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EFFECTS OF DIURON AND 3,4-DICHLOROANILINE (3,4-DCA) ON REPRODUCTION AND EARLY DEVELOPMENT OF JAVANESE MEDAKA (Oryzias javanicus, BLEEKER 1854)

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By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

February 2021

DEDICATION

Dedicated to my late parents, and my family

Abstract to Thesis Presented to the Senate of Universiti Putra Malaysia in fulfilments of the requirement for the degree of Doctor of Philosophy

EFFECTS OF DIURON AND 3, 4-DICHLOROANILINE (3, 4-DCA) ON REPRODUCTION AND EARLY DEVELOPMENT OF JAVANESE MEDAKA (*Oryzias javanicus*, BLEEKER 1854)

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Chairman : Syaizwan Zahmir bin Zulkifli, PhD
Faculty : Science

The indiscriminate application of pesticides in the environment affects human and wildlife health worldwide. Diuron, a chlorinated phenylurea herbicide and its primary metabolite, 3,4-dichloroaniline (3,4-DCA) exert toxic effects on non-target organisms. Growth, survival, and reproduction are the primary factors determining an organism's population structure in its habitat. Javanese medaka (*Oryzias javanicus*) is an emerging euryhaline model fish distributed around the coastal and estuarine regions of Peninsular Malaysia and other parts of Southeast Asia. The fish is a sentinel species that bioindicates ecosystem health. The objectives of this study were to evaluate the acute toxicity of diuron and 3,4-DCA on different life stages of Javanese medaka, to determine the effect of diuron and 3,4-DCA on the fecundity and reproductive biomarkers of Javanese medaka, and to evaluate the embryotoxicity of diuron and 3,4-DCA on Javanese medaka. Larvae, juveniles, and adults of Javanese medaka were exposed to diuron and 3,4-DCA for 96 hours to determine mortality (96 hour-LC_{50}; 50% lethal concentration to exposed organisms) and behavioural toxicity symptoms. Fish embryo toxicity (FET) test; mortality (LC_{50}) at 10-days and 96-hour for diuron and 3,4-DCA, and subchronic embryonic toxicity (20 days) for both diuron and 3,4-DCA were also evaluated. Reproductively active adults were used for a 21-day diuron and 3,4-DCA fish short-term reproductive assay (FSTRA). All the bioassays were conducted in a semi-static method. The LC_{50} of diuron and 3,4-DCA for embryo were; 632.5 mg/L (95% CI = 622.6 – 645, R^2 = 0.98, 10 days) and 32.87 mg/L (95% CI = 27.90 - 38.74, R^2 = 0.95, 96-hours), respectively. No behavioural toxicity symptoms were observed in both diuron and 3,4-DCA exposed individuals. The curve fit models (concentration-mortality) indicate a low concentration-dependent increase in the mortality rate for diuron and 3,4-DCA exposed adults. The LC_{50} trend was; larvae > juveniles > adults for both diuron and 3,4-DCA. Adult Javanese medaka was less susceptible to a slight increase in the concentration of diuron and 3,4-DCA. The fecundity of Javanese medaka exposed to diuron and 3,4-DCA were significantly affected ($p < 0.05$). Vitellogenin (VTG) concentration of diuron-exposed females was significantly higher ($p < 0.05$) with 58.62 ± 0.29 ng/L and 55.64 ± 7.60 ng/L at 0.5 mg/L and 1.0 mg/L, respectively, but there was no significant difference

($p > 0.05$) in male fish at the concentrations tested. Non-monotonic dose-response (NMDR) in the gonadal tissues was observed. Abnormal gametogenesis was less prominent in exposed-male Javanese medaka but more obvious in the female Javanese medaka exposed to both diuron and 3,4-DCA. The 20-days exposed embryos to both diuron and 3,4-DCA showed significant difference ($p < 0.05$) NMDR physiological and morphological features. The acute toxicity on the different life stages indicated that diuron was less potent than 3,4-DCA. Conversely, the chronic exposure showed that diuron exerted more toxicity effects to Javanese medaka compared to 3,4-DCA. The disruption of fecundity and alteration in gonads histology implied reproductive toxicity of diuron and 3,4-DCA on Javanese medaka. The NMDR indicates a disruption in normal hormonal activity during embryonic development. The increase in VTG implied an oestrogenic effect on female Javanese medaka but no effect on male Javanese medaka at a concentration up to 1.0 mg/L. The non-linear/NMDR in embryonic development signified disruption of endocrine activity by diuron and 3,4-DCA. Generally, the age of Javanese medaka plays a vital role in its susceptibility to diuron and 3,4-DCA. Both diuron and 3,4-DCA disrupt the hormonal activities during reproduction and embryonic development of Javanese medaka. Therefore, they are potential endocrine-disrupting chemicals (EDCs). This finding strengthens the potential endocrine-disrupting effect of diuron and 3,4-DCA on non-target aquatic organisms. The response of Javanese medaka to diuron and 3,-4-DCA can predict the potential developmental and reproductive effects on other exposed aquatic vertebrates. Further research on multi-generation and ecotoxicogenomics to support these results would add information to existing data on the effect of diuron and 3,4-DCA on the survival, growth, and reproduction of Javanese medaka.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

KESAN DIURON DAN 3, 4- DIKLOROANILIN (3,4-DCA) TERHADAP REPRODUKSI DAN PEMBANGUNAN AWAL IKAN BERAS (*Oryzias javanicus,* BLEEKER 1854)

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Penggunaan racun perosak secara berleluasa di persekitaran amat mempengaruhi kesihatan manusia dan hidupan liar di seluruh dunia. Diuron, sejenis racun rumput rumpai berklorin dan metabolit utamanya, 3,4-dikloroanilin (3,4-DCA) didapati memberikan kesan toksik kepada organisma bukan sasaran. Pertumbuhan, kelangsungan hidup, dan pembiakan semula adalah merupakan faktor utama yang menentukan struktur populasi sesuatu organisma di dalam habitatnya. Ikan beras (*Oryzias javanicus*) adalah merupakan ikan model eurihalin yang baru muncul dan terdapat di sekitar kawasan pesisir dan muara Semenanjung Malaysia dan beberapa bahagian lain di Asia Tenggara. Ikan medaka adalah spesies sentinel yang berupaya menunjukkan kesihatan ekosistem. Antara objektif kajian ini adalah untuk menilai ketoksikan akut diuron dan 3,4-DCA pada tahap kehidupan ikan medaka yang berbeza, untuk menentukan kesan diuron dan 3,4-DCA pada kesuburan dan biomarker pembiakan ikan medaka, dan untuk menilai embriotoksisiti diuron dan 3,4-DCA pada ikan medaka. Larva, juvenil dan ikan medaka dewasa telah didedahkan dengan diuron dan 3,4-DCA selama 96 jam untuk menentukan kematian (96 jam-LC_{50}; kepekatan mematikan 50% kepada organisma terdedah) dan tanda-tanda gejala ketoksikan. Ujian ketoksikan embrio ikan (FET); kematian (LC_{50}) selama 10 hari dan 96 jam untuk diuron dan 3,4-DCA, serta subkronik ketoksikan embrio (20 hari) bagi kedua-dua diuron dan 3,4-DCA juga telah dinilai. Ikan dewasa yang aktif membiak telah digunakan untuk ujian 21 hari diuron dan 3,4-DCA pembiakan jangka pendek ikan (FSTRA). Kesemua ujian-bio dilakukan dengan kaedah separa statik. LC_{50} diuron dan 3,4-DCA untuk embrio masing-masing adalah; 632.5 mg/L (95% CI = 622.6 - 645, R2 = 0.98, 10 hari) dan 32.87 mg/L (95% CI = 27.90 - 38.74, R2 = 0.95, 96-jam). Tiada tanda-tanda gejala ketoksikan yang diperhatikan pada individu yang didedahkan dengan diuron dan 3,4-DCA. Model keluk sesuai (kepekatan-kematian) menunjukkan peningkatan kepekatan-bergantung rendah dalam kadar kematian bagi ikan dewasa yang terdedah dengan diuron dan 3,4-DCA. Trend LC_{50} adalah; larva > juvenil > dewasa bagi kedua-dua diuron dan 3,4-DCA. Ikan medaka dewasa adalah kurang rentan terhadap sedikit peningkatan kepekatan diuron dan 3,4-DCA. Kesuburan ikan medaka yang terdedah dengan diuron dan 3,4-DCA adalah terjejas secara signifikan ($p < 0.05$).

Kepekatan Vitellogenin (VTG) pada ikan betina yang terdedah dengan diuron jauh lebih tinggi ($p < 0.05$) dengan bacaan 58.62 ± 0.29 ng/L dan 55.64 ± 7.60 ng/L pada 0.5 mg/L dan 1.0 mg/L, tetapi tidak ada perbezaan yang signifikan ($p > 0.05$) terhadap ikan jantan yang diuji dengan kepekatan tersebut. Tindak balas dos bukan monotonik (NMDR) dalam tisu gonad juga diperhatikan. Gametogenesis yang tidak normal kurang menonjol pada medaka jantan tetapi lebih jelas pada medaka betina yang didedahkan dengan diuron dan 3,4-DCA. Embrio 20 hari untuk kedua diuron dan 3,4-DCA menunjukkan ciri fisiologi dan morfologi NMDR ($p < 0.05$) yang ketara. Ketoksikan akut pada tahap kehidupan yang berbeza menunjukkan bahawa diuron kurang berkesan berbanding 3,4-DCA. Sebaliknya, pendedahan kronik menunjukkan bahawa diuron memberikan kesan toksik yang tinggi kepada ikan medaka berbanding dengan 3,4-DCA. Gangguan kesuburan dan perubahan histologi gonad menunjukkan kesan ketoksikan diuron dan 3,4-DCA kepada pembiakan ikan medaka. NMDR menunjukkan terdapat gangguan aktiviti normal hormon semasa perkembangan embrio. Peningkatan VTG menunjukkan kesan estrogenik kepada medaka betina tetapi tidak ada kesan ditemui pada medaka jantan pada kepekatan sehingga 1.0 mg/L. Tidak linear/NMDR dalam perkembangan embrio menandakan terdapat gangguan aktiviti endokrin oleh diuron dan 3,4-DCA. Umumnya, usia ikan medaka memainkan peranan penting dalam kerentanannya terhadap diuron dan 3,4-DCA. Kedua-dua diuron dan 3,4-DCA mengganggu aktiviti hormon semasa pembiakan dan perkembangan embrio ikan medaka. Oleh itu, mereka adalah bahan kimia yang berpotensi mengganggu endokrin (EDCs). Penemuan ini memperkuatkan lagi potensi diuron dan 3,4-DCA menggangu sistem endokrin pada organisma akuatik bukan sasaran. Tindak balas ikan medaka terhadap diuron dan 3,4-DCA dapat meramalkan kesan perkembangan dan pembiakan pada vertebrata akuatik lain yang terdedah. Penyelidikan lebih lanjut mengenai multi-generasi dan ekotoksikogenik untuk menyokong hasil kajian ini akan menambahkan lagi maklumat pada data yang ada mengenai kesan diuron dan 3,4-DCA terhadap kelangsungan hidup, pertumbuhan, dan pembiakan ikan medaka.

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LIST OF SYMBOLS AND ABBREVIATIONS

‰	Parts per thousand
AhR	Aryl Hydrocarbon Receptor
ANOVA	Analysis of Variance
CAS	Chemical Abstracts Service
CI	Confidence Interval
DART	Developmental and Reproductive Toxicity
DCA	Dichloroaniline
DMSO	Dimethyl Sulfoxide
DO	Dissolved Oxygen
dpe	Days post exposure
dpf	Days post fertilisation
dph	Days post hatched
EC_{50}	Median effective concentration
ED	Endocrine disruptor
EDC	Endocrine Disrupting Chemical
ELISA	Enzyme-Linked Immunosorbent Assay
ERA	Ecological Risk Assessment
EU	European Union
etOH	Ethanol
FET	Fish Embryo Toxicity
F_i	*i*th generation
FSTRA	Fish Short-Term Reproductive Assay
GSI	Gonadosomatic index
H&E	Haematoxylin and eosin
HSI	Hepatosomatic index

K_{oc}	Octanol–water partitioning coefficient
LC_{10}	10% Lethal Concentration
LC_{50}	Median (50%) Lethal Concentration
LOEC	Lowest Observed Effect Concentration
mph	Month post-hatch
NMDR	Non-Monotonic Dose-Response
NOEC	No Observed Effect Concentration
OECD	Organization for Economic Co-operation Development
PE	Pericardial oedema
SEM	Standard Error of Mean
USEPA	United States Environmental Protection Agency
VTG	Vitellogenin
YSE	Yolk-sac oedema
v/v	Volume per volume

CHAPTER 1

INTRODUCTION

1.1 General introduction

As far back as 1950, about 140,000 new chemicals and pesticides have been produced and distributed around the globe (Landrigan et al., 2019). Aquatic organisms accumulate pollutants from contaminated water or through ingestion of contaminated food; therefore the pollutants may lead the contamination not only of the aquatic life but also of the entire ecosystem, including man, through the food chain (Mai et al., 2013). Aquatic ecosystems are frequently contaminated with pesticides from diverse sources, mostly from agriculture run-off, causing potential hazardous effects to non-target living things. The extensive use of biocides as antifoulant and pesticides including their metabolites on the aquatic and terrestrial environment has drawn more concern for the monitoring of these chemicals (Maragou et al., 2011). The persistent and continuous rise in use pesticides cause a major threat to aquatic environments defending on exposure in time (Vieira et al., 2020).

