

Outcomes of Fukushima: Biological Effects of Radiation on Nonhuman Species

Three years have passed since the nuclear power plant in Fukushima faced meltdown in March 2011. Twenty-five years earlier, in April of 1986, a tragic nuclear accident of the same magnitude of 7 on the International Nuclear Disaster Scale (INDS) occurred at the Chernobyl Nuclear Power Plant in the Ukraine. Following the Chernobyl event, biologists were able to collect biological specimen samples and data only after extensive delays. These delays in the outset of biological studies resulted in a loss of important information on the impacts of ionizing radiation to ecosystems and human populations. To avoid repeating such shortcomings, biologists in Japan, with the collaboration of the international scientific community, began in the summer of 2011 to study outcomes of the nuclear accident in Fukushima. The massive release of ionizing radiation to areas near nuclear power plants may cause major irreversible shifts in ecosystems and severe damage to human health, and understanding the risks and quantifying the outcomes of nuclear accidents is of global concern.

This special collection compares data and describes some of the challenges of genetic studies on nonhuman species at Chernobyl and Fukushima. The goals of these ongoing projects are to identify strategies for further investigations of the general biological effects of ionizing radiation, as well as to understand the longer term genetic outcomes of various radiation levels. The collection, the first of such a series for *Journal of Heredity*, covers 3 diverse taxa: rice plants, butterflies, and birds.

Previous studies in genetics and ecological systems, including several by the present contributing authors (Otaki 2011; Hiyama et al. 2012, 2013; Iwata et al. 2013; Möller et al. 2012a, 2012b; Möller and Mousseau 2013a, 2013b; Endo et al. 2014; Möller et al. 2014; Mousseau et al. 2014; Nohara et al. 2014) for wild populations in Chernobyl and Fukushima, have demonstrated significant genetic, physiological, developmental, and fitness effects brought about by exposure to ionizing radiation. Observations at Fukushima and Chernobyl will serve as important baselines for the development of studies of ionizing radiation effects over time, as some biological outcomes may take years or generations to be expressed. It has been documented that there are considerable variations among taxa in their apparent sensitivity to ionizing radiation, reflecting behavioral differences as well as the evolutionary histories and genetic backgrounds of each group. The predominant hypothesis of the research reported here is that chronic exposure to ionizing radiation results in genetic damage and increased mutation rates in both somatic and germ cell lines within individuals. Hermann Joseph Muller has already shown in his research from 1927 onward that ionizing radiation causes genetic damage, and that the vast majority of such variations are likely to be deleterious (Muller 1927). However, to this date, we do not have a full understanding of the impact and thresholds of ionizing radiation exposure on the fitness of individuals in wild populations. We hope the 3 articles in this special issue will be the initiating point for further studies of the biological effects of radiation and its ecological impacts among nonhuman species.

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