



Certificate

this certificate is granted to

Dr. Endang Dewi Masithah, Ir., MP.

AS A ORAL PRESENTER

Surabaya, 26 September 2019

Dean

Faculty of Fisheries and Marine
Universitas Airlangga



Prof. Dr. Mimi Lamid, drh., M.P.
NIP. 196201161992032001

Chief Committee



Dr. A. Shofy Mubarak, S.Pi., M.Si
NIP. 197311012001121002

ISSN: 1755-1315

IOP Conference Series:
Earth and Environmental Science

The open Access Journal for Conference Proceedings
iopscience.org/jpcs

Table of contents

Volume 441

2020

◀ Previous issue Next issue ▶

2nd International Conference on Fisheries and Marine Science 26 September 2019, Surabaya, Indonesia

Accepted papers received: 16 January 2020

Published online: 24 February 2020

Open all abstracts

Preface

OPEN ACCESS 011001

Preface

+ Open abstract  View article  PDF

OPEN ACCESS 011002

Peer review statement

+ Open abstract  View article  PDF

Papers

Earth and Environmental Science

OPEN ACCESS 012001

The grow-out of abalone (*Haliotis squamata*) at different shelter shape on growth and survival and its marine environmental influences at Lembongan Bay coastal waters

I Ardi, E Setiadi, Rasidi and W S Pranowo

+ Open abstract  View article  PDF

OPEN ACCESS 012002

Stocking density of Rotifera, *Hexarthra mira* on water quality and production

I Ardi, S Cahyaningsih and E Setiadi

+ Open abstract  View article  PDF

OPEN ACCESS 012003

The effect addition of kappa carrageenan flour to the level of gel strength and acceptability of dumpling from threadfin bream fish (*Nemipterus nematophorus*) surimi

D M Astutik, L Sulmartiwi, E Saputra and D Y Pujiastuti

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012004

Maximizing production of a male offspring in *Moina macrocopa* culture through manipulation of rice bran suspension concentration

A S Mubarak, D Jusadi, M Zairin Jr and M A Suprayudi

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012005

The Concept of the Right to Management of Coastal Communities in the Regional Autonomy Era: Experience from Community Assistance to Obtain the Right to Manage Sea Cucumbers in Sunsak Bay, East Lombok.

A Wahyono and M Illiyani

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012006

Selective breeding technique: Pandu and Kunti tilapia (*Oreochromis niloticus*) broodstock candidates at PBIAT Janti, Klaten-Central Java

S H Samara, A W Fathurrozi and Sutarno

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012007

Potential of *Caulerpa racemosa* extracts as sunscreen creams

E B Ersalina, A A Abdillah and L Sulmartiwi

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012008

Histopathology of the gill of Vaname Shrimp (*Litopenaeus vannamei*) infested by protozoan ectoparasite

S R Pribadi, P D W Sari and S Subekti

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012009

The effect of iron powder as oxygen absorber active packaging on fish oil total oxidation value

E N Hidayah, RR J Triastuti and A A Abdillah

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012010

The occurrence of endoparasite helminth on Threadfin Bream (*Nemipterus japonicus*) from the fish auction place Mayangan, Probolinggo, East Java

D S Octatriana, P D W Sari and G Mahasri

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012011

Comparative study of marine fish freshness based on the handling method in Puncak Permai modern market and Simo Gunung traditional market, Surabaya

M Sari, J Triastuti, H Pramono and Sudarno

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012012

Determination of minimum inhibitory and minimum bactericidal concentration of ketapang (*Terminatia catappa*) leaves extract against *Vibrio harveyi*

A Kharisma, W Tjahjaningsih and Setiawati Sigit

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012013

The larasati tilapia (*Oreochromis niloticus*) fingerling rearing activity in PBIATJanti, Klaten, Central Java: its performance through survival rate

RV Prasetya, Sutarno and M B Santanumurti

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012014

Use of hydrogen peroxide to improve potential redox land preparation of land towards increasing production of traditional shrimp vanname (*Litopenaeus vanname*) in Wringin Putih, Muncar, Banyuwangi

D D Nindarwi, L A Sari, P D Wulansari, S H Samara and M B Santanumurti

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012015

The effect of feed larvae *Chironomus* sp. and high pellet protein to seedling goldfish (*Carassius auratus*)

K H Dwiardani, L A Sari, P. D. W. Sari, D. D. Nindarwi and S. Arsad

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012016

The maggot flour substitution potency (*Hermetia illucens*) in artificial feed formulation on growth and survival rates of African catfish (*Clarias gariepinus*)

M S Islam, Agustono and M Lamid

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012017

Influence addition of noni (*Morinda citrifolia*) in the commercial feed on protein and lipid retentions of sangkuriang catfish (*Clarias sp.*).

F Azizah, M Arief and W P Lokapirnasari

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012018

The growth, protein content, and fatty acid of catfish meat (*pangasius sp.*) With the addition of different lysine doses in commercial feed

E Aristasari, R A Nur 'Aini, W Nopita, Agustono, M Lamid and M A Al-Arif

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012019

Evaluation of hatching rate, growth performance, and survival rate of cantang grouper (*Epinephelus fuscoguttatus* × *lanceolatus*) in concrete pond at Situbondo, East Java, Indonesia

N S Anita and N N Dewi

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012020

The effect of temperature, salinity and antimicrobial agent on growth and viability of *Aeromonas hydrophila*

M F Ulkhaq, D S Budi and N N Rahayu

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012021

Utilization of agar *Gracilaria sp.* as a natural thickener on liquid bath soap formulation

L R Dita, Sudarno and J Triastuti

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012022

Correlation Between Glucose Level And Protozoan Ectoparasite Infestation Level Of Humpback Grouper (*Cromileptes altivelis*) Nursery In UPBL Situbondo, East Java

G Mahasri, I N D Yodharta, D Novalisa and A T Mukti

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012023

Study of heavy metal content cadmium (Cd) in various sizes of blood shells (*Anadargranosa*) in coastal Bancaran Bangkalan, Madura

E S Ulfah, B S Rahardja and K T Pursetyo

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012024

Identification and prevalence of ectoparasites on the fry of Asian sea bass (*Lates calcalifer*), white shrimp (*Litopenaeus vannamei*), and blue swimming crab (*Portunus pelagicus*)

Budianto, H Suprastyani, Q A'yunin and Z Nadlifah

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012025

Effect of dense stocking of *Gracilaria sp* on growth and survival of milkfish (*Chanos chanos forskal*) on polyculture culture systems

W Isroni, A S Bahri and A A Amin

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012026

The effect of *Dunaliella salina* extract on NFkB expression in Cantang Grouper (*Epinephelus fuscoguttatus x E. lanceolatus*) exposed by *Viral Nervous Necrosis*

Rani Yuwanita, A Yuniarti, SSP Rahardjo, Q Ayu'nin and AM Madyaratri

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012027

The Effectiveness of Vaccines in Gurame (*Osphronemus goramy*) and Challenged *Aeromonas hydrophila*

S U Setyaningsih, R Kusdarwati, Rozi and D Handijatno

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012028

Utilization of By Product *Kappaphycus alvarezii* as Earthquake Resistant Material Lightweight Concrete

A A Musthofa, M Z A Bahtiar, F M Ibrahim and A A Abdillah

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012029

The effect of density as *Skeletonema costatum* bioremediation agent of copper (Cu) heavy metal concentration

N A Pratama, B S Rahardja and L A Sari

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012030

Effectiveness of Heat Shock (40°C) With Different Duration for Tetraploid Formed in Mutiara Catfish (*Clarias sp.*) Juvenile

S Nuswantoro, MS Widodo, F Fariedah and E Artarini

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012031

Histopathological analysis of *Pangasius* sp. infected by *Edwardsiella tarda* causes Edwardsiellosis disease

Q A'yunin, Budianto, S Andayani and R Yuwanita

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012032

The use of bromelain enzyme on artificial hatching media as an effort to hatch Nile tilapia (*Oreochromis niloticus*) eggs outside the mother's mouth

F Fariedah, M S Widodo, S Nuswantoro and Sholikhin

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012033

Effects of different feed doses of Majapahit leaves (*Crescentia cujete* L.) on the growth of Nile tilapia (*Oreochromis niloticus*)

S Rahmaningsih, Jumiati and S Awwaliyah

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012034

Vaname shrimp (*Litopenaeus vannamei*) post-harvest marketing analysis in traditional pond systems at Turi District, Lamongan, East Java, Indonesia

M S A Ningsih, Prayogo and A M Sahidu

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012035

Effect of probiotic duration and dose of coffee peel fermentation (*Coffea* sp.) on crude protein and crude fiber as an alternative fish feed ingredient

N Fatmawati, Agustono and M Lamid

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012036

The effect of depuration on lead levels of the cockles *Anadara* sp. by using activated carbon as a filter

A R Firdaus, A S Mubarak and W Tjahjaningsih

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012037

Growth performance and survival rate of Boeseman's rainbowfish (*Melanotaenia boesemani*) in natural spawning technique at Depok, West Java, Indonesia

W M Akhsan, B Nur and N N Dewi

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012038

Masculinization of guppies (*Poecilia reticulata*) using water of coconut hybrid variety with the immersion method of pregnant female

G Meiliana, L Sulmartiwi and L Lutfiyah

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012039

The effect of commercial nutrients to increase the population of *Skeletonema costatum* on laboratory and mass scales

K A Azmi, S Arsad and L A Sari

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012040

Cultivation technique of *Chanos chanos* modular system and semi intensive at the center for brackish water aquaculture (BBPBAP) Jepara, Central of Java

M Nisa and K Kismiyati

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012041

Effect of *Spirulina platensis* supplementation in the diet to sperm performance of silver rasbora (*Rasbora argyrotaenia*)

M W D Putri, Prayogo and D S Budi

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012042

The variances of hematology of gurami (*Osphronemus gouramy*) which is vaccinated and challenged by *Aeromonas hydrophila*

D Alfaniah, R Kusdarwati, Rozi and D Handijatno

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012043

Antibacterial activity test of mahkota dewa leaf extract (*Phaleri amacrocarpa*) against bacteria *Aeromonas hydrophilla* by in vitro

R A Sarendah, Sudarno and R Kusdarwati

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012044

The effect of kersen (*Muntingia calabura* L) leaf extract on bacteria *Aeromonas salmonicida smithia* in vitro

N Kartika, Sudarno and D Handijatno

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012045

Growth and survival rate of silver barb, *Rasbora argyrotaenia* under different concentrations of sardinelle fish oil addition in fish feed

S A Dewi, A S Mubarak and A T Mukti

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012046

Substitution of fermented soybean juice dregs on catfish (*Pangasius pangasius*) feed formulation toward specific growth rate, efficiency of feed, feed conversion ratio, digestibility of crude protein, and energy

Z N Arifiina, A P Anjarwati, M Lamid and Agustono

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012047

Addition of lemuru fish oil in feed on the gonadal maturity level of female silver barb, *Rasbora argyrotaenia*

