



Ecological, Biological and Physiological studies on some fish species from Suez Canal and nearby areas

A THESIS Submitted for the Award of the Ph. D. in Zoology

BY

Amal Omar Baleg

M. Sc. In Biology Zawia University, Libya (2008)

Under the Supervision of

Prof. Abd El-Halim A. Saad

Professor of Aquatic Ecology
Zoology Department,
Faculty of Science
Ain Shams University

Prof. Waheed M. Emam

Professor of Aquatic Ecology
Zoology Department,
Faculty of Science
Ain Shams University

Prof. Khalid M. El-Moselhy

Prof. of Marine Pollution,
National Institute of
Oceanography & Fisheries

Dr. EmadHamdy Abu El-Naga

Associate. Prof. of Biochemistry,
National Institute of
Oceanography & Fisheries

**Zoology Department
Faculty of Science
Ain Shams University
2016**

Supervisors:

Prof. Abd El-Halim A. Saad

Professor of Aquatic Ecology, Zoology Department, Faculty of Science, Ain Shams University.

Prof. Waheed M. Emam

Professor of Aquatic Ecology, Zoology Department, Faculty of Science, Ain Shams University.

Prof. Khalid M. El-Moselhy

Prof. of Marine Pollution, National Institute of Oceanography & Fisheries.

Dr. Emad H. Abu El-Naga

Associate Prof. of Biochemistry, National Institute of Oceanography & Fisheries.

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

قالوا سبحانك لا
علم لنا إلا ما
علمتنا إنك أنت
العليم الحكيم

صدق الله العظيم
سورة البقرة 32

10 My Husband and Family

ACKNOWLEDGEMENT

I wish first to thank ALLAH the most merciful for the power and patience his almighty gave me to accomplish this thesis.

I wish to express my deep gratitude and sincere thanks to, Prof. Dr. Abd El-Halim A. Saad, Prof. of Aquatic Ecology, Zoology Department, Faculty of Science, Ain Shams University, who provided invaluable insight and guidance through supervision of this study. I am also grateful to Prof. Dr. Waheed M. Imam, Prof. of Aquatic Ecology, Zoology Department, Faculty of Science, Ain Shams University for supervising and reading of the manuscript.

I'm especially indebted to Prof. Dr. Khalid M. El-Moselhy, Prof. of Marine Pollution, National Institute of Oceanography and Fisheries for supervising and providing all kinds of help for this study. I'm thankful to Dr. Emad H. Abu El-Naga, Associate Prof. of Biochemistry, National Institute of Oceanography and Fisheries, for helping and facilities he offered continues supervision during the laboratory work and for his assistance in the statistical analysis, graphs and curve of work.

Special words to thanks and gratefulness to Dr. Lamiaa I. Mohamedein, lecturer of Marine Pollution, National Institute of Oceanography and Fisheries, for her effort in samples collection and metals analysis.

My greeting is due to my kind family and to my Husband for his very kind help and support during preparation of this thesis.

ABSTRACT

Suez Canal considered as the vital link between Red and Mediterranean seas with different environment. The canal was divided into three sectors (Port Said, Ismailia and Suez) including 12 sites, collected during period of collection (spring, 2013- winter, 2014). This study was concerned to physicochemical parameters, heavy metals, toxicity of lead and copper with physiological effects in addition to biological characters of a selected fish species.

Water temperature in the study area recorded its highest and lowest values in summer and winter. Highest seasonal salinity was recorded in winter. Autumn attained the highest dissolved oxygen and biochemical oxygen demand. Nutrient salts (ammonia, nitrite and nitrate) recorded their highest seasonal values during summer, while phosphate highest level was recorded in spring.

Heavy metals (lead, cadmium, copper, zinc and iron) were investigated in water, sediments and fish organs (muscles, liver and gills). Cadmium recorded the lowest values of all studied metals in water, sediments and fish organs, while iron was the highest one.

