoid; presence or absence of lateral process **A** *C. caretta*: process present QM J82108 **B** *C. mydas*: process absent QM J93579 **C** *C. caretta* x *C. mydas* hybrid: process present QM J97245.



Figure 8. Dentaries of **A** *C. caretta* QM J48380 **B** *C. mydas* QM J23029 **C** *C. caretta* x *C. mydas* hybrid QM J97245. The hybrid, like *C. mydas*, possesses an alveolar ridge and a midline cusp (though somewhat reduced). Its oral surface is larger than that of *C. mydas* and exhibits features resembling *C. caretta*.

Carapace

***C. caretta*.** Heart-shaped with fontanelles present between free rib ends (Fig. 1 in Dodd, 1988) but these may close with increasing age. For instance, in QM J57294, an adult-sized specimen (CCL = 93.8 cm), the peripherals are in direct contact with the pleurals (fontanelles fully closed). In QM J47984 (CCL = 81.5 cm), narrow fontanelles are present but are closing anterior to first rib and completely closed posteriorly on ribs seven and eight. Free rib ends not spatulate, tapering at tip and not significantly undercut at outer margin of pleural (Fig. 9a). Suprapygal with small, raised hump.

***C. mydas*.** Subcircular, peripherals separated from pleurals and only contacting at distal tips of ribs, with fontanelles between free rib ends (Fig. 5 in

Yudha et. al. 2020). Rib ends flattened (spatulate), uniformly broad with rounded tip, deeply undercut at outer margin of pleural (Fig. 9b). In QM J53270, a mature specimen (CCL = 111 cm), the first and second pleurals are in direct contact with the peripherals but fontanelles are present between the remaining rib ends. Suprapygal smoothly curved down midline.

***C. caretta* x *C. mydas*.** (Figs. 9c, 10) Distinctly resembles *C. mydas*, subcircular, fontanelles separating peripherals from pleurals (fused anterior to first rib), only contacting at distal tips of ribs. Free rib ends spatulate, uniformly broad with rounded tip, with slight undercutting at outer margin of pleural. Suprapygal bearing a slight hump resembling that of *C. caretta*.

Reg. no.	Species	CCL (cm)	Head width (HW, mm)	Head length (HL, mm)	HW/HL (%)	Lower jaw length	1 (mm)	1/lower jaw length (%)	2 (mm)	2/lower jaw length (%)
J59360	<i>C. mydas</i>	110	123	190	65	129	33	26	25	19
J53279	<i>C. mydas</i>	113	135	203	67	135	37	27	29	21
J51869	<i>C. mydas</i>	110	138	196	70	137	36	26	31	23
J51674	<i>C. mydas</i>	100	123	173	71	115	30	26	24	21
J54498	<i>C. mydas</i>	103	137	200	69	134	35	26	30	22
J54501	<i>C. mydas</i>	101	137	200	69	127	33	25	27	21
J51154	<i>C. mydas</i>	106	128	206	62	133	33	25	26	20
J51202	<i>C. mydas</i>	107	129	205	63	127	32	25	29	23
J51203	<i>C. mydas</i>	106	132	210	63	135	39	29	30	22
J51220	<i>C. mydas</i>	104	129	205	63	131	34	26	25	19
Mean <i>C. mydas</i>		106	131	199	66	130	34	26	28	21
J48380	<i>C. caretta</i>	97	176	253	70	174	57	33	60	34
J8549	<i>C. caretta</i>		225	280	80	194	71	37	71	37
J82108	<i>C. caretta</i>		162	211	77	149	47	32	48	32
J80048	<i>C. caretta</i>		137	194	71	133	44	33	48	36
J51212	<i>C. caretta</i>		190	238	80	170	57	34	62	36
J51213	<i>C. caretta</i>	100+	188	253	74	179	59	33	64	36
J51484	<i>C. caretta</i>	95	178	222	80	158	56	35	55	35
J51487	<i>C. caretta</i>	100.5	183	242	77	173	54	31	57	33
J51491	<i>C. caretta</i>		183	239	77	167	55	33	57	34
J51675	<i>C. caretta</i>	87	172	217	79	154	53	34	55	36
Mean <i>C. caretta</i>			179	235	76	165	55	34	58	35
QM J97245	<i>C. caretta</i> x <i>C. mydas</i> hybrid	111	158	250	63	159	48	30	44	28
QM J85544	<i>C. caretta</i> x <i>C. mydas</i> hybrid	51	82	142	58	89	24	27	24	27

Table 3. Summary of the carapace and skull measurements of turtles examined in this study. Details of individuals are given in **Material examined**. 1 = dentary height, 2 = dentary midline (anterior tip to mid-posterior edge = buccal surface).

