Research Open

Environmental Sustainability and Climate Change

Volume 1 Issue 1

Commentary

Ecotoxicological Genetics: from Mussel Watch to Crop Watch

Chee Kong Yap[1]*, Uma Rani Sinniah[2]

[1]Department of Biology, Faculty of Science, Universiti Putra Malaysia, 43400 UPM, Serdang, Selangor, Malaysia
[2]Faculty of Agriculture, Universiti Putra Malaysia, Serdang, Selangor, Darul Ehsan 43400, Malaysia

Corresponding author: Chee Kong Yap, Department of Biology, Faculty of Science, Universiti Putra Malaysia, 43400 UPM, Serdang, Selangor, Malaysia; **Email:** yapckong@hotmail.com; yapchee@upm.edu.my

Received: May 28, 2019; **Accepted:** June 15, 2019; **Published:** July 05, 2019;

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A good researcher usually specializes and enjoys a specific area of study. For example, the researcher is passionate to spend and devotes most of his/her time in studies like biomonitoring, ecology, ecotoxicology, genetics and plant crop improvements. The aim of this paper is to review Ecotoxicological Genetic (EG) study by using marine mussel *Perna viridis* under the Mussel Watch program and to discuss the potential EG o be applied to crop plants as Crop Watch.

From worldwide scenario, the pace of knowledge increment on EG studies highly indicates that this area is not a new knowledge since it can be easily found in the literature (see Nevo et al., 1986 [1]). However, in Malaysia, the first (perhaps) paper on such topic was published by Yap et al. [2], which will be further discussed in the following paragraph.

Anthropogenic activities have created significant impacts on chemical levels in the coastal environment [3], including inorganic and organic (persistent and emerging) chemicals. The evaluation of EG study in Malaysia is based on the marine mussel *P. viridis* as a model in this review paper.

Firstly, the most detailed ecotoxicological and biomonitoring study on *P. viridis* was that reported by Yap et al. [4] which reported on four heavy metals. As found in the literature, heavy metal pollution in Malaysia is increasingly reported in the literature since early 2000 see Yap et al., [5,6]. Application of the biomonitoring data of heavy metals in the marine mussels from Malaysia has been assessed for human health risks [7].

Secondly, the first genetic structures of *P. viridis* were investigated by Yap *et al.* [8] by using electrophoretic allozyme study. The genetics differentiation/composition of *P. viridis* is heavily dependent on free-swimming larvae along the west coast of Peninsular Malaysia especially in Malacca (Al-Barwani et al., 2007) [9]besides the physical barrier (the Johore Causeway [10] and heavy metal contamination in the east part of the Causeway [11,12]. These causative agents should merits more studies in future.

Yap and Tan [13] has made a comprehensive review on the EG studies, based on *P. viridis*, in Malaysia. This emerging research perspective, perhaps, has started with the use of allozyme polymorphism of *P. viridis* in relation to heavy metal stress [14]. Preliminary studies on the EG studies on biomonitors in Malaysia have been focused on green-lipped mussels [2,15,16], horseshoe crabs [17] and guppy fish [18].

Perhaps, the earliest EG study was that on the heavy metal stress on allozyme polymorphisms in Malaysia by Yap *et al.* [19]. They found a positive relationship between allozyme polymorphisms and heavy metal levels in *P. viridis* sampled from contaminated and uncontaminated coastal waters. Following that, Yap and Tan [15] reported changes in the enzymes *GOT*, *EST* and *ME* in direct connection to Zn stress. This was explained by a lower rate of filtration in the gills and a decreased value of condition index. The above laboratory experiment was conducted by using *P. viridis* as a test organism. The significance finding of Yap and Tan [15] supported the previous study by Yap et al. [20] that allozymes of *P. viridis* could be influenced by heavy metal stress based field collected samples. Yap *et al.* [16] reported significant ($P< 0.01$) relationships between heavy metal levels and RAPD primers in the byssus and soft tissues of *P. viridis*. This implied that correlation analysis between a specific primer of RAPD marker and a particular metal could be employed for the identification of metal pollution in the mussels.

Following the above EG studies by using *P. viridis* as a model, heavy allozyme polymorphisms and heavy metal levels were investigated in female guppy populations collected from two contrasting sites, namely polluted and unpolluted ecosystems [17]. They reported that the levels of Fe and Cu were significantly ($P< 0.05$) higher in guppy population sampled from polluted drainage than those from unpolluted ecosystem. This finding was largely supported by the significantly ($P< 0.05$) higher levels of Fe and Cu in the surface sediments, showing contamination by Fe and Cu in the polluted drainage. Based on allozyme study, they found that the banding pattern of the unpolluted wild guppy population with monomorphic alleles which were similar and comparable to unpolluted domesticated guppy population bought from a pet shop. This confirmed that LDH in the guppy can be used as a good biomarker of Fe and Cu contamination. Almost similar ecotoxicological genetic approach was applied to horseshoe crab populations in Malaysia by Yap *et al.* [18]. They sampled populations of horseshoe crab (*Carcinoscorpius rotundicauda*) from contaminated and uncontaminated coastal areas of Peninsular Malaysia.

Future ecotoxicological genetic studies should focus on crop plants since they are the major food sources to the ever increasing world populations nowadays. Food crop such as oil palm is an important focus. This is due to the fact that oil palm (*Elaeis guineensis* Jacq.) has arisen as a key economic crop nourishing the world population nowadays [21]. For example, ecotoxicological monitoring study has been conducted in the oil palm by Yap et al. [22] while genetic studies on the oil palm by Wahid et al. [23] for the high-quality planting material through genetic improvements. However, the above two studies were conducted separately and interpretations were made based on ecotoxicology and genetics, respectively. Future studies should merge the two areas as EG study to make the our understanding in a more holistic ecologically and genetically. Other ecotoxicological monitoring study in crops such as papaya and bananas have been published by Yap et al. [24] and Yap et al. [25], respectively. However, the genetic studies on the above crops are lacking in the literature.

Therefore, Crop Watch is a new research approach incorporating ecotoxicology and genetics. This EG studies hold a great potential research in the future, not only in academia but also commercial industries.

In conclusion, the above literature review indicated Crop Watch by means of EG studies is a potential (although not a new) research area. Considering the importance and combination of knowledge on ecology, ecotoxicology and genetics would help to monitor the growth and yield besides human health risk assessment of the crop better. This Crop Watch approach is expected to continue in future, especially in Malaysia and other Asian countries.

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Citation:
Chee Kong Yap, Uma Rani Sinniah (2019) Ecotoxicological Genetics: from Mussel Watch to Crop Watch. *Environ Sustain Clim Change* Volume 1(1): 1–2.