Pesticides are used all over the world as a means of controlling hostile organisms in agricultural activities or as antifouling biocides in paint formulations. They may enter the environment by a variety of routes including through urban (parking lots and residential areas) and run-off from farmlands, leaching or spray drift, contaminated soils and aquatic sediments. Pesticide contamination has now been widely recorded in waters and sediments from a number of European estuaries, coastal areas, and lakes. Once pesticide residues have been released into aquatic environments, they can persist from a few months to a number of years (Mai et al., 2013). Herbicides are one of the major classes of pollutants contaminating coastal ecosystem across the globe (Behrens et al., 2016). Pesticides are not highly selective but are generally toxic to many non-target organisms in aquatic ecosystem, which affect the physiology of organisms (Mukadam & Kulkarni, 2014). In 2014, it was reported that herbicides account for 83% of the total pesticide usage in Malaysia (Dilipkumar, 2017).

Numerous pesticides are described as endocrine disrupting chemicals (EDCs) (Mnif et al., 2011). However, more than 800 different chemical structures present in air, land, drinking water, and foodstuffs of plant and animal origin, consumer goods and personal care products, fuels, pharmaceuticals, and synthetic hormones are EDCs (Scognamiglio et al., 2016). A joined and organized international effort is required to define the effect of EDCs due to current decrease in both the health and populations of human and wildlife (Soares et al., 2014). Exposure to pesticides was linked to carcinogenicity, allergy, neurological and reproductive interference (Mnif et al., 2011).

Diuron,3-(3,4-Dichlorophenyl)-1,1-dimethylurea;DCMU also known as Dynex; and many other trade names is suspected to be an endocrine disrupting chemical (EDC) and it may likely result into toxic developmental and reproductive effects (Huovinen et al., 2015; Pereira et al., 2015; Pereira et al., 2016; Kamarudin et al., 2020).

Reduction in reporoduction might interferes with the population dynamic and survival of Javanese medaka in the future, thereby affecting the general ecosystem structure, and loss local or regional aquatic biodiversity in the distant future. Developmental toxicity studies provide an exclusive standpoint on ecological and organismal health. Organisms at the early developmental stage are the most vulnerable to toxicity of chemical due to a lack of protective mechanisms. Besides, tissue and vital organ systems are differentiating and developing, therefore any disruption or effect can result into lifelong consequences such as deformities. The cumulative effect of these factors makes developing organisms ideal for toxicological research studies (Wagner et al., 2017).

Javanese medaka (*Oryzias javanicus*) inhabit estuarine ecosystems of Peninsular Malaysia, Singapore, Indonesia and Thailand (Yusof, Ismail, & Alias, 2014; Aziz, Zulkifli, Mohamat-yusuff, Azmai, & Ismail, 2017; Ibrahim et al., 2020;). Javanese medaka possessed significant features that make it applicable as the other the widely used model fish and it is considered as sentinel species (Amal et al., 2019; Aziz et al., 2017; Rusni, Sassa, Takehana, Kinoshita, & Inoue, 2020; Salleh et al., 2017).

1.2 Problem statement

There is a substantial increase in the application of herbicides in Malaysia over the recent years (Ng, 2017). Agrochemicals disrupt the normal growth and reproduction of fish as bioindicators for evaluation of the ecosystem health (Celino-Brady et al., 2019). Diuron and its metabolites can be present in soil, surface and ground water, and sediment (Huovinen et al., 2015). Up to 3.9 mg/L of diuron was detected in water bodies around plantations and paddy fields in Malaysia (Mohamat-Yusuff et al., 2020). Degradation of diuron release metabolites that are more toxic in the environment (Coelho-Moreira et al., 2013).

Growth, survival and reproduction are the primary factors that regulate the population structure of any organism in its environment. To our knowledge, research on the early development and reproductive impairments of diuron and 3,4-DCA using sentinel organism in Malaysia is limited. Thus, the need for more toxicological research on native indicator species to evaluate the potential effects of diuron and 3,4-DCA on the reproduction and early development of Javanese medaka.

1.3 Objectives of the study

Toxicological and other biological research using Javanese medaka (*Oryzias javanicus*) has increased in recent times. However, there is still a need for more toxicological studies especially on the growth, survival and reproduction which are the key factors affecting its population structure and dynamics. This species has some special features that make it a suitable aquatic vertebrate model. Reproductive and developmental toxicity studies would give insight on the population dynamics due to biotic and abiotic stressors in the environment. The major aim of this study was to evaluate the effect of diuron and its primary metabolite, 3,4-dichloroaniline (3,4-DCA) on Javanese medaka (*Oryzias javanicus*), and to strengthen its suitability as a sentinel species for monitoring the health of aquatic ecosystems of Malaysia.

The specific objectives of this study were:

1. To determine the acute toxicity of diuron and 3,4-DCA on different life stages of Javanese medaka (*Oryzias javanicus*)
2. To evaluate the effect of diuron on reproduction of Javanese medaka (*Oryzias javanicus*).
3. To determine the effect of diuron on embryonic development of Javanese medaka (*Oryzias javanicus*).
4. To evaluate the effect of 3,4-DCA on reproduction of Javanese medaka (*Oryzias javanicus*).
5. To determine the effect of 3,4-DCA on embryonic development of Javanese medaka (*Oryzias javanicus*).

1.4 Hypotheses

Hypothesis 1:

H_0: Acute toxicity of diuron and 3,4-DCA is not different between different life stages of Javanese medaka (*Oryzias javanicus*).
H_α: Acute toxicity of diuron and 3,4-DCA is different between different life stages of Javanese medaka (*Oryzias javanicus*)

Hypothesis 2:

H_0: diuron does not affect reproduction in Javanese medaka (*Oryzias javanicus*).
H_α: diuron affects the reproduction in Javanese medaka (*Oryzias javanicus*).

Hypothesis 3:

H_0 : 3,4-DCA does not affect reproduction in Javanese medaka (*Oryzias javanicus*).
H_α: 3.4-DCA affect reproduction in Javanese medaka (*Oryzias javanicus*).

Hypothesis 4:

H_0: diuron affects the early development of Javanese medaka (*Oryzias javanicus*) embryo.
H_a: diuron affects the early development of Javanese medaka (*Oryzias javanicus*) embryo.

Hypothesis 5:

H_0: 3,4-DCA affects the early development of Javanese medaka (*Oryzias javanicus*) embryo.
H_a: 3,4-DCA affects the early development of Javanese medaka (*Oryzias javanicus*) embryo.

REFERENCES

Adema, D. M. M., & Vink, I. G. (1981). A comparative study of the toxicity of 1, 1, 2-trichloroethane, dieldrin, pentachlorophenol and 3, 4-dichloroaniline for marine and freshwater organisms. *Chemosphere*,10, 533-554.

Adeogun, A. O., Ibor, O. R., Imiuwa, M. E., Omogbemi, E. D., Chukwuka, A. V., Omiwole, R. A., & Arukwe, A. (2018). Endocrine disruptor responses in African sharptooth catfish (*Clarias gariepinus*) exposed to di-(2-ethylhexyl)-phthalate. *Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology*, 213, 7-18.

Agathokleous, E., Kitao, M., & Calabrese, E. J. (2018). Environmental hormesis and its fundamental biological basis: rewriting the history of toxicology. *Environmental research*, 165, 274-278.

Ajani, F., & Awogbade, A. A. (2012). Hematological Changes of the African Catfish *Clarias gariepinus* (Burchell, 1822) Juveniles Induced by Diuron. *Biotechnology Journal International*, 247-256.

Akcha, F., Spagnol, C., & Rouxel, J. (2012). Genotoxicity of diuron and glyphosate in oyster spermatozoa and embryos. *Aquatic Toxicology*, 106, 104-113.

Alker, A. P., Smith, G. W., & Kim, K. (2001). Characterization of *Aspergillus sydowii* (Thom et Church), a fungal pathogen of Caribbean sea fan corals. *Hydrobiologia*, 460, 105-111.

Allner, B. (1997). Toxikokinetik von 3, 4-Dichloranilin beim dreistacheligen Stichling (*Gasterosteus aculeatus*) unter besonderer Beru¨cksichtigung der Fortpflanzungsphysiologie. Dissertation, Johann Gutenberg-Universita¨t, Mainz.

Al-Shaalan, N. H., Ali, I., ALOthman, Z. A., Al-Wahaibi, L. H., & Alabdulmonem, H. (2019). High performance removal and simulation studies of diuron pesticide in water on MWCNTs. *Journal of Molecular Liquids*, 289, 111039.

Alzieu, C. (2000). Environmental impact of TBT: the French experience. *Science of the Total Environment*, 258, 99-102.

Amal, M. N. A., Roseli, M. F. A. M., Sutra, J., Roslan, S., Mazlan, S. N. K., Basri, L., … Nasruddin, N. S. (2019). Javanese Medaka (*Oryzias javanicus* Bleeker, 1854) as Potential Model Organism for Aeromoniasis and Vibriosis Study in Fish. *Pertanika Journal of Tropical Agricultural Science*, 42, 1049–1065.

Amal, M. N. A., Zarif, S. T., Suhaiba, M. S., Aidil, M. R. M., Shaqinah, N. N., Zamri-Saad, M., & Ismail, A. (2018). The effects of fish gender on susceptibility to acute *Streptococcus agalactiae* infection in Javanese medaka *Oryzias javanicus*. *Microbial Pathogenesis*, 114, 251-254.

Andersen, H. R., Wollenberger, L., Halling-Sørensen, B., & Kusk, K. O. (2001). Development of copepod nauplii to copepodites—a parameter for chronic toxicity including endocrine disruption. *Environmental Toxicology and Chemistry: An International Journal*, 20, 2821-2829.

Anderson, B., & Phillips, B. (2016). Saltwater Toxicity Tests. In *Marine Ecotoxicology* (pp. 167-197). Academic Press.

Angel, J. R. J., Vinay, T. N., Raghavan, R., Thomas, D., Satheesha Avunje, A. R., Shekhar, M. S., & Vijayan, K. K. (2019). First record of the Javanese ricefish, *Oryzias javanicus* (Bleeker, 1854) (Beloniformes: Adrianichthyidae) in the natural waters of India.

Ankley, G. T., & Jensen, K. M. (2014). A novel framework for interpretation of data from the fish short-term reproduction assay (FSTRA) for the detection of endocrine-disrupting chemicals. *Environmental Toxicology and Chemistry*, 33, 2529-2540.

Arai, T., Harino, H., Ohji, M., & Langston, W. J. (Eds.). (2009). *Ecotoxicology of Antifouling Biocides*. Springer Japan.

Araújo, F. G., Morado, C. N., Parente, T. T. E., Paumgartten, F. J., & Gomes, I. D. (2018). Biomarkers and bioindicators of the environmental condition using a fish species (*Pimelodus maculatus* Lacepède, 1803) in a tropical reservoir in Southeastern Brazil. *Brazilian Journal of Biology*, 78, 351-359.

Arcand-Hoy, L. D., & Benson, W. H. (1998). Fish reproduction: an ecologically relevant indicator of endocrine disruption. *Environmental Toxicology and Chemistry: An International Journal*, 17, 49-57.

Arellano-Aguilar, O., & Macias Garcia, C. (2009). Effects of methyl parathion exposure on development and reproduction in the viviparous fish *Girardinichthys multiradiatus*. *Environmental Toxicology: An International Journal,* 24, 178-186.

Arnold L.M, Lin D.T, Schultz, T.W. (1990). QSAR for methyl- and/or chloro-substituted anilines and the polar narcosis mechanism of toxicity. *Chemosphere* .183–191.

Arukwe, A. (2001). Cellular and molecular responses to endocrine-modulators and the impact on fish reproduction. *Marine Pollution Bulletin,* 42, 643-655.

Assas, M., Qiu, X., Chen, K., Ogawa, H., Xu, H., Shimasaki, Y., & Oshima, Y. (2020). Bioaccumulation and reproductive effects of fluorescent microplastics in medaka fish. *Marine Pollution Bulletin,* 158, 111446.

ASTM, (2012). Standard guide for conducting sexual reproduction tests with seaweeds. E1498e92. In: Annual Book of American Society of Testing and Materials Standards, Vol. 11.06. West Conshohocken, PA, USA.

Aziz, F. Z., Zulkifli, S. Z., Mohamat-Yusuff, F., Azmai, M. N. A., & Ismail, A. (2017). A histological study on mercury-induced gonadal impairment in Javanese medaka (*Oryzias javanicus*). *Turkish Journal of Fisheries and Aquatic Sciences*, 17, 621-627.

Baer, K. (1991). 'Static, Acute, 96-hour LC50 of DPX-14740-165 (KARMEX DF) to Rainbow Trout (*Oncorhynchus mykiss*)', Report No. HLR 464-91. Haskell Laboratory for Toxicology and Industrial Medicine. 23 September 1991.

Bagheri, D., & Koyama, J. (2016). Effects of Benzo (a) Pyrene on Ethoxyresorufin-O-deethylase (EROD) Activity and Genomic Damage in Java Medaka (*Oryzias Javanicus*). ISMJ, 19, 787-798.

Bahamonde, P. A., Munkittrick, K. R., & Martyniuk, C. J. (2013). Intersex in teleost fish: are we distinguishing endocrine disruption from natural phenomena?. *General and Comparative Endocrinology*, 192, 25-35.

Bai, J., Han, H., Wang, F., Su, L., Ding, H., Hu, X. ... & Li, Y. (2017). Maternal linuron exposure alters testicular development in male offspring rats at the whole genome level. *Toxicology*, 389, 13-20.

Bannister, J. V. (1976). The length-weight relationship, condition factor and gut contents of the dolphin-fish *Coryphaena hippurus* (L.) in the Mediterranean. *Journal of Fish Biology*, 9, 335-338.