L Agustin, L Sulmartiwi and A S Mubarak

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012048

The use of mangrove leaves flour *Avicenia rumphiana* as antioxidant feed additive in commercial feed towards growth and survival rate of Nile tilapia fry *Oreochromis niloticus*

D Wulansari, L Sulmartiwi and M A Alamsjah

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012049

The effect of combination *Bifidobacterium sp* and *Lactobacillus acidophilus* probiotic on egg yolk cholesterol, HDL, and LDL

W P Lokapirnasari, A M Sahidu, L Maslachah, A B Yulianto and R Najwan

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012050

The effect of using different polar solvents on the stability of thermal extraction phycocyanin from *Spirulina platensis*

D Irawati, A A Abdillah, H Pramono and L Sulmartiwi

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012051

Substitution of fermented maggot (*Hermetia illucens*) flour on commercial feed towards protein retention and energy retention in tambaqui (*Colossoma macropomum*) meat

N Wantika, Budiana, E Suryani, L Rubi'ah, N Dzatalini, Rusdiatin, Y T Nila, M B Santanumurti, S H Samara,

D D Nindarwi *et al*

[+](#) Open abstract [View article](#) [PDF](#)

-
- OPEN ACCESS** 012052
Nile tilapia (*Oreochromis niloticus*) fish hatchery technique: the survival rate evaluation in IBAT Pandaan, Pasuruan, East Java
T A Putri, S Maya and M B Santanumurti
[+](#) Open abstract [View article](#) [PDF](#)
-
- OPEN ACCESS** 012053
Observed snapshot condition of waters during El Niño Southern oscillation (ENSO) 2015-2017 events in the Maluku Channel
A Bayhaqi, D Surinati and H B Prayitno
[+](#) Open abstract [View article](#) [PDF](#)
-
- OPEN ACCESS** 012054
The effect of concrete tanks for the breeding technique of the sand sea cucumber (*Holothuria scabra*)
D A N Sitoresmi and K T Pursetyo
[+](#) Open abstract [View article](#) [PDF](#)
-
- OPEN ACCESS** 012055
Morphometric asymmetry of *Barbodes binotatus* (cyprinidae) collected from three different rivers in Java
S S Astuti, A M Hariati, W E Kusuma and D G R Wiadnya
[+](#) Open abstract [View article](#) [PDF](#)
-
- OPEN ACCESS** 012056
Chlorophyll and carotenoids analysis spectrophotometer using method on microalgae
M Rinawati, L A Sari and K T Pursetyo
[+](#) Open abstract [View article](#) [PDF](#)
-
- OPEN ACCESS** 012057
The effect of catfish and chicken cultivation waste to *Daphnia* sp. culture
N H Holy and L A Sari
[+](#) Open abstract [View article](#) [PDF](#)
-
- OPEN ACCESS** 012058
Neobenedenia girellae infestation on cobia (*Rachycentron canadum*) in Hurun Bay Lampung, Indonesia
R D B Putri, A R Rivaie, S Subekti and P D W Sari
[+](#) Open abstract [View article](#) [PDF](#)
-
- OPEN ACCESS** 012059

Ecotourism development through legality of mangrove processed products dan river tracing in Cemara Beach, Banyuwangi, East Java, Indonesia

E W Setyaningrum, Z Erwanto, K P Prapti, A L Jayanti, A T K Dewi and H D Susanti

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012060

The effect of various concentration of quail egg yolk on spermatozoa motility of kancra fish (*Tor soro Valenciennes*, 1842) post cryopreservation

M Laeni, Abinawanto, J Subagja and A H Kristanto

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012061

The fertilization of *Tor soro* fish (*Valenciennes*, 1842) using post cryopreservation sperm: the effect of skim milk as a cryoprotectant

E R Harjanti, Abinawanto, O Z Arifin and A H Kristanto

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012062

Honey effect on sperm motility of kancra fish (*Tor soro Valenciennes*, 1842) after 48 hours freezing

B S D Putri, Abinawanto, O Z Arifin and A H Kristanto

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012063

The spermatozoa viability of kancra fish (*Tor soro Valenciennes* 1842) 48-hour after freezing: effect of brown sugar as natural cryoprotectant

M A B Pamungkas, Abinawanto, O Z Arifin and A H Kristanto

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012064

Feed additive of curcuma flour (*Curcuma xanthorrhiza*) in commercial feed to growth rate and feed efficiency of tambaqui (*Colossoma macropomum*)

I Oktavianti, Agustono and M Lamid

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012065

The spermatozoa motility of kancra fish (*Tor soro Valenciennes*, 1842) after the frozen process: the application of egg yolk as a cryoprotectant

N Vardini, Abinawanto, J Subagja and A H Kristanto

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012066

Sperm motility of kancra fish (*Tor soro*, Valenciennes 1842) after frozen: the effect of soybean milk as a natural cryoprotectant

R Fatriani, Abinawanto, O Z Arifin and A H Kristanto

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012067

Effect of date palm (*Phoenix dactylifera* L.) on spermatozoa viability of kancra fish (*Tor soro* Valenciennes 1842) 48 hours post cryopreservation

D P Alifiani, Abinawanto, J Subagja and A H Kristanto

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012068

Effect of *Bacillus* spp. and *Nitrosomonas* sp. in commercial feed as a probiotic agent to increase growth performance and feed efficiency of sangkuriang satfish (*Clarias gariepinus*)

A A Yaqin, Sudarno and Rozi

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012069

The effect of giving commercial feed, beloso trash fish (*Saurida tumbil*), kurisi trash fish (*Nemipterus nematophorus*), and mixed trash fish on growth of cantang grouper (*Epinephelus fuscoguttatus-lanceolatus*) in floating net cage

M A Nugraha and Rozi

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012070

The Percentage of embryo viability after 48h sperm cryopreservation: effect of various natural cryoprotectant

S Lestari, Abinawanto, A Bowolaksono, R Gustiano and A H Kristanto

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012071

Degree of nematode endoparasite infection in asian swamp eel (*Monopterus albus*) from Banyuwangi regency

D I Bakti, G Mahasri, M F Ulkhaq, Kismiyati, D S Budi and Suciyono

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012072

Effect of different bacterial strain in probiotics on the growth performance of Nile Tilapia (*Oreochromis niloticus*)

T D Sholihuddin, M Arief and H Kenconojeti

[+](#) Open abstract [View article](#) [PDF](#)

-
- OPEN ACCESS** 012073
Infection analysis of *Rhadinorhynchus bicircumspinis* in barramundi (*Lates calcarifer*) from pond and floating net cage in Situbondo waters.
D N Putri, S Subekti, M F Ulkhaq, R Kusdarwati, D S Budi and H Kenconoati
[+](#) Open abstract [View article](#) [PDF](#)
-
- OPEN ACCESS** 012074
Population growth and fishery status of the *Lorjuk* shellfish (*Solen* sp.) on Pamekasan beaches, Indonesia
N Trisyani and Kamarudin
[+](#) Open abstract [View article](#) [PDF](#)
-
- OPEN ACCESS** 012075
Prevalence and intensity of protozoan ectoparasite infestation on nursery of humpback grouper (*Cromileptes altivelis*) in hatchery and floating net cage
G Mahasri, S Subekti, B B Angghara and F P Pratama
[+](#) Open abstract [View article](#) [PDF](#)
-
- OPEN ACCESS** 012076
Morphology, morphometrics, and some qualitative parameters of silver rasbora (*Rasbora argyrotaenia*) sperm
L A Adawiyah, L Sulmartiwi and D S Budi
[+](#) Open abstract [View article](#) [PDF](#)
-
- OPEN ACCESS** 012077
Inventory of ectoparasites in pacific white shrimp (*Litopenaeus vannamei*) that cultivated with high density
G D Pamenang, L Sulmartiwi, G Mahasri, N D Rahayu and B Angwarmas
[+](#) Open abstract [View article](#) [PDF](#)
-
- OPEN ACCESS** 012078
Growth of Cantang Hybrid Grouper Juvenile (*Epinephelus fuscoguttatus* x *Epinephelus lanceolatus*) With Different Feeding Frequency
D Nuraini, Agustono and L Lutfiyah
[+](#) Open abstract [View article](#) [PDF](#)
-
- OPEN ACCESS** 012079
The effect of fucoxanthin as coloring agent on the quality of Shrimp Paste
Z Zahrah, M N G Amin and M A Alamsjah
[+](#) Open abstract [View article](#) [PDF](#)
-
- OPEN ACCESS** 012080

The effect of fucoxanthin as coloring agent on the quality of catfish sausage

N W Aditya, M N G Amin and M A Alamsjah

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012081

The harmful effect of commercial powder detergent on water flea (*Daphnia* sp.)

H Kenconoajati, Suciyono and M H Azhar

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012082

Hematological parameters of Catfish (*Clarias* sp) vaccinated by *Aeromonas hydrophila* with different application methods

V N Nadiro, I Puspitasari, T A Setyastuti and A Santika

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012083

Detection potential fishing zones of Longtail tuna (*Thunnus tonggol*) using fisheries and remotely sensed data in the waters around Madura Island

A F Syah and M Sholeh

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012084

Evaluation of aqueous extract of robusta coffee (*Coffea canephora*) leaves for controlling *Argulus japonicus* infestation on common carp seed

N Afifah, Kismiyati and H Kenconoajati

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012085

The different effects of heat shock duration and initial period on hatching rate, abnormality rate, egg yolk absorption, and survival rate of spotted barb (*Puntius binotatus*) larvae

A T Mukti, M Ahmadi, Widjiati and E M Luqman

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012086

Addition different algae (*Spirulina*) flour to artificial feed on color quality and growth of Koi fish (*Cyprinus carpio-Koi*)

D A Sudirman, M Arief and A H Fasya

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012087

Tuna fisheries in fisheries management area Republic of Indonesia 572

N Suyasa, P Rahardjo, D R Putri and A Widagdo

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012088

Optimization of spermatozoa cryopreservation of Albino pangasius catfish: cryoprotectants with various concentrations and different equilibration times

U Hasanah, Abinawanto, A Alimuddin and A Boediono

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012089

The relation between quality of the sediment (nitrate, phosphate) and *Avicennia sp* density, case study; Mangrove Center Bengkak, Banyuwangi Regency, East Java

Suciyono, B S Rahardja, A I Prayoga, H Kenconoajati and M F Ulkhaq

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012090

The optimal n/p ratio of shrimp culture waste liquid fertilizer on growth of *Chlorella vulgaris*

P A Hidayati, A S Mubarak and Sudarno

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012091

Profile of Kerandang Fish (*Channa pleurophthalmus* Blkr) Proteins from Central Kalimantan

Aryani, E Suprayitno, B B Sasmito and Hardoko

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012092

Screening of antivibrio-producing lactic acid bacteria originated from aquatic animals as probiotic candidates

M Amin, M A Liliyanti, N H Nufus and M Ali

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012093

Length weight relationships and condition factor of sweet river prawn, *Macrobrachium esculentum* (Thalwitss, 1891) in the downstream Rongkong watershed