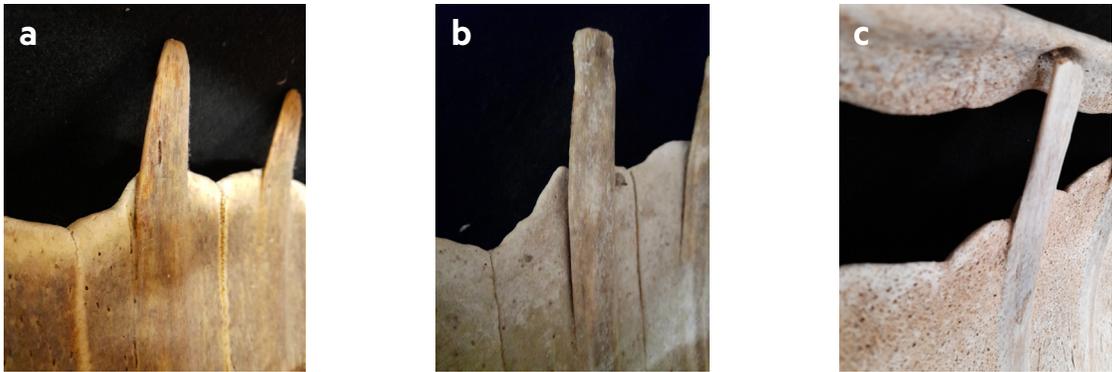


Figure 9. Distal ends of fourth rib in **A** *C. caretta* QM J47984 **B** *C. mydas* QM J53270 **C** *C. caretta* x *C. mydas* hybrid QM J97245. In both the hybrid and *C. mydas*, the ribs are broad and spatulate. They are deeply undercut at the outer margin of the pleural in *C. mydas* but show little undercutting in both *C. caretta* and the hybrid.

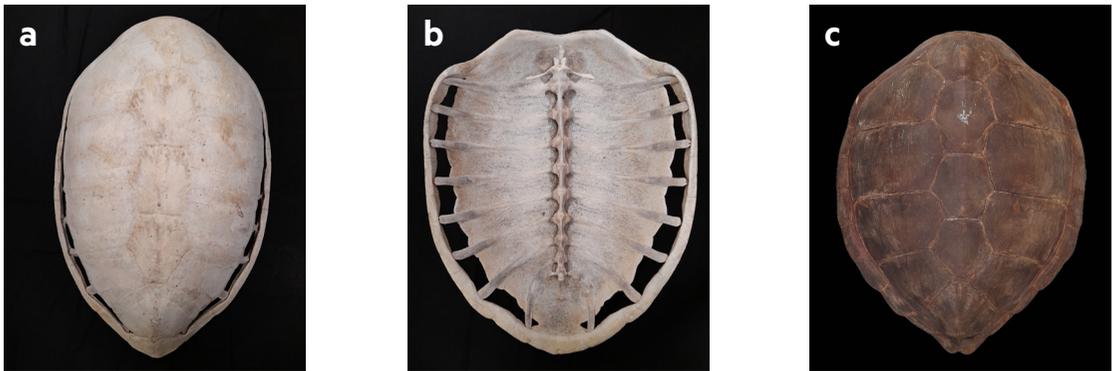


Figure 10. Carapace of QM J97245 (CCL = 111 cm) showing **A** a subcircular outline resembling *C. mydas* (compared to *C. caretta* heart-shaped outline) **B** wide fontanelles and flattened, spatulate free rib ends **C** carapace of *C. caretta* x *C. mydas* hybrid, CCL = 94 cm (captive individual T71785, on display at the Mon Repos Turtle Centre, Queensland).