Bao, V. W., Leung, K. M., Qiu, J. W., & Lam, M. H. (2011). Acute toxicities of five commonly used antifouling booster biocides to selected subtropical and cosmopolitan marine species. *Marine Pollution Bulletin*, *62*(5), 1147-1151.

Batista-Andrade, J. A., Caldas, S. S., de Oliveira Arias, J. L., Castro, I. B., Fillmann, G., & Primel, E. G. (2016). Antifouling booster biocides in coastal waters of Panama: first appraisal in one of the busiest shipping zones. *Marine Pollution Bulletin*, 112, 415-419.

Baumann, L., Holbech, H., Keiter, S., Kinnberg, K. L., Knörr, S., Nagel, T., & Braunbeck, T. (2013). The maturity index as a tool to facilitate the interpretation of changes in Vitellogenin production and sex ratio in the Fish Sexual Development Test. *Aquatic Toxicology*, 128, 34-42.

Becker, B., Görge, G., Kalsch, W., & Zock, A. (1990). Aufnahme, Metabolismus, Elimination und Toxizität von aromatischen Aminen bei Zebrabärblingen. *UBA-Forschungsvorhaben*,106, 053.

Behrens, D., Rouxel, J., Burgeot, T., & Akcha, F. (2016). Comparative embryotoxicity and genotoxicity of the herbicide diuron and its metabolites in early life stages of *Crassostrea gigas*: implication of reactive oxygen species production. *Aquatic Toxicology*, 175, 249-259.

Belanger, S. E., Rawlings, J. M., & Carr, G. J. (2013). Use of fish embryo toxicity tests for the prediction of acute fish toxicity to chemicals. *Environmental Toxicology and Chemistry*, 32, 1768-1783.

Bellas, J., Beiras, R., Marino-Balsa, J. C., & Fernández, N. (2005). Toxicity of organic compounds to marine invertebrate embryos and larvae: a comparison between the sea urchin embryogenesis bioassay and alternative test species. *Ecotoxicology*, 14, 337.

Berg, H., Modig, C., & Olsson, P. E. (2004). 17beta-estradiol induced vitellogenesis is inhibited by cortisol at the post-transcriptional level in Arctic char (*Salvelinus alpinus*). *Reproductive Biology and Endocrinology*, 2, 62.

Bernardes, M. F. F., Maschio, L. R., de Azeredo-Oliveira, M. T. V., & de Almeida, E. A. (2015). The use of biomarkers to study the effects of the mixture of diuron and hexazinone on small and large O. niloticus. *Ecotoxicology and Environmental Contamination*, *10*(1), 83-92.

Bhuiyan, M. N. H., Kang, H., Choi, J., Lim, S., Kho, Y., & Choi, K. (2020). Effects of 3,4-dichloroaniline (3,4-DCA) and 4,4′-methylenedianiline (4,4′-MDA) on sex hormone regulation and reproduction of adult zebrafish (*Danio rerio*). *Chemosphere*, 269.

Bhuiyan, M. N. H., Kang, H., Kim, J. H., Kim, S., Kho, Y., & Choi, K. (2019). Endocrine disruption by several aniline derivatives and related mechanisms in a human adrenal H295R cell line and adult male zebrafish. *Ecotoxicology and Environmental Safety*, 180, 326-332.

Bhuiyan, M. N.H., Kang, H., Kim, J. H., Kim, S., Kho, Y., & Choi, K. (2019). Endocrine disruption by several aniline derivatives and related mechanisms in a human adrenal H295R cell line and adult male zebrafish. *Ecotoxicology and Environmental Safety,* 180(February), 326–332.

Birnbaum, L. S. (2012). Environmental chemicals: evaluating low-dose effects.

Bleeker, P. (1854). Ichthyological observations were made on several trips in the residence Banten. *Wet. Magazine. Ned. Ind. ,* 7, 309-326.

Bojarski, B. A. R. T. O. S. Z., Jakubiak, M., & Witeska, M. (2018). Physiological and histological effects of herbicides in fish. Annals of Warsaw University of Life Sciences-SGGW. *Animal Science*, 57.

Boscolo Pereira, T. S., Pereira Boscolo, C. N., Felício, A. A., Batlouni, S. R., Schlenk, D., & Alves de Almeida, E. (2016). Estrogenic activities of diuron metabolites in female Nile tilapia (*Orevochromis niloticus*). *Chemosphere*, 146, 497–502.

Boscolo, C. N. P., Pereira, T. S. B., Batalhão, I. G., Dourado, P. L. R., Schlenk, D., & de Almeida, E. A. (2018). Diuron metabolites act as endocrine disruptors and alter aggressive behaviour in Nile tilapia (*Oreochromis niloticus*). *Chemosphere*, 191, 832-838.

Boscolo, C. N. P., Pereira, T. S. B., Batalhão, I. G., Dourado, P. L. R., Schlenk, D., & de Almeida, E. A. (2018). Diuron metabolites act as endocrine disruptors and alter aggressive behavior in Nile tilapia (Oreochromis niloticus). *Chemosphere*, *191*, 832-838.

Braunbeck, T., & Lammer, E. (2006). Fish embryo toxicity assays. *German Federal Environment Agency*, 298.

Braunbeck, T., Kais, B., Lammer, E., Otte, J., Schneider, K., Stengel, D., & Strecker, R. (2014). The fish embryo test (FET): origin, applications, and future. *Environmental Science and Pollution Research,* 22, 16247–16261.

Bringolf, R. B., Belden, J. B., & Summerfelt, R. C. (2004). Effects of atrazine on fathead minnow in a short-term reproduction assay. *Environmental Toxicology and Chemistry: An International Journal,* 23, 1019-1025.

Brito, I. P., Tropaldi, L., Carbonari, C. A., & Velini, E. D. (2018). Hormetic effects of glyphosate on plants. *Pest management Science,* 74, 1064-1070.

BUA (1994). 2, 4-Dichloranilin, 2, 5-dichloranilin, 3, 4-dichloranilin Wissenschaftliche Verlagsgesellschaft S. Hirzel Verlag, Stuttgart.

Burkina, V., Zamaratskaia, G., Sakalli, S., Giang, P. T., Kodes, V., Grabic, R., Velisek J., J. Turek, Kolarova, J., Zlabek, V. & Randak, T. (2018). Complex effects of pollution on fish in major rivers in the Czech Republic. *Ecotoxicology and Environmental Safety*, 164, 92-99.

Burnison, B. K., Meinelt, T., Playle, R., Pietrock, M., Wienke, A., & Steinberg, C. E. (2006). Cadmium accumulation in zebrafish (*Danio rerio*) eggs is modulated by dissolved organic matter (DOM). *Aquatic Toxicology*, 79, 185-191.

Calabrese, E. J., & Baldwin, L. A. (2003). Hormesis: the dose-response revolution. *Annual Review of Pharmacology and Toxicology*, 43, 175-197.

Calabrese, E. J., & Blain, R. (2005). The occurrence of hormetic dose responses in the toxicological literature, the hormesis database: an overview. *Toxicology and Applied Pharmacology*, 202, 289-301.

Calabrese, E. J., & Blain, R. B. (2011). The hormesis database: the occurrence of hormetic dose responses in the toxicological literature. *Regulatory Toxicology and Pharmacology*, 61, 73-81.

Calabrese, E. J., & Mattson, M. P. (2017). How does hormesis impact biology, toxicology, and medicine*?*. *NPJ Aging and Mechanisms of Disease,* 3, 1-8.

Calabrese, E. J., Bhatia, T. N., Calabrese, V., Dhawan, G., Giordano, J., Hanekamp, Y. N., Kapoor, R., Kozumbo, W.J. & Leak, R. K. (2019). Cytotoxicity models of Huntington's disease and relevance of hormetic mechanisms: A critical assessment of experimental approaches and strategies. *Pharmacological Research*, 150, 104371.

Call, D. J., Brooke, L. T., Kent, R. J., Knuth, M. L., Poirier, S. H., Huot, J. M., & Lima, A. R. (1987a). Bromacil and diuron herbicides: toxicity, uptake, and elimination in freshwater fish. *Archives of Environmental Contamination and Toxicology*, 16, 607-613.

Call, D. J., Poirier, S. H., Knuth, M. L., Harting, S. L., & Lindberg, C. A. (1987b). Toxicity of 3, 4-dichloroaniline to fathead minnows, *Pimephales promelas*, in acute and early life-stage exposures. *Bulletin of Environmental Contamination and Toxicology*,38, 352-358.

Cao, F., Souders, C. L., Li, P., Pang, S., Qiu, L., & Martyniuk, C. J. (2019). Developmental toxicity of the triazole fungicide cyproconazole in embryo-larval stages of zebrafish (*Danio rerio*). *Environmental Science and Pollution Research*, 26, 4913–4923.

Cao, Q., Gu, J., Wang, D., Liang, F., Zhang, H., Li, X., & Yin, S. (2018). Physiological mechanism of osmoregulatory adaptation in anguillid eels. *Fish Physiology and Biochemistry,* 44, 423–433.

Carbajal-Hernández, A. L., Valerio-García, R. C., Martínez-Ruíz, E. B., Jarquín-Díaz, V. H., & Martínez-Jerónimo, F. (2017). Maternal-embryonic metabolic and antioxidant response of Chapalichthys pardalis (Teleostei: Goodeidae) induced by exposure to 3,4-dichloroaniline. *Environmental Science and Pollution Research,* 24, 17534–17546.

Carducci, F., Biscotti, M. A., & Canapa, A. (2019). Vitellogenin gene family in vertebrates: evolution and functions. The European *Zoological Journal*, 86, 233-240.

Carena, L., Proto, M., Minella, M., Ghigo, G., Giovannoli, C., Brigante, M., Mailhot, G., Maurino, V., Minero, C. & Vione, D. (2018). Evidence of an important role of photochemistry in the attenuation of the secondary contaminant 3, 4-dichloroaniline in paddy water. *Environmental science & Technology*, 52, 6334-6342.

Carnevali, O., Santangeli, S., Forner-Piquer, I., Basili, D., & Maradonna, F. (2018). Endocrine-disrupting chemicals in aquatic environment: what are the risks for fish gametes?. *Fish Physiology and Biochemistry,* 44, 1561-1576.

Carson R. (1962). *Silent Spring*, Houghton Mifflin, Boston, Mass, USA.

Carvan III, M. J. (2007). Fish models in toxicology. *Zebrafish*, *4*(1), 9-20.

Castro, Í. B., Arroyo, M. F., Costa, P. G., & Fillmann, G. (2012). Butyltin compounds and imposex levels in Ecuador. *Archives of Environmental Contamination and Toxicology*, 62, 68-77.

Castro, Í. B., Westphal, E., & Fillmann, G. (2011). Third generation antifouling paints: new biocides in the aquatic environment. *Química Nova*, 34, 1021-1031.

Celino-Brady, F. T., Petro-Sakuma, C. K., Breves, J. P., Lerner, D. T., & Seale, A. P. (2019). Early-life exposure to 17β-estradiol and 4-nonylphenol impacts the growth hormone/insulin-like growth-factor system and estrogen receptors in Mozambique tilapia, *Oreochromis mossambicus*. *Aquatic Toxicology*, 217, 105336.

Cheikyula, J., Koyama, J., & Uno, S. (2008). Bioaccumulation of dietary polycyclic aromatic hydrocarbons and EROD induction in the red sea bream and Java medaka. *Japanese Journal of Environmental Toxicology,* 11, 99-115.

Chen, T., Chou, S., Tang, C., Chen, C., Meng, P., Ko, F., & Cheng, J. (2016). Endocrine disrupting effects of domestic wastewater on reproduction, sexual behavior , and gene expression in the brackish medaka *Oryzias melastigma*. *Chemosphere*, 1–10.

Coelho-Moreira, J. D. S., Bracht, A., Souza, A. C. D. S. D., Oliveira, R. F., Sá-Nakanishi, A. B. D., Souza, C. G. M. D., & Peralta, R. M. (2013). Degradation of diuron by Phanerochaete chrysosporium: role of ligninolytic enzymes and cytochrome P450. *BioMed Research International*, 2013.

Cole, R. F., Mills, G. A., Parker, R., Bolam, T., Birchenough, A., Kröger, S., & Fones, G. R. (2015). Trends in the analysis and monitoring of organotins in the aquatic environment. *Trends in Environmental Analytical Chemistry*, 8, 1-11.

Cresswell, T., Richards, J. P., Glegg, G. A., & Readman, J. W. (2006). The impact of legislation on the usage and environmental concentrations of Irgarol 1051 in UK coastal waters. *Marine Pollution Bulletin*, 52, 1169-1175.

Crollius, H. R., & Weissenbach, J. (2005). Fish genomics and biology. *Genome Research*, 15, 1675-1682.

Crossland, N. O. (1990). A review of the fate and toxicity of 3, 4-dichloroaniline in aquatic environments. *Chemosphere*,21, 1489-1497.

Crossland, N. O., & Hillaby, J. M. (1985). Fate and effects of 3, 4-dichloroaniline in the laboratory and in outdoor ponds: II. Chronic toxicity to Daphnia SPP. and other invertebrates. *Environmental Toxicology and Chemistry: An International Journal,* 4, 489-499.

Cunha, I., Torres, T., Oliveira, H., Martins, R., McGowan, T., Sheahan, D., & Santos, M. M. (2017). Using early life stages of marine animals to screen the toxicity of priority hazardous and noxious substances. *Environmental Science and Pollution Research*, 24, 10510-10518).

Dafforn, K. A., Lewis, J. A., & Johnston, E. L. (2011). Antifouling strategies: history and regulation, ecological impacts and mitigation. *Marine Pollution Bulletin*, 62, 453-465.

Dahl, B., & Blanck, H. (1996). Toxic effects of the antifouling agent Irgarol 1051 on periphyton communities in coastal water microcosms. *Marine Pollution Bulletin*, 32, 342-350.

