

# Theodora (Theo) Emily Colborn (1927-2014)

Theodora Colborn studied how chemicals affect organisms as they develop and reproduce during the twentieth and twenty-first centuries in the US. By the 1940s, researchers had reported that chemicals from agricultural and industrial processes affected how wild organisms developed, but in 1991, Colborn organized the Wingspread Conference in Racine, Wisconsin, at which a group of scientists classed these chemicals as environmentally harmful substances. Colborn and her colleagues called those chemicals endocrine disruptors, as they mimic or block the body's endocrine system. After scientists labeled these chemicals and showed that they harm humans and wildlife, the US Congress passed several acts to regulate these chemicals and to protect both wildlife and humans from their harmful effects.

Theodora Emily Colborn was born on 28 March 1927 to Margaret L. de Forge Decker and Theodore Decker in Plainfield, New Jersey. Colborn later said that as a girl, river water fascinated her. Colborn tended not use her given name Theodora, but instead adopted a shortened version, Theo. In 1943, Colborn entered Rutgers University in New Brunswick, New Jersey, where she graduated with a bachelor of science degree in pharmacy in 1947. While at Rutgers, Colborn met Harry R. Colborn, a fellow pharmacy student, whom she married on 20 January 1949, and with whom she had four children.

After graduation, both Colborns worked at a drugstore in Newton, New Jersey, that belonged to Harry Colborn's father. After taking over the business, the Colborns expanded the drugstore to two other locations. Colborn later said that she became disillusioned with the profession of pharmacy and did not like prescribing drugs with unknown side effects. The Colborns sold their business in the early 1960s and moved to Colorado.

In Colorado, the Colborns opened another drugstore and started raising sheep. In Colorado, Colborn reignited her interest in rivers when she noticed that locals suffered from poor health after they drank river water polluted by nearby coal mining. Colborn said that the misuse and overuse of water in the western US prompted her to enroll in Western State College of Colorado in Gunnison, Colorado, in 1978 to study fresh water ecology. That year, Colorado governor John D. Vanderhoof appointed Colborn to the Colorado National Areas Program, a statewide conservation effort. Colborn spent her summers doing field research for her master's thesis at the Rocky Mountain Biological Laboratory in Crested Butte, Colorado.

In 1981, Colborn graduated with a master's degree in freshwater ecology after she defended her thesis titled "Aquatic insects as measures of trace element presence: cadmium and molybdenum". In her thesis, Colborn discussed how aquatic insects like mayflies could be used to assess the heavy metal pollution of fresh water. Heavy metals like cadmium, a common industrial chemical that causes cancer, pollute fresh water and harm the wildlife species that drink from the water. Colborn, in her thesis, showed that measurements of cadmium levels in aquatic insects were more accurate than the standard testing measures of the time. In 1982, her thesis was published.

Colborn's husband died in 1983, and after graduating from Western State College of Colorado, Colborn moved to Madison, Wisconsin, where she began her doctorate in zoology at the University of Wisconsin, Madison. In 1985, Colborn received her doctoral degree in zoology, with minors in epidemiology, toxicology, and water chemistry. Her dissertation, "The use of stonefly, *Pteronarcys californica* Newport, as a measure of bioavailable cadmium in high altitude river system, Gunnison County, Colorado," built on her previous work and measured the amount of metal in aquatic insects as a measure for heavy metal pollution in their fresh water ecosystems.

In 1985, Colborn received a US Congressional Fellowship with the Office of Technology Assessment in Washington, D.C., where she evaluated technologies. At the Office of Technology Assessment, Colborn further studied water quality and water quality assessment. She continued this work when she began working in 1987 for the Conservation Foundation, a think tank in Washington, D.C. At the Conservation Foundation, Colborn contributed to a two-year study of the Great Lakes drainage basin.

As part of the study, Colborn reviewed literature about research on the Great Lakes ecosystem. While reviewing that literature, Colborn noted that sixteen animal species that ate fish from the lakes suffered from reproductive issues, often bearing abnormal young, if they bore any at all. The study culminated with the 1990 book, written by many members of the research team, including Colborn, titled *Great Lakes: Great Legacy?* The book detailed the environmental problems found in the area, including the deposition of chemicals like DDT, the deterioration of 80,000 small lakes due to acid rain, the loss of wetlands, and the high costs of solving those problems.