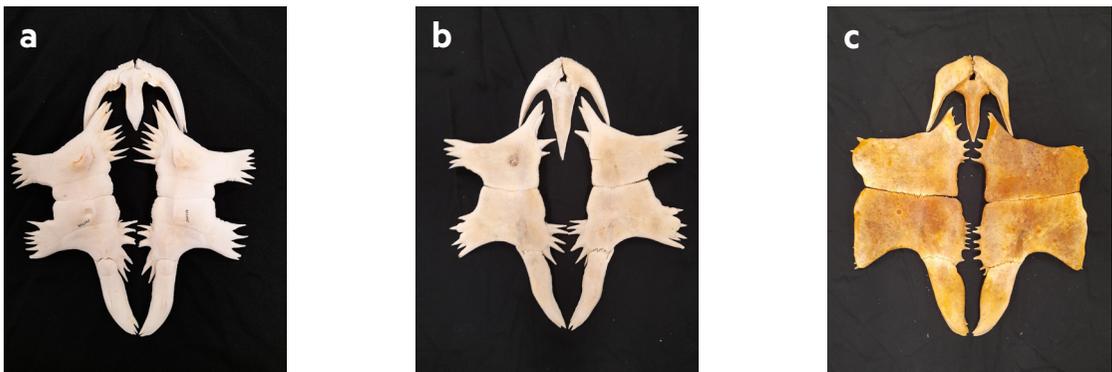


Figure 11. Plastral bones of *C. caretta* of three different age classes **A** QM J62756, CCL = 36.4 cm; **B** QM J95535, CCL = 68 cm; **C** QM J53275, CCL = 97.7 cm.

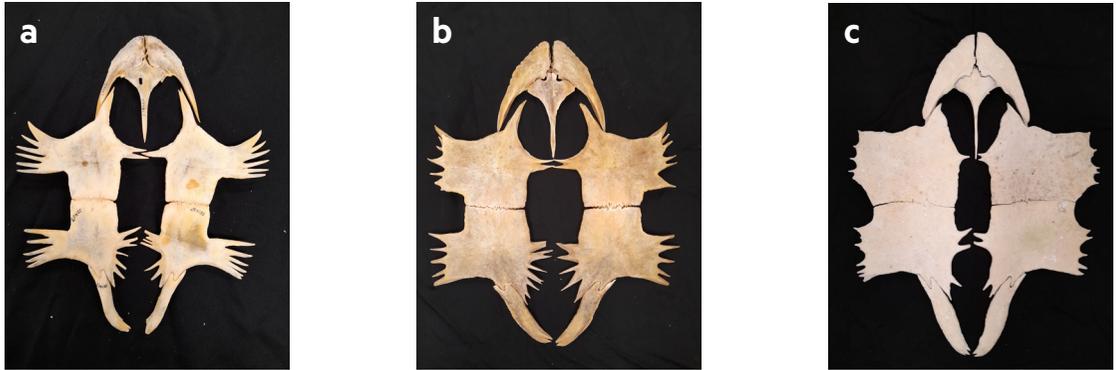


Figure 12. Plastral bones of *C. mydas* of three different age classes **A** QM J51657, CCL = 44.8 cm; **B** QM J49261, CCL = 99.2 cm; **C** QM J84649, large adult CCL unknown.