Jurniati, D Arfiati, A Maizar and A Kurniawan

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012094

Blood glucose and digestive tract endoparasite helminth infection of cantang grouper (*Epinephelus lanceolatus* x *Epheus fuscoguttatus*) from traditional ponds in the Kampung Kerapu of Lamongan East Java

B Angwarmas, L Sulmartiwi, G Mahasri, N D Rahayu and G D Pamenang

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012095

Inventory of ectoparasite helminth on the Hybrid Grouper (*Epinephelus fuscoguttatus x Epinephelus lanceolatus*) from traditional ponds in the Kampung Kerapu Lamongan East Java Indonesia

N D Rahayu, L Sulmartiwi, G Mahasri, Muntalim, B Angwarmas and G D Pamenang

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012096

Different Concentration of Rice Bran Suspension on Fecundity and Offspring Production of Each *Moina macrocopa* Broodstock

A Ullimaz, D D Nindarwi and A S Mubarak

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012097

The spatial pattern of turbidity and light transmission around the coastal waters of Cisadane in July and November 2014

M F Azis Ismail and H B Prayitno

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012098

Change of hepatopancreas conditions in intensive shrimp aquaculture (*Litopenaeus vannamei*) at Mayangan Village, Legon Kulon District West Java

D A Dana, T A Setyastuti, I Puspitasari and D Sukanto

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012099

Biology, Ecology and Aquaculture potential of *Osteochilus spilurus* (Bleeker 1851) in East Belitung, Indonesia

A Kurniawan, A M Hariati, A Kurniawan, Kartika, N Rizkika and D G R Wiadnya

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012100

The effect of seaweed (*Eucheuma cottonii*) age differences as a material on medium density fiberboard (MDF) manufacture

F H Arrosyad and M A Alamsjah

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012101

Biological activities of Indonesian mangroves obtained by subcritical water extraction

Ratih Pangestuti, Evi Amelia Siahaan, Febriana Untari and Byung Soo Chun

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012102

Viability of Tor fish spermatozoa (*Tor soro*, Valenciennes 1842) 48-hours cryopreservation: the effects of duck egg yolk as a natural cryoprotectant

P D Wulandari, Abinawanto, J Subagja and A H Kristanto

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012103

Antiproliferation effects of *Glycine max* Linn ethanolic extract on induced mammary gland carcinoma in albino rats

N M Triana, E Wilujeng, M W H Putri, D M P Yuda, A L Hardiono, M T E Purnama and F Fikri

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012104

Structure communities of macrozoobenthos in mangrove tourism area, Wongsorejo sub-district, Banyuwangi regency, East Java

D Fatmawati, B S Rahardja, Suciyono, L Lutfiah and M F Ulkhaq

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012105

Probiotic enriched *Daphnia* sp: the nutritional profile and enzymatic activities

E Riyani, A Yuniarti and A M Hariati

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012106

Effect of different carbon doses of tapioca (*Manihot esculenta*) flour on vegetative cells and spore production of *Bacillus megaterium*

I M D Mahariawan, N B Ariffin, W E Kusuma, A Yuniarti, M A G Beltran and A M Hariati

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012107

Enrichment of feed for growth of cantang grouper (*E. fuscoguttatus* x *E. lanceolatus*) in floating cages

D D Afifah, W H Satyantini, A T Mukti and Y Cahyoko

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012108

The efficacy of probiotic with different storage to decrease the total organic matter, ammonia, and total *Vibrio* on shrimp pond water

H S Farizky, W H Satyantini and D D Nindarwi

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS 012109

Analysis degradation of mangrove vegetation in Tangerang District, Banten Province

R Haryanti, A Fahrudin and H A Susanto

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS 012110

Determination spesies flying fishes (*exocoetidae*) in makassar strait

Indrayani, A B Sambah, A Kurniawan, A Pariakan, A Jufri and D G R Wiadnya

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS 012111

Potential stock of stony corals in Indonesia

T A Hadi, Giyanto, R M Siringoringo, A Budiyanto, O Johan, J Souhoka, M Abrar, N W P Sari, B Sadarun, B Prayudha *et al*

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS 012112

Social network analysis: Key actors of cooperation between *Sama Bajo* and land-dwellers in Wakatobi marine national park

T La Ola, N I Wianti, M Tadjuddah, Suriana, T Buana, Rosmawaty, S Abdullah and I A Wunawarsih

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS 012113

Niche ornamental-marine fishery of Bangsring and the surrounding areas

D G R Wiadnya, A M Hariati and W E Kusuma

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS 012114

The profile of *Carassius auratus* growth and hepatosomatic index in different salinity

L Ningsih, L Sulmartiwi and L Lutfiyah

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS 012115

Haematological parameters of Catfish (*Clarias* sp.) fed by immunostimulant added with Cr^{+3} - Yeast (*Saccaromices cerevisiae*) and Garlic

F Indriani, I Puspitasari, T A Setyastuti and A Santika

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS 012116

Addition of lemuru fish oil in the diet on the fat retention and fatty acid profile of silver barb (*Rasbora argyrotaenia*)

A Marini, A S Mubarak and A T Mukti

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012117

Addition of Lemuru Fish Oil to Protein Retention and Feed Utilization Efficiency of silver barb *Rasbora argyrotaenia*

R Ayunda, L Sulmartiwi and A S Mubarak

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012118

Study on mangrove canopy cover in Lembeh Island, North Sulawesi

A P Rumengan, C P Paruntu, D Paransa and S H Rumengan

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012119

The immune responses of *Oreochromis niloticus* under different form of *Bacillus* supplementation

A Yuniarti, N B Arifin, N Muawiyah, M Fakhri and A M Hariati

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012120

Response of kutuklin hemagglutinin protein adhesion in koi fish (*Cyprinus carpio*) infected by *Myxobolus* sp.

U Yanuhar, N S Junirahma, N R Caesar, M Musa and G Mahasri

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012121

Effect of different filter media use on aquaponics system on ammonium (NH₄⁺), nitrite (NO₂) and nitrate (NO₃) concentrations of catfish (*Clarias* sp.) aquaculture

T A Lukmantoro, Prayogo and B S Rahardja

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012122

Different addition of molasses on feed conversion ratio and water quality in catfish (*Clarias* sp.) rearing with biofloc-aquaponic system

H D Rahmatullah, Prayogo and B S Rahardja

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012123

The different effects of heat shock duration and embryo age on embryonic development and hatching lengths of spotted barb (*Puntius binotatus*) fish

I Rizal, A T Mukti, A S Mubarak, W H Satyantini and Widjiati

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012124

Preliminary study: the effect of cryopreservation on the gastrula-staged embryo of African catfish (*Clarias gariepinus*)

S H Eka, A T Mukti, W H Satyantini and A S Mubarak

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012125

Composition analysis of organic and inorganic waste and the impacts of coastal city in Palu-Central Sulawesi

J Y Walalangi, T D Lelono, A M Suryanto, A Damar, H Effendi and E Susilo

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012126

Growth rate and survivorship of *Acropora* sp. fragments that transplanted on the artificial substrate made from *fly ash* and *bottom ash*

R I Khasanah, E Y Herawati, A M Hariati, M Mahmudi, A Sartimbul, D G R Wiadnya, E Asrial, Yudatomo and E Nabil

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012128

Marine litter distribution in Ampana Beach Tojo Una-Una Regency Central Sulawesi Province

D Sulistiawati, K Mansyur, A E Putra, M Safir, A M Tahya and Z R Ya'la

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012129

Comparison of water quality and its influences on phytoplankton abundance based on water characteristics in coastal of Banyuwangi Regency, Jawa Timur, Indonesia

E W Setyaningrum, E D Masithah, M Yuniartik, M P Nugrahani and A T K Dewi

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012130

The differences of depth on the species composition of spiny lobster puerulus on south Pacitan Regency East Java

W A Saputra, K A Pambudi, A Setyanto and A Tumulyadi

[+](#) Open abstract [View article](#) [PDF](#)

-
- OPEN ACCESS** 012131
Different concentration influence of *Moringa oleifera* leaf aqueous extract immersion against *Argulus japonicus* egg damage
F Idris, Kismiyati and G Mahasri
[+ Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012132
The effect of using the initial weight of seedlings by the floating method on the percentage of daily growth of seaweed *eucheuma cottonii*.
W Isoni, A S Bahri and A A Amin
[+ Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012133
Nursery method of Jatimbulan Tilapia (*Oreochromis niloticus*) in Pasuruan, East Java
I Anggraeni and P D W Sari
[+ Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012134
The effect of distance of floating karamba on placement of phytoplankton abundance in coastal waters of Sathean Village, Langgur - Tual Regency
W Isoni, A S Bahri and A A Amin
[+ Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012135
Growth performances of Nile Tilapia, *Oreochromis niloticus*, reared in recirculating aquaculture and active suspension systems
M Amin, L Musdalifah and M Ali
[+ Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012136
Utility of almond leaf (*Terminalia cattapa*) for improving growth and color quality of neon tetra fish (*Paracheirodon innesi*)
I Ardi, M Zamroni and E Setiadi
[+ Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012137
Re-description of lobster fishery following ministerial decree of marine affair and fisheries 56/2016: case study in Pacitan, East Java
W Setyawati, A Setyanto and D G R Wiadnya
[+ Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012138

Screening of ammonia-degrading bacteria to reduce ammonia content in the manure of laying hens

M Ali, M Zubair, A Rosyidi and M Amin

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012139

Provision of bacteria from shrimp pond sediment towards N/P ratio, plankton abundance, and total bacteria in the culture media of white shrimp (*Litopenaeus vannamei*)

W H Satyantini, M Salsabila, D D Nindarwi, A M Sahidu and A T Mukti

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012140

Oxidative stress parameters in landrace pigs slaughtered by the stunning method

M T E Purnama, S F Prayoga, N M Triana, W K Dewi, B S Purnomoaji, D K Wardhana and F Fikri

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012141

Spawning potential ratio (SPR) of Sulphur Goatfish (*Upeneus sulphureus*): biological basis for demersal fishery management in Java Sea

M A Prayitno, H Setiawan, I Jatmiko, M A Rahman and D G R Wiadnya

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012142

Characterization of nano calcium powder from blood cockle (*Anadara* sp.) shell produced by using different hydrochloric acid concentration

G Y Pramudi, L Sulmartiwi, W Tjahjaningsih, E D Mashitah, Patmawati and M N G Amin

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012143

Relationship of long weight between milkfish (*Chanos chanos* forsskal) and sea cucumber (*Holothuria leucospilot*) that are multi-trophic sea farming

J A Surbakti, I A L Dewi, M A Alamsjah and M Lamid

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012144

The effect of addition of fish bone meal on the concentration of nitrogen (N), phosphorus (P), and potassium (K) in seaweed liquid organic fertilizer of *Gracilaria* sp.

