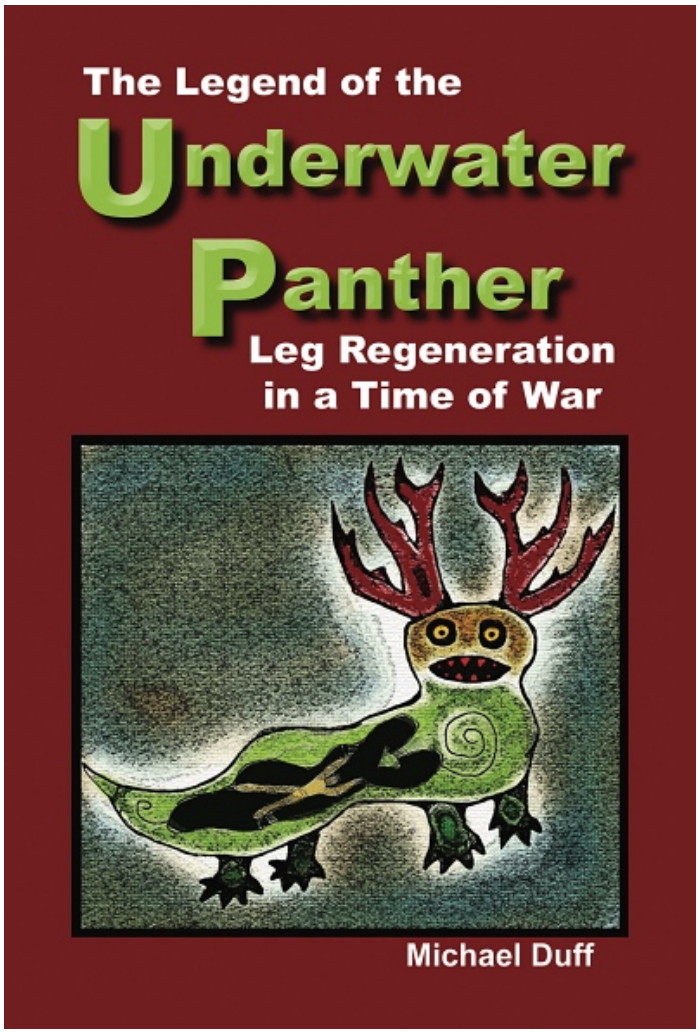

Underwater Panther limb bud (blastema) transplants regenerate human legs.

THE LEGEND OF THE UNDERWATER PANTHER: Leg Regeneration in a Time of War

By Michael Duff

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Leg Regeneration in a Time of War

Michael Duff

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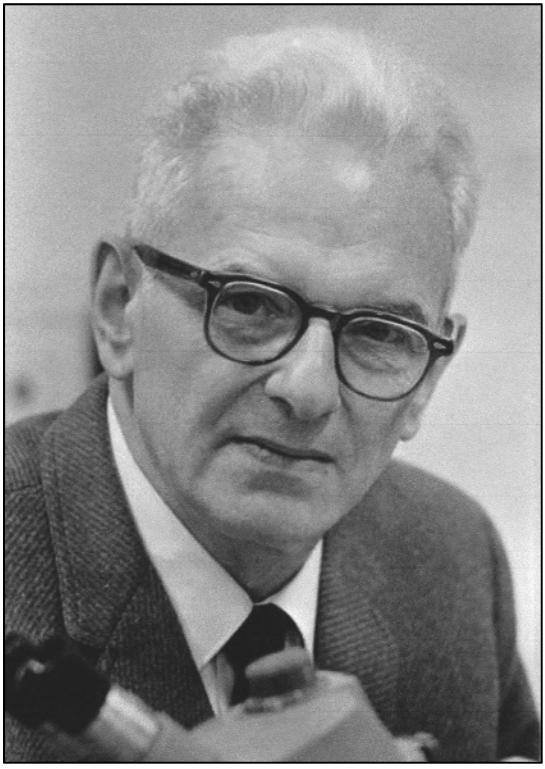