While at the Conservation Foundation, Colborn studied the chemical pollutants found in the Great Lakes area. She joined the World Wildlife Fund in Washington D.C. as a senior fellow in 1988, and she began to study the effects of those chemical pollutants. In 1991, she published a study about the reproductive challenges faced by bald eagles living in the Great Lakes region. In that study, Colborn showed that if female eagles were exposed to environmental pollutants found in the Great Lakes area, pollutants like pesticide dichloro-diphenyl-trichloroethane (DDT), then the offspring of those eagles were less likely than normal to live long enough to reproduce. She hypothesized that the pollutants affected the birds' hormone systems.

Later that year, Colborn organized the Wingspread Conference, where she brought together scientists who studied the effects of industrial chemicals on ecosystems. The scientists discussed the possibility that agricultural and industrial chemicals adversely affected organisms through the mimicry or blockage of natural hormones in the bodies of those organisms. In 1992, the Wingspread consensus statement was published as "Chemically-induced Alterations in Sexual and Functional Development: the Wildlife/Human Connection." The statement said that agricultural and industrial chemicals affected the growth and development of several wildlife species. The authors then discussed the effects of the drug diethylstilbestrol in women who used it to prevent miscarriages. Physicians prescribed diethylstilbestrol to four million women between 1938 and 1971, before its use was banned due to its toxic health effects. They Wingspread scientists noted similarities between the effects of diethylstilbestrol and those of the chemicals, and they concluded that many of the chemicals affecting wildlife may have similar effects on humans.

In 1993, Colborn published "Developmental effects of endocrine-disrupting chemicals in wildlife and humans," along with developmental biologist Frederick S. vom Saal and cell biologist Ana M. Soto. In that paper, the authors presented twenty years of evidence demonstrating the effects that environmental pollutants have on wildlife and humans, especially when the exposure takes place prenatally, on both the pregnant female and the embryo. The authors coined the term endocrine disruptor in this publication. Endocrine disruptors refer to those chemicals that cause alterations in sexual and functional development through interaction with the hormone (endocrine) system of the body.

Later in 1993, Colborn became a senior scientist and director of the Wildlife and Contaminants Program for the World Wildlife Fund. While at the World Wildlife Fund, Colborn continued to research endocrine disruptors and their effects on growth, and she advocated for policy reforms to protect humans and wildlife against endocrine disruptors.

In 1996, Colborn coauthored a book with environmental journalist Dianne Dumanoski and environmental health scientist John Peterson Myers. The book, titled *Our Stolen Future: Are We Threatening Our Fertility, Intelligence, and Survival? A Scientific Detective Story*, targeted a general audience, and it described endocrine disruptors and their effects on growth and development. The book spurred the US Congress to pass two acts that led to the creation of the Endocrine Disruptor Screening Program, a program led by the Environmental Protection Agency in Washington D.C. to test new chemicals for their possible effects on endocrine systems. As of 2014, the Endocrine Disruptor Screening Program remains the US government's sole attempt to regulate endocrine

disruptors.

After 1996, Colborn published several articles about possible screening methods for endocrine disruptors. She also discovered new detrimental effects of endocrine disruptors, including endocrine disruptors and their link to hypospadias, a birth defect of the urethral opening in males, and to problems in brain development.

After leaving the World Wildlife Foundation in 2003, Colborn founded The Endocrine Disruption Exchange (TEDX) in Paonia, Colorado. TEDX is a nonprofit organization that focuses on disseminating scientific evidence of the effects of low dose exposure to endocrine disruptors. TEDX addresses a unique property of endocrine disruptors: that they do not require large amounts of a given chemical to cause disadvantageous effects in the exposed organism. In 2004, Colborn began teaching at the University of Florida in Gainesville, Florida.

Colborn won many awards for her work on endocrine disruptors. In 1994, the National Wildlife Federation awarded her the National Conservation Achievement Award in Science. In 1997, the United Nations Environment Programme awarded her the Women Leadership in the Environment Award. She also received the Asahi Glass Foundation's Blue Planet Award in 2000, and the Center for Science and the Public Interest's Rachel Carson award in 2004.

In 2009, Colborn left TEDX and the University of Florida and moved to Paonia, Colorado. She died on 14 December 2014.

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