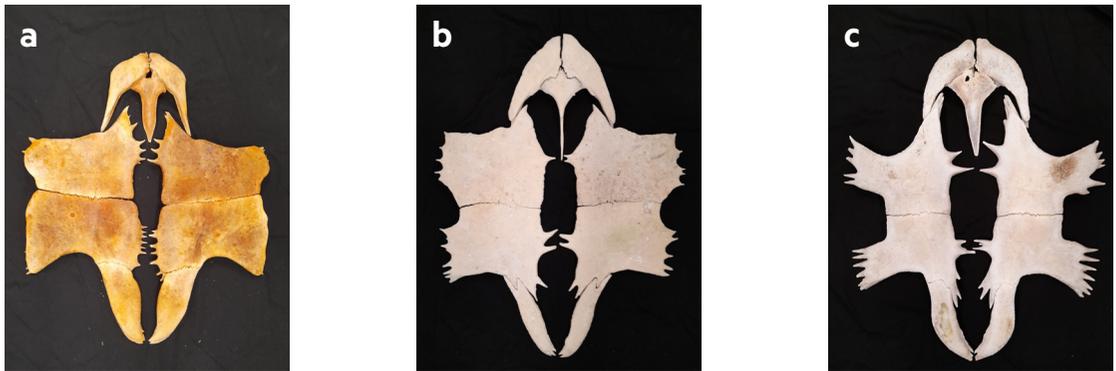


Figure 13. Plastral bones of adult-sized turtles **A** *C. caretta* QM J53275, CCL = 97.7 cm **B** *C. mydas* QM J84694, CCL unknown **C** *C. caretta* x *C. mydas* hybrid QM J97245, CCL = 111 cm. The hybrid resembles *C. caretta* in its entoplastron and the shape and robust build of the xiphiplastron. The inner edges of the hyoplastron and hypoplastron have reduced spinosity and resemble *C. mydas* in this regard. The loss of spike-tipped, lateral extensions on the bridge edge of the hyoplastron and hypoplastron in *C. mydas* and *C. caretta* is age-related.

Plastral bones

C. caretta. (Figs. 11, 13a) Entoplastron with wide, spear-like shaft. Hyoplastron with broad lateral extension on the anterior bridge edge, terminating in a series of sharp spikes (~ 6); inner, anterior edge with a series of sharp spikes (~ 3–8), the anterior-most curving forward to meet the epiplastron. Hypoplastron with a broad lateral extension on posterior bridge edge, terminating in a series of sharp spikes (~ 5–6); inner edge with a series of spikes (~ 6–7; Figs. 11a & b). Xiphiplastron relatively broad, not interdigitating with hyoplastron. The lateral spikes on the hyoplastron and hypoplastron are less pronounced in larger adults. The hyoplastron

and hypoplastron are oblong-shaped with reduced spikes (Fig. 11c) or rounded on the bridge edges (Fig. 2 in Dodd 1988) in older individuals.

C. mydas. (Figs. 12, 13b) Entoplastron tapering gradually, shaft thin and needle-like posteriorly. Hyoplastron squarish, with a single anterior spike that extends forward to meet the inner edge of the epiplastron; a broad lateral extension on the anterior bridge edge terminates with a series of prong-like spikes (~ 6); inner lateral edge with only one or two shorter spikes. Hypoplastron with a broad lateral extension on the posterior bridge edge that terminates with a series of prong-like spikes (~ 5); ~ 6 spikes on inner edge.

Xiphiplastron relatively slender, interdigitating with hyoplastron. The prong-like projections on the hyoplastron and hypoplastron change with age and are more pronounced in younger individuals. The hyoplastron and hypoplastron are squarish in older individuals, with relatively short spikes on the lateral edges (Fig. 12c).

C. *caretta* x C. *mydas*. (Fig. 13c) The hybrid turtle resembles *C. caretta* in the shape of the entoplastron (broad shaft vs. thin shaft in *C. mydas*) and the xiphiplastron (broad vs. relatively slender in *C. mydas*). As with adult *C. caretta*, the xiphiplastron does not interdigitate with the hyoplastron. The inner anterior edge of the hyoplastron resembles *C. mydas* in having a single forward projecting spike curving forward to meet the epiplastron. The inner edges of the hyoplastron and hypoplastron also resemble *C. mydas*, with only two short, sharp spikes (vs. the usually pronounced ~6–7 spiked condition of *C. caretta*). Despite its large size (CCL = 111 cm), the hybrid turtle has similarities to the sub-adult *C. caretta* (Fig. 11b) regarding the spike-tipped, lateral extensions on the bridge edges of the hyoplastron and hypoplastron. In large adult *C. mydas* and *C. caretta*, these processes are no longer apparent.

Notes on the skeletal features of a juvenile *C. caretta* x *C. mydas* hybrid

The skull and dentary of the juvenile hybrid (QM J85544, CCL = 51 cm) and the adult hybrid (QM J97245) are proportionally similar (Table 3) and exhibit the same modifications to oral surfaces. Its carapace resembles *C. mydas* in general form, when compared to the carapace of a similar-sized *C. mydas* (QM J47075, CCL = 49 cm). However, it differs in having no undercutting of the ribs at the outer margin of the pleurals (vs. pronounced undercutting in QM J47075). Its epiplastron is broader than that of the similar-sized *C. mydas* and its xiphiplastron more robust.