Dallinger, R., Berger, B., Gruber, C., Hunziker, P., & Stürzenbaum, S. (2000). Metallothioneins in terrestrial invertebrates: structural aspects, biological significance and implications for their use as biomarkers. *Cellular and Molecular Biology*. Noisy-le-Grand, France, 46, 331-346.

Darbre, P. D. (Ed.). (2015). Endocrine disruption and human health. Academic Press.

Dawson, D. A., Scott, B. D., Ellenberger, M. J., Pöch, G., & Rinaldi, A. C. (2004). Evaluation of dose-response curve analysis in delineating shared or different molecular sites of action for osteolathyrogens. *Environmental Toxicology and Pharmacology*, 16, 13-23.

De Coster, S., & Van Larebeke, N. (2012). Endocrine-disrupting chemicals: associated disorders and mechanisms of action. *Journal of Environmental and Public Health*, 2012.

De Oliveira, E. C., Auache-Filho, A. A., Damasio, D., de Castilhos Ghisi, N., & Michels-Souza, M. A. (2019). Reproductive indicators of the endemic species *Astyanax bifasciatus* (Teleostei: Characidae) in a tributary of the Lower Iguaçu River Basin, Brazil. Acta Scientiarum. *Biological Sciences*, 41, e47720-e47720.

Dearfield, K. L., McCarroll, N. E., Protzel, A., Stack, H. F., Jackson, M. A., & Waters, M. D. (1999). A survey of EPA/OPP and open literature on selected pesticide chemicals: II. Mutagenicity and carcinogenicity of selected chloroacetanilides and related compounds. *Mutation Research/Genetic Toxicology and Environmental Mutagenesis*, 443, 183-221.

DeCourten, B. M., Connon, R. E., & Brander, S. M. (2019). Direct and indirect parental exposure to endocrine disruptors and elevated temperature influences gene expression across generations in a euryhaline model fish. *PeerJ*, 7, e6156.

Dehnert, G. K., Freitas, M. B., Sharma, P. P., Barry, T. P., & Karasov, W. H. (2020). Impacts of subchronic exposure to a commercial 2,4-D herbicide on developmental stages of multiple freshwater fish species. *Chemosphere*, 263, 127638.

Dehnert, G. K., Karasov, W. H., & Wolman, M. A. (2019). 2,4-Dichlorophenoxyacetic acid containing herbicide impairs essential visually guided behaviors of larval fish. *Aquatic Toxicology*, 209, 1-12.

Denslow, N., & Sepúlveda, M. (2007). Ecotoxicological effects of endocrine disrupting compounds on fish reproduction. In The Fish Oocyte (pp. 255-322). *Springer*, Dordrecht.

Diamanti-Kandarakis, E., Bourguignon, J. P., Giudice, L. C., Hauser, R., Prins, G. S., Soto, A. M., ... & Gore, A. C. (2009). Endocrine-disrupting chemicals: an Endocrine Society scientific statement. *Endocrine Reviews*, 30, 293-342.

Dilipkumar, M., Chuah, T. S., Goh, S. S., & Sahid, I. (2017). Weed management issues, challenges, and opportunities in Malaysia. *Crop Protection*.

Du Gas, L. M., Ross, P. S., Walker, J., Marlatt, V. L., & Kennedy, C. J. (2017). Effects of atrazine and chlorothalonil on the reproductive success, development, and growth of early life stage sockeye salmon (*Oncorhynchus nerka). Environmental Toxicology and Chemistry*, 36, 1354-1364.

Dupraz, V., Coquillé, N., Ménard, D., Sussarellu, R., Haugarreau, L., & Stachowski-Haberkorn, S. (2016). Microalgal sensitivity varies between a diuron-resistant strain and two wild strains when exposed to diuron and irgarol, alone and in mixtures. *Chemosphere*, 151, 241-252.

Dupret, J.M., Cocaign, A., Mougin, C., Rodrigues-Lima, F., Busi, F., Dairou, J., Martins, M. & Silar, P. (2011). Pesticide-derived aromatic amines and their biotransformation. In *Pesticides in the Modern World-Pests Control and Pesticides Exposure and Toxicity Assessment*. IntechOpen.

Eissa, F. I., Makawy, A. I., Badr, M. I., & Elhamalawy, O. H. (2012). Assessment of 3,4-Dichloroaniline Toxicity as Environmental Pollutant in Male Mice. *European Journal of Biological Sciences*, 4, 73-82.

EMJRC (2017). Comparison of fish acute toxicity tests using zebrafish reports from China, Japan and Korea. 3,4-Dichloroaniline. *Expert Meeting of Joint Research for Chemicals between China, Japan and Korea*.

European Commission (2012). Addressing the New Challenges for Risk Assessment. 10.2772/37863.

European Parliament and Council (1998) Directive 98/8/EC of the European Parliament and of the Council of 16 February 1998 concerning the placing of biocidal products on the market. *98/8/EC*, Brussels.

European Union (2006). European Union Risk Assessment Report 65: 3,4-dichloroaniline

Feist, S. W., Stentiford, G. D., Kent, M. L., Santos, A. R., & Lorance, P. (2015). Histopathological assessment of liver and gonad pathology in continental slope fish from the northeast Atlantic Ocean. *Marine Environmental Research*, 106, 42-50.

Felício, A. A., Freitas, J. S., Scarin, J. B., de Souza Ondei, L., Teresa, F. B., Schlenk, D., & de Almeida, E. A. (2018). Isolated and mixed effects of diuron and its metabolites on biotransformation enzymes and oxidative stress response of Nile tilapia (*Oreochromis niloticus*). *Ecotoxicology and Environmental Safety*, 149, 248-256.

Fenske, M., Maack, G., Schäfers, C., & Segner, H. (2005). An environmentally relevant concentration of estrogen induces arrest of male gonad development in zebrafish, *Danio rerio*. *Environmental Toxicology and Chemistry: An International Journal*, 24, 1088-1098.

Ferreira, M. F., Nostro, F. L., Honji, R., Ansaldo, M., & Genovese, G. (2019). Endocrine and reproductive endpoints of Notothenia Rossii and N. coriiceps: A baseline study for ecotoxicological monitoring in Antarctic waters. *Marine Pollution Bulletin*, 145, 418-428.

Field, J. A., Reed, R. L., Sawyer, T. E., Griffith, S. M., & Wigington, P. J. (2003). Diuron occurrence and distribution in soil and surface and groundwater associated with grass seed production. *Journal of Environmental Quality*, 32, 171-179.

Fields, S., & Johnston, M. (2005). Whither model organism research. Science, 307(5717), 1885-1886.

Finn, R. N., & Kapoor, B. G. (2008). *Fish larval physiology*.

Finney, D. J. (1971). Probit analysis, Cambridge University Press. Cambridge, UK.

Foekema, E. M., Deerenberg, C. M., & Murk, A. J. (2008). Prolonged ELS test with the marine flatfish sole (*Solea solea*) shows delayed toxic effects of previous exposure to PCB 126. *Aquatic Toxicology*, 90, 197-203.

Forsman, A., Tibblin, P., Berggren, H., Nordahl, O., Koch-Schmidt, P., & Larsson, P. (2015). Pike *Esox lucius* as an emerging model organism for studies in ecology and evolutionary biology: a review. *Journal of Fish Biology*, 87, 472-479.

Gaaied, S., Oliveira, M., Le Bihanic, F., Cachot, J., & Banni, M. (2019). Gene expression patterns and related enzymatic activities of detoxification and oxidative stress systems in zebrafish larvae exposed to the 2,4-dichlorophenoxyacetic acid herbicide. *Chemosphere*, 224, 289-297.

Gallagher, E. P., Goksøyr, A., Hahn, M. E., & Larsson, D. G. (2007). Fish models in toxicology. *Zebrafish*, 4, 9-20.

Gallego, V., & Asturiano, J. F. (2019). Fish sperm motility assessment as a tool for aquaculture research: a historical approach. *Reviews in Aquaculture*, 11, 697-724.

Genovese, G., Regueira, M., Da Cuña, R. H., Ferreira, M. F., Varela, M. L., & Nostro, F. L. (2014). Nonmonotonic response of Vitellogenin and estrogen receptor α gene expression after octylphenol exposure of *Cichlasoma dimerus* (Perciformes, Cichlidae). *Aquatic toxicology*, 156, 30-40.

Giacomazzi, S., & Cochet, N. (2004). Environmental impact of diuron transformation: a review. *Chemosphere*, 56, 1021-1032.

Giari, L., Simoni, E., Manera, M., & Dezfuli, B. S. (2008). Histo-cytological responses of *Dicentrarchus labrax* (L.) following mercury exposure. *Ecotoxicology and Environmental safety*, 70, 400-410.

Gilannejad, N., Dorafshan, S., Heyrati, F.P., Soofiani, N.M., Asadollah, S., Martos-Sitcha, J.A., Prat, F., Yúfera, M. & Martínez-Rodríguez, G., (2016). Vitellogenin expression in wild cyprinid *Petroleuciscus esfahani* as a biomarker of endocrine disruption along the Zayandeh Roud River, Iran. *Chemosphere*, 144, 1342-1350.

Glinka, C. O., Frasca, S., Provatas, A. A., Lama, T., DeGuise, S., & Bosker, T. (2015). The effects of model androgen 5α-dihydrotestosterone on Mummichog (*Fundulus heteroclitus*) reproduction under different salinities. Aquatic Toxicology, 165, 266–276.

Godfrey, A., Hooser, B., Abdelmoneim, A., Horzmann, K. A., Freemanc, J. L., & Sepúlveda, M. S. (2017). Thyroid disrupting effects of halogenated and next generation chemicals on the swim bladder development of zebrafish. *Aquatic Toxicology*, 193, 228-235.

Gonsioroski, A., Mourikes, V. E., & Flaws, J. A. (2020). Endocrine Disruptors in Water and Their Effects on the Reproductive System. *International Journal of Molecular Sciences,* 21, 1929.

Google Earth (2018). "Sepang" 2°37'15.38''N, 101°42'38.33''E". Google Earth. November 26, 2018. July 14, 2018.

Govind, P. (2011). Model organisms used in molecular biology or medical research. *International Research Journal of Pharmacy*, 2 , 62-65.

Guo, D., Wang, Y., Qian, Y., Chen, C., Jiao, B., Cai, L., & Wang, Q. (2017). Joint acute and endocrine disruptive toxicities of malathion, cypermethrin and prochloraz to embryo-larval zebrafish, *Danio rerio*. *Chemosphere*, 166, 63-71

Gupta, R. C. (Ed.). (2019). *Biomarkers in toxicology*. Academic Press.

Hakim, M. L., Nugroho, B., Nurrohman, M. N., Suastika, I. K., & Utama, I. K. A. P. (2019). Investigation of fuel consumption on an operating ship due to biofouling growth and quality of anti-fouling coating. In *IOP Conference Series: Earth and Environmental Science* (Vol. 339, No. 1, p. 012037). IOP Publishing.

Hanapiah, M., Zulkifli, S. Z., Mustafa, M., Mohamat-Yusuff, F., & Ismail, A. (2018). Isolation, characterization, and identification of potential Diuron-degrading bacteria from surface sediments of Port Klang, Malaysia. *Marine Pollution Bulletin*, 127, 453-457.

Handy, R. D., & Depledge, M. H. (1999). Physiological responses: their measurement and use as environmental biomarkers in ecotoxicology. *Ecotoxicology*, 8, 329-349.

Hara, A., Hiramatsu, N., & Fujita, T. (2016). Vitellogenesis and choriogenesis in fishes. Fisheries science, 82, 187-202.

Harino, H., Arai, T., Ohji, M., Ismail, A. B., & Miyazaki, N. (2009). Contamination profiles of antifouling biocides in selected coastal regions of Malaysia. *Archives of Environmental Contamination and Toxicology*, 56, 468-478.

Harino, H., Arifin, Z., Rumengan, I. F., Arai, T., Ohji, M., & Miyazaki, N. (2012). Distribution of antifouling biocides and perfluoroalkyl compounds in sediments from selected locations in Indonesian coastal waters. *Archives of Environmental Contamination and Toxicology*, 63, 13-21.

Harino, H., Ohji, M., Wattayakorn, G., Arai, T., Rungsupa, S., & Miyazaki, N. (2006). Occurrence of antifouling biocides in sediment and green mussels from Thailand. *Archives of Environmental Contamination and Toxicology*, 51, 400-407.

Haron, M. H., Powe, D., Khan, I. A., & Dasmahapatra, A. K. (2012). Feasibility of medaka (*Oryzias latipes*) as an animal model to study fetal alcohol spectrum disorder. *In Advances in Molecular Toxicology* (Vol. 6, pp. 77-128). Elsevier.

Harvey, P.J., Campanella, B.F., Castro, P.M., Harms, H., Lichtfouse, E., Schäffner, A.R., Smrcek, S. & Werck-Reichhart, D. (2002). Phytoremediation of polyaromatic hydrocarbons, anilines and phenols. *Environmental Science and Pollution Research*, 9, 29-47.

Hasanuzzaman, M., Mohsin, S. M., Bhuyan, M. B., Bhuiyan, T. F., Anee, T. I., Masud, A. A. C., & Nahar, K. (2020). Phytotoxicity, environmental and health hazards of herbicides: challenges and ways forward. *In Agrochemicals Detection, Treatment and Remediation* (pp. 55-99). Butterworth-Heinemann.

Hassanien, A. E., El-Bendary, N., Sweidan, A. H., Mohamed, A. E. K., & Hegazy, O. M. (2016). Hybrid-biomarker case-based reasoning system for water pollution assessment in Abou Hammad Sharkia, Egypt. *Applied Soft Computing*, 46, 1043-1055.

