THE CONVERSATION

Questionable studies won't help identify Fukushima's effects

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With a flap of a butterfly's wings. KENPEI, CC BY-SA

Irradiated plants taken from the evacuated areas around the stricken Fukushima Dai-ichi nuclear power plant have been reported to cause growth abnormalities and early death when fed to butterfly larvae, according to a paper published in Nature's Scientific Reports journal.

The larvae of the Pale Grass Blue butterfly (*Zizeeria maha*) from Okinawa, 1,000km south

Fukushima which the authors describe as likely the least polluted locality in Japan, were fed fresh leaves containing radioactive caesium (^{137}Cs and ^{134}Cs) to examine the effects. While such studies of the effects of exposure to ionising radiation are important to improve our scientific understanding of the risks involved, it's unfortunate that the authors of the study chose to delay publishing their estimates of the dose rates their butterflies had received. Because we're quite sure that if they had done so in this paper then they'd have questioned their own conclusions.

Using openly available software such as Erica, the authors could have estimated a dose rate (radiological dose, measured in Gray per hour) for their stated LD_{50} (the lethal dose required to kill 50% of exposed individuals). We estimate this to be around 8 µGy per hour (micro-Gray, one millionth of a Gray), assuming a worst case in which the larvae retained all the caesium they ingested over the period of around 12 days.

This is likely to be a considerable overestimate of the dose they actually received, given the levels of radioactivity detected in those larvae that had died, which were around three orders of magnitude lower than the estimate we've used. The dose rate from natural background radiation is typically in the micro-Gray per hour range. Consequently, the LD_{50} dose the authors report is close to the levels of radiation that organisms are normally exposed to from natural sources. The implication of this is that organisms would be at risk everywhere – yet this is a situation that is clearly not the case.

While there are few studies on butterflies, the existing scientific literature on invertebrates suggests that the LD_{50} for subadult live-stages is at least 1 Gray (requiring, over 12 days, more than 400 times the dose rate we estimate for the authors LD_{50}). Consequently, the authors' claim that their results suggest "that the Pale Grass Blue butterfly is generally resistant to internal radiation exposure. The possible biological impacts of much lower radiation levels will be the subject of future investigations" demonstrates a worrying lack of awareness of current scientific knowledge.

Unfortunately a more detailed analysis is difficult due to the lack of information provided in the paper. While all of the treated larvae (except the control) showed similar mortality and abnormality rates, the authors also acknowledge an error in the number of individuals in the control group, which leaves the reader at a loss as to whether this has any impact on the results.

There are also some technical errors in the paper. For instance they record dose in Becquerel (Bq), which is a measure of the rate of radioactive decays per second. Yet radioactive dose is properly measured in Gray (Gy), equivalent to a joule of radiated energy absorbed by a kilogramme of mass. The authors state their observations support the linear no-threshold (LNT) model, yet the LNT model does not relate to deterministic (as reported in this paper) effects.

We welcome papers investigating the impact of ionising radiation on wildlife, but these basic errors show we must ensure that the peer review of such papers involves scientists from an appropriate range of disciplines. It's been noted that many papers purporting to show significant radiological impacts on wildlife are appearing in journals not usually focused on or specialising in radiation protection.

Fukushima
Butterflies
Radioactivity
Radioactive poisoning