

TEMPERATURE PROFILING AND SEX RATIO  
OF GREEN TURTLE HATCHLINGS (*CHELONIA  
MYDAS*) OF CHAGAR HUIANG BEACH IN  
PULAU REDANG, TERENGGANU MALAYSIA.

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TESIS

**TEMPERATURE PROFILING AND SEX RATIOS OF GREEN TURTLE  
HATCHLINGS (*Chelonia mydas*) OF CHAGAR HUTANG BEACH IN  
PULAU REDANG, TERENGGANU, MALAYSIA.**

**By**

**PUSHPALATHA M. PALANIAPPAN**

**Thesis Submitted in Fulfilment of the Requirements for  
the Degree of Master of Science in the Faculty of  
Applied Science and Technology,  
Universiti Putra Malaysia Terengganu**

**November 1997**

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**DEDICATION**

**TO ALL CHELONIANS, MAY YOU ONCE AGAIN, ROAM THE SEAS  
FREELY**

**AND**

**TO "THE DEVIL IN A TUX", JANUARY NINTH AWAITS...**

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All publications arising from the project will be prepared in collaboration with the programme leader.

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**PREFACE**

*"I am affected by the thought that the earth nurses these eggs. They are planted in the earth, and the earth takes care of them; she is genial to them and does not kill them. It suggests a certain vitality and intelligence in the earth, which I had not realized. This mother is not merely inanimate and inorganic. Though the immediate mother turtle abandons her offspring, the earth and the sun are kind to them. The old turtle on which the earth rests takes care of them while the other waddles off. Earth was not made poisonous and deadly to them. The earth has some virtue in it; when seeds are put into it, they germinate; when turtles' eggs, they hatch in due time."*

-Henry David Thoreau (1967)

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Abstract of the theses presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirements for the Degree of Master of Science.

### LIST OF ABBREVIATIONS

<b>ANOVA</b>	<b>Analysis of Variances</b>
<b>CITES</b>	<b>Convention on International Trade in Endangered Species of Wild Fauna and Flora</b>
<b>ESD</b>	<b>Environmentally-determined sex determination</b>
<b>IUCN</b>	<b>The World Conservation Union</b>
<b>GSD</b>	<b>Genetically-determined sex determination</b>
<b>MTRC</b>	<b>Marine Turtle Research and Conservation Unit</b>
<b>SEATRU</b>	<b>Sea Turtle Research Unit</b>
<b>SEAFDEC</b>	<b>Southeast Asian Fisheries Development Centre</b>
<b>SSC</b>	<b>Species Survival Commission</b>
<b>TIHPA</b>	<b>Turtle Islands Heritage Protected Area</b>
<b>TSD</b>	<b>Temperature-dependent sex determination</b>

Abstract of the thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the Degree of Master of Science.

**TEMPERATURE PROFILING AND SEX RATIOS OF GREEN TURTLE  
HATCHLINGS (*Chelonia mydas*) OF CHAGAR HUTANG BEACH IN  
PULAU REDANG, TERENGGANU, MALAYSIA.**

by

**PUSHPALATHA M. PALANIAPPAN**

**November 1997**

**Chairperson : Assoc. Prof. Dr. Chan Eng Heng**

**Faculty : Applied Science and Technology**

A study of sand temperatures and an analysis of sex ratios were conducted in Chagar Hutang in 1995 to determine the temperature regime of the beach and the sex ratio of the green turtle hatchlings that would have been produced from nests deposited in this beach. The beach was divided into two thermal zones, the 'Shade' zone which was located 2 metres from vegetation and the 'Open beach' zone which was located between the 'Shade' zone and the high tide mark. Average temperatures of the whole study period in the open zone which were higher exceeded those in the shaded zone by not more than 1.39°C.

Spatial variation in temperature was detected along the beach with the area near the western end of the beach subjected to the higher temperatures at all three depths, 30 to 90cm, in both zones. Average temperatures during the six month duration at 30cm depth ranged from  $29.59^{\circ}\text{C}\pm 1.00$  (range  $26.6^{\circ}\text{C} - 31.5^{\circ}\text{C}$ ) in the 'Shade' zone to  $30.88^{\circ}\text{C}\pm 1.02$  (range  $29.1^{\circ}\text{C} - 32.8^{\circ}\text{C}$ ) in the 'Open beach' zone. At the eastern extreme of the beach, average temperatures at 30cm were between  $27.76^{\circ}\text{C}\pm 0.76$  (range  $26.1^{\circ}\text{C} - 29.6^{\circ}\text{C}$ ) in the shaded zone and  $28.98^{\circ}\text{C}\pm 0.81$  (range  $27.6^{\circ}\text{C} - 30.9^{\circ}\text{C}$ ) in the open beach zone.

