

**SPATIAL DISTRIBUTION WITHIN
DIFFERENT AGE OF TWO *ANGUILLA* SPECIES
IN PENINSULAR MALAYSIA**

CHAI INN JU

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ABSTRACT

Abstract of thesis presented to the Senate of Universiti Malaysia Terengganu in fulfillment of the requirement for the degree of Master of Science

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Main supervisor : Li Lian Wong, Ph.D
Co-supervisor : Professor Takaomi Arai, Ph.D
Institution : Institute of Tropical Aquaculture and Fisheries

Freshwater eels are divided into tropical and temperate species based on their geographical distribution. Spatial distribution of tropical eels in Malaysia can be revealed through the analysis of migratory pattern. There are studies emphasize on the diversity data of *Anguilla* species in Malaysia but not their migratory patterns. The objectives of this study were to determine age by otolith annuli examination and to determine the migratory pattern of tropical eels by examining otolith strontium (Sr) to calcium (Ca) ratios using an electron probe microanalyzer (EPMA). Present study provides an insight of tropical eel migratory history and habitat preferences in Peninsular Malaysia, In this study, age of tropical eels was determined by the annual rings of otolith while their migratory patterns were determined by the Sr: Ca ratio of their otoliths that reflect eel movements among various saline environments. A total of 164 eel individuals composed of 126 *Anguilla bicolor bicolor* and 38 *A. bengalensis bengalensis* were collected from ten rivers in the states of Penang, Perak and Kedah in the northwestern Peninsular Malaysia. Migratory patterns observed among species and were divided into four contingent types: 1) Type 1, freshwater, 2) Type 2a, freshwater-favoring, 3) Type 2b, seawater-favoring and 4) Type 3, shift type. The age of *A. bicolor bicolor* ranged from two to seven years old and the age of

A. bengalensis bengalensis ranged from three to nine years old. *A. bicolor bicolor* were found to reside in the freshwater environment at younger age (2 to 4 years old) and reside in the estuarine environment at an older age (5 to 7 years old) while *A. bengalensis bengalensis* prefer either freshwater or estuarine environment for their growth, regardless of ages. Spatial distribution of tropical anguillid eels changed in relation to age and are influenced by biological factors such as growth and size of individuals, osmoregulation mechanisms, morphological changes, inter-specific competition, domination of species, and environmental factors such as salinity and topographic differences. A better understanding of the spatial distribution of eel species at different ages can contribute to their sustainability through enhancing the protection towards their growth habitat in future.

ABSTRAK

Abstrak tesis yang dikemukakan kepada Senat Universiti Malaysia Terengganu bagi memenuhi keperluan untuk ijazah Sarjana Sains

TABURAN SPATIAL BAGI DUA *ANGUILLA* SPESIES PADA UMUR BERBEZA DI SEMENANJUNG MALAYSIA

CHAI INN JU

2020

Penyelia Utama : Li Lian Wong, Ph.D
Penyelia Bersama : Professor Takaomi Arai, Ph.D
Institut : Institut Akuakultur Tropika dan Perikanan

Belut air tawar dibahagikan kepada spesies iklim tropika dan sederhana berdasarkan taburan geografinya. Taburan spatial belut tropika di Malaysia dapat didedahkan melalui analisis pola migrasi. Kajian yang dijalankan oleh para penyelidik banyak mengutamakan data kepelbagaian spesies *Anguilla* di Malaysia dan tiada yang fokus pada corak migrasi belut. Objektif kajian ini adalah untuk menentukan umur melalui pemeriksaan pada lingkaran otolit dan untuk menentukan corak migrasi belut tropika melalui pemeriksaan nisbah kepekatan strontium (Sr) dan kalsium (Ca) otolit menggunakan mikroanalisis probe elektron (EPMA). Kajian ini memberi gambaran mengenai sejarah migrasi belut tropika dan pilihan habitat di Semenanjung Malaysia. Umur belut tropika dalam kajian ini ditentukan oleh lingkaran tahunan otolit sementara corak migrasi ditentukan oleh nisbah Sr: Ca dari otolit mereka yang mencerminkan pergerakan belut di persekitaran yang berlainan tahap kemasinannya. Sebanyak 164 ekor belut yang terdiri daripada 126 *Anguilla bicolor bicolor* dan 38 *A. bengalensis bengalensis* dikumpulkan dari sepuluh batang sungai di negeri Pulau Pinang, Perak dan Kedah di barat laut Semenanjung Malaysia. Corak migrasi belut boleh dibahagikan kepada empat jenis kontingen: 1) Jenis 1, air tawar, 2) Jenis 2a,

memihak kepada air tawar, 3) Jenis 2b, memihak kepada air laut dan 4) Jenis 3, jenis pengalihan. *A. bicolor bicolor* berumur antara dua hingga tujuh tahun dan *A. bengalensis bengalensis* berumur antara tiga hingga sembilan tahun. *A. bicolor bicolor* didapati tinggal di persekitaran air tawar pada umur yang lebih muda (2 hingga 4 tahun) dan tinggal di persekitaran muara pada umur yang lebih tua (5 hingga 7 tahun) sementara *A. bengalensis bengalensis* lebih suka persekitaran air tawar atau muara untuk pertumbuhan mereka, tanpa mengira usia. Taburan spatial belut anguillid tropika berubah berdasarkan umur dan dipengaruhi oleh faktor-faktor biologi seperti pertumbuhan dan saiz individu, mekanisme osmoregulasi, perubahan morfologi, persaingan antara spesies, penguasaan spesies, dan faktor-faktor persekitaran seperti saliniti dan perbezaan topografi. Pemahaman terhadap taburan spatial spesis belut pada usia yang berlainan dapat menyumbang kepada kelestariannya dengan meningkatkan perlindungan terhadap habitat pertumbuhan mereka pada masa depan.