Hiramatsu, N., Cheek, A. O., Sullivan, C. V., Matsubara, T., & Hara, A. (2005). Vitellogenesis and endocrine disruption. *In Biochemistry and Molecular Biology of Fishes* (Vol. 6, pp. 431-471). Elsevier.

Hiramatsu, N., Matsubara, T., Fujita, T., Sullivan, C. V., & Hara, A. (2006). Multiple piscine vitellogenins: biomarkers of fish exposure to estrogenic endocrine disruptors in aquatic environments. *Marine Biology*, 149, 35-47.

Hodson, P. V. (1985). A comparison of the acute toxicity of chemicals to fish, rats and mice. *Journal of Applied Toxicology*, 5, 220-226.

Horie, Y., Kanazawa, N., Yamagishi, T., Yonekura, K., & Tatarazako, N. (2018). Ecotoxicological test assay using OECD TG 212 in marine Java medaka (*Oryzias javanicus*) and freshwater Japanese medaka (*Oryzias latipes*). *Bulletin of Environmental Contamination and Toxicology*, 101, 344-348.

https://pubchem.ncbi.nlm.nih.gov/compound/3_4-Dichloroaniline (accessed on Dec. 25, 2019).

Hunter, P. (2008). The paradox of model organisms. EMBO reports 9, 717-720.

Huovinen, M., Loikkanen, J., Naarala, J., & Vähäkangas, K. (2015). Toxicity of diuron in human cancer cells. *Toxicology in vitro*, 29, 1577-1586.

Ibrahim, M. A., Zulkifli, S. Z., Azmai, M. N. A., Mohamat-Yusuff, F., & Ismail, A. (2020). Embryonic toxicity of 3,4-dichloroaniline (3,4-DCA) on Javanese medaka (*Oryzias javanicus,* Bleeker, 1854). *Toxicology Reports*, 7, 1039-1045.

Imai, S., Koyama, J., & Fujii, K. (2005). Effects of 17β-estradiol on the reproduction of Java-medaka (*Oryzias javanicus*), a new test fish species. *Marine Pollution Bulletin*, 51, 708-714.

Imai, S., Koyama, J., & Fujii, K. (2007). Effects of estrone on full life cycle of Java medaka (*Oryzias javanicus*), a new marine test fish. *Environmental Toxicology and Chemistry: An International Journal*, 26, 726-731.

Inoue, K., & Takei, Y. (2002). Diverse adaptability in Oryzias species to high environmental salinity. *Zoological Science*, 19, 727-734.

Ishikawa, Y. (2000). Medaka fish as a model system for vertebrate developmental genetics. *Bioessays*, 22, 487-495.

Ito, Y., Matsuda, Y., & Suzuki, T. (2010). Effects of 3, 4-dichloroaniline on expression of ahr2 and cyp1a1 in zebrafish adults and embryos. *Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology*, 152, 189-194.

Iwamatsu, T. (2004). Stages of normal development in the medaka Oryzias latipes. Mechanisms of Development, 121, 605-618.

Iwamatsu, T., Fluck, R. A., & Mori, T. (1993). Mechanical dechorionation of fertilized eggs for experimental embryology in the medaka. *Zoological Science*, 10, 945-951.

Iwamatsu, T., Hirata, K., (1984). Normal course of development of the Java medaka, *Oryzias javanicus*. *Bull. Aichi. Univ. Educ*. 33, 87–109.

Jiang, W., Fang, J., Gao, Y., Du, M., Fang, J., Wang, X., Li, F., Lin, F. and Jiang, Z. (2019). Biomarkers responses in Manila clam, *Ruditapes philippinarum* after single and combined exposure to mercury and benzo [a] pyrene. *Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology*, 220, 1-8.

Johnson, R., Wolf, J., & Braunbeck, T. (2009). OECD guidance document for the diagnosis of endocrine-related histopathology of fish gonads. *Organization for Economic Co-operation and Development,* 96.

Jones, P. D., De Coen, W. M., Tremblay, L., & Giesy, J. P. (2000). Vitellogenin as a biomarker for environmental estrogens. *Water Science and Technology*, 42(7-8), 1-14.

Kamarudin, N. A., Zulkifli, S. Z., Abd-Aziz, F. Z. A., & Ismail, A. (2019). Histological Alterations in Liver and Kidney of Javanese Medaka (*Oryzias javanicus*, Bleeker 1854) Exposed to Sublethal Concentration of Herbicide Diuron. *Pertanika Journal of Science & Technology*, 27.

Kamarudin, N. A., Zulkifli, S. Z., Azmai, M. N. A., Abd-Aziz, F. Z. A., & Ismail, A. (2020). Herbicide diuron as endocrine disrupting chemicals (EDCs) through histopathalogical analysis in gonads of Javanese medaka (*Oryzias javanicus*, Bleeker 1854). *Animals*, 10 525.

Kao, C. M., Ou, W. J., Lin, H. D., Eva, A. W., Wang, T. L., & Chen, S. C. (2019). Toxicity of diuron in HepG2 cells and zebrafish embryos. *Ecotoxicology and Environmental Safety*, 172, 432-438.

Karami, A., Romano, N., Hamzah, H., Simpson, S. L., & Yap, C. K. (2016). Acute phenanthrene toxicity to juvenile diploid and triploid African catfish (*Clarias gariepinus*): Molecular, biochemical, and histopathological alterations. *Environmental Pollution,* 212, 155-165.

Kasahara, M., Naruse, K., Sasaki, S., Nakatani, Y., Qu, W., Ahsan, B., Yamada, T., Nagayasu, Y., Doi, K., Kasai, Y., Jindo, T., Kobayashi, D., Shimada, A., Toyoda, A., Kuroki, Y., Fujiyama, A., Sasaki, T., Shimizu, A., Asakawa, S., Shimizu, N., Hashimoto, S.I., Yang, J., Lee, Y., Matsushima, K., Sugano, S., Sakaizumi, M., Narita, T., Ohishi, K., Haga, S., Ohta, F., Nomoto, H., Nogata, K., Morishita, T., Endo, T., Shin-I, T., Takeda, H., Morishita, S., Kohara, Y. (2007).The medaka draft genome and insights into vertebrate genome evolution. *Nature*. London, 447:714–719.

Kawasaki, T., Saito, K., Deguchi, T., Fujimori, K., Tadokoro, M., Yuba, S., Ohgushi, H., & Kawarabayasi, Y. (2008). Pharmacological characterization of isoproterenol-treated medaka fish. *Pharmacological Research*, 58, 348-355.

Kellock, K. A., Moore, A. P., & Bringolf, R. B. (2018). Chronic nitrate exposure alters reproductive physiology in fathead minnows. *Environmental Pollution*, 232, 322-328.

Kennedy, C. J., Osachoff, H. L., & Shelley, L. K. (2013). Estrogenic endocrine disrupting chemicals in fish. *In Fish physiology* (Vol. 33, pp. 257-307). Academic Press.

Ketata, I., Denier, X., Hamza-Chaffai, A., & Minier, C. (2008). Endocrine-related reproductive effects in molluscs. *Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology*, 147, 261-270.

Khodadoust, D., Ismail, A., & Zulkifli, S.Z. (2012). Application of Java Medaka (*Oryzias javanicus*) Fish and Surface Sediments to Assess Cd and Cu Contamination in Linggi Estuary, Malaysia. *Acta Biologica Malaysiana*, 1, 46-54.

Khodadoust, D., Ismail, A., Zulkifli, S. Z., & Tayefeh, F. H. (2013). Short time effect of cadmium on juveniles and adults of Java medaka (*Oryzias javanicus*) fish as a bioindicator for ecotoxicological studies. *Life Science Journal*, 10, 1857-1861.

Kim, B. M., Kim, J., Choi, I. Y., Raisuddin, S., Au, D. W., Leung, K. M., Wu, R.S., Rhee, J.S., & Lee, J. S. (2016a). Omics of the marine medaka (*Oryzias melastigma*) and its relevance to marine environmental research. *Marine Environmental Research*, 113, 141-152.

Kim, K. T., & Tanguay, R. L. (2014). The role of chorion on toxicity of silver nanoparticles in the embryonic zebrafish assay. *Environmental Health and Toxicology*, 29.

Kim, Y. J., Lee, N., Woo, S., Ryu, J. C., & Yum, S. (2016b). Transcriptomic change as evidence for cadmium-induced endocrine disruption in marine fish model of medaka, *Oryzias javanicus*. *Molecular & Cellular Toxicology*, 12, 409-420.

King-Heiden, T. C., Mehta, V., Xiong, K. M., Lanham, K. A., Antkiewicz, D. S., Ganser, A., ... & Peterson, R. E. (2012). Reproductive and developmental toxicity of dioxin in fish. *Molecular and Cellular Endocrinology*, 354, 121-138.

Kinoshita, M., Murata, K., Naruse, K., & Tanaka, M. (Eds.). (2009). *Medaka: Biology, Management, and Experimental Protocols*. John Wiley & Sons.

Kleinhenz, L. S., Nugegoda, D., Verspaandonk, E. R., Coombes, D. C., Howe, S., & Shimeta, J. (2016). Toxicity of an herbicide and adjuvant to saltmarsh invertebrates in the management of invasive grass; Comparative laboratory and field tests. *Marine Pollution Bulletin,* 109, 334-343.

Kowalska, A., Siwicki, A. K., & Kowalski, R. K. (2017). Dietary resveratrol improves immunity but reduces reproduction of broodstock medaka *Oryzias latipes* (Temminck & Schlegel). *Fish Physiology and Biochemistry,* 43, 27-37.

Koyama, J., Kawamata, M., Imai, S., Fukunaga, M., Uno, S., & Kakuno, A. (2008). Java medaka: a proposed new marine test fish for ecotoxicology. *Environmental Toxicology: An International Journal,* 23, 487-491.

Krieger, R. (2010). Hayes' handbook of pesticide toxicology (Vol. 1). Academic press. Chapter 80. P.1727.

Kroon, F., Streten, C., & Harries, S. (2017). A protocol for identifying suitable biomarkers to assess fish health: A systematic review. *PLOS one*, 12, e0174762.

Lagarde, F., Beausoleil, C., Belcher, S. M., Belzunces, L. P., Emond, C., Guerbet, M., & Rousselle, C. (2015). Non-monotonic dose-response relationships and endocrine disruptors: a qualitative method of assessment. *Environmental Health*, 14, 13.

Lambert, S. J., Thomas, K. V., & Davy, A. J. (2006). Assessment of the risk posed by the antifouling booster biocides Irgarol 1051 and diuron to freshwater macrophytes. *Chemosphere*, 63, 734-743.

Lamoree, M. H., Swart, C. P., Van der Horst, A., & Van Hattum, B. (2002). Determination of diuron and the antifouling paint biocide Irgarol 1051 in Dutch marinas and coastal waters. *Journal of Chromatography A*, 970, 183-190.

Landrigan, P. J., Fuller, R., Fisher, S., Suk, W. A., Sly, P., Chiles, T. C., & Bose-O'Reilly, S. (2019). Pollution and children's health. *Science of the Total Environment*, 650, 2389-2394.

Lazhar, M., Hela, T., Moncef, B., & Néji, A. (2012). Toxicity of three selected pesticides (Alachlor, Atrazine and Diuron) to the marine fish, turbot (*Psetta maxima*). *African Journal of Biotechnology*, 11, 11321-11328.

Lee, B. Y., Park, J. C., Kim, M. S., Choi, B. S., Kim, D. H., Lim, J. S., Yum, S., Hwang, U.K., Nah, G.J., & Lee, J. S. (2020). The genome of the Java medaka (*Oryzias javanicus*): Potential for its use in marine molecular ecotoxicology. *Marine Pollution Bulletin*, 154, 111118.

Lee, D. H., Eom, H. J., Kim, M., Jung, J. H., & Rhee, J. S. (2017). Non-target effects of antifouling agents on mortality, hatching success, and acetylcholinesterase activity in the brine shrimp *Artemia salina*. *Toxicology and Environmental Health Sciences*, 9, 237-243.

Lei, B., Wen, Y., Wang, X., Zha, J., Li, W., Wang, Z., Sun, Y., Kang, J., & Wang, Y. (2013). Effects of estrone on the early life stages and expression of Vitellogenin and oestrogen receptor genes of Japanese medaka (*Oryzias latipes*). *Chemosphere*, 93, 1104-1110.

Lewis, P. N., Hewitt, C. L., Riddle, M., & McMinn, A. (2003). Marine introductions in the Southern Ocean: an unrecognised hazard to biodiversity. *Marine Pollution Bulletin*, 46, 213-223.

Li, K., Wu, J. Q., Jiang, L. L., Shen, L. Z., Li, J. Y., He, Z. H., Wei, P., Lv, Z. & He, M. F. (2017). Developmental toxicity of 2, 4-dichlorophenoxyacetic acid in zebrafish embryos. *Chemosphere*, 171, 40-48.

Li, W., Yin, D., Zhou, Y., Hu, S., & Wang, L. (2003). 3, 4-Dichloroaniline-induced oxidative stress in liver of Crucian carp (*Carassius auratus*), 56, 251–255.

Li, Z. (2018). Health and safety assessment and regulatory management of Aldicarb, Atrazine, Diuron, Glyphosate, and MCPA by theoretical maximum daily intake estimation. *Journal of Chemical Health & Safety,* 25, 3-14.

Liebel, S., Tomotake, M. E. M., & Ribeiro, C. A. O. (2013). Fish histopathology as biomarker to evaluate water quality. *Ecotoxicology and Environmental Contamination,* 8, 09-15.

