

**ECOLOGY OF MONOGENEANS ON THE GILLS
OF TWO SPECIES OF FRESHWATER FISHES IN
RELATION TO THE WATER QUALITY IN KENYIR
LAKE, TERENGGANU, MALAYSIA.**

BAKO MALLAM MODU

**Thesis Submitted in Fulfilment of the
Requirement for the Degree of Doctor of
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DEDICATION

To my deceased parents Mallam Modu Gajiram and Ya Fatimatu-Zahra Aliyam who passed away three decades ago, may their gentle souls rest in peace Amin.

Abstract of thesis presented to the Senate of Universiti Malaysia Terengganu
in fulfilment of the requirement for the Degree of Doctor of Philosophy

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A parasitological survey of gill monogenean parasites was carried out on two different fish species (*Hampala macrolepidota* Van Hasselt & Kuhl 1823 and *Hemibagrus nemurus* Valenciennes 1840) from six different locations in Kenyir Lake. Studies on monogenetic parasites in relation to water quality are poorly known in this part of Southeast Asia. This is particularly true in Malaysia where most of the monogenean studies have been done at taxonomic level. There have been no previous comprehensive studies of these parasites in comparison to environmental parameters in the lake. The current study focused principally on the relationship between the monogenean prevalence and water quality parameters with regard to their diversity, seasonal fluctuation patterns and microhabitat preferences on the fish gills.

A total of 1269 fish specimens which comprise 652 *H. macrolepidota* and 617 *H. nemurus* have been examined for the gill monogenean from six different locations in the lake. All fish specimens were sampled with gill netting (mesh size 5 – 10 cm) while water samples were collected using the Niskin water sampler once a month from each location. Prevalence and mean intensity of the parasites on both fishes were evaluated in comparison with the water quality parameters of the lake. Six gill monogenean parasites (*Dactylogyrus macrolepidoti*, *D. hampali*, and *D. quadribrachiatus*, from *H. macrolepidota*; *Cornudiscoides malayensis*, *C. sundanensis*, and *Bifurcohaptor baungi* from *H. nemurus*) were identified in this study. A new monogenean species (*D. terengganusis* n. sp) was also found in *H. macrolepidota* and described from two main tributaries of the lake (Sungai Kiang and Sungai Tanjung Mentong).

Water quality parameters such as temperature (T), pH, dissolved oxygen (DO), total ammonia-nitrogen (TAN), nitrite-nitrogen (NO₂-N), nitrate-nitrogen (NO₃-N), total alkalinity and water transparency (TRSP) were analysed and correlated with monogenean prevalence. A highly positive significant ($P < 0.05$) correlation was established between monogenean infections and most of the water quality variables (e.g. temperature and dissolved oxygen) from all locations. Results revealed that three locations namely; Sungai Ketiar, Sungai Petang Island and Sungai Tanjung Mentong were having the highest prevalence (100%) but lower in terms of monogenean diversity compared to

three other locations such as Sungai Kiang, Sungai Tembat and Sungai Cacing.

The influence of seasonality on the abundance and diversities of monogenean on the two fish species were also analysed. The present study demonstrated that monogenean diversity was significantly ($P < 0.05$) pronounced during non-monsoon (Shannon $H' = 0.5983$; Simpson $1/D = 3.953$ – in *H. macrolepidota* and Shannon $H' = 0.476$; Simpson $1/D = 3.002$ – in *H. nemurus*) compared to monsoon ($H' = 0.411$; $1/D = 2.305$ – *H. macrolepidota*; $H' = 0.291$; $1/D = 1.921$ – in *H. nemurus*) in both fish species. Interestingly, lower monogenean abundance was noticed during monsoon period (November – February) compared to non-monsoon (March – July) in all locations. The richness of the monogenean community from the lake was higher during monsoon period compared to non-monsoon in contrast to their diversity in both fish species examined. Berger-Parker Dominance ($1/d$) index showed higher dominance at the Sungai Tembat in April 2011 ($1/d = 3.226$) followed by Sungai Tanjung Mentong in March 2011 ($1/d = 2.964$) and lower at Sungai Kiang in January 2010 ($1/d = 1.697$). The overall results of the regression analyses showed that with an increase of host size, there are some relative increases in the parasite intensities.