P T Bhaskoro, W Tjahjaningsih and A S Mubarak

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012145

Activity test of anti-stress from extract of *Datura metel* seeds with ethanol solvent towards blood glucose levels and survival rate of *Osphronemus gouramy* seed in closed system

transportation

M M Mashuda, J Triastuti and K T Pursetyo

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012146

Identification and prevalence infection of helminth in the gastrointestinal tract swamp eel (*Synbranchus bengalensis*) which marketed in Surabaya, East Java

S Subekti, M R Kurniawan and S A Sudjarwo

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012147

Potential concentration of heavy metal copper (cu) and microalgae growth *Spirulina plantesis* in culture media

R M S Budi, B S Rahardja and E D Masithah

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012148

Isolation and identification of bacteria in gastrointestinal of eel (*Anguilla bicolor*) that has potential as probiotic

P Lestari, D Suprpto and G Mahasri

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012149

Effect of fucoidan concentration from *Sargassum* sp. on skin lotion antioxidant activities

R C D Putra, M A Alamsjah and L Sulmartiwi

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012150

Correlation between water quality and prevalence on Koi (*Cyprinus carpio*) which infested by *Argulus* in Mungkid Subdistrict and Muntilan Subdistrict, Magelang Regency, Central Java

R D Yunikasari, Kismiyati and G Mahasri

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012151

The effectiveness of activated carbon as adsorbent in the oil purification process fish by-product of the fish canning industry

A Nadia, S Subekti, A Manan and P Wahyudin

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012152

The effect of hydrochloric acid concentration and temperature demineralization on characteristics of chitin from penshell (*Atrina pectinata*)

I L Nugroho, E D Masithah and K T Pursetyo

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012153

Effect of Mengkudu's (*Morinda citrifolia*) distillation with differential fruit ripeness to control *Argulus* on *Carassius auratus auratus*.

I Asiseh, Kismiyati and G Mahasri

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012154

Effect of enzyme papain against natural flavor of raw meat waste laundering surimi

N A Harahap, W H Satyantini and Sudarno

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012155

Effect of eggs immersion in tannin solution against embryonic development of common carp fish (*Cyprinus carpio* L.)

N Fauziah, E D Masithah and L Sulmartiwi

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012156

The effect of giving fermented rice bran suspension on fecundity and production of *moina macrocopa* offspring per parent

K Y Damayanti, A S Mubarak and L A Sari

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012157

Concentration of fermented tilapia feces suspension by decomposer bacteria as a feed to induce *moina macrocopa* sexual reproduction

A F Zuhro, A S Mubarak and E D Masithah

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012158

Correlation between Osteoprotegerin Serum Levels and Arterial Stiffness Assessed by Cardio-ankle Vascular Index (CAVI) in Hypertensive Patients

A Ariendanie, J N E Putranto and I G N I R Ranuh

[+](#) Open abstract [View article](#) [PDF](#)

OPEN ACCESS

012159

The Correlation between Work Stress and Hypertension among Industrial Workers: A Cross-sectional Study

A D Rengganis, A B Rakhimullah and H Garna

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012160

Hypoxic Preconditioning Effect on the Expression of Intracellular Heat Shock Protein (HSP) 27, HSP 70 and HSP 90 on Cultured Adipocyte-Derived Mesenchymal Stem Cells (AMSCs)

A F Ghaznawie, I G R Suryawan, A Andrianto and A Romdiyana

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012161

Hypoxic Preconditioning Effects of Bone Marrow-derived Culture Mesenchymal Stem Cells on CD31+ Expression, Vascular Endothelial Growth Factors-a (VEGF-A) and Stromal-derived Sactors-1 Alpha (SDF-1 α)

A F Muzakkir, I G R Suryawan and T Yusrizal

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012162

Correlation between Wall Motion Score Index (WMSI) and Anatomical M-mode (AAM) Systolic Thickening with Functional Capacity in Heart Failure among Post-myocardial Infarction Patients

AF Rahimah, BS Pikir and O Imatsu

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012163

Effects of Garlic Extract (allicin) on Proliferation of Endothelial Progenitor Cells (EPC) in Patients with Stable Coronary Artery Disease

A Y Putri, B S Pikir, Y H Oktaviono and F Alzahra'

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012164

Antigen Candidates for Atherosclerosis Vaccine Development

D K S C Putri, M J Al-Farabi and I G R Suryawan

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012165

Immature Platelet Level in Stable Coronary Heart Disease (CHD) Patients with Diabetes Mellitus compared to Stable CHD Patients without Diabetes Mellitus

D R Balti, A Andrianto, B B Dharmadjati and D N Asmarani

[+](#) [Open abstract](#) [View article](#) [PDF](#)

-
- OPEN ACCESS** 012166
Correlation Between Arterial and Left Ventricle Diastolic Stiffness in Hypertensive Patients
D Sumantha, E R Utami and B S Pikir
[+ Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012167
Neglected Cases of Hypertension in Rural Indonesia: A Cross-Sectional Study of Prevalence and Risk Factors on Adult Population
E P B Mulia and S Prajitno
[+ Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012168
The Challenges of Managing Deep Vein Thrombosis in the Elderly: A Narrative Review
E P B Mulia and H Firdausi
[+ Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012169
Effect of Black Tea (*camellia sinensis*) on Serum Adiponectin Level in Atherogenic Diet Rats
E R Utami, M Ardiana, B Lestari, E S Wahyuni, E Widjajanto and R Rizkiawan
[+ Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012170
Late Eyelid Reconstruction of Necrotizing Fasciitis
F A Muthie and Sutjipto
[+ Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012171
Difference in the Level of p-Selectin Blood Edge between Uni-Valvular and Multivalvular in Rheumatic Heart Disease
F Filianovika, A Lefi, R Romdoni and M F Ramadhan
[+ Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012172
Importance of Basal Soluble ST2 and Global Longitudinal Strain 2D-Speckle Tracking Echocardiography to Detect Left Ventricle Remodeling in Post-Myocardial Infarction Patients
F S Hasibuan, M Aminuddin, B Utomo and I S Pratama
[+ Open abstract](#) [View article](#) [PDF](#)
-
- OPEN ACCESS** 012173

Left Atrial Volume Index (LAVI) as an Indicator of Severity and Pulmonary Hypertension in Mitral Stenosis

G M Rahman and A Subagio

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012174

Contrast does not Affect Adipose Mesenchymal Stem Cell (AMSC) Proliferation

G R Soekarno, I G R Suryawan, A Andrianto and W M Valentidenta

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012175

The Clinical Benefit of D-ribose in Cardiovascular Ischemic Disease: A New Potential Energy Supplement

I Damanik and D Soemantri

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012176

Association between White Blood Cell to Mean Platelet Volume Ratio (WMR) with Troponin for Refractory Angina Prediction in NSTEMI-ACS patients

I E Hermawati and M Y Assegaf

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012177

Lower Gensini Score in Navy Personnel Compared to Civilians, rather than for Non-Commissioned Officers

I G P G Semita, M J Al-Farabi, M F Huda, B Jovie and I G R Suryawan

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012178

Correlation between Global Longitudinal Strain (GLS)-Left Ventricle and TEI Index (TI) with Seattle Heart Failure Model (SHFM) Score in Chronic Heart Failure Patients with Systolic Dysfunction

I Kartikasari, A Lefi, D Soemantri and R R Juwita

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012179

Atria Score for Antithrombotic Agent Utilization in Ischemic Stroke Patients with Atrial Fibrillation

I P Dewi, K P Dewi and R T Pinzon

[+](#) [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012180

Renal Artery Stenosis: The Challenging in Diagnosis and Therapy

I P Dewi and N Mardiana

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012181

Plasma Histamine Level as a Distinguishing Factor between Stable Coronary Artery Disease and Acute Coronary Syndrome

I S Prihatiningsih, J N E Putranto, D Soemantri and A S Hadi

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012182

Correlation between Left Ventricular Function with Functional Capacity in Post Infarct Myocard Patients with Heart Failure

I Sudirman, B S Pikir and L G P Rinjani

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012183

Fibrinogen and Low-Density Lipoprotein (LDL) Cholesterol Levels with the Occurrence of Acute Myocardial Infarction: Is it Correlated?

I S Warno, J N E Putranto and B Novitalia

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012184

Supine Percutaneous Nephrolitholapaxy Profile in Jombang General Hospital from 2017 until 2018

J H Purba, F Surahmad and J Renaldo

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012185

The Correlation between p53 Serum Levels and Vascular Age was Measured by Carotid Intima Media Thickness (CIMT) in Patients with Moderate Cardiovascular Risk Factors

J R S Tengor, D Soemantri, J N E Putranto and B F K Putra

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012186

Cluster of differentiation 36 (CD 36), ENac, and AQP 2 effects on heart

J Sunariani

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012187

Systolic Function is Related to the Quality of Life in Chronic Heart Failure Patients

K A Shonafi, R B Wicaksono, R I Gunadi, R Herdyanto and A Andrianto

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012188

Correlation between Serum Galectin-3 Level with Wall Motion Score Index in Patients with ST-Segment Elevation Myocardial Infarction

K Halid, M Aminuddin and I P Dewi

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012189

The Correlation between Serum Tryptase Level and Ventricular Remodeling in Patient with Acute Coronary Syndrome After 1 Month of Onset

L D Yuni, D Soemantri and M I Ilman

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012190

Levofloxacin and Drug-Induced Long QT Syndrome (diLQTS): The Incidence and How to Prevent It

L G Catelya, C T Tjahjono and A Hanafi

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012191

The Effect of Atorvastatin Administration before Percutaneous Coronary Intervention on Stable Coronary Artery Disease Against Event of Periprocedural Myocardial Infarction

L P C Dewi, R M Yogiarto, I G R Suryawan and M D Pratama

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012192

Correlation between Arterial Stiffness with Left Ventricular Mass Index and Diastolic Function in Patients with Stage 3 and 4 of Non-Diabetic Chronic Kidney Disease

L Pramushinta, B S Pikir, Pranawa and D E Wardhani

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012193

Thrombolytic Therapy in Octogenarian Patient with STEMI at Buleleng General Hospital

M A Pasha and I K Susila

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012194

The Correlation Between Strain and Strain Rate Left Ventricle with Functional Capacity in Post Myocardial Infarction Patients with Heart Failure

M Muqsith, B S Pikir and M Rifqi

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012195

Predicting the Likelihood for Severe CAD and CABG Indication on Elective Patients:
Comparison of Novel CHA2DS2-VASc-HSF with CHA2DS2 and CHA2DS2-VASc Score

M J Al-Farabi, I G P G Semita, K A Shonafi, R Ramadhiani, B Jovie and A Andrianto

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012196

Early and Late Initiation Time of Statin Administration Effects on Early and Long-Term
Outcome in Acute Coronary Syndrome Patients: A Literature Review

M Q A'yun

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012197

Predictors of Arteriovenous Fistula Early Failure in End-Stage Renal Disease Patients:
Real-World Data in Surabaya

M R Amadis, J N E Putranto, I Maghfirah and N Mardiana

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012198

Different Grades of Body Mass Index are Correlated with Left Atrium and Ventricle
Structures in Patients with Hypertensive Heart Disease

M S Bhisma, M J Al-Farabi and B S Pikir

[+ Open abstract](#) [View article](#) [PDF](#)

JOURNAL LINKS

[Journal home](#)

[Journal scope](#)

[Information for organizers](#)

[Information for authors](#)

[Contact us](#)