DISCUSSION

In many cases, hybridisation in marine turtles is first inferred from abnormalities in scalation, colour pattern and shape. The turtle's hybrid nature is then confirmed using genetic markers. For example, Shamblin et al. (2018) assessed the possible hybrid status of a juvenile *C. mydas* from Florida that exhibited some characteristics typical of *C. caretta*. Their genetic analyses confirmed its hybrid nature and indicated a first-generation hybrid between a male Green Turtle and female Loggerhead Turtle. However, turtles displaying characteristics that are typical of another turtle species are not always hybrids. For example, when Garofalo et al. (2012) used a combination of mitochondrial and nuclear sequences to assess a turtle from Torre Faro (Messina, Sicily) that resembled *C. caretta*, they found no evidence of hybridisation. The turtle exhibited a strange prefrontal configuration and resembled *E. imbricata* in head shape, colour pattern and beak profile. It also resembled *C. mydas* in having a single claw on each front flipper. Despite these irregularities, these authors concluded that these were '...morphological traits seldom observed in this species'.

The hybrid hatchlings in our study were reared for the purpose of examining their external morphology and to assess whether scalation could be used as a reliable means of identification. They exhibited scale characters that were symmetrical but atypical of both parent species. Asymmetrical or fragmented scales on the other hand are less informative and not unusual in reptiles (PC & CL pers. obs.). A study involving a tropical snake showed that scale asymmetry and fragmentation were increased by rapid embryogenesis (i.e. shorter incubation periods at higher temperatures) and a disruption of early embryonic development resulted in variations in morphology that impacted ecological performance, including survivorship (Brown et al. 2017). There are also studies involving marine turtles that show nest temperatures influence hatchling fitness and morphology (Mickelson and Downie 2010; Sim et al. 2015; Staines et al. 2019; Stewart et al. 2019). The eggs of Loggerhead Turtles incubated at higher temperatures produced hatchlings of smaller body sizes, decreased physical responses and overall fitness (Fleming et al. 2020; Martins et al. 2020).

They also had a higher incidence of ghost crab predation while crossing the beach on their seaward transit (Martins et al. 2020). While abnormalities in head scale configurations are unlikely to impair fitness, they may indicate suboptimal incubation conditions and provide a useful marker for more subtle phenotypic failures (Brown et al. 2017; Maffucci et al. 2019). This may explain why anomalous head scale configurations are commonly seen in hatchling or post-hatchling size classes but less frequently in larger individuals (CL pers. comm.).

The turtles in this study, however, exhibited a suite of symmetrical head scale characters that were consistent in both hatchlings and an adult-sized individual. (i.e. prefrontals: two pairs, temporals: two pairs, postorbital scales: three pairs). We believe these characters, especially when combined with atypical bridge and carapace conditions, are sufficiently diagnostic for identifying *C. caretta* × *C. mydas* hybrids on external morphology alone. We also identified a diagnostic suite of skeletal elements (illustrated herein), some of which may prove useful in identifying other hybrid combinations. Skeletal characters showed considerable uniformity across size classes with respect to skull shape, the size and structure of the oral surfaces (palate and dentary), the shape of plastral elements (entoplastron and xiphiplastron) and the shape and degree of undercutting on the free rib ends (rib extending beyond the outer margin of the pleural). We believe that species-specific differences and intermediate states thereof (illustrated herein) can be used to identify hybrid turtles. Skeletal characters can be examined using radiographs and CT scans and individual skulls can be assessed independently from other skeletal elements, as the oral surfaces show conditions that are intermediate between the parent species. Species-specific features and intermediate states thereof can be seen in the palatal and buccal rhamphotheci (Wyneken 2001). Use of a standard veterinary canine mouth gag will allow the oral cavity of a suspected hybrid to be viewed in the field, further confirming its hybrid nature, over and above any symmetrical scale features already observed. These observations provide a quick and easy means of assessing a hybrid turtle in the field and largely negate the need for follow-up genetic confirmation.

More than 100,000 adult marine turtles have been examined on nesting beaches in eastern Australia (CJL, DL); however, to date, no individuals have been identified displaying the suite of atypical, symmetrical head shields seen in the *C. caretta* × *C. mydas* hybrids discussed herein. It is possible that female hybrids are mostly infertile and, therefore, unlikely to be encountered on a nesting beach. Arguing against this is the observation of an intersex Green Turtle with the external morphology of a male, found attempting to dig a nest at the Raine Island rookery (Limpus et al. 2009), suggesting that nesting behaviour may be 'hard-wired'. Additionally, infertility would not explain why hybrid-like turtles are not detected in feeding ground studies, where more than 50,000 individual marine turtles of both sexes, across multiple size classes have been captured and examined in Queensland waters. It seems reasonable to suggest that hybridisation is rare in eastern Australia and high mortality during the early pelagic stage may remove most of these turtles from the population before they enter inshore feeding grounds or appear as adult females on nesting beaches.