Study on microhabitat selection by monogenean on the gills of the two fish investigated was evaluated. T-test analysis showed a significant difference

between monogenean preferences on the gill segments and same differences were noticed between four gill arches of the two fish gills examined ($P < 0.05$). *Dactylogyrus macrolepidoti* preferred site C (Distal-dorsal) on the third gill arch followed by site D (Proximal-dorsal). *Dactylogyrus quadribrahiatus* on the other hand preferred site B (Dorsal-median) of the third gill arch than any other site followed by site E of the same gill arch. *Cornudisoides malayensis* showed significant ($P < 0.05$) preference on site E (Proximal-median) of the third gill arch on both sides of the fish gill while *C. sundanensis* preferred site C (Distal-dorsal) of the third gill arch.

The present study has demonstrated a combined approach of physico-chemical and biological assessment of the lake water from all locations. Such study was ecologically relevant, demonstrating the potentiality of parasites and toxicological impacts of environmental contaminants to fish. It can be concluded that a positive correlation exists between the monogenean prevalence with the water quality variables in all the locations. The noticeable fluctuation of seasonal diversity in all cases of the monogenean community has led to a conclusion that the monogenetic trematodes had a significant relationship with the aquatic environmental parameters.

Abstrak tesis yang dikemukakan kepada Senat Universiti Malaysia Terengganu sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

**EKOLOGI MONOGENEA INSANG DUA SPESIES IKAN AIR TAWAR
BERIKAITAN DENGAN PEKAITAN KUALITI AIR DI TASIK KENYIR,
TERENGGANU, MALAYSIA**

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Satu kajian tentang parasit monogenea telah dijalankan ke atas dua jenis ikan (*Hampala macrolepidota* Van Hasselt & Kuhl 1823 dan *Hemibagrus nemurus* Valenciennes 1840) di enam lokasi yang berbeza di Tasik Kenyir. Kajian mengenai perhubungan parasit monogenetik dengan kualiti air kurang diketahui di Asia Tenggara. Ini adalah benar khususnya di Malaysia di mana kebanyakan kajian monogenean telah dilakukan di peringkat taksonomi sahaja. Tiada kajian menyeluruh dibunet sebelum ini tentang parasit berbanding dengan parameter alam sekitar di tasik. Kajian ini memberi tumpuan terutamanya kepada hubungan antara prevalen monogenea dan parameter kualiti air dengan mengambil kira kesan kepelbagaian, corak turun naik bermusim dan kecenderongan mikrohabitat pada insang ikan.

Sejumlah daripada n = 1269 spesimen ikan yang terdiri daripada 652 ekor *H. macrolepidota* dan 617 ekor *H. nemurus* telah dikaji untuk parasit insang monogenea dari enam lokasi yang berbeza dalam tasik ini. Semua spesimen ikan telah disampel dengan menggunakan jaring (saiz jaringan 5 - 10 cm) manakala sampel air telah diambil menggunakan penyampel air Niskin sebulan sekali dari setiap lokasi. Prevalen dan purata keamatan parasit pada kedua-dua ikan telah dinilai melalui perbandingan dengan parameter kualiti air tasik ini. Enam parasit insang monogenea (*Dactylogyrus macrolepidoti*, *D. hampali*, dan *D. quadribrachiatus*, daripada ikan *H. macrolepidota*, *Cornudiscooides malayensis*, *C. sundanensis*, dan *Bifurcohaptor baungi* daripada ikan *H. nemurus*) telah dikenal pasti dalam kajian ini. Satu spesies baru parasit insang monogenea (*D. terengganusis* n. sp.) juga telah ditemui pada ikan *H. macrolepidota* dari dua anak sungai utama tasik ini (Sungai Kiang dan Sungai Tanjung Mentong).

