

**ECOLOGY AND USE OF THE ASIAN SOFT-SHELL TURTLE
(*AMYDA CARTILAGINEA*), WITH NOTES ON OTHER SPECIES**

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**A thesis submitted in fulfillment of the requirements for the degree of
Master of Science in Ecology**

Institute of Biodiversity and Environmental Conservation

UNIVERSITI MALAYSIA SARAWAK

2006

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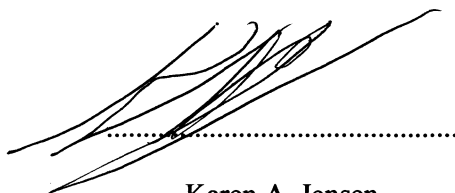
Karen A. Jensen

DEDICATION

This thesis is dedicated to the memory of my mother, Francis Marita Huffaker Jensen. She instilled my passion for the outdoors and animals by making me ride my first horse at four years old, teaching me to swim before I could walk, sending me to my grandparents' farm every summer, and especially for those long hikes to the top of "Thunder Mountain" with the wild horses.

DECLARATION

No portion of the work referred to in this thesis has been submitted in support of an application for another degree or qualification to this or any other university or institution of higher learning.

A handwritten signature in black ink, appearing to read 'Karen A. Jensen', is written over a horizontal dotted line. The signature is fluid and cursive, with some overlapping strokes.

Karen A. Jensen

ACKNOWLEDGEMENTS

For financial support of my research I am thankful to Universiti Malaysia Sarawak (UNIMAS) ('The herpetofauna of Loagan Bunut'; Fundamental grant number: 1/94/441/2004[179]) and ('Studies on the natural history and systematics of the herpetofauna of peat swamp forest of Sarawak, East Malaysia'; Fundamental grant number: 1/26/303/2002[40]) for providing necessary funding for field gear and the initial work at Loagan Bunut National Park and Balai Ringin. To the United Nations Development Project - Global Environment Fund (UNDP-GEF) ('Conservation and Sustainable Use of Tropical Swamp Forests and Associated Wetland Ecosystems', UNDP-GEF Funded Project MAL/99/G31), under a consultancy to Dr. Indraneil Das, for supporting some field costs and providing in-kind service in terms of field technicians and boats at Loagan Bunut National Park; The Chelonian Research Foundation for a Linnaeus Fund Research Award for supporting this project; to the British Chelonia Group for funding to purchase a much needed computer; to Idea Wild for donation of a camera; and to Grand Perfect for providing funding for work in the Bintulu area.

For his patience in teaching me and sharing with me his enthusiasm for reptiles, especially turtles, as well as untiring editing assistance, I am greatly indebted to Dr. Indraneil Das. He encouraged me to reach new levels of inquiry and understanding of scientific investigation. A generous thank you to Richard C. Vogt who provided positive encouragement and guidance during this process as well as sharing his vast experience of turtle biology. To Robert Steubing for sharing his passion of Borneo and reptiles and providing insight into the challenges of doing field work here, I am grateful. To Peter Paul van Dijk for planting that seed, the original idea for this project, thanks. Thank you Doug Hendrie for some kind words and recommendations that has helped me along the way. Thank you to Hans Hazebroek for his generosity and providing copyright permission to use maps from his books. To Dr. Leh Moi Ung, Charles from the Sarawak Museum for greatly appreciated access to specimens. To Dr. Thomas Wong, and the staff at City Veterinary Centre for supplies and interesting conversations on veterinary techniques.

A special thanks to Datin Eileen Yen Ee Lee and Margarita Naming from the Sarawak Biodiversity Centre for providing me research permit (Research Agreement number: SBC-RA-0073-KAJ) and (Research Permit number: SBC-RP-0085-KAJ). Thank you to Lai Khim Kuet and especially to Bolhan Budeng from the Sarawak Forestry Department for providing a permit to survey for freshwater turtles in Sarawak (Permit number: 03697). To Engkamat Lading from the Sarawak Forestry Corporation for reviewing and recommending this project move forward. A special thanks to Abang Arabi Abang Hj. Aimran from the Sarawak Forestry Corporation for providing in-kind service and people to assist me in my work at Loagan Bunut. A heartfelt thanks to the staff at Loagan Bunut National Park, Sam Pasan, for permission and use of equipment; Jok Ngau for sharing his knowledge of freshwater turtles, the Loagan Bunut wetland system and his family's hospitality and many welcomed hot meals after long days in the field; Gilin Gasing for all the those long hours in the field helping me catch turtles.