[Reprint services from Curran Associates](#)

Concentration of fermented tilapia feces suspension by decomposer bacteria as a feed to induce *moina macrocopa* sexual reproduction

A F Zuhro¹, A S Mubarak^{2*} and E D Masithah²

¹Aquaculture, Faculty of Fisheries and Marine, Universitas Airlangga, Kampus C Unair, Jl. Mulyorejo Surabaya 60115, East Java, Indonesia

²Departement of Marine, Faculty of Fisheries and Marine, Universitas Airlangga, Kampus C Unair, Jl. Mulyorejo Surabaya 60115, East Java, Indonesia

*Corresponding author: shofy.ua@gmail.com

Abstract. Sexual induction of *M. macrocopa* can be induced by setting a density of feed concentration. To optimize the production of ephippia, sexual females must be given sufficient quality feed. Fermentation of tilapia fish from the results of preliminary studies showed a significant increase in protein concentration but fat concentration decreased. This research to determine the best concentration of fermented tilapia feces feed to produce ephippia *M. macrocopa*. This research is experimental by using a completely randomized design (CRD). This research consisted of 4 treatments of feed concentration is fermented feces suspension concentration of 33,30 mg/L (P1), 37,00 mg/L (P2) and 40,70 mg/L (P3) and control using rice bran suspension feed concentration of 37,00 mg/L(P0), with each using 5 replications. Induction sexual offspring is maintained at a density of 1000 ind/L for 6 days. During cultivation is calculated survival rate, *M. macrocopa* ephippia production, and some water quality parameters as support. Data were analyzed using ANOVA and Duncan test. This research showed that *M. macrocopa* cultivation using several concentrations of suspension feed of fermented tilapia feces at concentrations of 40.70 mg/L can induce sexual females and produce ephippia and showed the highest survival rate (1186 ± 26,45 grains/L) and 88,13%.

1. Introduction

M. macrocopa is a natural food for fish and shrimp larvae that are spread in freshwaters [1]. Increasing the price of cyst *Artemia* sp. making *Moina* sp. as an alternative natural feed for fish and shrimp larvae [2]. *Moina* sp. reproduces in two ways sexual and asexual (parthenogenesis) [3]. Sexual female *Moina* sp. does not reproduce by parthenogenesis so that if the egg is fertilized by a male. It will experience carapace thickening and ephippia are formed [4]. Maintenance of the population of *Moina* sp. with high density and adequate feeding can induce the production of male and female sexual offspring [5].



Fish farming activities produce waste originating from feces and fish feed residues [6]. Preliminary research results show that tilapia feces contain protein (18.19%), fat (1.46%), EPA (0.13%), DHA (0.20%), and amino acid histidine (0.26%) and arginine (0.78%).

Previous research has successfully cultivated *Moina* sp. with fecal fish fees which produce the highest fecundity [7] and populations with high densities of 1000 ind/L [8]. Tilapia feces can be used as direct feed if made in the form of suspension. To increase the solubility of tilapia fish, fermentation using decomposer bacteria can be done. This research tries to determine the effect of suspension concentration of fermented tilapia with decomposer bacteria on the induction of ephippia production from the sexual female *M. macrocopa*.

2. Materials and methods

This study was conducted in the Laboratory of the Faculty of Fisheries and Marine, Universitas Airlangga and Balai Riset dan Standardisasi Industri Surabaya, Surabaya, East Java, Indonesia.

2.1 Materials

The materials used in the research are: *M. macrocopa*, freshwater, dolomite, tilapia feces suspension, molasses, EM-4 agriculture, rice bran suspension, and detergent.

2.2 Research methods

This research uses an experimental method. The design used is a Completely Randomized Design (CRD) with 4 treatments and 5 replications, are:

P0: Feeding of *M. macrocopa* using suspension rice bran (control) concentration of 37.00mg/ L

P1: Feeding of *M. macrocopa* using suspension of fermented tilapia feces concentration of 33.30 mg/ L

P2: Feeding of *M. macrocopa* using suspension of fermented tilapia feces concentration of 37.00 mg/ L

P3: Feeding of *M. macrocopa* using suspension of fermented tilapia feces concentration of 40.70 mg/ L

2.3 Provision of inoculants and culture of *M. macrocopa*

M. macrocopa used in this study was obtained from waters in the Surabaya region, then cultivated individually (one *Moina*/20 mL) in several generations to obtain species that have the best growth and production performance of offspring. Furthermore, *Moina* is cultured with bran suspension feed for 2 months at a density of 20 / L volume of 10 L water. The cultivated *Moina* offspring now become inoculants in this study with the same initial density [3].

2.4 Research parameters

The main parameters in this research are the survival rate of the broodstock, the amount of ephippia production. The ephippia calculation is performed on the fifth to the seventh day of each treatment. Ephippia was taken based on maintenance jars for each treatment. The percentage of survival of the broodstock is calculated using the formula [9] as follows:

$$\text{Survival Rate} = \frac{N_t}{N_0} \times 100\%$$

Supporting parameters in this research are measurements of water quality in *M. macrocopa* maintenance media, which include pH, DO, temperature, and alkalinity. Observation of water quality is carried out every day in the morning and evening.

2.5 Data Analysis

Data were analyzed using Analysis of Variance (ANOVA) to determine the effect of treatment and continued with the DUNCAN test to determine and determine the treatment with the best results.

3. Results and discussion

3.1 Results

ANOVA test results showed that the cultivation *M. macrocopa* using several concentrations of fermented tilapia suspension feces showed an influence on total ehippia production and ehippia per brood ($P < 0.05$) (Table 1). The highest total production of ehippia *M. macrocopa* (3015 grains/L) and the highest production of ehippia per brood was (3.36 grains/brood) produced from aquaculture using rice bran suspension (control) feed.

Table 1. Ehippia Production of *M. macrocopa*

Treatment	Ehippia Production (Ind/L)	
	Total Ehippia \pm SD	Ehippia per Brood \pm SD
Control	3015 ^a \pm 57.88	3.36 ^a \pm 0.09
P1 (33.30 mg/L)	438 ^d \pm 35.60	0.52 ^d \pm 0.05
P2 (37.00 mg/L)	817 ^c \pm 53.36	0.95 ^c \pm 0.07
P3 (40.70 mg/L)	1186 ^b \pm 26.45	1.35 ^b \pm 0.05

Note: Different superscripts in the same column show significant differences ($P < 0.05$).

The graph of the ANOVA test results showed that the cultivation of *M. macrocopa* using several concentrations of fermented tilapia suspension feces showed an influence on the daily ehippia production ($P < 0.05$) (Figure 1).

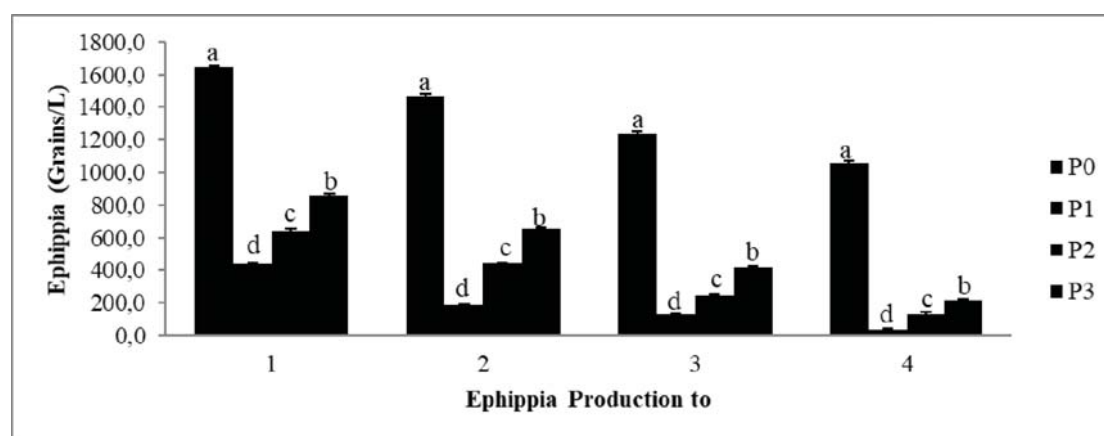


Figure 1. Daily Ehippia Production of *M. macrocopa*

ANOVA test results showed that *M. macrocopa* cultivation using several concentrations of fermented tilapia suspension did not affect the survival rate ($P > 0.05$) (Table 2). The survival rate of *M. macrocopa* on the density of 1000 ind/L with fermented tilapia suspension feces was 83.93-89.73%. Water quality during the maintenance of *M. macrocopa* that still supports life sustainability (Table 3).

Table 2. *M. macrocopa* Survival rate

Treatment	Survival Rate (%) \pm SD
Control	89.73 ^a \pm 2.01
P1 (33.30 mg/L)	83.93 ^c \pm 1.84

P2 (37.00 mg/L)	85.67 ^{bc} ± 1.70
P3 (40.70 mg/L)	88.13 ^{ab} ± 2.08

Note: Different superscripts in the same column show significant differences (P<0.05).

Table 3. *M. macrocopa* Maintenance Parameter Water Quality

Parameter	Value Range	Optimal Conditions
pH	8.19 – 8.25	7.0 – 8.0 (Miah <i>et al.</i> , 2013)
DO (ppm)	5.13 – 5.49	> 3.50 (Miah <i>et al.</i> , 2013)
Temperature (°C)	28.28 – 28.64	25 – 31 (Tan and Wang, 2010)
Alkalinity (mg/L)	24.00 – 31.00	> 50 (Tan and Wang, 2010)

3.2 Discussion

Induction of *M. macrocopa* sexual females in Cladosera has been developed using induction factors which include water quality, population density [10] as well as quantity and quality of feed [11]. The induction of *M. macrocopa* sexual female production in this research was carried out by setting the density of 660 ind/L by giving 37.00 mg/L concentration of rice bran suspension feed, as in previous studies that the cultivation of *M. macrocopa* with rice bran concentration of 37.00-64.40 mg/L produces females with the highest ephippia production (3052 ± 199 grains/L) [12].

The induced child is then reared at a density of 1000 ind/L and fed with fermented tilapia suspension. [10] stated that the saplings of *Moina* sp. maintained at a density of 1000 ind/L can induce ephippia production, as in research *M. branchiata* which are cultivated with densities of 750-1000 ind/L produce 70% sexual females and cultivation with child densities of 1000 ind *Moina*/L, using rice bran suspension feed concentration of 37.00-64.4 mg/L produces the highest ephippia production as many as 2102±120 grains/L.

Cultivation using fermented tilapia suspension fermented tilapia concentration of 40.70 mg/L produced the highest ephippia production (1186 ± 26.45 grains/L) compared to 33.30 mg/L concentration (438 ± 35.60 grains/L), but the ephippia production is still lower than the cultivation using bran suspension feed (3015 ± 57.88 grains / L), this is presumably due to the higher protein content in fermented tilapia suspension at 72.82%.

