Total length and head length relationship in Mugger Crocodiles Crocodylus palustris (Reptilia: Crocodilia: Crocodylidae) in Iran

Asghar Mobaraki, Elham Abtin, Malihe Erfani & Colin Stevenson

26 July 2021 | Vol. 13 | No. 8 | Pages: 19162–19164
DOI: 10.11609/jott.6272.13.8.19162-19164
Total length and head length relationship in Mugger Crocodiles 
*Crocodylus palustris* (Reptilia: Crocodylia: Crocodylidae) in Iran

Asghar Mobaraki1, Elham Abtin2, Malihe Erfani3 & Colin Stevenson4

1 Natural Environment Deputy, Wildlife Conservation and Management Bureau, Department of Environment, Tehran, Iran.
2 Natural Environment Division, Department of Environment Office in Sistsan and Baluchestan Province, Zahedan, Iran.
3 Department of Environmental Sciences, Faculty of Natural Resources, University of Zabol, Zabol, Iran.
4 Crocodiles of the World, Burford Road, Brize Norton, Oxfordshire, OX18 3NX, UK.

1 amobaraki@yahoo.com, 2 ala_saly@yahoo.co.uk, 3 maliheerfani@uoz.ac.ir (corresponding author), 4 coleosuchus@hotmail.com

A small population of around 500 Mugger crocodiles *Crocodylus palustris* in southeastern Iran occupies the western-most extreme of the species’ global range (de Silva & Lenin 2010). This population is scattered across the region and individuals often come into close contact with local communities (Mobaraki 2015). The Mugger’s habit of moving between different habitats depending on local climatic and seasonal conditions means that they often turn up in remote areas (Abtin & Mobaraki 2016). Because this population persists at the extreme edge of the species distribution, environmental limits or conditions are likely to effect its biology and population dynamics, as well as its susceptibility to potential threats (Mobaraki et al. 2019).

Like many other crocodilians around the world, monitoring of the *C. palustris* population in Iran has been based on day and night-time (spotlight) surveys. During surveys, crocodiles are usually partly submerged, with only the head exposed to observers. Where observers have considerable experience with carrying out surveys and capturing large numbers of different-sized crocodiles, estimating body length from size of the head comes somewhat naturally (C. Manolis, pers. comm. 2021). However, this is not the case in many situations, including that in Iran.

Researchers working on morphometric relationships of different species of crocodilians have invariably noted that head length (HL) relative to total length (TL) tends to change little across size classes (e.g., Webb & Messel 1978; Magnusson 1983; Webb et al. 1983; Montague 1984; Hutton 1987; Verdade 2000; Wu et al. 2006; Platt et al. 2011; Fukuda et al. 2013; Edwards et al. 2017). Whitaker & Whitaker (2008) examined the HL/TL ratio for a number of crocodilian species, and confirmed the average ratio to be around 1:7, but this ratio was found to be closer to 1:8 for large (>4 m TL) species such as *Crocodylus porosus*, due to ontogenic changes associated with the head with increasing body size (Webb & Messel 1978; Whitaker & Whitaker 2008; Britton et al. 2012; Fukuda et al. 2013). In this study, we aim to quantify the relationship between TL and HL for Iranian Muggers, as well as examining the ratio between these two morphometric measures.

Material and Methods: Natural and artificial ponds are
the main Mugger habitats along or near the Bahoukalat River, the main part of which runs within the Gandou Protected Area. This area comprises 3,825km² (61.46E and 25.75N at central part), and was established in 1970 for the conservation of the crocodile population. Fifty-three Mugger crocodiles of varying sizes and sex were captured using fishing nets or ropes, during surveys or the translocation of nuisance specimens, in 2018 and 2019. Head length (HL) was measured from the anterior tip of the snout to the rear edge of the cranial platform (parietal bone). Total length (TL) was measured from the anterior tip of the snout to posterior tip of the tail along the back of the animal. Both measurements were taken using fiberglass tape, and the results rounded to the nearest cm. We excluded any specimens that were missing the tip of their tail. Sex was determined for 30 individual by examination of the cliteropenis, but as this sample size was considered small, the effect of sex was not examined further.

Statistical methods: The measurements were first tested for normality using Shapiro-Wilk (SW) and Kolmogorov-Smirnov (KS) tests. Linear regression analysis was used to examine the relationship between TL and HL, and between the TL/HL ratio and body size (TL and HL).