96-h LC₅₀ values of lead and copper in fish *Liza carinata* were 2.818 and 0.447 mg/l, respectively. At exposure of fish to 20% 96-h LC₅₀ of Pb and Cu, transaminases and alkaline phosphatase were increased in their activity at first 24 h then decline under control level with increasing the time of exposure. Protein level fluctuated around the control level in muscles and liver in addition to the total lipid in muscles.

Fish *Liza carinata* had mean total length and weight of 14.80±2.20 cm and 37.53±16.38 gm, respectively and with sex ratio (males: females) of 1.00:1.64. The highest gonado-somatic index of female was recorded in autumn and winter for males. The higher frequencies percent of females and males were observed at length intervals of 15.0-15.9 and 14.0-14.9 cm, respectively. The length weight relationship was followed the equation $W=aL^b$.

Key words: Suez Canal, physico-chemical parameters, heavy metals, water, sediments, fish organs, toxicity, enzymes, lipids, protein, biological aspects.

CONTENTS

| | Pages |
|--|-------|
| List of figures..... | I |
| List of tables | V |
| Introduction | 1 |
| Aim of the study | 5 |
| Literature review | 6 |
| 1. Physical and chemical parameters | 7 |
| 2. Heavy metals | 9 |
| 3. Toxicity and biochemical effects | 20 |
| 4. Biological studies of fish <i>Liza carinata</i> | 25 |
| Materials and methods | 28 |
| 1. Study area | 28 |
| 2. Samples collection and storage | 31 |
| 2.1 Water | 31 |
| 2.2- Sediments | 31 |
| 2.3- Fish | 31 |
| 3. Parameters under investigation | 32 |
| 4. Procedures | 32 |
| 4.1. Physical parameters..... | 32 |
| 4.2. Chemical parameters..... | 32 |
| 4.3. Nutrients salts..... | 34 |
| 4.4. Heavy metals..... | 35 |
| 5. Toxicity and biochemical parameters..... | 37 |
| 5.1.Toxicity..... | 37 |
| 5.2. Biochemical parameters..... | 38 |
| 6. Biological aspects of <i>Liza carinata</i> | 40 |
| 7. Data analysis | 41 |
| Results | 42 |
| 1. Physico-chemical parameters | 42 |
| 2. Nutrient salts..... | 53 |
| 3. Heavy metals | 63 |
| 3.1. Heavy metals in water..... | 63 |

| | |
|--|-----|
| 3.2. Heavy metals in sediments..... | 76 |
| 3.3 Heavy metals in fish..... | 79 |
| Correlation matrix between different parameters in Suez Canal water | 88 |
| Analysis of variance | 89 |
| 4. Toxicity of lead and copper on <i>Liza carinata</i> | 90 |
| 5. Biochemical effects of lead and copper on <i>Liza carinata</i> | 92 |
| 6. Biological aspects of fish <i>Liza carinata</i> | 98 |
| Discussion | 103 |
| Physico-chemical parameters | 103 |
| Nutrient salts..... | 108 |
| Heavy metals | 111 |
| Toxicity of lead (Pb) and Copper (Cu) in <i>Liza carinata</i> | 119 |
| Biochemical indices of lead and copper on <i>Liza carinata</i> | 122 |
| Activity of liver enzymes, aspartate (AST) and alanine transaminases (ALT) and alkaline phosphatase (ALP) | 122 |
| Total protein and total lipids..... | 123 |
| Biological aspects of fish <i>Liza carinata</i> | 127 |
| Summary and conclusion | 129 |
| Recommendation | 137 |
| References | 138 |
| Arabic summary | |



دراسات بيئية وبيولوجية وفسولوجية على بعض الانواع من الاسماك من قناة السويس والمناطق القريبة

رسالة مقدمة للحصول على درجة فلسفة الدكتوراه في
علم الحيوان (بيئة مائية وفسولوجيا)
من

