

WHO'S GOT THE BIGGEST?

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[Adapted by inclusion of additional images from article in Crocodile Specialist Group Newsletter 27(4): 26-30]

The fascination for 'finding the biggest' is deeply engrained, and when film producer Harry Marshall at Icon Films (UK) offered a chance to search for the world's largest crocodilian - who could refuse?

Claims of giant crocodiles are as wild as those for outsize fish and snakes. "It was longer than the boat", has been earnestly related in a dozen languages, from the Rift Valley lakes of Ethiopia to the mighty Fly River in Papua New Guinea. And the Fly River is where this 'skull quest' (for that's what it's become) began.

Largest Crocodile with Photographic Documentation

In 1980 I (RW) was working for the United Nations crocodile program in Papua New Guinea as 'Production Manager'; the second author (NW) was also there, see illustration. Along with UN volunteer Jerome Montague, also a biologist, we went off on patrol down the Fly River, checking on the success of village crocodile farms, and providing water pumps and advice on husbandry. When we arrived at Obo Village one sultry afternoon the villagers gathered on the riverbank to greet us and to excitedly show what they had caught the previous morning in a net set for the famous local fish, the barramundi.

A huge male Saltwater crocodile had gotten his teeth tangled in the hand-made rope net and drowned. It took 50 men to haul the giant out onto the bank (it could have weighed a ton), and when they cut it open there was a whole Rusa deer in its stomach. The skin had been salted and rolled up, so we flattened it out on the ground and measured it. The total length was 6.20 m long (a little over 20') (Figs. 1 and 2). Since it was already a bit dry, it may have been a little longer.



Figure 1. Jerome Montague with Komovai villagers, Fly River, Papua New Guinea, and 6.2 m (20') *C. porosus* skin. Photograph: Rom Whitaker.



Figure 2. Alistair Graham with skull of 6.2 m (20') long *C. porosus* from the Fly River, Papua New Guinea (see Fig. 1). Photograph: Rom Whitaker.

The note that Jerome published on this find (Montague 1983) didn't exactly shake the world. People were (and still are) quite convinced that *C. porosus* well over 20' long are on record. But when the quest for the biggest started to get serious, it was soon obvious that these 'records' are mostly anecdotes with no solid evidence. Some colleagues are ready to accept anecdotal total lengths - we are much more skeptical.

The 1:7 Hypothesis

Wouldn't it be just great if you could get the head (skull) length of a crocodile, multiply it by a simple number and get the total length? Well, Banks (1931), Schmidt (1944), Wermuth (1964), Bellairs (1970), Greer (1974) and Woodward *et al.* (1995) are some of the authors who concurred that an average ratio for head length (HL) to total length (TL) comes close to 1:7, using several samples of *C. porosus*, *C. niloticus* and *Alligator mississippiensis*. In this formula, the simple measurement of the skull/head length is from nose tip to the back of the cranial platform (see Fig. 3), preferably using a big tree caliper or at least a perpendicular steel ruler front and back while laying the tape. (Professional 'skullers' will warn that a crocodile skull will shrink up to 4% in passing years).

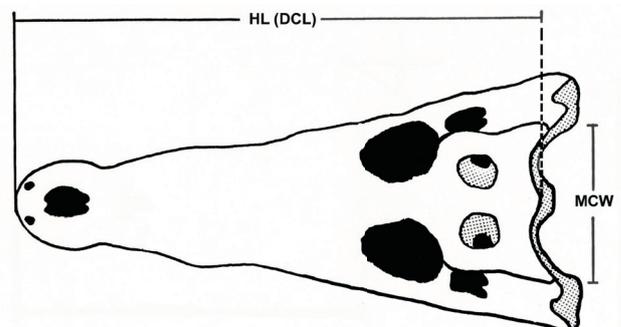


Figure 3. Standard measurement of head length (HL) [= dorsal cranial length (DCL)] and maximum cranium width (MCW).

Unfortunately some crocodile workers have taken head length to mean from nose tip to the back of the mandible (lower jaw bone, which sticks way out behind the skull), adding 25% or more in length. Other workers routinely measure from nose tip to the back of the occipital condyle which articulates with the spinal column, which adds a few extra centimetres to the length of a large skull.