A seasonal trend in temperature was noted. Data recorded during the entire 6 month period showed that temperatures were higher from May which recorded an average temperature of  $32.1^{\circ}\text{C}\pm 0.93$  (range  $30.4^{\circ}\text{C} - 33.2^{\circ}\text{C}$ ) at 30cm depth in the 'Open beach' zone at western end of the beach decreased to  $29.2^{\circ}\text{C}\pm 0.67$  (range  $28.5^{\circ}\text{C} - 30.1^{\circ}\text{C}$ ) in October.

A total of 560 green turtle nests were deposited on the beach. These nests were located in both the shaded (22.7%) and open (74.3%) areas of the beach. The highest number of nests were deposited in June and July with total nests amounting to 138 nests (24.6%) and 162 nests (28.9%), respectively.

31 August 1995. Sand temperatures of the eastern end to middle portion of the

beach. The range of average middle trimester incubation temperatures of the 24 nests that were sampled was between 27.9°C to 31.5°C. The percentage of female hatchlings in the sampled nests of both open beach and shaded zones were found to have been influenced by location of nest on the beach with respect to shade, and time of oviposition during the nesting season. In the open beach zone, the percentage of female hatchlings was 85.4% compared to 52.9% in the shaded zone. Phase One (7 May to 22 June 1995) of the sampling period produced 87.5% female hatchlings whereas Phases Two (23 June to 31 July) and Three (1 to 31 August) produced 56.9% and 63.2% females, respectively.

79.6% females to 20.0% males and 1.4% intersexed hatchlings.

Incubation temperatures of the middle trimester and whole period had negative correlations with incubation duration ( $y=-0.1268x+36.36$ ,  $r^2=0.2448$  and  $y=-0.1188x+36.065$ ,  $r^2=0.2148$ , respectively). Longer incubation duration resulted in less female hatchlings ( $y=-4.654x+292.06$ ,  $r^2=0.4396$ ). There was a poor correlation between nest depth and number of female hatchlings ( $y=1.0444x-16.37$ ,  $r^2=0.2038$ ).

The pivotal temperature, 28.2°C, was calculated using sex ratios and middle trimester incubation temperatures from the nests sampled from 7 May to

31 August 1995. Sand temperatures of the eastern end to middle portion of the beach exceeded the pivotal incubation temperature by almost 1°C to 3°C at all depths in the open zone during the warmer months of May to July. Differences were less apparent from August to October. In the shade zone the sand temperatures were similar or lower than the pivotal. The western end of the beach had higher sand temperatures and differed from the pivotal temperature by a factor of 2°C or 4°C. In the shade zone however, between the cooler months of August and October, sand temperatures were 1°C to 2 °C higher or similar to the pivotal incubation temperature. The overall green turtle hatchling sex ratio that would have been produced in Chagar Hutang beach in 1995 was estimated to be 79.6% females to 19.0% males and 1.4% intersexed hatchlings.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi sebahagian dari keperluan untuk Ijazah Master Sains.

**PROFIL SUHU DAN NISBAH JANTINA BAGI ANAK PENYU  
AGAR (*Chelonia mydas*) DI PANTAI CHAGAR HUTANG  
DI PULAU REDANG, TERENGGANU, MALAYSIA.**

oleh

**PUSHPALATHA M. PALANIAPPAN**

**November 1997**

**Pengerusi : Prof. Madya Dr. Chan Eng Heng**

**Fakulti : Sains Gunaan dan Teknologi**

Profil suhu pasir dan nisbah jantina anak penyu agar ditentukan melalui kajian suhu pasir dan analisa nisbah jantina yang mungkin dihasilkan dijalankan di Chagar Hutang pada tahun 1995. Pantai dibahagikan kepada dua zon suhu, iaitu zon 'Teduhan' yang terletak 2 meter dari kawasan tumbuhan dan zon 'Terdedah' yang terletak di antara zon 'Teduhan' dan paras air pasang penuh. Purata suhu di zon 'Terdedah' lebih tinggi berbanding dengan zon 'Teduhan' di mana perbezaannya tidak melebihi 1.39°C.