ACKNOWLEDGEMENTS

The authors wish to thank John Meech (Queensland Parks and Wildlife Service) for monitoring successive nests by T2625 during the 1990–91 & 1991–92 nesting seasons and for assisting to collect and measure the *C. caretta* × *C. mydas* hatchlings. Numerous QPWS turtle conservation volunteers assisted with the nightly monitoring of nesting turtles, and hatchling emergence from nests during the breeding season. Special thanks to Trevor Long and Marnie Horton who cared for the captive hybrids at Sea World and to Dr David Blyde who oversaw their veterinary care. Trevor, Marnie, and David also provided data used in this study. The Department of Environment and Science and Queensland Museum supported the publication of this research.

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MATERIAL EXAMINED

Hatchlings from the second nest of female *C. caretta* (tag number T2625) in the 1990–91 breeding season

***C. caretta*, spirit specimens:** QM J97702, QM J97704–QM J97710

***C. caretta*, cleared and stained specimens:** QM J97703, QM J97711

***C. caretta* x *C. mydas*, spirit specimens:** QM J97712, QM J97713, QM J97716–QM J97721

***C. caretta* x *C. mydas*, cleared and stained specimens:** QM J97714, QM J97715

Skeletal material

Complete skeleton: *C. mydas*: QM J47075, no locality data.

Skull and associated mandible: *C. mydas*: QM J23029, North Shore, Cooktown, 15° 27' S, 145° 16' E; QM J59360, Burnett River crossing, 8 km west of Gayndah 25° 07' S, 151° 32'E; QM J51869, Manly Boat Harbour 27° 28' S, 153° 11' E; QM J53279, Wynnum Ck mouth 27° 26' S, 153° 11' E; QM J51674, Manly 27° 28' S, 153° 11' E; QM J54498, Moreton Bay 27° 25' S, 153° 20' E; QM J54501, Deception Bay 27° 12' S, 153° 02 E; QM J51154, Moreton Is., 2 km south of Bulwer 27° 18' S, 153° 22' E; QM J51202, Banksia Beach, Bribie Is. 27° 01' S, 153° 01' E; QM J51203, Cleveland Point, Moreton Bay 27° 31' S, 153° 17' E; QM J51220, Nudgee Beach 27° 21' S, 153° 06' E; and images provided in Wyneken (2001, pp. 13–15).

C. caretta: QM J48380, Bribie Is., surf beach 27° 03' S, 153° 12' E; QM J8549, North Reef 23° 11' S, 151° 54' E; QM J82108, no data; QM J80048, Tinnanbar near Tin Can Bay 25° 45' 34" S, 152° 57' 15" E; QM J51212, Moreton Is., ocean beach 27° 13' S, 153° 25' E; QM J51213, Moreton Is., western side, south of Shark Spit 27° 15' S, 153° 23' E; QM J51484, Bundaberg 24° 47' S, 152° 26' E; QM J51487, Mon Repos 24° 48' S, 152° 27' E; QM J51491, Mon Repos, Neilson Park 24° 48' S, 152° 27' E; QM J51675, Bundaberg, Moore Park 24° 43' S, 152° 17' E; and images provided in Wyneken (2001, pp. 16–17).

Carapace: *C. mydas*: QM J53270, Cape Moreton, 13 km ESE 27° 09' S, 153° 33' E; QM J47075, no data;

QM J28455, Moreton Bay 27° 25' S, 153° 20' E; QM J96278, Coral Sea 18° 32' S, 152° 18' E; QM J47984, Moreton Bay 27° 32' S, 153° 12' E.

C. caretta: QM J47984 Moreton Bay, Peel Is. to Wellington Point 27° 32' S, 153° 12' E; QM J49809 North Stradbroke Island, near Amity Point 27° 30' S, 153° 30' E; QM J51205 Stradbroke Island 27° 30' S, 153° 30' E; QMJ53276 Tangalooma, Moreton Island 27° 12' S, 153° 22' E.