I would like to thank every staff member at the Institute of Biodiversity and Environmental Conservation (IBEC) for their help and professionalism over the past two years; Dr. Andrew Alek Tuen, Mohammed Yazis Abd. Kadir, Sendie Tangan, Kamaria Bt. Abdul Rahim, Mahadir Sidi, and Sulaiman Bol. I couldn't have done this project without your caring assistance.

Finally, without the support and humour of good friends, Julie Vanderwier, Kelly Hawk, Nedi McKnight, and Stacy Love, life would be less fun and to my faithful dog Nalu, for exhibiting traits that most humans cannot, loyalty and unconditional love.

ABSTRACT

Turtles and tortoises play important, albeit incompletely understood and largely unappreciated, roles in both the ecology of their ecosystems, and in the economy and sociology of the human cultures that interact with these enigmatic creatures. South-east Asia is home to a high diversity of freshwater turtle species. However, none of the species known from Borneo have been studied at length and consequently, little is known of their ecology. The present work is the first ecological study of *Amyda cartilaginea* not only in Borneo, but Malaysia. Notes were opportunistically collected on other freshwater turtle species, termed hard-shell turtles and included individuals of *Cyclemys dentata*, *Cuora amboinensis*, *Heosemys spinosa*, *Notochelys platynota*, and another native soft-shell turtle, *Dogania subplana*. Field work was concentrated at the primary study area, Loagan Bunut National Park (LBNP), but two visits were made to Balai Ringin, a fishing village located within a peat swamp to augment data collected at LBNP. Information collected pertaining to cultural use and trafficking of turtles was done opportunistically throughout Sarawak and on one visit in Sabah. Study site choice was based on available funding and opportunities for field visits. Capture rates for *Amyda cartilaginea* were extremely low. Out of 2,046 trap-nights at LBNP, 14 *Amyda cartilaginea* were captured, representing a success rate of 0.54%. Out of 720 trap nights at Balai Ringin, five *Amyda cartilaginea* were captured, representing a success rate of 0.69%. Relatively few hard-shell turtles were found during the course of this study. At LBNP, three *Cuora amboinensis* and seven *Cyclemys dentata* were captured. At Balai Ringin, one *Cyclemys dentata* and one *Heosemys spinosa* were captured. Several environmental factors seem to affect turtle behaviour or at least capture rates. Hard-shell turtles had the greatest capture rate during the full moon phase, indicating that lunar illumination is necessary for foraging and other activities. Both *Amyda cartilaginea* and the hard-shell turtles favoured overcast weather versus clear skies or rain, for moving and foraging. Seasons did not have a dramatic affect on the capture rate of turtles. Results of size class examination for three species, *Amyda cartilaginea*, *Cuora amboinensis*, and *Cyclemys dentata* possibly indicate that animals may not be living long enough to attain large size.

However, it is possible more animals from Borneo should be measured to determine a true range of sizes and determine if there is indeed a lack of recruitment into the largest known size classes. Sexual size dimorphism was not statistically significant, perhaps an effect of skewed size of captured animals. This may be a factor of equipment or techniques used biased towards medium-sized animals and the largest individuals are relatively trap-shy, or perhaps a result of past exploitation. All allometric analyses indicate strong proportional changes with growth of all species. *Cyclemys dentata* stands out in that this species shows great variation among individuals. Some animals are flattened in shape while others are high domed. *Amyda cartilaginea* from Borneo have a distinct series of black splotches and a black saddle band over a brown base colour on the carapace, unique from other patterns found on this species on the Asian continent. Dietary analysis of *Amyda cartilaginea* indicates that they are opportunistic omnivores, playing an important role in the peat swamps of Borneo by cycling energy from both animal and plant material. The other species analysed for diet also contribute to the ecosystem by breaking down cellulose material into energy and also in seed dispersal. Scavenging behaviour is one of the more important aspects of nutrient cycling for both the wetlands and for human populations. Wet market surveys and interviews with turtle hunters and fishermen show that *Amyda cartilaginea* is a prized food item in Sarawak culture. These surveys suggest that cultural use of turtles remain high although they are protected by State legislation, but the level of commercial use for food is unclear. Pet trade in local and exotic turtles is active in Sarawak. The harvest rate of turtles in Sarawak along with any international trafficking needs to be investigated.