However, the 1:7 ratio is based mainly on smaller individuals, with few samples of crocodilians over 4 m in length. While alligators and broad-snouted crocodiles like the mugger (*C. palustris*) are relatively 'stumpy' animals, and the Indian gharial (*Gavialis gangeticus*) are at the other linear extreme, salties and American crocodiles (*C. acutus*) fall in the intermediate range. Wermuth (1964) notes that *C. porosus* have a proportionately longer tail (relative to trunk length) than other crocodiles and that in individuals over 1.5 m, the head width increases at a proportionately greater rate than trunk length (Fig. 4). The other problem is of course that crocodiles are like us, they grow long when young, then slow down and start growing outward, again complicating the simple ratio.



Figure 4. Captive 5.4 m long *C. porosus* at Moitaka, Papua New Guinea. Photograph: Rom Whitaker.

So there are bound to be serious difficulties when trying to apply the 1:7 ratio to all crocodiles of all ages. Predictably, though there are some big skulls in collections, there are very few whole skeletons or reliable total lengths to go with these skulls. A single illustration will serve as an example of the unreliability of historical references (Barbour 1924): the *C. porosus* skull from Luzon, Philippines (killed in the 1880s), measures 71 cm (dorsal cranial length, not the mandible), a big one indeed. Using the 1:7 ratio that would make it 4.7 m long, yet the data card for the skull, repeated ad nauseum in the literature, assures us that it was an amazing 33' or 10 m in length (plus 4% for shrinkage)! Even with a 1:9 HL:TL ratio (which we can confirm some salties indeed have) this animal couldn't have been more than 6.5 m long (21.5').

Australia

Although the Aussies claim the biggest crocodiles, there is

little solid evidence. The often quoted 28 footer killed back in July 1957 by the Pawlowskis in the Norman River estuary of the Gulf of Carpentaria remains just an unverified anecdote, no matter how many publications the story appears in.

Adam Britton and I (RW) measured two of the largest *C. porosus* skulls in Australia, one called 'Charley' at the Darwin Crocodile Farm (a 'mere' 64.4 cm) and one shot by Terry Hulse on display at the Corroboree Tavern near Darwin (Manolis 2006). This one measures 68.8 cm and is possibly the largest skull in Australia. Driving down the road we stopped in for yet another cold one at the Bark Hut Inn, Annaburroo, where we found and measured a *C. porosus* mandible - at 89.9 cm it was longer than the Corroboree mandible. Adam has heard of another skull in the Northern Territory with a mandible of 96 cm (close to the size of the Paris Museum monster crocodile). The search continues for the largest Aussie skull.

News of an estimated 6.7 m (22') animal on the Bullo River was also noted. We saw some 4.9 m (16') crocodiles, and one massive slide, but the Bullo giant is still out there.

India

In India there are current stories of 7 m (23') long crocodiles in Bhitarkanika National Park in the State of Orissa. In fact, someone is such a convincing story teller that the Guinness Book of Records proclaims that this is where the largest crocodile in the world lives. It could be true, we hope it is, but we need evidence and not another tale of 'it was bigger than the boat'. Hopefully Guinness does more rigorous verification with their other stories.

There is, however, some solid evidence of giant crocodiles in the form of a couple of skulls, one of them owned by Prince Shivendra, the Raja of the erstwhile Principality of Kanika (part of it now included in the National Park, famous for its amazingly successful crocodile recovery program) (Kar 2006b). A big crocodile, killed in 1926 on the Dhamra River was said to have been 7 m long. The huge skull is the only remaining evidence, and at 73.3 cm from nose tip to back of occiput, appears to be the largest *C. porosus* skull in India (one in the Indian Museum, Calcutta, measures 73 cm) and one of the top three in the world. [Note: Daniel and Hussain (1973) reported this skull to be 1 m, and in 1978 I (RW) reported it as 78 cm! Obviously meticulous measurements using tree calipers is the way to go].