High protein concentration is a limiting factor in ephippia production. High protein content limits ephippia production [13], but high concentrations of fatty acids can produce ephippia [14]. The success of *M. macrocopa* in producing ephippia requires the role of omega-3 fatty acids in the form of EPA and DHA, where these needs begin in the period of previtellogenesis to the process of ovulation [14]. The availability of EPA and DHA has the potential to increase the process of gametogenesis because omega-3 fatty acids have an impact on egg production during reproduction [15]. High protein in fermented tilapia suspension (72.82%) resulted in lower ephippia production (438-1186 grains/L) compared to rice bran suspension feed (20.66%) which resulted in ephippia of (3015 grains/L).

The production of ephippia *M. macrocopa* can also be influenced by amino acids in the form of histidine and arginine. The amino acid histidine in tilapia feces was (0.26%) and arginine was (0.87%), while the amino acid histidine in rice bran suspension was (1.61%) and arginine (3.82%). The low amino acid in tilapia suspension stool feed could potentially support the production of ephippia *M. macrocopa* compared to rice bran suspension feed, but the high protein content in

fermented tilapia suspension was (72.82%) compared to rice bran suspension feed (20.66%) thought to be able to limit the production of *M. macrocopa* ephippia.

The amino acid histidine and arginine in feed can reduce the production of ephippia in Cladocera [13]. The amino acid histidine influences protein synthesis [16], while the amino acid arginine influences the reproduction of *Moina* sp.[17].

Feed concentration also affects the availability of nutrients (protein, fat and amino acids) *Moina* sp.[18]. Different treatment of fermented tilapia feces feed concentration, is thought to cause the availability of nutrients (protein and fat) for the production of ephippia *M.macroscopa*, this is consistent with the statement [8] that different nutritional values will have different effects on population development and ephippia production. High concentrations of feed can increase the availability of nutrients (protein, fat and amino acids) that can affect the body's metabolism thereby increasing the fecundity or production of ephippia [18], this is according to research [19], that Cladocera uses 68% of the energy produced by its metabolism to reproduce. According to [20] that, low concentrations of feed can reduce nutrients in feed, thus affecting the regulation of stress in Cladocera and can affect the reproductive model.

M. macrocopa began producing ephippia on the fourth day of maintenance. Production of ephippia on the fifth day and subsequently decreased, this was thought to decrease the availability of nutrients (protein and fat) in feed for the reproduction of *M. macrocopa*. The production of ephippia in aquaculture uses fermented tilapia suspension feed fermented on the first day (1200-2363 grains/L), the second day ephippia production (527-1807 grains/L), ephippia production on the third day (353-1150 grains/L), and the production of ephippia on the fourth day is (110-610 grains/L), while the production of ephippia in cultivation uses rice bran suspension feed on the first day (4590 grains/L), the second day ephippia production is (4083 grains/L) , ephippia production on the third day (3450 grains/L), and ephippia production on the fourth day (2953 grains/L). According to [21] that a large nutritional deficiency in feed can cause decreased egg production produced by the ovaries.

M. macrocopa cultivation in research with fermented tilapia suspension feed with a concentration of 40.70 mg/L has a higher survival rate, but lower than rice bran suspension feed, this is because the rice bran suspension contains lower protein from tilapia suspension fermented which is thought to support the survival of *M. macrocopa*, due to the growth of *Moina* sp. supported by appropriate feed nutrition to accelerate growth [22].

Cultivation of *M. macrocopa* density of 1000 ind/L fed fermented tilapia suspension fermented fish with different concentrations had water quality values, temperatures ranged from 28.28 to 28.64°C, alkalinity ranged from 24-30 mg/L, DO ranged from 5.13-5.49 ppm, and the pH of water ranges from 8.19 to 8.25 which still supports the survival of *M. macrocopa* [23; 24]. The increase in pH value during the study was caused by the media added with dolomite $\text{CaMg}(\text{CO}_3)_2$. The presence of calcium (Ca) in the media reacts with H^+ which causes the pH to increase [25].

4. Conclusion

The conclusion from the research of suspension concentration of fermented tilapia that has been fermented with decomposer bacteria, namely the daily production of ephippia, ephippia per brood and the highest total ephippia occurred in the cultivation of *M. macrocopa* concentration of 40.70 mg/L of 215.3-857.3 grains/L, 1.35 ± 0.05 ind/L and 1186 ± 26.45 ind/L

5. References

- [1] Rosyadi 2013 *J. Dinamika Pertanian* **2** 153-160
- [2] Dodson S, Caceras C, Rogers C 2010 Academic Press
- [3] Hiruta C, C Nishida, S Tochinai 2010 *ChromosomeResearch* **18** 833-840
- [4] Alekseev V R, De Stasio B T, Gilbert J J 2007 Springer Science and Business Media 214
- [5] Azuraiddi O, Yusoff F M, Shamsudin M N, Raha R A, Alekseev V R, Matias P H M 2013 *Aquaculture* **412-413** 131-135.
- [6] Effendi H, Utomo , B A, Darmawangsa G M, Karo- R E 2015 *Ecolab* **2** 80-92

- [7] Yan L Y, C W How, Y D Hii, G Khoo, H K A Ong 2009 *J. of Science and Technology in the Tropics* **5** 5-10
- [8] Mubarak A S, Jusadi D, Zairin M Jr, Suprayudi M A 2017 *AAC Bioflux* **3** 512- 524
- [9] Effendie M I 1978 Institut Pertanian Bogor 105
- [10] Zadereev E, Lopatina , T 2007 *Aquaculture Ecology* **41** 255-261
- [11] Hakima B, Khémisa A, Boudjéma S 2013 *J. Biology Sciences* **5** 25-31
- [12] Mubarak A S 2017 Institut Pertanian Bogor 94
- [13] Koch U, Creuzburg D, Grossart P, Straile D 2011 *Oecologia* **167** 981-989
- [14] Abrusan G, Fink P, Lampert W 2007 *J. Limnology Oceanography* **52** 1724-1728
- [15] Mazorra C, Bruce M, Bell J G, Davie A Alornd , E, Jordan N, J Rees, Papanikos N, Porter M, Bromage N 2003 *Aquaculture* **227** 21-33
- [16] Li P, K Mai, J Trushenski, Guoyao 2008 *Towards Functional and Environmentally Oriented Aquafeeds Amino Acid* **37** 43–53
- [17] Jobgen W S, Fried S K, W J Fu, Meininger C J, Wu G 2006 *J. Nutrition Biochemical* **17** 571-588
- [18] Fink P, Pflitsch C, Marin K 2011 *Plos One* **10** 1371
- [19] Richman S 1958 *Ecological* **2** 273-291
- [20] Aragone J, P Fraisl, M Baes, P Carmeliet 2009 Elsevier Inc 11-22
- [21] Gliwicz Z M, M J Noavida 1996 *J. Plankton Research* **18** 863-880
- [22] Loh J Y, K A O Han, S H Yii, J S Thomas, M L Malcolm, K Gideon 2013 *J. of Aquaculture* **8**
- [23] Tan Q G, W X Wang 2010 *Lim Ocean* **55** ,1426–1434
- [24] Miah F, S Roy, E Jinnat, Z K Khan 2013 *J. of Research in Formal Applied and Natural Sciences* **4**, 1–7
- [25] Arumsari C 2019 *J. Fakultas Perikanan dan Kelautan Universitas Riau* **13**

Acknowledgments

The authors are grateful to the Government of The Republic of Indonesia for all support to this research.



SURAT KETERANGAN
Nomor: 1440/UN3.FPK/KP/2023

Yang bertanda tangan di bawah ini:

Nama : **Dr. Eng. Sapto Andriyono, S.Pi., MT.**
NIP : 197909252008121002
Pangkat/Golongan : Penata/III - C
Jabatan : Wakil Dekan III

Dengan ini menerangkan bahwa:

Nama : **Dr. Endang Dewi Masithah, Ir., MP.**
NIP : 196909121997022001
Pangkat/Golongan : Pembina/IV - A
Jabatan : Lektor Kepala

Telah melakukan penelitian yang dipublikasi pada tahun 2020 dengan judul sebagai berikut:
Concentration of fermented tilapia feces suspension by decomposer bacteria as a feed to induce Moina macrocopa sexual reproduction

Adapun penelitian ini sudah mengacu pada prosedur pertimbangan etik dari:

1. *American Fisheries Society* (AFS, 2014) yang berjudul *Guideline for the Use of Fishes in Research* yang menyebutkan bahwa: penelitian dalam kondisi laboratorium baru mengatur tentang hewan percobaan berupa ikan hidup, untuk hewan percobaan berupa zooplankton tidak termasuk (hal 43 ; terlampir), dan
2. *Canadian Council on Animal Care* (CCAC, 2005) yang berjudul *Guideline on the Care and Use of Fish in Research, Teaching and Testing* yang menyebutkan bahwa: pedoman tersebut hanya digunakan untuk hewan uji berupa ikan (Kelas: Chondrichthyes, Agnatha, dan Osteichthyes) dan Avertebrata (Kelas: Cephalopoda) (hal 13,14 ; terlampir).

Sedangkan dalam penelitian tersebut menggunakan zooplankton (*Moina macrocopa*) sebagai hewan percobaan. Sehingga penelitian tersebut tidak perlu dilakukan ***Uji Ethical Clearence***.

Demikian Surat Keterangan ini kami buat untuk dapat dipergunakan sebagai persyaratan pengusulan Jabatan Fungsional **Guru Besar** atas nama Dr. Endang Dewi Masithah, Ir., MP.

Surabaya, 27 April 2023

Wakil Dekan III FPK Unair

Dr. Eng. Sapto Andriyono, S.Pi., MT.
NIP. 197909252008121002

Mengetahui,
Dekan FPK Unair

Prof. Moch. Amin Alamsjah, Ir., M.Si., Ph.D.
NIP. 197001161995031002

Guidelines for the Use of Fishes in Research

Use of Fishes in Research Committee members:

J. A. Jenkins, Chair, H. L. Bart, Jr., J. D. Bowker, P. R. Bowser, J. R. MacMillan, J. G. Nickum, J. D. Rose, P. W. Sorensen, and G. W. Whitley on behalf of the American Fisheries Society; J. W. Rachlin and B. E. Warkentine on behalf of the American Institute of Fishery Research Biologists; and H. L. Bart on behalf of the American Society of Ichthyologists and Herpetologists

American Fisheries Society
Bethesda, Maryland
2014

A suggested citation format for this book follows.

Use of Fishes in Research Committee (joint committee of the American Fisheries Society, the American Institute of Fishery Research Biologists, and the American Society of Ichthyologists and Herpetologists). 2014. Guidelines for the use of fishes in research. American Fisheries Society, Bethesda, Maryland.

Cover art: Close-up photograph of Brown Trout, *Salmo trutta*, from the South Fork of the Cache la Poudre River, Colorado, taken by James Rose in 2010.

© Copyright 2014 by the American Fisheries Society

All rights reserved. Photocopying for internal or personal use, or for the internal or personal use of specific clients, is permitted by AFS provided that the appropriate fee is paid directly to Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, Massachusetts 01923, USA; phone 978-750-8400. Request authorization to make multiple copies for classroom use from CCC. These permissions do not extend to electronic distribution or long-term storage of articles or to copying for resale, promotion, advertising, general distribution, or creation of new collective works. For such uses, permission or license must be obtained from AFS.