آمال عمر بلق

ماجستير في الاحياء جامعة الزاوية، ليبيا ٢٠٠٨

تحت إشراف

| | |
|---------------------------------------|---------------------------------------|
| الأستاذ الدكتور / عبد الحليم سعد عبده | الأستاذ الدكتور / وحيد محمود إمام |
| أستاذ البيئة المائية، قسم علم الحيوان | أستاذ البيئة المائية، قسم علم الحيوان |
| كلية العلوم، جامعة عين شمس | كلية العلوم، جامعة عين شمس |
| الأستاذ الدكتور / خالد محمد المصيلحي | الدكتور / عماد حمدي أبو النجا |
| أستاذ التلوث البحري | أستاذ مساعد الكيمياء الحيوية |
| المعهد القومي لعلوم البحار والمصايد | المعهد القومي لعلوم البحار و المصايد |

قسم علم الحيوان

كلية العلوم - جامعة عين شمس

٢٠١٦

المشرفون:

الأستاذ الدكتور/ عبد الحليم عبده سعد

أستاذ البيئة المائية، قسم علم الحيوان، كلية العلوم، جامعة عين شمس

الأستاذ الدكتور/ وحيد محمود إمام

أستاذ البيئة المائية، قسم علم الحيوان، كلية العلوم، جامعة عين شمس

الأستاذ الدكتور/ خالد محمد المصيلحي

أستاذ التلوث البحري، المعهد القومي لعلوم البحار والمصايد

الدكتور/ عماد حمدي أبو النجا

أستاذ مساعد الكيمياء الحيوية، المعهد القومي لعلوم البحار والمصايد/ فرع السويس

المستخلص

تمت الدراسة على قناة السويس من بورسعيد شمالا حتى السويس جنوبا و قسمت إلى ثلاث قطاعات (بورسعيد والإسماعيلية والسويس) متضمنة ١٢ محطة. وسجلت درجة حرارة الماء أعلى معدل لها في فصل الصيف وأقل معدل لها في فصل الشتاء. بينما سجل الشتاء أعلى معدل للملوحة. تم رصد أعلى قيم للأكسجين الذائب والأكسجين الحيوى الممتص في فصل الخريف. وبالنسبة للأملاح المغذية كان أعلى معدل للأمونيا والنيتريت والنترات في فصل الصيف أما الفوسفات فكانت أعلى في فصل الربيع.

تم قياس العناصر الثقيلة (الرصاص والكاديوم والنحاس والزنك والحديد) في عينات الماء والرواسب وبعض أعضاء الأسماك من منطقة الدراسة، حيث سجل عنصر الكاديوم أقل القيم مقارنة بالعناصر الأخرى بينما سجل الحديد أعلى القيم في كل من الماء والرواسب والأسماك. وأظهرت نتائج سمية عنصرى الرصاص والنحاس أن الأخير أكثر سمية، وبدراسة تأثير هذين العنصرين على نشاط بعض الإنزيمات الكبدية فقد ارتفع نشاطها في الأربع والعشرون ساعة الأولى ثم هبط نشاطها إلى أقل من معدل المرجع بمرور زمن التعرض للملوث. بالإضافة الى دراسة النواحي البيولوجية لأحد أسماك المنطقة وهى سمكة السهلية.

الكلمات الدالة:

قناة السويس، الخصائص الفيزيائية والكيميائية، العناصر الثقيلة، السمية، التأثير الفسيولوجي وبعض الخصائص البيولوجية لسمكة السهلية.

List of abbreviations

| | |
|------------------|-------------------------------------|
| AAS | Atomic absorption spectrophotometer |
| ACP | Acid phosphatase |
| ALP | Alkaline phosphatase |
| ALT | Alanine transaminase |
| APDC | Ammonium pyrolidine dithiocarbamate |
| AST | Aspartate transaminases |
| BOD | Biochemical oxygen demand |
| Cd | Cadmium |
| CF | Concentration factor |
| Co | Cobalt |
| Cr | Chromium |
| Cu | Copper |
| DO | Dissolved oxygen |
| Fe | Iron |
| GIS | Geographical information system |
| GSI | Gonado-somatic index |
| GuW | Gutted weight |
| GW | Gonad weight |
| Hg | Mercury |
| HIS | Hepato-somatic index |
| LC | Lethal concentration |
| LC ₅₀ | Median lethal concentration |
| LLR | Length-length relationship |
| LW | Liver weight |