But if 'Kalia' (the name of this giant crocodile which reportedly ate 13 women - their bangles were recovered from his stomach; Fig. 5) was indeed 7 m long, then the skull length to total length ratio is 1:9.4, far away from the 'standard' ratio of 1:7. Another crocodile, found dead in the same river by the Wildlife Department in 2005, had a head length of 66 cm and a total length of about 5.2 m (17') (ratio= 1:7.9), though the authorities reported that the carcass measured over 5.7 m (19') and the skull 68 cm (ratio= 1:8.38) (Kar 2006a). Luckily the entire skeleton was preserved and can be carefully re-measured.

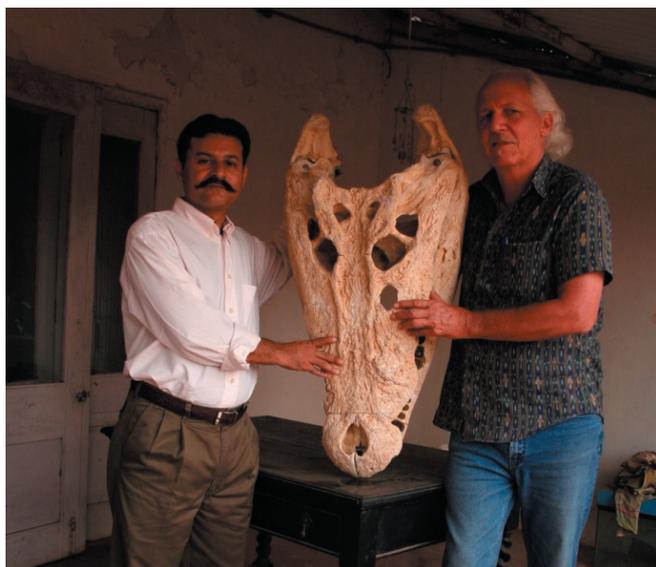


Figure 5. Prince Shivendra, Raja of Bhitarkanika, with Rom Whitaker and 'Kalia', India's biggest Saltwater crocodile skull. Photograph: Janaki Lenin.

To confirm the inapplicability of the 1:7 ratio for big crocodiles, we measured 'Jaws III', the 4.8 m (16'), 38-year-old *C. porosus* at the Madras Crocodile Bank. The HL:TL ratio was 1:9. If we just had a larger sample size we would be closer to a more realistic ratio. It is very evident that big crocodiles (alligators too) slow down on linear growth and start getting bulkier at a certain point. Webb and Messel (1978) make the point that it would not be valid to apply the same formulae used in smaller individuals to those over 4 m. This of course tosses the 1:7 ratio for a loop, though it's still helpful and somewhat accurate for animals below 4 m, especially when doing size estimates during night counts when all you see is the head.

Biggest Saltie Skull in the World

At the CSG meeting in Montelimar in June 2006, Peter Taylor promised to blow our minds with details of a spectacular skull at the Paris Museum, which he was privileged to measure in great detail in July 2003. And sure enough, with a dorsal head length of 76 cm, maximum skull width of 48 cm and a massive mandible of 98.3 cm, this specimen gets the prize of biggest known *C. porosus* skull; these three measurements exceed anything else on record for broad-snouted crocodiles. It was apparently killed in Cambodia in the early 1800s, but no other details are available.

Giant Nile Crocodiles

The last lap of the "skullology tour" had to be Africa. Everyone has seen the spectacular footage of wildebeest and gazelles being snapped up like rats by huge Nile crocodiles, but just how big are they? Local intelligence was that the largest *C. niloticus* were at Lake Chamo, a Rift Valley lake in southern Ethiopia. We used some fancy military issue range-finding binoculars to get very accurate distances between us (and camera) and the crocodiles. Then, combined with an ordinary digital camera and a bit of Photoshop magic we

got some accurate remote measurements of Nile crocodiles, some over 5.5 m (18') - saltie size. This is how it's done: do the range-finding and picture simultaneously, put the picture onto Photoshop where the pixel length of the croc is easily converted to millimeters, multiply the pixel length by the recorded distance of camera-to-crocodile in millimetres (ie how big it actually was on the camera sensor) and then divide by the focal length of the lens. This gives you a reasonably accurate length of the critter. Other researchers have proposed similar photographic techniques for estimating size (Gorzula 1984; Choquenot and Webb 1987)