Printed in the United States of America on acid-free paper.

Library of Congress Control Number 2014943876
ISBN 978-1-934874-39-4

American Fisheries Society Web site address: www.fisheries.org

American Fisheries Society
5410 Grosvenor Lane, Suite 100
Bethesda, Maryland 20814
USA

Table of Contents

Use of Fishes in Research Committee, 2014	vii
Preface.....	ix
Acknowledgments.....	xi
Statement of Purpose	xiii
1. Introduction.....	1
2. General Considerations.....	3
2.1 Approval of Research Plans by IACUCs	3
2.2 Project Quality Assurance Plans and Standard Operating Procedures	4
2.3 Statistical Design.....	5
2.4 Mortality as an Experimental Endpoint	6
2.5 Fish Health Management: Control of Pathogens and Parasites	6
3. Statutory Requirements and Regulatory Bodies.....	9
3.1 International Regulations and Guidelines	9
3.2 Biosecurity	11
3.3 Federal, State, and Local Regulations.....	12
3.4 Permits and Certificates	14
4. Animal Welfare Considerations.....	17
4.1 General Considerations	17
4.2 Stress	17
4.2.1 Stages of Stress.....	18
4.2.2 Measuring and Avoiding Stress.....	18
4.3 Nociception and Pain	20
5. Field Activities.....	23
5.1 Habitat and Population Considerations.....	23
5.2 Field Collections	23
5.2.1 Permits.....	23
5.2.2 Natural History Collections.....	24

5.2.3 Representative Samples	24
5.2.4 Collection of Imperiled Species	25
5.2.5 Museum Specimens and Other Preserved Specimens	26
5.3 Live Capture Techniques and Equipment	28
5.4 Field Restraint of Fishes: Sedatives	28
5.4.1 Drugs Approved for Use on Fish	29
5.4.2 Low Regulatory Priority (LRP) Drugs	29
5.4.3 Investigational New Animal Drugs (INAD)	30
5.5 Dangerous Species and Specimens	30
5.6 Handling and Transport	31
5.7 Facilities for Temporary Holding and Maintenance	32
5.8 Field Acclimation	33
5.9 Collection of Blood and Other Tissues	34
6. Marking and Tagging	37
6.1 General Principles	37
6.2 External Tags and Marks	37
6.3 Internal Tags and Marks, and Biotelemetry	38
6.4 Genetic Markers	40
6.5 Stable Isotopes	41
6.6 Fatty Acids	42
7. Laboratory Activities	43
7.1 General Principles	43
7.2 Confinement, Isolation, and Quarantine	43
7.3 Acclimation to Laboratory Conditions	45
7.4 Facilities for Long-Term Housing of Fishes	45
7.5 Density of Animals	47
7.6 Feeds and Feeding	47
7.7 Water Quality	49
7.8 Water Recirculation Units	50
7.9 Effluents and Permits	51

7.10 Dangerous Species and Specimens in Captivity	51
7.11 Restraint of Fishes: Sedatives and Related Chemicals.....	52
7.12 Surgical Procedures.....	53
7.13 Administration of Drugs, Biologics, and Other Chemicals	55
7.13.1 Drugs	55
7.13.2 Biologics and Other Chemicals	56
7.13.3 Chemical Facility Anti-Terrorism Standards (CFATS)	56
8. Final Disposition of Experimental Animals	59
8.1 Euthanasia	59
8.2 Storage or Return to Aquatic Habitat.....	60
9. Future Revisions	61
10. Literature Cited	63
Appendix.....	85
Brief Checklist for IACUC Readiness	85
List of Low Regulatory Priority Drugs and Consideration for Their Use	86
Appendix Table 1. Low regulatory priority aquaculture drugs, indications, and doses.	87
Appendix Table 2. OIE-notifiable causative disease agents for fish and amphibians.	88
Index of Terms and Acronyms.....	89
Note on Additional Readings	90

7. Laboratory Activities

7.1 General Principles

Working with live fishes under laboratory conditions requires attention to many details concerning the requirements for, and limits of tolerance of, the particular species under study. Acceptable physical facilities and an adequate supply of water with good quality must be provided, even if the fishes are to be held for only short periods of time. Although fish may tolerate marginal facilities and conditions for a few hours or even several days, holding them under less than optimal conditions will affect the results of the research. Standards for humane treatment of animals must also be maintained, regardless of the length of time that the fishes are held.

The reader should note that some content of section 7 is not restricted to laboratory activities, but may be applicable to field situations, as well.

7.2 Confinement, Isolation, and Quarantine

Prior to bringing fishes into a laboratory, facilities and plans should be in place to ensure that the fish cannot escape, especially species not native to the watershed, and that the introduced fishes can be isolated physically from fishes already present. Each holding unit should have its own set of nets and other equipment. Facilities and equipment used for previous studies should be disinfected prior to use in new studies, typically with a chlorinated disinfectant or another disinfectant such as Virkon[®] Aquatic (www.wchemical.com/). If the introduced fishes may carry disease agents, especially pathogens or parasites that are not endemic to the area, quarantine-level facilities should be used. The level of quarantine required will vary with the seriousness of the known or suspected disease agent (see section [2.5 Fish Health Management: Control of Pathogens and Parasites](#)).

Individual fish with suspected ill health should be quarantined from the others so as to negate the potential for spread of potential disease agents. Such fish should be evaluated by an individual with expertise in fish diseases (fish pathologist or veterinarian), and the proper therapeutant should be applied as directed. Providing guidance for the treatment of specific diseases is beyond the scope of this document. The investigator is strongly urged to establish a working relationship with individuals with expertise in fish health with whom they may consult.

Experimentation with nonindigenous fishes, transgenic fishes, or other genetically modified fishes is a special situation that requires additional precautions to preclude their escape. Permitting with site visits by state wildlife agencies may be required for holding nonindigenous species (see section [3.4 Permits and Certificates](#)). The specific barriers may be similar to those used to prevent the escape of disease agents but must be developed to fit the physical characteristics of the laboratory or experimental facility. The USDA has developed

Canadian Council on Animal Care



guidelines on:

***the care and use of
fish in research,
teaching and
testing***

This document, the CCAC *guidelines on: the care and use of fish in research, teaching and testing*, has been developed by the *ad hoc* subcommittee on fish of the Canadian Council on Animal Care (CCAC) Guidelines Committee.

Mr John Batt, Dalhousie University
Dr Kristina Bennett-Steward, Bioniche
Mr Cyr Couturier, Memorial University
Dr Larry Hammell, University of Prince Edward Island
Dr Chris Harvey-Clark, University of British Columbia (Chair)
Mr Henrik Kreiberg, Fisheries and Oceans Canada
Dr George Iwama, Acadia University
Dr Santosh Lall, National Research Council
Dr Matt Litvak, University of New Brunswick at St John
Dr Don Rainnie, University of Prince Edward Island
Dr Don Stevens, University of Guelph
Dr Jim Wright, University of Calgary
Dr Gilly Griffin, Canadian Council on Animal Care

In addition, the CCAC is grateful to former members of CCAC Council: Ms Susan Waddy, Fisheries and Oceans Canada; Dr Jack Miller, University of Western Ontario; and Dr Choong Foong, Dalhousie University; and to Dr David Noakes, University of Guelph who provided considerable assistance in preliminary phases of this project. CCAC thanks the many individuals, organizations and associations that provided comments on earlier drafts of this guidelines document. In particular, thanks are extended to representatives of Fisheries and Oceans Canada, Environment Canada, the Canadian Aquaculture Institute, the Canadian Food Inspection Agency and the Canadian Society of Zoologists.

© Canadian Council on Animal Care, 2005

ISBN: 0-919087-43-4

Canadian Council on Animal Care
1510-130 Albert Street
Ottawa ON CANADA
K1P 5G4

<http://www.ccac.ca>

TABLE OF CONTENTS

A. PREFACE	1		
SUMMARY OF THE GUIDELINES LISTED IN THIS DOCUMENT	3		
B. INTRODUCTION	13		
1. Definition of Fish	13		
2. Rationale for Guidelines on the Care and Use of Fish	13		
3. Ethical Overview	14		
3.1 Principles of the Three Rs	14		
4. Responsibilities	15		
4.1 Responsibilities of investigators	15		
4.2 Responsibilities of the animal care committee	16		
4.3 Role of the veterinarian	17		
5. Government Regulations and Policies on the Use of Fish	17		
5.1 International	17		
5.2 Federal	18		
5.3 First Nations	20		
5.4 Provincial/territorial	20		
5.5 Municipal	20		
C. AQUATIC FACILITIES	21		
1. Water Supply	21		
2. Water Quality	21		
3. Engineering and Design	22		
3.1 Structural materials	23		
3.2 Room ventilation and airflow in aquatic areas	24		
3.3 Mechanical and electrical requirements	25		
3.4 Lighting	25		
3.5 Redundancy in aquatic life support systems	26		
4. Types of Systems	26		
4.1 Flow-through systems	27		
4.2 Recirculation systems	27		
4.3 Static systems	27		
4.4 Mesocosms	28		
5. Fish Housing	28		
5.1 Fish well-being	28		
5.2 Tank/enclosure design	28		
D. FACILITY MANAGEMENT, OPERATION AND MAINTENANCE	31		
1. Security and Access	31		
2. General Maintenance of the Facility	31		
3. Environmental Monitoring and Control	32		
3.1 Management of water quality	33		
3.2 Temperature	33		
3.3 Oxygen	34		
3.4 Supersaturation	34		
3.5 pH	35		
3.6 Nitrogen compounds	35		
3.7 Carbon dioxide	36		
3.8 Salinity	36		
3.9 Toxic agents	37		
E. CAPTURE, ACQUISITION, TRANSPORTATION AND QUARANTINE	38		
1. Capture of Wild Stock	38		
2. Killed Specimens	38		
3. Piscicidal Compounds	38		