Lin, C. Y., Chiang, C. Y., & Tsai, H. J. (2016). Zebrafish and Medaka: new model organisms for modern biomedical research. *Journal of Biomedical Science,* 23, 1-11.

Liu, G., Ke, M., Fan, X., Zhang, M., Zhu, Y., Lu, T., Sun, L., & Qian, H. (2018). Reproductive and endocrine-disrupting toxicity of *Microcystis aeruginosa* in female zebrafish. *Chemosphere*, 192, 289-296.

Liu, J., Plagnes-Juan, E., Geurden, I., Panserat, S., & Marandel, L. (2017). Exposure to an acute hypoxic stimulus during early life affects the expression of glucose metabolism-related genes at first-feeding in trout. *Scientific Reports*, 7, 1-12.

López-Barea, J. (1995). Biomarkers in ecotoxicology: an overview. In Toxicology in transition (pp. 57-79). Springer, Berlin, Heidelberg.

López-Doval, J. C., Poquet, M., & Muñoz, I. (2014). Sublethal effects of the herbicide diuron on the freshwater snail *Physella acuta*. *Limnetica*, 33, 205-216.

Luckey, T. D. (2006). Radiation hormesis: the good, the bad, and the ugly. Dose-response, 4(3), *Dose-Response*.

Luzio, A., Monteiro, S. M., Rocha, E., Fontaínhas-Fernandes, A. A., & Coimbra, A. M. (2016). Development and recovery of histopathological alterations in the gonads of zebrafish (*Danio rerio*) after single and combined exposure to endocrine disruptors (17α-ethinylestradiol and fadrozole). *Aquatic Toxicology*, 175, 90-105.

Mabansag, C. J. A., Paraso, M. G. V., Marcelino, R. T., Clavecillas, A. A., & Lola, M. S. E. G. (2019). A Preliminary Survey of Estrogenic Effects in Cultured Adult Male Nile Tilapia (*Oreochromis niloticus*) in the Seven Lakes of San Pablo City, Philippines. *Bulletin of Environmental Contamination and Toxicology,* 103, 400-404.

Mackie, C., & Lloyd, G. (2002). Antifoulants and marine biocides. *The Biocides Business: Regulation, Safety and Applications*, 287-300.

Magtoon, W., & Termvidchakorn, A. (2009). A revised taxonomic account of rice fish Oryzias (Beloniformes; Adrianichthyidae), in Thailand, Indonesia and Japan. *The Natural History Journal of Chulalongkorn University*, 9, 35-68.

Maharajan, A., Kitto, M. R., Paruruckumani, P. S., & Ganapiriya, V. (2016). Histopathology biomarker responses in Asian sea bass, *Lates calcarifer* (Bloch) exposed to copper. *The Journal of Basic & Applied Zoology,* 77, 21–30.

Mai, H., Morin, B., Pardon, P., Gonzalez, P., Budzinski, H., & Cachot, J. (2013). Environmental concentrations of irgarol, diuron and S-metolachlor induce deleterious effects on gametes and embryos of the Pacific oyster, *Crassostrea gigas*. *Marine Environmental Research,* 89, 1-8.

Malato, S., Blanco, J., Cáceres, J., Fernández-Alba, A. R., Agüera, A., & Rodrıguez, A. (2002). Photocatalytic treatment of water-soluble pesticides by photo-Fenton and TiO_2 using solar energy. *Catalysis Today*, 76, 209-220.

Maloney, E., Sykes, H., Morrissey, C., Peru, K., Headley, J., & Liber, K. (2019). Comparing the acute toxicity of imidacloprid to alternative systemic insecticides in the aquatic insect, *Chironomus dilutus*. *Environmental Toxicology and Chemistry*.

Mansano, A. S., Moreira, R. A., Dornfeld, H. C., Diniz, L. G., Vieira, E. M., Daam, M. A., Rocha, O., & Seleghim, M. H. (2018). Acute and chronic toxicity of diuron and carbofuran to the neotropical cladoceran *Ceriodaphnia silvestrii*. *Environmental Science and Pollution Research,* 25, 13335-13346.

Maragou, N. C., Thomaidis, N. S., & Koupparis, M. A. (2011). Optimization and comparison of ESI and APCI LC-MS/MS methods: a case study of irgarol 1051, diuron, and their degradation products in environmental samples. *Journal of the American Society for Mass Spectrometry,* 22.

Marlatt, V. L., & Martyniuk, C. J. (2017). Biological responses to phenylurea herbicides in fish and amphibians: new directions for characterizing mechanisms of toxicity. *Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology*, 194, 9-21.

Martin, O. V. and, & Voulvoulis, N. (2009). Sustainable risk management of emerging contaminants in municipal wastewaters. Philosophical Transactions of the Royal Society A: Mathematical, *Physical and Engineering Sciences,* 367(1904), 3895–3922.

Martyniuk, C. J., Feswick, A., Munkittrick, K. R., Dreier, D. A., & Denslow, N. D. (2020). Twenty years of transcriptomics, 17alpha-ethinylestradiol, and fish. *General and Comparative Endocrinology*, 286, 113325.

Marzullo, R. D. C. M., dos Santos Matai, P. H. L., & Morita, D. M. (2018). New method to calculate water ecotoxicity footprint of products: A contribution to the decision-making process toward sustainability. *Journal of Cleaner Production*, 188, 888-899.

Matozzo, V., Gagné, F., Marin, M. G., Ricciardi, F., & Blaise, C. (2008). Vitellogenin as a biomarker of exposure to estrogenic compounds in aquatic invertebrates: a review. *Environment international*, 34, 531-545.

McCuaig, L. M., Martyniuk, C. J., & Marlatt, V. L. (2020). Morphometric and proteomic responses of early-life stage rainbow trout (*Oncorhynchus mykiss*) to the aquatic herbicide diquat dibromide. *Aquatic Toxicology*, 222, 105446.

McMahon, T. A., Boughton, R. K., Martin, L. B., & Rohr, J. R. (2017). Exposure to the herbicide atrazine nonlinearly affects tadpole corticosterone levels. *Journal of Herpetology*, 51, 270-273.

Meijide, F. J., Rey Vázquez, G., Grier, H. J., Lo Nostro, F. L., & Guerrero, G. A. (2016). Development of the germinal epithelium and early folliculogenesis during ovarian morphogenesis in the cichlid fish *Cichlasoma dimerus* (Teleostei, Perciformes). Acta Zoologica, 97, 18-33.

Mendes, K. F., Régo, A. P. J., Takeshita, V., & Tornisielo, V. L. (2019). Water Resource Pollution by Herbicide Residues. *In Organic Pollutants. IntechOpen.*

Michael, P. O. (2018). Sublethal effect of diuron on DNA status, hematological and biochemical indices of fresh water catfish, *Clarias gariepinus* Juveniles. 6: 621-627.

Midorikawa, S., Arai, T., Harino, H., Ohji, M., Cu, N. D., & Miyazaki, N. (2004). Concentrations of organotin compounds in sediment and clams collected from coastal areas in Vietnam. *Environmental Pollution*, 131, 401-408.

Mnif, W., Hassine, A. I. H., Bouaziz, A., Bartegi, A., Thomas, O., & Roig, B. (2011). Effect of endocrine disruptor pesticides: a review. *International Journal of Environmental Research and Public Health*, 8, 2265-2303.

Mohamat-Yusuff, F., Sarah-Nabila, A. G., Zulkifli, S. Z., Azmai, M. N. A., Ibrahim, W. N. W., Yusof, S., & Ismail, A. (2018). Acute toxicity test of copper pyrithione on Javanese medaka and the behavioural stress symptoms. *Marine Pollution Bulletin*, 127, 150-153.

Mohamat-Yusuff, F., Zulkarnain, Z., Anuar, N. Z. A., Joni, A. A. M., Kusin, F. M., Mohamed, K. N., ... & Ismail, A. (2020). Impact of Diuron contamination on blood cockles (Tegillarca granosa Linnaeus, 1758). *Marine Pollution Bulletin*, *161*, 111698.

Mohammed, A. M., Karttunen, V., Huuskonen, P., Huovinen, M., Auriola, S., & Vähäkangas, K. (2018). Transplacental transfer and metabolism of diuron in human placenta. *Toxicology Letters*, 295, 307-313.

Moreira, L. B., Diamante, G., Giroux, M., Coffin, S., Xu, E. G., Moledo de Souza Abessa, D., & Schlenk, D. (2018). Impacts of salinity and temperature on the thyroidogenic effects of the biocide diuron in *Menidia beryllina*. *Environmental Science & Technology*, 52, 3146-3155.

Morgan, A. J., Stürzenbaum, S. R., Winters, C., Grime, G. W., Aziz, N. A. A., & Kille, P. (2004). Differential metallothionein expression in earthworm (*Lumbricus rubellus*) tissues. *Ecotoxicology and Environmental Safety,* 57, 11-19.

Mukadam, M., & Kulkarni, A. (2014). Acute toxicity of cypermethrin, a synthetic pyrethroid to estuarine clam *Katelysia opima* (Gmelin) and its effect on oxygen consumption. *Journal of Agricultural Chemistry and Environment,* 3, 139.

Mukherjee, A., Rao, K. M., & Ramesh, U. S. (2009). Predicted concentrations of biocides from antifouling paints in Visakhapatnam Harbour. *Journal of Environmental Management*, 90, S51-S59.

Mukherjee, A., Sengupta, M. K., Hossain, M. A., Ahamed, S., Das, B., Nayak, B., Lodh, D., Rahman, M.M., & Chakraborti, D. (2006). Arsenic contamination in groundwater: a global perspective with emphasis on the Asian scenario. *Journal of Health, Population and Nutrition*, 142-163.

Mukhtar, A., Mohamat-Yusuff, F., Zulkifli, S. Z., Harino, H., Ismail, A., & Inoue, K. (2019). Concentration of Organotin and Booster Biocides in Sediments of Seagrass Area from Sungai Pulai Estuary, South of Johor, Malaysia. *Environments*, 6, 26.

Muliari, M., Zulfahmi, I., Akmal, Y., Karja, N. W. K., Nisa, C., Sumon, K. A., & Rahman, M. M. (2020). Toxicity of palm oil mill effluent on the early life stages of Nile tilapia (*Oreochromis niloticus*, Linnaeus 1758). *Environmental Science and Pollution Research*, 1-8.

Naderi, M., Wong, M. Y., & Gholami, F. (2014). Developmental exposure of zebrafish (Danio rerio) to bisphenol-S impairs subsequent reproduction potential and hormonal balance in adults. *Aquatic Toxicology*, 148, 195-203.

NCBI (2019). PubChem Database.National Centre for Biotechology Information https://pubchem.ncbi.nlm.nih.gov/. Accessed 5 November 2019.

Nebeker, A. V., & Schuytema, G. S. (1998). Chronic effects of the herbicide diuron on freshwater cladocerans, amphipods, midges, minnows, worms, and snails. *Archives of Environmental Contamination and Toxicology*, *35*(3), 441-446.

Neuwoehner, J., Zilberman, T., Fenner, K., & Escher, B. I. (2010). QSAR-analysis and mixture toxicity as diagnostic tools: Influence of degradation on the toxicity and mode of action of diuron in algae and daphnids. *Aquatic Toxicology*, 97, 58-67.

Newman, M. C. (2009). Fundamentals of ecotoxicology. Ch.9 CRC press.

Ng, C. (2017). Agriculture and Water Pollution Risks. *UTAR Agriculture Science Journal,* 3, 34-44.

Nilsen, B. M., Berg, K., Eidem, J. K., Kristiansen, S. I., Brion, F., Porcher, J. M., & Goksøyr, A. (2004). Development of quantitative vitellogenin-ELISAs for fish test species used in endocrine disruptor screening. *Analytical and Bioanalytical Chemistry,* 378, 621-633.

Nishimura, Y., Inoue, A., Sasagawa, S., Koiwa, J., Kawaguchi, K., Kawase, R., Maruyama, T., Kim, S., & Tanaka, T. (2016). Using zebrafish in systems toxicology for developmental toxicity testing. *Congenital Anomalies*, 56, 18-27.

Norrgren, L. (2012, December). Fish models for ecotoxicology. *In Acta Veterinaria Scandinavica* (Vol. 54, No. 1, pp. 1-2). BioMed Central.

OECD (1992). Test No. 203: Fish, acute toxicity test. OECD Publishing.

OECD (2010a). Workshop report on OECD countries activities regarding testing, assessment, and management of endocrine disruptors. 22–24.

OECD (2010b) OECD Guidance Document for the Diagnosis of Endocrine-Related Histopathology of Fish Gonads. OECD. OECD series on testing and assessment no. 123. Organisation for Economic Cooperation and Development, Paris, p 182.

OECD (2013). OECD guidelines for the testing of chemicals section 2: Effects on biotic systems *Test No 236: fish embryo acute toxicity (FET) test.* Organization for Economic Cooperation and Development, Paris, France.

OECD. (2012). Test No. 229: Fish Short Term Reproduction Assay. OECD Guidelines for the Testing of Chemicals, Section 2, (October), 40.

Örn, S., Svenson, A., Viktor, T., Holbech, H., & Norrgren, L. (2006). Male-biased sex ratios and vitellogenin induction in zebrafish exposed to effluent water from a Swedish pulp mill. *Archives of Environmental Contamination and Toxicology*, 51, 445-451.

Orton, F., Lutz, I., Kloas, W., & Routledge, E. J. (2009). Endocrine disrupting effects of herbicides and pentachlorophenol: in vitro and in vivo evidence. *Environmental Science & technology*, 43(6), 2144-2150.

Osman, A. G., Wuertz, S., Mekkawy, I. A., Exner, H. J., & Kirschbaum, F. (2007). Lead induced malformations in embryos of the African catfish *Clarias gariepinus* (Burchell, 1822). *Environmental Toxicology: An International Journal*, 22, 375-389.