We discovered a dusty little cubbyhole at the Arba Minch Crocodile Ranch near Chamo where skulls of crocodiles drowned in fishing nets (Nile perch) were given their final rest. It was a bonanza of giant skulls and our excitement grew as we measured a dozen of the biggest. All we could think was "bloody hell, these are the biggest Nile crocodile skulls on record". Our enthusiasm was obviously infectious, the farm manager, Assegid Gebre, got all the skulls cleaned up and the next time we visited he had them carefully mounted in glass cases. These are truly invaluable specimens, one measuring over 68 cm, the size of the Corroboree Tavern *C. porosus* skull, the biggest we found in Australia. This Lake Chamo skull is the largest on record for *C. niloticus*!



Figure 6. Rom Whitaker with record size *C. niloticus* skull at Arba Minch Crocodile Ranch, Ethiopia. Photograph: Nik Whitaker.

Other Giants

After years of being convinced that salties are the biggest crocodilian, colleagues who knew of our interest started sending in intriguing bits of information, including the statistics of a *C. acutus* skull at the American Museum of Natural History (AMNH) in New York. At 73.5 cm it is a shade bigger than 'Kalia' the giant Orissa *C. porosus* skull.

But what really zapped us were sizes of Malayan false gharial (*Tomistoma schlegelii*) skulls: one at the British Museum measures 84 cm (this is presently the longest known crocodilian skull in existence; Fig. 7); one at Munich Museum at 81.5 cm; and, another at the AMNH at 76.5 cm - overshadowing the other species. What the HL:TL ratio is for this species is only now coming to light. Our friend Uthen Youngprapakorn has

a gang of living giant ‘Tommys’ at Samut Prakarn Crocodile Farm in Bangkok, and in early November our colleague Ralf Sommerlad was able to put a tape to one of 4.76 m TL (close to 16’). With a dorsal cranial length of 74.2 cm we get a ratio of 1:6.4; using this ratio, the world’s biggest skull came from a 5.38 m (18’) *Tomistoma* (so the ‘broadsnouts’ still rule!).



Figure 7. Colin McCarthy (Natural History Museum, London) with world’s largest crocodile skull, *Tomistoma schlegelii*. Photograph: George Craig.

The third longest skull in the world is an Indian gharial at Munich, which measures 77.3 cm, but again we don’t know how long the animal was or what the HL:TL ratio might be (ratio for 4 *Gavialis* of 1.5 to 3.7 m TL measured on the Chambal last February was 1:5 to 1:6.5). Skull lengths are proportionally longer for these species compared with other crocodilians, and don’t necessarily translate to longest body length.

Discussion

While we can now say with certainty that *C. porosus* can reach lengths of 6 m (20’) and above, it is also quite certain that *G. gangeticus*, *T. schlegelii*, *C. acutus* and *C. niloticus* can reach over 6 m. And we shouldn’t totally discount the Orinoco crocodile (*C. intermedius*) measured by A. von Humboldt’s assistant in 1800, which was purportedly 6.78 m (22’ 3”) (Schmidt 1944).

An interesting aside gleaned while spending an afternoon with paleo-croc master, Dr. Wann Langston Jr. at the University of Texas in Austin: while modern crocodilians seem to peak out at around 6 m (20’), the big extinct mesoeucrocodylians like *Deinosuchus*, *Sarcosuchus* and *Terminonaris* seemed to have peaked at about 12 m (40’) and weighed up to 3000 kg! We wonder what their HL:TL ratio is?

