Study finds tire abrasion particles threaten fresh water habitats

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The researchers investigated the effects of the toxic particle mixture on the non-biting midge species Chironomus riparius. Credit: Pfenninger / Senckenberg

A research team led by Prof. Dr. Markus Pfenninger from the

Senckenberg Biodiversity and Climate Research Center Frankfurt (SBiK-F) has investigated the effects of tire-abrasion particles on freshwater ecosystems.

Their study, now published in the journal *Science of The Total Environment*, shows that the toxic particle mixture resulting from road traffic harms important aquatic organisms. The researchers warn of this underestimated danger to our environment.

The negative effects of road traffic on the environment, the climate, and human health are generally known and are widely discussed in society. The primary focus is on CO_2 emissions and air pollution due to exhaust fumes and particulates. Less attention is paid to emissions that are not released into the air.

The nano- to micrometer-sized particles, which are continuously generated by the wear and tear of tires and road surfaces, can easily be dispersed into the environment through wind and rain. In this way, they also enter bodies of water and endanger the ecosystems.

The team, which included researchers from the LOEWE Center for Translational Biodiversity Genomics (TBG) and Goethe University in Frankfurt, investigated the effects of tire-abrasion particles on larvae of the non-biting midge species Chironomus riparius—one of the most numerous creatures in aquatic ecosystems and a widely used organism in environmental impact assessments—and reached an alarming conclusion: Tire abrasion impairs the organisms' survival, development, and reproduction.

"The minute tire- and road-wear particles—TRWP for short—are a chemically complex mixture of many different components such as microplastics, polycyclic aromatic hydrocarbons (PAHs), mineral oils, metals, tire rubber, and synthetic chemicals, including tire rubber

additives and plasticizers. Every year, more than 20,000 tons of this mixture are discharged into water bodies in Germany alone, mainly through unfiltered road runoff," explains Pfenninger.

The researchers analyzed sediments from retention basins near roads and first determined the quantity and composition of the tire abrasion they contained. The midge larvae were then exposed to different concentrations of the sediments, after which the researchers measured parameters such as mortality, development, the sex ratio, fertility, and size.

They further analyzed the extent to which the organisms were exposed to "oxidative stress" caused by free radicals and estimated the development of the population growth rate.

"We found a highly complex mixture of substances characteristic for pollution from road runoff in the urban sediments," reports Lorenzo Rigano, the study's first author and a Ph.D. student at the LOEWE Center for Translational Biodiversity Genomics (TBG).

"In our laboratory tests, this mixture had complex and clearly harmful effects on the midge larvae and the adult organisms. The contaminated sediment increased mortality by almost 30%. Fertility also decreased noticeably, and there was a reduction in the number of fertile eggs per female. We were able to detect clear signs of oxidative stress, and the population growth rate was significantly reduced depending on the concentration.

"Our study clearly shows that tire-abrasion particles pose an underestimated threat to our waters. Collectively, the pollutants contained in the particles have a more toxic effect on aquatic organisms than each individual component would have on its own."

A particularly concerning aspect highlighted by the study is the possibility that the observed reproductive disruptions could potentially persist over several generations. In addition, TRWPs contain a multitude of chemicals and pollutants that can accumulate in body tissue and thus may have cascading effects on freshwater ecosystems via the food chain.

"Our results emphasize the need to closely examine the toxic effects of mixed substances, as their interactions can have unexpected effects," adds Pfenninger in conclusion. "Specifically, we need to reduce the contamination of our environment by toxic tire abrasion in order to protect our waters and preserve biodiversity."

More information: Lorenzo Rigano et al, Mind your tyres: The ecotoxicological impact of urban sediments on an aquatic organism, *Science of The Total Environment* (2024). DOI: 10.1016/j.scitotenv.2024.175597

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