Paolucci, M., Coccia, E., Imperatore, R., & Varricchio, E. (2020). A cross-talk between leptin and 17β-estradiol in Vitellogenin synthesis in rainbow trout *Oncorhynchus mykiss* liver. *Fish Physiology and Biochemistry*, 46, 331-344.

Papoulias, D. M., Tillitt, D. E., Talykina, M. G., Whyte, J. J., & Richter, C. A. (2014). Atrazine reduces reproduction in Japanese medaka (*Oryzias latipes*). Aquatic toxicology, 154, 230-239.

Parenti, L. R. (2008). A phylogenetic analysis and taxonomic revision of ricefishes, Oryzias and relatives (Beloniformes, Adrianichthyidae). *Zoological Journal of the Linnean Society*, 154, 494-610.

Park, C. B., Kim, G. E., Kim, Y. J., Park, C. G., Kwon, Y. S., Yeom, D. H., & Cho, S. H. (2020). Reproductive dysfunction linked to alteration of endocrine activities in zebrafish exposed to mono-(2-ethylhexyl) phthalate (MEHP). *Environmental Pollution*, 114362.

Pereira, T. S. B., Boscolo, C. N. P., da Silva, D. G. H., Batlouni, S. R., Schlenk, D., & de Almeida, E. A. (2015). Anti-androgenic activities of diuron and its metabolites in male Nile tilapia (*Oreochromis niloticus*). *Aquatic Toxicology*, 164, 10-15.

Pereira, T. S. B., Boscolo, C. N. P., Felício, A. A., Batlouni, S. R., Schlenk, D., & de Almeida, E. A. (2016). Estrogenic activities of diuron metabolites in female Nile tilapia (*Oreochromis niloticus*). *Chemosphere*, 146, 497-502.

Perrichon, P., Pasparakis, C., Mager, E. M., Stieglitz, J. D., Benetti, D. D., Grosell, M., & Burggren, W. W. (2017). Morphology and cardiac physiology are differentially affected by temperature in developing larvae of the marine fish mahi-mahi (*Coryphaena hippurus*). *Biology Open*, 6, 800-809.

Pesce, S., Margoum, C., & Foulquier, A. (2016). Pollution-induced community tolerance for in situ assessment of recovery in river microbial communities following the ban of the herbicide diuron. *Agriculture, Ecosystems & Environment*, 221, 79-86.

Philippe, C., Grégoir, A. F., Thoré, E. S., Brendonck, L., De Boeck, G., & Pinceel, T. (2018). Acute sensitivity of the killifish Nothobranchius furzeri to a combination of temperature and reference toxicants (cadmium, chlorpyrifos and 3, 4-dichloroaniline). *Environmental Science and Pollution Research*, 25, 10029-10038.

Philippe, C., Hautekiet, P., Grégoir, A. F., Thoré, E. S., Brendonck, L., De Boeck, G., & Pinceel, T. (2019). Interactive effects of 3, 4-DCA and temperature on the annual killifish *Nothobranchius furzeri*. *Aquatic Toxicology*, 212, 146-153.

Piña, B., Casado, M., & Quirós, L. (2007). Analysis of gene expression as a new tool in ecotoxicology and environmental monitoring. *TrAC Trends in Analytical Chemistry*, 26, 1145-1154.

Pinto, P. I., Estêvão, M. D., & Power, D. M. (2014). Effects of estrogens and estrogenic disrupting compounds on fish mineralized tissues. *Marine drugs*, 12, 4474-4494.

Planas, C., Puig, A., Rivera, J., & Caixach, J. (2006). Analysis of pesticides and metabolites in Spanish surface waters by isotope dilution gas chromatography/mass spectrometry with previous automated solid-phase extraction: Estimation of the uncertainty of the analytical results. *Journal of Chromatography A*, 1131, 242-252.

Porseryd, T., Caspillo, N. R., Volkova, K., Elabbas, L., Källman, T., Dinnétz, P., Olsson, P.E., & Porsch-Hällström, I. (2018). Testis transcriptome alterations in zebrafish (*Danio rerio*) with reduced fertility due to developmental exposure to 17α-ethinyl estradiol. *General and Comparative Endocrinology,* 262, 44-58.

Prado, P. S., Pinheiro, A. P. B., Bazzoli, N., & Rizzo, E. (2014). Reproductive biomarkers responses induced by xenoestrogens in the characid fish *Astyanax fasciatus* inhabiting a South American reservoir: an integrated field and laboratory approach. *Environmental Research*, 131, 165-173.

Puspitasari, R., Purbonegoro, T., & Putri, D. I. (2018). Short time effect of cadmium and copper on java medaka (*Oryzias javanicus*) as bioindicator for ecotoxicological studies. *In AIP Conference Proceedings* (Vol. 2026, No. 1, p. 020015). AIP Publishing LLC.

Rainbow, C.A.T.J. C. A P. S. (Eds.). (2012). *Ecological biomarkers: indicators of ecotoxicological effects*. CRC Press.

Reading, B. J., Sullivan, C. V., & Schilling, J. (2011). Vitellogenesis in fishes. *Encyclopedia of fish physiology: from genome to environment,* 1, 635-646.

Rijnsdorp, A. D., Peck, M. A., Engelhard, G. H., Möllmann, C., & Pinnegar, J. K. (2009). Resolving the effect of climate change on fish populations. *ICES Journal of Marine Science*, 66, 1570-1583.

Ritz, C., Cedergreen, N., Jensen, J. E., & Streibig, J. C. (2006). Relative potency in nonsimilar dose–response curves. *Weed Science*, 54, 407-412.

Rodgers-Gray, T. P., Jobling, S., Kelly, C., Morris, S., Brighty, G., Waldock, M. J., Sumpter, J.P., & Tyler, C. R. (2001). Exposure of juvenile roach (*Rutilus rutilus*) to treated sewage effluent induces dose-dependent and persistent disruption in gonadal duct development. *Environmental Science & Technology*, 35, 462-470.

Rodrigues, S., Antunes, S. C., Correia, A. T., & Nunes, B. (2017). Rainbow trout (*Oncorhynchus mykiss*) pro-oxidant and genotoxic responses following acute and chronic exposure to the antibiotic oxytetracycline. *Ecotoxicology*, 26, 104-117.

Rohr, J. R., Sager, T., Sesterhenn, T. M., & Palmer, B. D. (2006). Exposure, postexposure, and density-mediated effects of atrazine on amphibians: breaking down net effects into their parts. *Environmental Health Perspectives,* 114, 46-50.

Rombough, P. (2011). The energetics of embryonic growth. Respiratory physiology & neurobiology, 178, 22-29.

Rusni, S., Sassa, M., Takehana, Y., Kinoshita, M., & Inoue, K. (2020). Correlation between cytochrome P450 1A (cyp1a) mRNA expression and ambient phenanthrene and pyrene concentration in Javanese *Medaka Oryzias* javanicus. *Fisheries Science*, *86*, 605-613.

Russom, C. L., Bradbury, S. P., Broderius, S. J., Hammermeister, D. E., & Drummond, R. A. (1997). Predicting modes of toxic action from chemical structure: acute toxicity in the fathead minnow (*Pimephales promelas*). *Environmental Toxicology and Chemistry: An International Journal,* 16, 948-967.

Saeed, S., Al-Naema, N., Butler, J. D., & Febbo, E. J. (2015). Arabian killifish (*Aphanius dispar*) embryos: A model organism for the risk assessment of the Arabian Gulf coastal waters. *Environmental Toxicology and Chemistry*, 34, 2898-2905.

Saglio, P., & Trijasse, S. (1998). Behavioral responses to atrazine and diuron in goldfish. *Archives of Environmental Contamination and Toxicology,* 35, 484-491.

Saleh, A., Molaei, S., Fumani, N. S., & Abedi, E. (2016). Antifouling paint booster biocides (Irgarol 1051 and diuron) in marinas and ports of Bushehr, Persian Gulf. *Marine Pollution Bulletin*, 105, 367-372.

Salleh, A. F. M., Amal, M. N. A., Nasruddin, N. S., Zulkifli, S. Z., Yusuff, F. M., Ibrahim, W. N. W., & Ismail, A. (2017). Water pH effects on survival, reproductive performances, and ultrastructure of gonads, gills, and skins of the Javanese medaka (*Oryzias javanicus*). *Turkish Journal of Veterinary and Animal Sciences*, 41, 471-481.

Salvestrini, S., Di Cerbo, P., & Capasso, S. (2002). Kinetics of the chemical degradation of diuron. *Chemosphere*, 48, 69-73.

Sardo, M., Azeiteiro, U. M., Pereira, L., Morgado, F., & Soares, A. M. (2005). Histological evaluation of the exposure to 3, 4-dichloroaniline in the estuarine mysid Mesopodopsis slabberi, under experimental conditions. *Fresenius Environmental Bulletin*, 14, 579-583.

Sari, D. K., Andriani, I., & Yaqin, K. (2018). Histological study of the circulatory system of Sulawesi Medaka fish (*Oryzias celebensis*) for animal model research. *In Journal of Physics: Conference Series* 1028, p. 012008. IOP Publishing.

Schäfers, C., & Nagel, R. (1993). Toxicity of 3, 4-dichloroaniline to perch (*Perca fluviatilis*) in acute and early life stage exposures. *Chemosphere*, 26, 1641-1651.

Scheil, V., Kienle, C., Osterauer, R., Gerhardt, A., & Köhler, H. R. (2009). Effects of 3,4-dichloroaniline and diazinon on different biological organisation levels of zebrafish (*Danio rerio*) embryos and larvae. *Ecotoxicology*, 18, 355-363.

Schwaiger, J., Wanke, R., Adam, S., Pawert, M., Honnen, W., & Triebskorn, R. (1997). The use of histopathological indicators to evaluate contaminant-related stress in fish. *Journal of Aquatic Ecosystem Stress and Recovery*, 6, 75-86.

Scognamiglio, V., Antonacci, A., Patrolecco, L., Lambreva, M. D., Litescu, S. C., Ghuge, S. A., & Rea, G. (2016). Analytical tools monitoring endocrine disrupting chemicals. *TrAC Trends in Analytical Chemistry,* 80, 555-567.

Scott, A. P., & Hylland, K. (2002). Biological effects of contaminants: Radioimmunoassay (RIA) and enzyme-linked immunosorbent assay (ELISA) techniques for the measurement of marine fish vitellogenins.

Segner, H. (2011). Reproductive and developmental toxicity in fishes. In *Reproductive and Developmental Toxicology* (pp. 1145-1166). Academic Press.

Seki, M., Yokota, H., Matsubara, H., Tsuruda, Y., Maeda, M., Tadokoro, H., & Kobayashi, K. (2002). Effect of ethinylestradiol on the reproduction and induction of Vitellogenin and testis-ova in medaka (*Oryzias latipes*). *Environmental Toxicology and Chemistry: An International Journal*, 21, 1692-1698.

Sepp KÖ (2009). Examination of endocrine disruptor effects in neuroendocrine systems, *in vivo* and *in vitro* (Doctoral dissertation, szte).

Shaala, N. M. A., Zulkifli, S. Z., Ismail, A., Azmai, M. N. A., & Mohamat-Yusuff, F. (2015). Lethal concentration 50 (LC50) and effects of Diuron on morphology of brine shrimp *Artemia salina* (Branchiopoda: Anostraca) Nauplii. *Procedia Environmental Sciences*, 30, 279-284.

Shankar, A., Kongot, M., Saini, V. K., & Kumar, A. (2020). Removal of pentachlorophenol pesticide from aqueous solutions using modified chitosan. *Arabian Journal of Chemistry,* 13, 1821-1830.

Simões, T., Novais, S. C., Natal-da-Luz, T., Renaud, M., Leston, S., Ramos, F., Römbke, J., Roelofs, D., Van Straalen, N.M., Sousa, J.P., & Lemos, M. F. (2019). From laboratory to the field: Validating molecular markers of effect in Folsomia candida exposed to a fungicide-based formulation. *Environment International*, 127, 522-530.

Soares, D. A., Vitais, E. D. E., Soares, D. A., Andrade, S., Campos, J., Brasil … Awofeso, N. (2014). *Epidemiologia e indicadores de saúde. Ciência & Saúde Coletiva* .16.

Solomon, K. R., Dalhoff, K., Volz, D., & Van Der Kraak, G. (2013). Effects of herbicides on fish. *In Fish physiology*. 33, pp. 369-409. Academic Press.

Song, H. Y., Nam, Y. K., Bang, I. C., & Kim, D. S. (2010). Hybridization between marine medaka *Oryzias dancena* and Javanese medaka Oryzias javanicus. *Korean Journal of Fisheries and Aquatic Sciences,* 43, 462-473.

Sørensen, S. R., Albers, C. N., & Aamand, J. (2008). Rapid mineralization of the phenylurea herbicide diuron by *Variovorax* sp. strain SRS16 in pure culture and within a two-member consortium. *Applied and Environmental Microbiology*, 74, 2332-2340.

Spencer, H. B., Hussein, W. R., & Tchounwou, P. B. (2002). Effects of tetrachloroethylene on the viability and development of embryos of the Japanese medaka, *Oryzias latipes*. *Archives of Environmental Contamination and Toxicology*, 42, 463-469.

Stillway, M. E., & Teh, S. J. (2020). The Effect of Herbicide Formulations and Herbicide-Adjuvant Mixtures on Aquatic Food Web Species of the Sacramento-San Joaquin Delta, California, USA. *Environmental Toxicology and Chemistry*. 39, 1375-1381.

Stoskopf, M. K. (2015). Biology and management of laboratory fishes. *In Laboratory Animal Medicine* .pp. 1063-1086. Academic Press.