Labi-labi dan kura-kura memainkan peranan penting dalam ekologi, ekonomi dan sosiologi manusia yang berinteraksi dengan haiwan tersebut walaupun peranan ini kurang difahami dan tidak dihargai. Asia Tenggara adalah habitat bagi berbagai jenis labi-labi dan kura-kura. Namun demikian, tiada spesies dari kepulauan Borneo yang telah dikaji dengan teliti, oleh itu tidak banyak diketahui mengenai ekologinya. Kajian ini merupakan kajian pertama mengenai ekologi *Amyda cartilaginea* bukan sahaja di Borneo tetapi juga di Malaysia. Juga dikumpulkan secara oportunistik ialah maklumat tentang spesies labi-labi dan kura-kura lain termasuk jenis yang bercenkerang keras (“hard-shell”) iaitu *Cyclemys dentata*, *Cuora ambionensis*, *Heosemys spinosa*, *Notochelys platynota* dan jenis yang bercenkerang lembut (“soft-shell”) *Dogania subplana*. Kebanyakan kerjalapangan dilakukan di Taman Negara Loagan Bunut (LBNP). Dua lawatan juga dibuat ke Balai Ringin, sebuah kampung nelayan yang terletak di hutan paya gambut, untuk menyokong maklumat yang diperolehi dari LBNP. Maklumat mengenai penggunaan dan penjualan penyu dibuat secara oportunistik di seluruh Sarawak dan melalui satu lawatan ke Sabah. Pemilihan tempat kajian adalah berdasarkan adanya pembiayaan dan peluang untuk membuat kerjalapangan. Kadar tangkapan untuk *Amyda cartilaginea* amat rendah. Daripada 2,046 malam-perangkap di LBNP, 14 ekor *Amyda cartilaginea* telah ditangkap, bersamaan kadar tangkapan sebanyak 0.54%. Daripada 720 malam perangkap di Balai Ringin, lima ekor *Amyda cartilaginea* telah ditangkap, bersamaan kadar tangkapan sebanyak 0.69%. Tidak banyak kura-kura bercenkerang keras dijumpai dalam kajian ini. Di LBNP, tiga *Cuora ambionensis* dan tujuh *Cyclemys dentata* ditangkap. Di Balai Ringin, se ekor *Cyclemys dentata* dan se ekor *Heosemys spinosa* telah ditangkap. Ada berberapa factor abiotik yang mempengaruhi kelakuan labi-labi and kura-kura atau kadar tangkapan. Labi-labi dan kura-kura berkulit keras banyak ditangkap semasa fasa bulan purnama, ini menunjukkan bahawa labi-labi dan kura-kura memerlukan keadaan terang untuk mencari makan dan aktiviti lain. Kedua *Amyda cartilaginea* dan kura-kura bercenkerang keras suka cuaca mendung banding cuaca cerah atau hujan untuk bergerak dan mencari makan. Musim tidak mempunyai kesan terhadap kadar tangkapan penyu. Hasil kajian keatas kelas

saiz bagi tiga sepsis, *Amyda cartilaginea*, *Cuora ambionensis* dan *Cyclemys dentata* menunjuk kemungkinan haiwan-haiwan tersebut tidak cukup tua untuk mencapai tahap saiz yang besar. Mungkin juga perlu lebih banyak lagi haiwan dari Borneo yang perlu diukur untuk menentukan saiz julat badan yang sebenar dan mengenalpasti jika benar labi-labi membesar hanya ke kelas saiz yang tertentu. Dimorfisme seksual tidak signifikan, mungkin kesan saiz tangkapan ya tidak normal. Ini mungkin kerana faktor peralatan or teknik yang lebih cenderung ke arah haiwan yang sederhana saiznya dan haiwan yang besar agak susah ditangkap atau mungkin kesan eksploitasi sebelum ini. Kesemua analisis alometri menunjukkan perubahan perbahagian dengan pertumbuhan bagi setiap spesies. *Cyclemys dentata* menonjol di dalam variasi antara individu. Ada individu yang lebih pipih dan ada yang lebih melenkung belakangnya. *Amyda cartilaginea* dari Borneo mempunyai tanda-tanda kehitaman dan jalur hitam pada bahagian belakang, bahagian karapace lain berwarna coklat; corak ini adalah unik bagi sepsis ini dan berlainan dari sepsis yang terdapat di daratan Asia. Analisis keatas pemakanan *Amyda cartilaginea* menunjukkan bahawa mereka adalah omnivore oportunistik, memainkan peranan penting dalam paya gambut di Borneo dengan memutar tenaga dari kedua tumbuhan dan haiwan. Spesies lain yang dianalisis dietnya juga menyumbang kepada ekosistem dengan menghuraikan bahan selulos kepada tenaga dan menyebarkan benih. Tingkahlaku makan bangkai merupakan salah satu daripada aspek pemutar tenaga bagi kedua kawasan berair dan populasi manusia. Survei dipasar basah serta temuramah dengan pemburu penyu dan nelayan menunjukkan bahawa *Amyda cartilaginea* adalah item makanan yang amat digenari di Sarawak. Survei tersebut menunjukkan bahawa kegunaan penyu dalam kebudayaan adalah tinggi walaupun ia dilindungi oleh perundangan Negeri tetapi tahap penggunaan sebagai makanan komersial tidak jelas. Perdagangan penyu tempatan dan eksotik sebagai haiwan mainan di Sarawak adalah aktif. Kadar tangkapan penyu di Sarawak dan perdagangan haram antarabangsa penyu tersebut perlu diselidik.