Results: Total length of the 53 Mugger crocodiles varied from 43 to 280 cm (average ± SD: 169 cm ± 63.7), and head length from 6 to 45 cm (average ± SD: 24.4 cm ± 9.93). Shapiro-Wilk and Kolmogorov-Smirnov tests (SW= 0.973 and p-value= 0.271, KS= 0.0758 and p-value= 0.200 for total length; and SW= 0.978 and p-value= 0.426, KS= 0.066 and p-value= 0.200 for head length) confirmed data normality, allowing parametric tests like linear regression. The linear regression relationship between TL and HL was highly significant, and is described as:

\[ TL (cm) = 15.52 + 6.283HL (cm) \quad (N= 53; \text{SEE}= 13.08; \ p= 0.00; \ r^2= 0.96) \ (\text{Figure 1}) \]

The mean TL/HL ratio was 7.03 (N=53; range 5.8 to 8.5; SD= 0.57). The linear regression relationships between TL/HL, and TL and HL, were significant, albeit highly variable and relatively low proportions of the variation explained by the regressions.

\[ \text{TL/HL} = 7.55 - 0.003\text{TL} (\text{cm}) \quad (N= 53; \text{SEE}= 0.54; \ p= 0.01; \ r^2= 0.12) \ (\text{Figure 2}) \]
\[ \text{TL/HL} = 7.75 - 0.03\text{HL} (\text{cm}) \quad (N= 53; \text{SEE}= 0.49; \ p= 0.00; \ r^2= 0.26) \ (\text{Figure 3}) \]

Discussion and Conclusion: As with other crocodilians, the relationship between HL and TL in Iranian Muggers was linear and thus provides a means to estimate size from heads/skulls found in the field or as museum specimens. The mean TL/HL ratio in this study (7.03) was similar to that obtained by Whitaker & Whitaker (2008) in their review of other crocodilian species. For all but perhaps the most longirostrine species, there appears a similarity in TL/HL ratio for crocodilians of moderate size.

The increasing TL/HL ratio with increasing size in our sample of Muggers merits further investigation, particularly with inclusion of data from larger Muggers (>3 m TL), since in some other species there is an increase in the TL/HL ratio in the largest crocodiles (Whitaker & Whitaker 2008; Fukuda et al. 2013). More
accurate data on additional head measurements (e.g., see Webb & Messel 1978) is likely to have provided more insights into how head shape changes with size in our sample of Muggers, and future work will take this into consideration.

In view of the relatively harsh environment in which Iranian Muggers occur, similar studies in other range states, namely Pakistan, Nepal, India, and Sri Lanka, may provide a clearer picture of potential morphometric differences across localities or populations for Muggers.

References

Abtin, E. & A. Mobaraki (2016). Gondou, Marsh Crocodile in Iran. Nashr-E-Talaie, Tehran, 144pp.

Britton, A., R. Whitaker & N. Whitaker (2012). Here be a dragon: exceptional size in a Saltwater Crocodile (Crocodylus porosus) from the Philippines. Herpetological Review 43(4): 541–546.

De Silva, A. & J. Lenin (2010). Mugger Crocodile Crocodylus palustris. pp. 94–98. In: Manolis, S.C. & C. Stevenson (eds.). Crocodiles. Status Survey and Conservation Action Plan. Third Edition. Crocodile Specialist Group, Australia.

Edwards, G.P., G.J. Webb, S.C. Manolis & A. Mazanov (2017). Morphometric analysis of the Australian freshwater crocodile (Crocodylus johnstoni). Australian Journal of Zoology 65(2): 97–111.

Fukuda, Y., K. Saalfeld, G. Lindner & T. Nichols (2013). Estimation of total length from head length of Saltwater Crocodiles (Crocodylus porosus) in the Northern Territory, Australia. Journal of Herpetology 47(1): 34–40.

Hutton, J.M. (1987). Morphometrics and field estimation of the size of the Nile crocodile. African Journal of Ecology 25: 225–230.

Magnusson, W.E. (1983). Size estimates of crocodilians. Journal of Herpetology 17(1): 86–88.

Mobaraki, A. (2015). Sustainable Management and Conservation of the Mugger Crocodile (Crocodylus palustris) in Iran. Msc thesis, International University of Andalusia, Spain, 58pp.

Mobaraki, A., M. Erfani, E. Abtin & F. Ataie (2019). Assessing habitat suitability of the mugger crocodile using maximum entropy. Environmental Sciences 16(4): 47–62.

Montague, J.J (1984). Morphometric analysis of Crocodylus novaeguineae from the Fly River Drainage, Papua New Guinea. Australian Wildlife Research 11(2): 395–414.

Platt, S.G., T.R. Rainwater, J.B. Thorbjarnarson & D. Martin (2011). Size estimation, morphometrics, sex ratio, sexual size dimorphism, and biomass of Crocodylus acutus in the coastal zone of Belize. Salamandra 47(4): 179–192.