Perbezaan suhu telah dikesan di sepanjang pantai ini. Purata suhu tertinggi, di antara  $29.59^{\circ}\text{C}\pm 1.00$  (julat  $26.6^{\circ}\text{C}$  -  $31.5^{\circ}\text{C}$ ) di zon teduhan hingga  $30.88^{\circ}\text{C}\pm 1.02$  (julat  $29.1^{\circ}\text{C}$  -  $32.8^{\circ}\text{C}$ ) di zon terdedah didapati pada kedalaman, 30cm di hujung bahagian barat pantai. Suhu terendah pula didapati di hujung bahagian timur pantai, purata  $27.76^{\circ}\text{C}\pm 0.76$  (julat  $26.1^{\circ}\text{C}$  -  $29.6^{\circ}\text{C}$ ) di zon teduhan hingga  $28.98^{\circ}\text{C}\pm 0.81$  (julat  $27.6^{\circ}\text{C}$  -  $30.9^{\circ}\text{C}$ ) di zon terdedah.

Perbezaan suhu juga dikesan secara "temporal", di mana purata suhu pada kedalaman 30cm di bahagian barat pantai di zon terdedah  $32.1^{\circ}\text{C}\pm 0.93$  (julat  $30.4^{\circ}\text{C}$  -  $33.2^{\circ}\text{C}$ ) pada bulan Mei adalah lebih tinggi berbanding purata suhu pada bulan Oktober  $29.2^{\circ}\text{C}\pm 0.67$  (julat  $28.5^{\circ}\text{C}$  -  $30.1^{\circ}\text{C}$ ).

Terdapat sejumlah 560 sarang penyu agar, iaitu 74.3% di zon 'Terdedah' dan 22.7% di zon 'Teduhan' di pantai Chagar Hutang pada tahun 1995. Jumlah sarang yang tertinggi didapati pada bulan Jun dan Julai iaitu sejumlah 138 (24.6%) dan 162 (28.9%) sarang, masing-masing.

Suhu "trimester" pertengahan sarang yang disampel berada dalam julat  $27.9^{\circ}\text{C}$  hingga  $31.5^{\circ}\text{C}$ . Peratus anak penyu betina didapati dipengaruhi oleh lokasi sarang, samada di zon 'Teduhan' atau 'Terdedah' dan masa penyu bertelur. Zon

terdedah menghasilkan 85.4% anak penyu betina manakala zon teduhan menghasilkan 52.9% anak penyu betina. Fasa persampelan Satu (7 Mei hingga 22 Jun 1995) pula menghasilkan 87.5% anak penyu betina berbanding dengan 56.9% dan 63.2% yang dihasilkan pada Fasa Dua (23 Jun hingga 31 Julai) dan Tiga (1 hingga 31 Ogos), masing-masing.

Suhu pengeraman semasa “trimester” pertengahan dan seluruh jangkamasa mempunyai perhubungan korelasi negatif dengan jangkamasa pengeraman ( $y=-0.1268x+36.36$ ,  $r^2=0.2448$  dan  $y=-0.1188x+36.065$ ,  $r^2=0.2148$ , masing-masing). Jankasama pengeraman yang lama menghasilkan jumlah anak penyu betina yang rendah ( $y=-4.654x+292.06$ ,  $r^2=0.4396$ ). Korelasi di antara kedalaman sarang dan jumlah anak penyu betina tidak ketara ( $y=1.0444x-16.37$ ,  $r^2=0.2038$ ).

Suhu pengeraman “pivotal”, iaitu 28.2°C, adalah berdasarkan suhu pengeraman dan nisbah jantina dari sarang yang disampel dari 7 May hingga 31 Ogos 1995. Suhu ini 1°C hingga 3°C lebih rendah dari suhu pasir dari hujung timur hingga bahagian pertengahan pantai pada kesemua kedalaman di zon terdedah dari bulan Mei hingga Julai. Perbezaan suhu tidak begitu ketara dari bulan Ogos hinggs Oktober. Pada zon teduhan, perbezaan suhu “pivotal” dan

suhu pasir adalah lebih kurang sama atau lebih rendah dari suhu “pivotal” sepanjang jangkamasa kajian. Hujung sebelah barat pantai didedahkan kepada suhu tinggi yang lebih. Suhu pasir ini melebihi suhu “pivotal” sebanyak 2°C atau 4°C. Di zon teduhan, di antara bulan Ogos dan Oktober yang lebih sejuk, suhu pasir melebihi suhu “pivotal” sebanyak 1°C hingga 2°C atau lebih kurang sama dengan suhu tersebut. Nisbah jantina keseluruhan anak penyu agar yang dijangka terhasil dari Chagar Hutang dianggarkan 79.6% betina kepada 19.0% jantan dan 1.4% anak penyu yang mempunyai dua jantina.