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LIST OF ABBREVIATIONS

Asin	Arcsine
ATTWG	Asian Turtle and Tortoise Working Group
°C	degrees Centigrade
cc	cubic centimeter
CDC	Center for Disease Control
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
cm	centimetre
GPS	global positioning system
ha	hectare
HSUS	Humane Society of the United States
IUCN	World Conservation Union
kg	kilogram
KV	kilovolts
km	kilometre
L	litre
LBNP	Loagan Bunut National Park
m	metre
μA	milliAmperes
mg	milligram
ml	millilitres
mm	millimetre
pH	power of hydrogen
RM	Malaysian Ringgit
SCL	straight carapace length
SCW	straight carapace width
SH	shell height or carapace depth

LIST OF ABBREVIATIONS continued

SD	standard deviation
ULAM	Unit for Laboratory Animal Medicine
UNDP-GEF	United Nations Development Programme - Global Environment Fund
UNIMAS	Universiti Malaysia Sarawak
X	mean

INTRODUCTION

Turtles and tortoises play important, albeit incompletely understood and largely unappreciated, roles in both the ecology of their ecosystems, and in the economy and sociology of the human cultures that interact with these enigmatic creatures. Non-marine turtles can be found in three broad categories by habitat use; freshwater turtles which share a dependency on slow moving or stagnant freshwater habitats; river turtles which inhabit lotic environments, and the tortoises and some turtles whose relatives inhabit either of the two aforementioned habitats. Each is a valuable component of their ecosystem providing functions such as energy flow and nutrient cycling, dispersal of vegetation, maintaining water quality and creating microhabitats for other species. The following sections highlight the varied roles turtles play in their ecosystems and in human culture.

1.1 The Roles of Turtles in the Ecosystem

1.1.1 Herbivory

Many turtles are herbivorous, or predominately so as adults. Herbivores, in general, perform an important function of nutrient cycling by breaking down the energy of plant material and converting it into protein. River turtles consume a wide variety of aquatic vascular and non-vascular plants in a variety of habitats, and both freshwater turtles and tortoises eat terrestrial plants, flowers, and fruits: *Carettochelys insculpta* (Georges and Rose, 1993); *Elseya dentata* (Kennet and Tory, 1996); *Homopus signatus signatus* (Loehr, 2002); *Dermatemys mawei* (D. Moll, 1989); *Batagur baska* (E.O. Moll, 1980); and *Pseudemys* and *Graptemys* (Webb, 1961).

Some herbivorous turtles, *Dermatemys mawei*, *Pseudemys concinna*, and *Pseudemys nelsoni*, have been shown to have a symbiotic relationship with gut micro-organisms, which assist in the breakdown of plant structure for digestion (Bjorndal and Bolten, 1990, 1992; Vogt and Flores-Villela, 1992; Thomas *et al.*, 1994). A few species of turtles, *Batagur baska*, *Podocnemis unifilis*, and *Pangshura tentoria*, are known to regularly eat water hyacinths (*Eichhornia* sp.) (Davenport *et al.* 1992; Varghese and Tonapia, 1986; Fachin-Terán *et al.*,