| | |
|------|---|
| LWR | Weight-length relationships |
| MIBK | Methyl isobutyl Ketone |
| Mn | Manganese |
| MPC | Maximum Permissible Concentration |
| ND | Not detected |
| NED | Ethylene diamine dihydrochloride solution |
| Ni | Nickel |
| OOM | Oxidizable organic matter |
| Pb | Lead |
| pH | Hydrogen ion concentration |
| SCA | Suez Canal Authority |
| SD | Standard deviation |
| TW | Total weight |
| WLR | Weight-length relationship |
| Zn | Zinc |

LIST OF FIGURES

| No. | Title of figures | Page |
|--------|--|------|
| Fig. 1 | Suez Canal map showing sampling stations and sectors.. | 30 |
| Fig.2 | Seasonal variation of water temperature (°C) at different sectors (Port Said, Ismailia and Suez) during 2013-2014 in Suez Canal. | 49 |
| Fig. 3 | Seasonal variation of water pH at different sectors (Port Said, Ismailia and Suez) during 2013-2014 in Suez Canal. | 49 |
| Fig. 4 | Seasonal variation of water salinity ‰ at different sectors (Port Said, Ismailia and Suez) during 2013-2014 in Suez Canal. | 50 |
| Fig. 5 | Seasonal variation of water DO (mg O ₂ /l) at different sectors (Port Said, Ismailia and Suez) during 2013-2014 in Suez Canal. | 50 |
| Fig. 6 | Seasonal variation of water BOD (mg O ₂ /l) at different sectors (Port Said, Ismailia and Suez) during 2013-2014 in Suez Canal. | 51 |
| Fig. 7 | Annual mean of temperature (A), pH (B), salinity (C), DO (D) and BOD (E) in water at different stations along Suez Canal during 2013-2014. | 52 |
| Fig. 8 | Seasonal variation of water ammonia (µg at.NH ₄ -N/l) at different sectors (Port Said, Ismailia and Suez) during 2013-2014 in Suez Canal. | 60 |
| Fig. 9 | Seasonal variation of water nitrite (µg at.-N/l) at different sectors (Port Said, Ismailia and Suez) during 2013-2014 in | 60 |

| | | |
|---------|---|----|
| | Suez Canal. | |
| Fig. 10 | Seasonal variation of water nitrate ($\mu\text{g at.-N/l}$) at different sectors (Port said, Ismailia and Suez) during 2013-2014 in Suez Canal. | 61 |
| Fig. 11 | Seasonal variation of water phosphate ($\mu\text{g at.-N/l}$) at different sectors (Port Said, Ismailia and Suez) during 2013-2014 in Suez Canal. | 61 |
| Fig. 12 | Annual mean of ammonia (A), nitrite (B), nitrate (C) and phosphate (D) in water at different stations along Suez Canal during 2013-2014. | 62 |
| Fig. 13 | Seasonal variation of lead ($\mu\text{g/l}$) in water at different sectors (Port Said, Ismailia and Suez) Suez Canal during 2013-2014. | 72 |
| Fig. 14 | Seasonal variation of cadmium ($\mu\text{g /l}$) in water at different sectors (Port Said, Ismailia and Suez) Suez Canal during 2013-2014. | 72 |
| Fig. 15 | Seasonal variation of copper ($\mu\text{g/l}$) in water at different sectors (Port Said, Ismailia and Suez) Suez Canal during 2013-2014. | 73 |
| Fig. 16 | Seasonal variation of zinc ($\mu\text{g/l}$) in water at different sectors (Port Said, Ismailia and Suez) Suez Canal during 2013-2014. | 73 |
| Fig. 17 | Seasonal variation of iron ($\mu\text{g/l}$) in water at different sectors (Port Said, Ismailia and Suez) Suez Canal during 2013-2014. | 74 |
| Fig. 18 | Annual mean values of lead (A), cadmium (B), copper (C), zinc (D) and | 75 |