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Dietary exposure to neonicotinoid-contaminated plant material poses risk to leaf-shredding invertebrates

Neonicotinoids are pesticides applied to plants to protect them from insects. The use of neonicotinoids may lead to contamination of aquatic environments through, among other routes, the input of contaminated plant material into waterways. While it is well established that direct exposure to contaminated water endangers aquatic invertebrates, scientists have now published findings indicating that dietary exposure through the consumption of contaminated plant material puts leaf-shredding species at increased risk. The researchers recommend that policymakers registering systemic insecticides (those whose active ingredients are transported throughout the plant tissues) consider dietary exposure, and its potential implications for ecosystem integrity, in addition to other exposure pathways.

Neonicotinoids are effective against a large variety of insects and are used globally on a number of widely-grown crops. Some neonicotinoids applied onto crops or trees are subsequently transported into nearby bodies of water, for example through spray drift, surface run-off or contaminated plant material (such as leaves). Prior research has indicated that several groups of organisms experience negative effects from waterborne exposure to neonicotinoids. In the case of leaf-shredding invertebrates (shredders), it is possible that dietary exposure presents an additional risk. Until now, the effects attributable to the two exposure routes (waterborne and dietary) had not been systematically investigated.

The researchers conducted an experiment to compare the effects of waterborne exposure and combined (simultaneous waterborne and dietary) exposure on shredders. Researchers subjected members of two model shredder species — adult *Gammarus fossarum* (a crustacean) and larvae of *Chaetopteryx villosa* (an insect) — to either waterborne or combined exposure over a duration of seven days, before analysing the effects of each scenario on each species' feeding activity and survival rates. They also conducted several investigative tests concerning food-selection, in order to determine whether the shredders were actively avoiding neonicotinoid-contaminated food.

Overall, this study found that, for both species, combined exposure was associated with greater effects than waterborne exposure alone. Notably, the insect larvae appeared to be more sensitive than the crustaceans, exhibiting increased mortality under the combined exposure pathway — an outcome that might be explained by the fact that the former species consumed four times more leaf material (in relation to its own dry weight) than the latter. Moreover, both species exhibited decreased feeding rates in the combined exposure scenario. However, the scientists did not find consistent evidence that either species preferentially fed on the neonicotinoid-free or neonicotinoid-contaminated leaf material. This suggests that shredders are unable to actively avoid dietary neonicotinoid exposure.

Taken together, these findings indicate that dietary neonicotinoid exposure may pose a significant risk to invertebrates that feed on leaf material, including reduced survival. Importantly, by hampering energy acquisition via reduced feeding, such exposure could significantly hamper population development and limit shredders' contribution to the leaf-litter breakdown process — two outcomes that could have significant ecosystem-wide implications. The researchers therefore recommend that policymakers and decisionmakers considering the registration and use of neonicotinoids and other systemic insecticides account for dietary exposure alongside other contamination pathways. This is especially pertinent given that insecticide use is expected to rise to tackle the growing impact of native and invasive pests caused by climate change.

Source: Englert, D., Zubrod, J. P., Link, M. *et al.* (2017). Does waterborne exposure explain effects caused by neonicotinoid-contaminated plant material in aquatic systems? *Environmental Science & Technology*, 51(10): 5793-5802. DOI: 10.1021/acs.est.7b00827.

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