This is an intriguing subject and hopefully this note will encourage colleagues out there to come up with bigger skulls (or other solid evidence) than we’ve been able to find. It might also encourage some re-measuring, using a standard caliper, some creative mathematics to account for shrinkage and a more comprehensive table of crocodilian maximum sizes for all crocodilian species. We also need to take a cue from Webb and Messel (1978) where they suggest that it might make more sense to derive a relationship between volume of bone in the skull and TL rather than linear ratios which just don’t seem to work for the real big ones. And not to be ignored is the formula derived by John Thorbjarnarson and colleagues working with a large sample of Orinoco and American crocodiles [TL = hindfoot (longest toe with nail) length x 11.85 - 12.97; Thorbjarnarson and Hernandez 1993]. The days of listening to the same old ‘bigger than the boat’ stories are over.

Table 1 lists the 30 or so biggest crocodiles/skulls we were able to locate, and includes the very few examples of both HL and TL that we have been able to find for big crocodiles and also some of the wide ranging ratios that are driving us ‘skulldiggers’ nuts. The unfortunate thing is that perhaps the genes favouring gigantism have been lost from the gene pool as a result of the selective killing of big crocodiles around the world. This is a good argument against the continued ‘safari’ harvests of the world’s remaining giant crocodiles.

Acknowledgements

A number of colleagues generously contributed to this compilation of big crocodile information and we’d like to profusely thank: Wayne King, the late Phil Hall, Ivan Ineich, Wann Langston, Peter Taylor, Paolo Piras, Gunther Koehler, Fred Glaw, Adam Britton, Charlie Manolis, Jack Cox, Mike Klemens, George Craig, Sudhakar Kar, Jerome Montague, Assegid Gebre, Allan Woodward, Ruth Elsey, John Thorbjarnarson, Ralf Sommerlad, Rich Fergusson, John Brueggen, Jeff Lang, Kent Vliet, Uthen Youngprapakorn, Kaushik Deuti and others we may have omitted. Thanks also to the Icon Films crew for facilitating the crocodile measuring trip around the world and to African Parks colleagues who hosted Nik and I in Ethiopia. Janaki Lenin, John Thorbjarnarson and Adam Britton kindly reviewed the manuscript.

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Table 1. Data on 40 “record” crocodile skulls. Species (Sp.): Cc = *Crocodylus cataphractus*; Ci = *Crocodylus intermedius*; Cn = *Crocodylus niloticus*; Cp = *Crocodylus porosus*; Gg = *Gavialis gangeticus*; Ts = *Tomistoma schlegelii*; Am = *Alligator mississippiensis*. AMNH= American Museum of Natural History, MCZ= Museum of Comparative Zoology. ¹ not including occipital condyle; ² there are several more 64-69 cm (HL) *T. schlegelii* skulls at Munich; ³ there are several more 64-67 cm (HL) *C. niloticus* skulls at Arba Minch. MHW= maximum head width; HL= head length; TL= total length.