4.	Acquisition of Hatchery Fish	39	3.3	Anesthesia	53
5.	Transportation	39	3.4	Surgical equipment	54
6.	Quarantine and Acclimation	40	3.5	Incisions	54
	6.1 Quarantine	40	3.6	Suture materials and techniques	54
	6.2 Acclimation	41	3.7	Pathophysiology of surgery and wound healing in fishes	55
			3.8	Postoperative care	55
F.	HUSBANDRY	42	4.	Administration of Compounds and Devices by Various Routes	56
1.	Record-keeping and Documentation	42	4.1	Branchial diffusion ("inhalation")	56
1.1	Standard Operating Procedures	42	4.2	Oral	56
1.2	General checklists	42	4.3	Injection	57
1.3	Assessment of fish well-being	42	4.4	Implants, windows and bioreactors	57
2.	Density and Carrying Capacity	42	5.	Tagging and Marking	57
3.	Food, Feeding and Nutrition	43	5.1	Tissue marking	58
3.1	Nutrition	43	5.2	Tagging	58
3.2	Food and feeding	43	6.	Collection of Body Fluids	58
3.3	Feed quality and storage	43	7.	Use of Infectious Disease Agents, Tumorigenic or Mutagenic Agents, and Toxic and Noxious Compounds	59
3.4	Larval weaning	45	8.	Endpoints and Criteria for Early Euthanasia	59
3.5	Use of medicated feeds	45	8.1	Recognition of "pain", "distress" and "stress"	59
4.	Broodstock and Breeding	46	8.2	Choosing an appropriate endpoint	60
4.1	Induction of spawning	46	9.	Monitoring	62
G.	HEALTH AND DISEASE CONTROL	47	10.	Negative Reinforcement Modalities	62
1.	Fish Health Program	47	11.	Exercise to Exhaustion	62
1.1	Disease prevention	47	12.	Environmental Extremes	62
1.2	Disease diagnosis and identification of pathogens	47	13.	Genetically Modified Fish	62
1.3	Injuries and other disorders	48	I.	EUTHANASIA	64
H.	EXPERIMENTAL PROCEDURES	50	J.	DISPOSITION OF FISH AFTER STUDY	65
1.	Handling and Restraint	50			
1.1	Restraint of dangerous species	51			
2.	Restricted Environments	51			
3.	Surgery	51			
3.1	Surgical preparation and skin disinfection	52			
3.2	Water quality during surgery	53			

1. Consumption of Fish65
2. Release of Fish to Wild65
3. Fish as Pets65
4. Transfer of Fish Between Facilities65
5. Disposal of Dead Fish65
K. REFERENCES66
L. GLOSSARY73
M. ABBREVIATIONS75
APPENDIX A RELEVANT GUIDELINES AND ORGANIZATIONS76

APPENDIX B ZOOBOTIC DISEASE- TRANSMISSION OF FISH DISEASES TO MAN77
--	------------

APPENDIX C GUIDELINES FOR CONTAINMENT FACILITIES (FOR PATHOGEN STUDIES)79
--	------------

APPENDIX D WATER QUALITY CRITERIA FOR OPTIMUM FISH HEALTH – FOR COLDWATER, WARMWATER AND MARINE SPECIES OF FISH84
--	------------

the care and use of fish in research, teaching and testing



A. PREFACE

The Canadian Council on Animal Care (CCAC) is the national peer review agency responsible for setting and maintaining standards for the care and use of animals used in research, teaching and testing throughout Canada. In addition to the *Guide to the Care and Use of Experimental Animals*, vol. 1, 2nd ed., 1993 and vol. 2, 1984, which provide the general principles for the care and use of animals, the CCAC also publishes detailed guidelines on issues of current and emerging concerns. The CCAC *guidelines on: the care and use of fish in research, teaching and testing* is the seventh of this series. This document supersedes Chapter I - Fish, *Guide to the Care and Use of Experimental Animals*, vol. 2 (CCAC, 1984).

These guidelines aim to provide information for investigators, animal care committees, facility managers and animal care staff that will assist in improving both the care given to fishes and the manner in which experimental procedures are carried out.

The present document has drawn substantially from the work of organizations listed in Appendix A. Their contributions to the development of these guidelines are gratefully acknowledged.

The guidelines have been developed by the CCAC subcommittee on fish and were reviewed by a total of 69 experts. A preliminary first draft was agreed on by the subcommittee and circulated to experts in June 2002 (including representatives of the organizations listed in Appendix A), and a second draft was circulated for widespread comment in June 2003. A final review was carried out in August 2004 involving all individuals who had previously provided significant input to the development process. The development of these guidelines also involved consultation with the Canadian Association for Laboratory Animal Science (CALAS) and the Canadian Society of Zoologists (CSZ) through workshops held at annual meetings in Québec City (June 2003), Acadia University (May 2004), and Hamilton (June 2004). Consultations were also held at the Aquaculture Association of Canada and AquaNet annual meetings in Québec City (October 2004), and at the CCAC Workshop on the Fish Guidelines in Vancouver (April 2005).

The guidelines have been organized in a format that should facilitate easy access to relevant sections. Early sections provide an ethical overview relevant to the use of fishes in research, teaching and testing. This is followed

by a brief overview of regulations and responsibilities relevant to the care and use of fishes in science in Canada. The remainder of the document provides guidelines to assist in caring for fishes in laboratory facilities, followed by guidelines to help in the development and review of experimental protocols. An overview of the CCAC *guidelines on: the care and use of fish in research, teaching and testing* is provided through a summary of the guidelines listed in

this document prior to the beginning of the main text.

The refinement of animal care and use guidelines is a continuous process. These guidelines are intended to provide assistance in the implementation of best practices, and should not be viewed as regulations. Where regulatory requirements are involved or where it is absolutely imperative to adhere to a particular guideline, the term *must* has been used.

B. INTRODUCTION

The greatest challenge in providing *guidelines on: the care and use of fish* is the wide variety of fishes used in Canada and the diversity of their habits, behavior, life history, and environmental and husbandry requirements. In addition, the scientific information required to define the preferred conditions for fish well-being is limited. While considerable research has been conducted on culture strategies and environmental and water quality requirements, such studies have generally been aimed at determining conditions that optimize production in aquaculture systems, rather than improving the welfare of fishes, and have not usually addressed the difference between *tolerance* and *preference* (Fisher, 2000).

An important consideration in these guidelines is the naturally high mortality rates of juveniles in species whose ecological strategies include the generation of large numbers of progeny to ensure adequate survival in the wild. In addition, many experimental populations of species with usually high survival contain individuals that will not thrive to adulthood even under the best environmental conditions. In some situations, a population-based (or a group of study fish) approach to well-being may be appropriate, but individuals that are not likely to thrive should be euthanized as soon as they are identified.

Another consideration for these guidelines is the general acceptance by the public of the current killing methods used in harvesting wild fishes or in recreational angling. In general, the public appears to be willing to accept these killing methods for food production but not when fishes are used for research. These guidelines accept that for research, teaching, and testing use of any animal, including fishes, more emphasis will be placed on individual well-being than is generally accepted for the commercial harvesting or production of animals for food. It is recognized, however, that in some instances investigators may obtain fishes from people involved in commercial or recreational harvesting and have little influence over the capture methods.

These guidelines apply to fishes held in facilities for research, teaching and testing, as well as to fishes that are studied in their natural habitats.

1. Definition of Fish

For the purpose of these guidelines, fishes are defined as all bony and cartilaginous fish genera (classes Chondrichthyes [cartilaginous fishes], Agnatha, and Osteichthyes [bony fishes]). Fish eggs, embryos or larvae that have not developed beyond exclusive reliance on their own yolk nutrients are not covered by these guidelines. Similarly, invertebrates (except cephalopods) are not covered under the CCAC system of surveillance, but institutions are encouraged to foster respect for these animals by ensuring that holding facilities and levels of husbandry meet standards equivalent to those used for fishes.

2. Rationale for Guidelines on the Care and Use of Fish

The use of fishes as experimental subjects has increased substantially over the past two decades. This increase in use is a result of the rapid development of the aquaculture industry, requirements for testing involving fishes as indicators of environmental change, and the use of fishes as a replacement for mammals in biomedical, pharmacological and genetic research (DeTolla *et al.*, 1995; Fabacher & Little, 2000). The trend toward the use of fishes as a replacement for studies that would previously have used mammals as experimental subjects is not discouraged. However, it must also be recognized that fishes have the capacity to perceive noxious stimuli. Noxious stimuli are those stimuli that are damaging or potentially damaging to normal tissue (e.g., mechanical pressure, extremes of temperature and corrosive chemicals). Whether or not fishes have the capacity to experience any of the adverse states usually associated with pain in mammals is subject to a great deal of debate in the scientific literature (FAWC, 1996; FSBI, 2002; Rose, 2002; Braithwaite & Huntingford, 2004). Nonetheless, fishes are capable of behavioral,

physiological and hormonal responses to stressors (including noxious stimuli) which can be detrimental to their well-being. These CCAC guidelines both support the leadership role that Canadians play in fish research, and ensure that the welfare of fishes is carefully considered during the use of fishes for research, teaching and testing, recognizing that better welfare will result in better science.

3. Ethical Overview

Guideline 1:

Fishes used in research, teaching and testing must be treated with the respect accorded to other vertebrate species.

The CCAC's surveillance system for animals used in research, teaching and testing is based on the principles of humane science, i.e. the Three Rs of Russell and Burch (Russell & Burch, 1959) - Reduction, Replacement and Refinement. For the CCAC, these principles are laid out in its *policy statement on: ethics of animal investigation* (CCAC, 1989). The *ethics of animal investigation* applies to all species covered by the CCAC system, i.e. all vertebrates and cephalopods.

In addition, the CCAC system takes a "moral stewardship" approach to the use of animals in science as explained in the CCAC Experimental Animal User Training Core Topics - Module 2, Ethics in Animal Experimentation (http://www.ccac.ca/en/CCAC_Programs/ETCC/Module02/toc.html).

The first guideline statement in the CCAC *guidelines on: institutional animal user training* (CCAC, 1999a) states, "Institutions must strive through their training programs to sustain an institutional culture of respect for animal life".

3.1 Principles of the Three Rs

According to the CCAC *policy statement on: ethics of animal investigation* (CCAC, 1989), it is the responsibility of the local animal care committee (ACC) to ensure that fishes are used only if the investigator's best efforts to find a non-animal model have failed.

As for any other species covered by the CCAC system, investigators using fishes are required to use the most humane methods on the smallest

number of animals necessary to obtain valid information. This requires the use of a sound research strategy, including: identification of key experiments that determine whether a particular line of enquiry is worth pursuing; use of pilot studies; staging of *in vitro* to *in vivo* experiments where possible; and implementation of staged increase in test stimuli where possible (Balls *et al.*, 1995). The numbers and species of animals required depend on the questions to be explored. Field studies, aquaculture studies and laboratory studies require different statistical designs; field studies and aquaculture production typically require the use of larger numbers of animals. The life stage of the fishes used in each study will also affect the numbers of animals needed. Studies of early life stages typically require large numbers of individuals. In all cases, studies should be designed to use the fewest animals necessary. Heffner *et al.* (1996) and Festing *et al.* (2002) provide discussions on the appropriate treatment of samples and experimental units. Investigators are encouraged to consult with a statistician to develop study designs that have the appropriate statistical power to accomplish the research objectives (Nickum *et al.*, 2004).

The CCAC *policy statement on: ethics of animal investigation* (CCAC, 1989) also requires adherence to the following principles:

- animals must be maintained in a manner that provides for their optimal health and well-being, consistent with the demands imposed by the experimental protocol;
- animals must not be subjected to pain and/or distress that is avoidable and that is not required by the nature of the relevant protocol;
- expert opinion must attest to the potential value of studies with all animals, including fishes (e.g., scientific merit for research, see CCAC *policy statement on: the importance of independent scientific merit of animal based research projects* [CCAC, 2000a]; pedagogical value for teaching; and the appropriateness of the method to provide data for testing according to current regulatory requirements);
- if pain or distress is a justified component of