Verdade, L.M. (2000). Regression equation between body and head measurement in the broad-snouted caiman (Caiman latirostris). Revista Brasileira de Biologia 60(3): 469–482.

Whitaker, R. & N. Whitaker (2008). Who’s got the biggest? Crocodile Specialist Group Newsletter 27(4): 26–30.

Webb, G.J.W. & H. Messel (1978). Morphometric analysis of Crocodylus porosus from the north coast of Arnhem Land, northern Australia. Australian Journal of Zoology 26: 1–27.

Webb, G. J. W., R. Buckworth, and S. C. Manolis (1983). Crocodylus johnstoni in the McKinlay River area, NT. Ill. Growth, movement and population age structure. Australian Wildlife Research 10: 383–401.

Wu, X.B., H. Xue, L.S. Wu, J.L. Zhu & R.P . Wang (2006). Regression analysis between body and head measurements of Chinese alligators (Alligator sinensis) in captive population. Animal Biodiversity and Conservation 29(1): 65–71.
Communications

Distribution and habitat preferences of the Chinese Pangolin Manis pentadactyla (Mammalia: Manidae) in the mid-hills of Nepal

– Suman Acharya, Hari Prasad Sharma, Rajeev Bhattachar, Beeju Poudyal, Sonia Sharma & Suraj Upadhyaya, Pp. 18959–18966

On the occurrence of the Himalayan Wolf Canis lupus, L. 1758 (Mammalia: Carnivora: Canidae) in the Gaurishankar Conservation Area, Nepal; its existence confirmed through sign and visual evidence in Rohwaling Valley

– Bishnu Prasad Pandey, Shankar Man Thami, Rabin Shrestha & Mukesh Kumar Chalise, Pp. 18967–18974

Group size, crowding, and age class composition of the threatened Sambar Rusa unicolor (Kerr, 1792) (Mammalia: Cetartiodactyla: Cervidae) in the semi-arid regions of northeastern Rajasthan, India

– Deepak Rui & Kalpana, Pp. 18975–18985

Study on the impacts of LULC change on the wildlife habitat and the livelihood of people in and around Dampa Tiger Reserve, Mizoram, India

– Sushanto Gouda, Janmeyaj Sethy, Netrapal Singh Chauhan & Harendra Singh Bargali, Pp. 18986–18992

Characterisation of breeding habitat of Grizzled Giant Squirrel Ratofo mormoa (Mammalia: Sciuridae) in Chininar Wildlife Sanctuary, Western Ghats, India

– Kiran Thomas & P.O. Nameer, Pp. 18993–19001

Seasonal prey availability and diet composition of Lesser Asiatic Yellow House Bat Scotophilus hulii Leach, 1821

– Shani Kumar Bhatry & Vadmalalai Elangovan, Pp. 19002–19010

Bird composition, diversity and foraging guilds in agricultural landscapes: a case study from eastern Uttar Pradesh, India

– Yashminta-Ulman & Manoj Singh, Pp. 19011–19028

Identification of a unique barb from the dorsal body contour feathers of the Indian Pitta Pitta brachyura (Aves: Passeriformes: Pittidae)

– Prateek Dey, Swapna Devi Ray, Sanjeev Kumar Sharma, Padmanabhan Pramod & Ram Pratap Singh, Pp. 19029–19039

Moths of the superfamly Gelechioidae (Microlepidoptera) from the Western Ghats of India

– Amit Katoe & Prakash Chand Pathania, Pp. 19040–19062

On the diversity and abundance of riparian odonate fauna (Insecta) of the midstream Chalakkudy River, Kerala, India

– C. Nitha Bose, C.F. Binoy & Francy K. Kakukose, Pp. 19063–19069

Species diversity and abundance patterns of epiphytic orchids in Aralam Wildlife Sanctuary in Kerala, India

– Jis Sebastian, Durairaj Kathiresan & Giby Kuriakose, Pp. 19060–19069

Status and conservation needs of Cycapectmotho Buch.-Ham. in its natural habitat at Baroypahalia National Park, Bangladesh

– M.K. Hossain, M.A. Hossain, S. Hossen, M.R. Rahman, M.I. Hossain, S.K. Nath & M.B.N. Siddiqui, Pp. 19070–19078

Review

Limitations of current knowledge about the ecology of Grey Foxes hammer conservation efforts

– Maximillian L. Allen, Alexandra C. Avrin, Morgan J. Farmer, Laura S. Whipple, Emmarie P. Alexander, Alyson M. Cervantes & Javan M. Bauder, Pp. 19079–19092