Stoss, F. W., & Haines, T. A. (1979). The effects of toluene on embryos and fry of the Japanese medaka *Oryzias latipes* with a proposal for rapid determination of maximum acceptable toxicant concentration. *Environmental Pollution* (1970), 20, 139-148.

Takehana, Y., Naruse, K., & Sakaizumi, M. (2005). Molecular phylogeny of the medaka fishes genus *Oryzias* (Beloniformes: Adrianichthyidae) based on nuclear and mitochondrial DNA sequences. *Molecular Phylogenetics and Evolution,* 36, 417-428.

Tasca, A. L., & Fletcher, A. (2018). State of the art of the environmental behaviour and removal techniques of the endocrine disruptor 3, 4-dichloroaniline. *Journal of Environmental Science and Health, Part A*, 53, 260-270.

Termvidchakorn, A., & Magtoon, W. (2008). Development and identification of the ricefish *Oryzias* in Thailand. *ScienceAsia*, 34, 426-428.

Tetreault, G. R., Bennett, C. J., Shires, K., Knight, B., Servos, M. R., & McMaster, M. E. (2011). Intersex and reproductive impairment of wild fish exposed to multiple municipal wastewater discharges. *Aquatic Toxicology*, 104, 278-290.

Thiel, N. A., Sachett, A., Schneider, S. E., Garbinato, C., Decui, L., Eichwald, T., Conterato, G.M., Latini, A., Piato, A., & Siebel, A. M. (2020). Exposure to the herbicide 2,4-dichlorophenoxyacetic acid impairs mitochondrial function, oxidative status, and behavior in adult zebrafish. *Environmental Science and Pollution Research*, 1-9.

Thomas, K. V., Fileman, T. W., Readman, J. W., & Waldock, M. J. (2001). Antifouling paint booster biocides in the UK coastal environment and potential risks of biological effects. *Marine Pollution Bulletin*, 42, 677-688.

Tillitt, D. E., Papoulias, D. M., Whyte, J. J., & Richter, C. A. (2010). Atrazine reduces reproduction in fathead minnow (*Pimephales promelas*). *Aquatic Toxicology*, 99, 149-159.

Tran, A. T., Hyne, R. V., & Doble, P. (2007). Determination of commonly used polar herbicides in agricultural drainage waters in Australia by HPLC. *Chemosphere*, 67, 944-953.

Trudeau, V. L., Thomson, P., Zhang, W. S., Reyaud, S., Navarro-Martin, L., & Langlois, V. S. (2020). Agrochemicals disrupt multiple endocrine axes in amphibians. *Molecular and Cellular Endocrinology,* 110861.

Uchida, D., Yamashita, M., Kitano, T., & Iguchi, T. (2004). An aromatase inhibitor or high water temperature induce oocyte apoptosis and depletion of P450 aromatase activity in the gonads of genetic female zebrafish during sex-reversal. *Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology,* 137, 11-20.

USEPA (2002). Methods for Measuring Acute Toxicity of Effluents and Receiving Water to Freshwater and Marine Organisms. EPA-821-R-02e012. Office of Research and Development, Washington, DC.

USEPA (2003) *RED for Diuron*, Available at: http://www.epa.gov/oppfead1/endanger/effects/diuron_efed_chapter.pdf

USEPA (2004). US EPA Pesticide Ecotoxicity Database; for further information and contacts for access see http://www.epa.gov/oppefed1/general/databasesdescription.htm.

USEPA (2020). Ecotoxicology Database. [Online] Available: https://cfpub.epa.gov/ecotox/search.cfm.

Valentovic, M. A., Yahia, T., Ball, J. G., Hong, S. K., Brown, P. I., & Rankin, G. O. (1997). 3,4-Dicholoroaniline acute toxicity in male Fischer 344 rats. *Toxicology*, 124, 125-134.

Vandenberg, L. N., Colborn, T., Hayes, T. B., Heindel, J. J., Jacobs Jr, D. R., Lee, D. H., Shioda, T., Soto, A.M., vom Saal, F.S., Welshons, W.V. & Zoeller, R. T. (2012). Hormones and endocrine-disrupting chemicals: low-dose effects and nonmonotonic dose responses. *Endocrine Reviews*, 33, 378-455.

Vandenberg, L. N., Colborn, T., Hayes, T. B., Heindel, J. J., Jacobs Jr, D. R., Lee, D. H., Myers, J.P., Shioda, T., Soto, A.M., vom Saal, F.S. & Welshons, W. V. (2013). Regulatory decisions on endocrine disrupting chemicals should be based on the principles of endocrinology. *Reproductive Toxicology*, 38, 1-15.

Vega, A. B., Frenich, A. G., & Vidal, J. M. (2005). Monitoring of pesticides in agricultural water and soil samples from Andalusia by liquid chromatography coupled to mass spectrometry. *Analytica Chimica Acta*, 538, 117-127.

Velki, M., Di Paolo, C., Nelles, J., Seiler, T. B., & Hollert, H. (2017). Diuron and diazinon alter the behavior of zebrafish embryos and larvae in the absence of acute toxicity. *Chemosphere*, 180, 65-76.

Vieira, L. R., Hissa, D. C., de Souza, T. M., Sá, C. A., Evaristo, J. A., Nogueira, F. C., ... & Farias, D. F. (2020). Proteomics analysis of zebrafish larvae exposed to 3, 4- dichloroaniline using the fish embryo acute toxicity test. *Environmental toxicology*, *35*(8), 849-860.

Voelker, D., Stetefeld, N., Schirmer, K., & Scholz, S. (2008). The role of cyp1a and heme oxygenase 1 gene expression for the toxicity of 3, 4-dichloroaniline in zebrafish (*Danio rerio*) embryos. *Aquatic Toxicology*, 86, 112-120.

Voelker, D., Vess, C., Tillmann, M., Nagel, R., Otto, G. W., Geisler, R., Schirmer, K., & Scholz, S. (2007). Differential gene expression as a toxicant-sensitive endpoint in zebrafish embryos and larvae. *Aquatic Toxicology*, 81, 355-364.

Wagner, S. D., Kurobe, T., Hammock, B. G., Lam, C. H., Wu, G., Vasylieva, N., Geeb,S.J., Hammock ,B.D., & Teh, S. J. (2017). Developmental effects of fipronil on Japanese Medaka (*Oryzias latipes*) embryos. *Chemosphere*, 166, 511-520.

Wang, Q., Wang, C., Wang, J., Liu, W., Hao, L., Zhou, J., Wang, Z., & Wu, Q. (2020). Sensitive determination of phenylurea herbicides in soybean milk and tomato samples by a novel hypercrosslinked polymer based solid-phase extraction coupled with high performance liquid chromatography. *Food Chemistry*, 317, 126410.

Watanabe, H., Horie, Y., Takanobu, H., Koshio, M., Flynn, K., Iguchi, T., & Tatarazako, N. (2017). Medaka extended one-generation reproduction test evaluating 4-nonylphenol. *Environmental Toxicology and Chemistry,* 36, 3254–3266.

Weber, A. A., Moreira, D. P., Melo, R. M. C., Vieira, A. B. C., Prado, P. S., da Silva, M. A. N., Bazzoli, N., & Rizzo, E. (2017). Reproductive effects of oestrogenic endocrine disrupting chemicals in Astyanax rivularis inhabiting headwaters of the Velhas River, Brazil. *Science of the Total Environment*, 592, 693-703.

Wisk, J. D., & Cooper, K. R. (1990). The stage specific toxicity of 2, 3, 7, 8-tetrachlorodibenzo-p-dioxin in embryos of the Japanese medaka (*Oryzias latipes*). *Environmental Toxicology and Chemistry: An International Journal*, 9, 1159-1169.

Woo, S., Jeon, H. Y., Lee, T. K., Kim, S. R., Lee, S. H., & Yum, S. (2011). Expression profiling of liver in Java medaka fish exposed to 17β-estradiol. *Molecular & Cellular Toxicology*, 7, 271.

Woo, S., Yum, S., Kim, D. W., & Park, H. S. (2009a). Transcripts level responses in a marine medaka (*Oryzias javanicus*) exposed to organophosphorus pesticide. *Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology*, 149, 427-432.

Woo, S., Yum, S., Park, H. S., Lee, T. K., & Ryu, J. C. (2009b). Effects of heavy metals on antioxidants and stress-responsive gene expression in Javanese medaka (*Oryzias javanicus*). *Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology,* 149, 289-299.

Xiao, H., Kuckelkorn, J., Nüßer, L. K., Floehr, T., Hennig, M. P., Roß-Nickoll, M., Schäffer, A & Hollert, H. (2016). The metabolite 3, 4, 3′, 4′-tetrachloroazobenzene (TCAB) exerts a higher ecotoxicity than the parent compounds 3, 4-dichloroaniline (3, 4-DCA) and propanil. *Science of the Total Environment*, 551, 304-316.

Xu, Q., Wu, D., Dang, Y., Yu, L., Liu, C., & Wang, J. (2017). Reproduction impairment and endocrine disruption in adult zebrafish (*Danio rerio*) after waterborne exposure to TBOEP. *Aquatic Toxicology*, 182, 163-171.

Yan, S., Liang, M., Chen, R., Hong, X., & Zha, J. (2020). Reproductive toxicity and estrogen activity in Japanese medaka (*Oryzias latipes*) exposed to environmentally relevant concentrations of octocrylene. *Environmental Pollution,* 261, 114104.

Yao, X. F., Khan, F., Pandey, R., Pandey, J., Mourant, R. G., Jain, R. K., Guo, J.H., Russell, R.J., Oakeshott, J.G. & Pandey, G. (2011). Degradation of dichloroaniline isomers by a newly isolated strain, *Bacillus megaterium* IMT21. *Microbiology*, 157, 721-726.

Yebra, D. M., Kiil, S., & Dam-Johansen, K. (2004). Antifouling technology—past, present and future steps towards efficient and environmentally friendly antifouling coatings. *Progress in Organic Coatings*, 50, 75-104.

Yi, X., Li, C., Zhong, X., & Gong, Y. (2018). Development of a lipovitellin-based sandwich ELISA for determination of Vitellogenin in the marine medaka *Oryzias melastigma*. *Chemosphere*, 197, 477-484.

Yuan, Y., Zhang, P., Schäffer, A., & Schmidt, B. (2017). 3, 4-Dichloroaniline revisited: a study on the fate of the priority pollutant in a sediment-water system derived from a rice-growing region in Italy. *Science of the Total Environment*, 574, 1012-1020.

Yunus, K., Jaafar, A. M., & John, A. (2019). Acute-lethal Toxicity (LC50) Effect of Terminalia Catappa Linn. Leaves Extract on *Oreochromis niloticus* (Red Nile Tilapia) juveniles under static toxicity exposure. *Oriental Journal of Chemistry*, 35, 270-274.

Yusof, S., Ismail, A., & Alias, M. S. (2014). Effect of glyphosate-based herbicide on early life stages of Java medaka (*Oryzias javanicus*): A potential tropical test fish. *Marine Pollution Bulletin*, 85, 494–498.

Yusof, S., Ismail, A., & Rahman, F. (2013). Distribution and localities of Java medaka fish (*Oryzias javanicus*) in Peninsular Malaysia. *Malayan Nature Journal*, 65, 38-46.

Yusof, S., Ismail, A., Koito, T., Kinoshita, M., & Inoue, K. (2012). Occurrence of two closely related rice fishes, Javanese medaka (*Oryzias javanicus*) and Indian medaka (*Oryzias dancena*) at sites with different salinity in Peninsular Malaysia. *Environmental Biology of Fishes*, 93, 43-49.

Zagatto, P.A. (2008). Aquatic ecotoxicology: principles and applications (Vol. 478). E. Bertoletti (Ed.). São Carlos: RiMa.

Zhang, B., & Sen, L. I. N. (2009). Effects of 3,4-dichloroaniline on testicle enzymes as biological markers in rats. *Biomedical and Environmental Sciences,* 22, 40-43.

Zhang, Q. F., Li, Y. W., Liu, Z. H., & Chen, Q. L. (2016). Exposure to mercuric chloride induces developmental damage, oxidative stress and immunotoxicity in zebrafish embryos-larvae. *Aquatic Toxicology*, 181, 76-85.

Zhang, Z., Ju, Z., Wells, M. C., & Walter, R. B. (2009). Genomic approaches in the identification of hypoxia biomarkers in model fish species. *Journal of Experimental Marine Biology and Ecology,* 381, S180-S187.

Zhou, J. L. (2008). Occurrence and persistence of antifouling biocide Irgarol 1051 and its main metabolite in the coastal waters of Southern England. *Science of the Total Environment*, 406, 239-246.

Zhu, B., Liu, T., Hu, X., & Wang, G. (2013). Developmental toxicity of 3,4-dichloroaniline on rare minnow (*Gobiocypris rarus*) embryos and larvae. *Chemosphere*, 90, 1132–1139.

Zoltan (2001).The Acute Toxicity of Diuron Techn. to Rainbow Trout (Onchorhynchus mykiss walbaum)', Laboratory of Hydrobiology, Százhalombatta, Hungary. Owner: North-Hungarian Chemical Works Co Ltd.

Zuk, M., Garcia-Gonzalez, F., Herberstein, M. E., & Simmons, L. W. (2014). Model systems, taxonomic bias, and sexual selection: beyond Drosophila. *Annual Review of Entomology*, 59:321-338.

Zulfahmi, I., Muliari, M., Akmal, Y., & Batubara, A. S. (2018). Reproductive performance and gonad histopathology of female Nile tilapia (*Oreochromis niloticus*, Linnaeus1758) exposed to palm oil mill effluent. *The Egyptian Journal of Aquatic Research*, 44, 327-332.