Sp.	Origin	Current Location	HL ¹ (cm)	MHW (cm)	TL (m)	TL (ft)	HL:TL Ratio	Mandible (cm)	Source
Ts		British Museum	84.0	-	-	-	-	104.0	G. Craig, C. McCarthy (pers. comm.)
Ts	Central Borneo	Munich Museum	81.5	-	-	-	-	-	Muller (1927)
Gg	India	Munich Museum	77.3	-	-	-	-	-	Muller (1927)
Ts	Central Borneo	Munich Museum	77.0	-	-	-	-	-	Muller (1927)
Ts	Borneo	Munich Museum	76.5 ²	-	-	-	-	-	Muller (1927)
Ts		AMNH, New York	76.3	-	-	-	-	-	Paolo Piras (pers. comm.)
Cp	Cambodia	Paris Museum	76.0	48.0	-	-	-	98.3	Peter Taylor (pers. comm.)
Ts		Brussels Museum	75.9	-	-	-	-	-	Paolo Piras (pers. comm.)
Gg	India	Paris Museum	75.3	-	-	-	-	-	Paolo Piras (pers. comm.)
Gg	India	Munich Museum	75.0	-	-	-	-	-	Muller (1927)
Cp		Leningrad?	74.0 ?	-	-	-	-	-	Sudhakar Kar (2006a)
Ca	S. America	AMNH, New York	73.5	-	-	-	-	-	Paolo Piras (pers. comm.)
Cp	Bhitarkanika, India	Raja of Kanika	73.3	45.8	-	23'?	1:9.0 ?	-	RW (pers. obs.)
Cp	India	Indian Mus., Calcutta	73.0	39.0	-	-	-	92.0	Kaushik Deuti (pers. comm.)
Cp	Obo, Fly R., PNG	Wildlife Department?	72.0	-	6.20	20.7'	1:8.6	-	RW (pers. obs.)
Cp	Bengal	British Museum	71.1	-	-	33' myth	-	91.4	George Craig (pers. comm.)
Cp	Sarawak	Sarawak Museum	71.1	-	-	-	-	-	Banks (1931)
Cp	India	Indian Museum	71.0	35.0	-	-	-	86.0	Kaushik Deuti (pers. comm.)
Ts		MMNB, Berlin	70.4	-	-	-	-	-	Paolo Piras (pers. comm.)
Gg	India	Tubingen rept	70.3	-	-	-	-	-	Paolo Piras (pers. comm.)
Gg	India	AMNH, New York	69.7	-	-	-	-	-	Paolo Piras (pers. comm.)
Cp	Fly R., PNG	St. Aug. Gator Farm	69.0	-	5.34	17.8'	-	-	“Gomek”; J. Brueggen (pers. comm.)
Cp	Mary R., Australia	Corroboree, Darwin	68.8	43.9	5.64	18.5'	1:8.1	86.0	AB, RW (pers. obs.)
Cn	L. Chamo, Ethiopia	Arba Minch, Ethiopia	68.6	40.4	5.40?	18' ?	1:7.8 ?	87.0	RW (pers. obs.)
Cn	L. Chamo, Ethiopia	Arba Minch, Ethiopia	67.9	41.4	5.40?	18' ?	1:7.8 ?	-	RW (pers. obs.)
Ts		MCZ, Harvard	67.8	-	-	-	-	-	Paolo Piras (pers. comm.)
Cn	L. Chamo, Ethiopia	Arba Minch, Ethiopia	67.3 ³	42.1	5.40?	18' ?	1:7.8 ?	85.8	RW (pers. obs.)
Cp		Paris Museum	66.4	39.2	-	-	-	84.0	Ivan Ineich (pers. comm.)
Cp	Bhitarkanika, India	Wildlife Department	66.0	40.2	5.10?	17' ?	1:7.7	-	RW (pers. obs.)
Cp	Luzon, Philippines	MCZ, Harvard	66.0	-	-	29' myth	-	84.4	Greer (1974)
Ci	S. America	Senckenberg	65.1	-	-	-	-	-	Paolo Piras (pers. comm.)
Gg	India	MMNB Berlin	65.5	-	-	-	-	-	Paolo Piras (pers. comm.)
Cp	Mary R., Australia	Darwin Croc Farm	64.4	46.3	6.00?	20' ?	1:9.3 ?	-	“Charley”; Webb and Messel (1978)
Am	Sebastian R. Florida	MCZ, Harvard	64.0	-	4.54	14.8'	1:7	-	Barbour (1933)
Cp	Bhitarkanika, India	Wildlife Department	62.8	42	5.40?	18' ?	1:8.5 ?	-	Orissa Wildlife Dept. (pers. obs.)
Cc	Africa	Paris Museum	61.7	-	-	-	-	-	Paolo Piras (pers. comm.)
Am	Apilachicola R., Fl.		60.0	-	4.27	14.3'	1:7.1	-	Woodward <i>et al.</i> (1995)
Am	Orange Lake, Florida		58.4	-	4.23	14.1'	1:7.2	-	Woodward <i>et al.</i> (1995)
Cp	Singapore?	Madras Croc Bank	56.3	-	5.13	16.8'	1:9.1	-	“Jaws”; RW (pers. obs.)
Cp	Australia	St. August. Gator Farm	55.0	-	4.65	15.5'	1:8.5	-	“Maximo”; J. Brueggen (pers. comm.)

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Citation: Whitaker, R. and Whitaker, N. (2008). Who's got the biggest? Crocodile Specialist Group Newsletter 27(4): 26-30.