Short Communications

On the freshwater fish fauna of Krishna River, Sangli District, Maharashtra, India

– Suresh M. Kumbar, Shrikant S. Jadhav, Swapnali B. Lad, Abhijit B. Ghadage, Satyawan S. Patil & C. Shiva Shankar, Pp. 19093–19101

Diversity and distribution of the large centipedes (Chilopoda: Scolopendromorpha) in the Pha Oac - Pha Den National Park, Vietnam

– Le Xuan Son, Nguyen Thi Thanh Binh, Trang Thi Thanh Phuong, Tran Thi Thanh Binh, Thu Anh T. Nguyen & Nguyen D. Nguyen, Pp. 19102–19107

Diversity of ants in Aerrey Milk Colony, Mumbai, India

– Akshay Gawade & Amol P. Patwardhan, Pp. 19108–19117

First record of ghost shrimp Corollinossa couterei (Nobili, 1904) (Decapoda: Anuidea: Callichiridae) from Indian waters

– Piyush Vadher, Hitesh Kardani, Prakash Bambahaniya & Imtayj Beleem, Pp. 19118–19124

Notes

First photographic record of Mishmi Takin Budorcus taxicolor taxicolor and Red Goral Nemorhaedus baileyi from Kamlang Tiger Reserve, Arunachal Pradesh, India

– Chechta Singh & Deepiti Gupta, Pp. 19149–19152

Utilisation of honey trap method to ensnare a dispersing sub-adult Bengal Tiger Panthera tigris tigris L. in a human dominated landscape

– Gobind Sagar Bhardwaj, Bahali Kari & Arvind Mathur, Pp. 19153–19155

First camera trap photographs of Indian Pangolin Manis crassicaudata (Mammalia: Pholidota: Manidae) from Pakistan

– Misbah Bint Riaz, Faraz Akirn, Siddiqa Qasim, Syed Afaq Bukhari, Asad Aslam, Muhammad Waseem, Rizwana Imitaz & Tariq Mahmood, Pp. 19156–19158

Photographic record of Lesser Flamingo Phoeniconaias minor (Aves: Phoenicopteridae) in Ramganga river, Bareilly, India

– Pichaimuth Gangaaimaran, Aftab U. Usmani, G.V. Gopi, S.A. Hussain & Khursid A. Khan, Pp. 19159–19161

Total length and head length relationship in Mugger Crocodiles Crocodylus palustris (Reptilia: Crocodyliae) in Iran

– Ashgar Mobarak, Elham Abtin, Mahlhe Erdini & Colin Stevenson, Pp. 19162–19164

First record of the hoverfly genus Spilomyia Meigen (Diptera: Syrphidae) for Pakistan

– Muhammad Asghar Hassan, Imran Bodlah, Riaz Hussain, Azam Karam, Fazlullah & Azaz Ahmad, Pp. 19165–19167

Rediscovery of Watson’s Dorsum Stimulo awleoha/awlehoo (Elwes & Edwards, 1897) (Lepidoptera: Hesperidae: Hesperinidae) in Meghalaya, India after 60 years

– Suman Bhowmik & Atanu Bora, Pp. 19168–19170

A new distribution record of Bionorourypa dineri (Krombein, 1949) (Lepidoptera: Geometridae: Ennominae) from the Garhwal Himalaya, India

– Arun P. Singh & Lekhendar, Pp. 19171–19172

Report of Bradinopygia konkanensis Joshi & Sawant, 2020 (Insecta: Odonata) from Kerala, India

– Muhammad Haneef, B. Raju Stiven Crasta & A. Vivek Chandran, Pp. 19173–19176

A new distribution record of Bionorourypa dineri (Krombein, 1949) (Lepidoptera: Geometridae: Ennominae) from Kerala, India

– Nishi Babu, John T.D. Caleb & G. Prasad, Pp. 19177–19180

Notes on lectotypification of the Assam Ironwood Musea assamica (King & Prain) Kosterm. (Calophyllaceae)

– Prantik Sharma Baruah, Mynta Singh & Edwards, 1897)

On the rediscovery of a rare root parasite Gleadowia ruborum Gamble & Prain (Orobanchaceae) from Uttarakhand, western Himalaya, India

– Amol Kumar, Navendu V. Page, Bhupendra S. Adhikari, Manoj V. Nair & Gopal S. Rawat, Pp. 19185–19188

Occurrence of vivipary in Gleadovia ruborum (Nobili, 1904) (Decapoda: Axiidea: Callichiridae) from Indian waters

– Amit Kumar, Navendu V. Page, Bhupendra S. Adhikari, Manoj V. Nair & Gopal S. Rawat, Pp. 19185–19188