Parameter kualiti air seperti suhu (T), pH, oksigen terlarut (DO), jumlah ammonia-nitrogen (TAN), nitrit-nitrogen (NO₂-N), nitrat nitrogen (NO₃-N), kealkalian total dan ketelusan air (TRSP) telah dianalisis dan berkait rapat dengan prevalen monogean. Korelasi positif yang signifikan (P < 0.05) telah dikenalpasti antara jangkitan monogenea dan kebanyakan pembolehubah kualiti air (seperti suhu dan oksigen terlarut) dari semua lokasi. Hasil kajian menunjukkan bahawa tiga lokasi iaitu Sungai Ketiar, Sungai Petang Island dan Sungai Tanjung Mentong mempunyai kelaziman tertinggi (100%) tetapi rendah dari segi kepelbagaian monogenea berbanding tiga lokasi lain seperti Sungai Kiang, Sungai Tembat dan Sungai

Cacing. Keputusan pemeriksaan histopatologi mendedahkan patologi ringan insang seperti hiperplasia dan keadaan oedema di lamela insang sekunder. Analisis statistik (PCA) bagi lesi insang berbanding parameter kualiti air dan prevalen di semua lokasi menunjukkan hubungan yang signifikan ($P < 0.05$). Pengaruh bermusim pada kepadatan dan kepelbagaian monogenea pada kedua-dua spesies ikan turut dianalisis. Kajian ini menunjukkan bahawa kepelbagaian monogenea adalah lebih ketara semasa musim bukan monsun (Shannon $H' = 0,5983$; Simpson $1/D = 3,953$ - di *H. macrolepidota* dan Shannon $H' = 0.476$; Simpson $1/D = 3,002$ - di *H. nemurus*) berbanding monsun ($H' = 0,411$; $1/D = 2,305$ - di *H. macrolepidota* $H' = 0,291$; $1/D = 1,921$ - di *H. nemurus*) untuk kedua-dua spesies ikan. Menariknya, kepadatan monogean yang rendah telah dikenalpasti semasa tempoh monsun (November - Februari) berbanding bukan monsun (Mac - Julai) di semua lokasi. Kekayaan komuniti monogean dari tasik adalah lebih tinggi ketika musim monsun berbanding bukan monsun berbeza kepada kepelbagaian mereka di kedua-dua spesies ikan diperiksa. Indeks Penguasaan Berger-Parker ($1/d$) menunjukkan penguasaan yang lebih tinggi di Sungai Tembat pada bulan April 2011 ($1/d = 3.226$) diikuti oleh Sungai Tanjung Mentong pada Mac 2011 ($1/d = 2,964$) dan lebih rendah di Sungai Kiang pada Januari 2010 ($1/d = 1,697$). Keputusan keseluruhan analisis regresi menunjukkan bahawa dengan peningkatan saiz hos, terdapat beberapa peningkatan relatif dalam keamatan parasit.

Kajian pada pemilihan mikrohabitat oleh monogenea pada insang kedua-dua ikan yang disiasat telah dinilai. Analisis Ujian-T menunjukkan perbezaan

yang signifikan antara pemilihan monogenea pada segmen insang dan perbezaan yang sama telah dikenalpasti antara empat lengkung insang pada dua insang ikan yang diperiksa ($P < 0.05$). *Dactylogyrus macrolepidoti* memilih tapak C (Distal-dorsal) pada lengkung insang ketiga diikuti dengan tapak D (Proksimal-dorsal). *Dactylogyrus quadribrachiatatus* sebaliknya memilih tapak B (Dorsal-median) pada lengkung insang ketiga daripada mana-mana tapak yang lain diikuti dengan tapak E iaitu lengkung insang sama. *Cornudiscoides malayensis* menunjukkan keutamaan signifikan ($P < 0.05$) tapak E (Proksimal-median) lengkung insang ketiga pada kedua-dua belah insang ikan manakala *C. Sundanensis* memilih tapak C (Distal-dorsal) lengkung insang ketiga.

Kajian ini telah menunjukkan pendekatan gabungan taksiran fiziko-kimia dan biologi pada air tasik dari semua lokasi . Kajian seperti ini relevan kepada ekologi, menunjukkan potensi parasit dan kesan toksikologi bahan pencemar alam sekitar ke atas ikan. Kesimpulan ada korelasi positif antara prevalen monogenea dengan parameter kualiti air di semua lokasi. Turun naik ketara kepelbagaian bermusim dalam semua kes-kes masyarakat monogean telah membawa kepada kesimpulan bahawa trematod monogenetic mempunyai hubungan yang signifikan dengan parameter alam sekitar akuatik.