Plastron: *C. mydas*: QM J51657, Manly 27° 28' S, 153° 11' E; QM J49261, Cleveland Point to Raby Bay, Moreton Bay 27° 25' S, 153° 20' E; QM J84649, Gravely Beach, Tide Island, Gladstone 23° 48' S, 151° 13' E; QM J47075, No data; QM J28455, Moreton Bay 27° 25' S, 153° 20' E; QM J96278, Coral Sea 18° 32' S, 152° 18' E.

C. caretta: QM J62756, Mornington Peninsula, Vic. 38° 21' S, 144° 45' E; QM J95535, Tasman Sea, NSW 33° 30' S, 159° 56' E; QM J53275, Moreton Banks, Moreton Bay 27° 22' S, 153° 23' E; QM J51205, Stradbroke Island 27° 30' S, 153° 30' E; QM J53276, Tangalooma, Moreton Island 27° 12' S, 153° 22' E.

APPENDIX

Tag numbers	T71784 PIT tag: 2201504720	T71785 PIT tag: 22003D2962	T71786 PIT tag: 22003B582E
Gender	female	female	male
Date	History		
02 Dec 1990	Clutch laid by T2625 (Mon Repos)		
23 Jan 1991	Hatchling emergence		
06 Jan 1992	Commenced morphometric measures		
2 Sep 1993	Flipper tagged		
5 Apr 1992	To penguin pool		
15 Nov 1994	To shark rehab pool		
16 Jun 1995	To turtle rehab pool		
29 Nov 1995		Biting: to Oceanarium	
23 Dec 1995	To Dolphin Cove		
29 Mar 1996	PIT tagged; Laparoscopy: prepubescent female; 1 mm white strait oviduct; granular pale ovary	PIT tagged; Laparoscopy: prepubescent female; 1 mm white strait oviduct; granular pale-yellow ovary; large lungs; very fat on intestine and body wall.	PIT tagged; Laparoscopy: prepubescent male; epididymis not bulging from body wall; testis resembles normal testis superficially; large lungs; very fat on intestine and body wall.
01 May 1996	To shark pool: <i>Big Guy</i> (large adult male <i>C. caretta</i>) also present		
15 Feb 1998	Hybrids very large, aggressive feeders and ready biters		
25 Feb 2001		Escaped from Sea World pool; ~ 1 week later found on rocks at Sorrento Lethargic over following weeks	
04 Mar 2001		Deceased: Necropsy: prepubescent 'female'; extremely obese, ~ 10 cm thick fat at plastron; faecal compaction in rectal area; ovary devoid of previtellogenic follicles; 2.5 mm white straight oviduct	
29 Oct 2001	Ultrasound exam: previtellogenic follicles not in evidence; obese		
15 Jan 2011			Deceased: advanced decomposition, no necropsy; not eating for week before death
15 Nov 2011	Courtship: Mounted twice by adult male <i>C. caretta</i>		
19 Nov 2013	To Shark Bay		

Tag numbers	T71784 PIT tag: 2201504720	T71785 PIT tag: 22003D2962	T71786 PIT tag: 22003B582E
Gender	female	female	male
Date	History		
02 Apr 2014	Eating from bottom of pool and spitting gravel		
09 Sep 2015	Courtship: mating behaviour from adult male <i>C. caretta</i>		
12 Jul 2019	Blood sample: slightly anaemic		
31 Aug 2019	Courtship: successful 5 hour mounting by adult male <i>C. caretta</i>		
03 Sep 2019	Veterinary monitoring due to abnormal behaviour. Lethargic, periods of buoyancy.		
13 Jul 2020	Deceased		
14 Jul 2020	Necropsy: adult 'female'; death from cancer (Multisystemic malignant neoplasm); ovary with low density small 'follicles' and no evidence of healing corpora albicantia; enlarged convoluted oviduct		
	Fate of carcass		
	Queensland Museum specimen: QM J97245	Preserved carapace in teaching collection at Mon Repos Conservation Park	Disposed of carcass

Summary of the history of three sibling hybrid *C. caretta* x *C. mydas* turtles hatched from the second clutch laid by *C. caretta* female T2625 at Mon Repos during the 1990–91 breeding season. The turtles are identified by the titanium flipper tags applied during their growth at Sea World. Gender was determined by gonad examination during rearing.