DOCTOR VIKTOR HAMBURGER AND THE NAZIS

Dr. Viktor Hamburger worked in an experimental embryology lab under Professor Spemann at the University in Freiburg, Germany. He repeated an experiment that demonstrated limb development in frog embryo could occur without nerves using micro-surgical techniques developed by Dr. Spemann. Dr. Spemann is considered the father of micro-surgery, and his group did the first nuclear transplants. He was awarded a Nobel Prize in 1935 for studies in embryonic cellular induction, the only Embryologist ever awarded that prize. He was expelled two years later in 1937 by the Nazis.

In 1932 Dr. Hamburger traveled to the University of Chicago on a Rockefeller grant to demonstrate the experimental micro-surgical

techniques. In 1933 the Nazi party revoked his position and all Jewish faculty in German Universities. Dr. Spemann, also Jewish, lost his position in 1937. In 1935 Dr. Hamburger came to Washington University in St. Louis and became a full professor and head of the Department of Zoology in 1941.

The Lady of the Cells

DR LEVI-MONTALCINI DID NOT LET WAR DISRUPT HER EXPERIMENTS

During this time period in Turin, Italy, a talented physician and experimental embryologist, Rita Levi-Montalcini, was banned from working in University Laboratories by Mussolini's fascist edicts. She was inspired by a 1934 article by Victor Hamburger and continued her research in a laboratory set up in her bedroom. She was exposed to the Allied bombing of Turin in 1941.

Professor Giuseppe Levi, a master histologist, was her inspiration in medical school. "He had devoted himself with increasing enthusiasm to the study of nerve cells grown in vitro. This research had begun in the United States during the first decade of the century with Ross Granville Harrison's investigation of the growth of nerve fibers from amphibian spinal-cord fragments in a semi-solid medium." Vide infra, Levi-Montalcini, p.59. Dr. Harrison placed frog embryos on the underside of microscope slides in a nutrient medium and could watch

them develop. This is the hanging drop technique he perfected at Yale University and led to advanced tissue culture techniques. This ultimately led Rita Levi-Montalcini to culture sensory ganglia and demonstrate the effect of pit viper venom on dorsal root ganglia nerve growth. Harrison's German friend, Dr. Schotte, idolized Harrison and referred to him as a "fine gentleman and an apsolutely funtastik embryologist that was the true father of tissue culture." "Origin of the blastema cells in epimorphic regeneration of urodele appendages: a history of ideas." Richard Liversage. p. 182. *A History of Regeneration Research.* Charles Dinsmore. Cambridge University Press.

DON'T BOMB MY ZEISS BINOCULAR MICROSCOPE

"Almost every night, the lugubrious whine of sirens, warning of British planes overhead forced us to go down into the basement in spite of the risk - of being buried under the ruins of bombed buildings. Every time the alarm sounded, I would carry down to the precarious safety of the cellars the Zeiss binocular microscope and my most precious silver-stained embryonic sections." p. 95. In: *In Praise of Imperfection. My Life and Work.* Rita Levi-Montalcini. Basic Books, New York. 1988.

She survived the Nazi invasion of Italy in 1943 and went underground working with partisans before the invasion of Anzio. In 1944 she worked in Italian refugee camps treating epidemics of infectious disease and abdominal typhoid, which spread death among the refugees and doctors due to a contaminated water supply. In May of 1945, when the war ended in Italy, she returned to the University. In the Fall of 1947 Dr. Viktor Hamburger asked her to join him in St. Louis at the Department of Zoology, Washington University, to repeat some experiments to solve a limb innervation development problem in chick embryos. She became a full professor at Washington University in 1958. Viktor and Rita were joined by a talented biochemist, Dr. Stanley Cohen. Dr. Cohen earned his PhD

from the University of Michigan studying nitrogen metabolism in earth worms, a species used in regeneration experiments for many years.

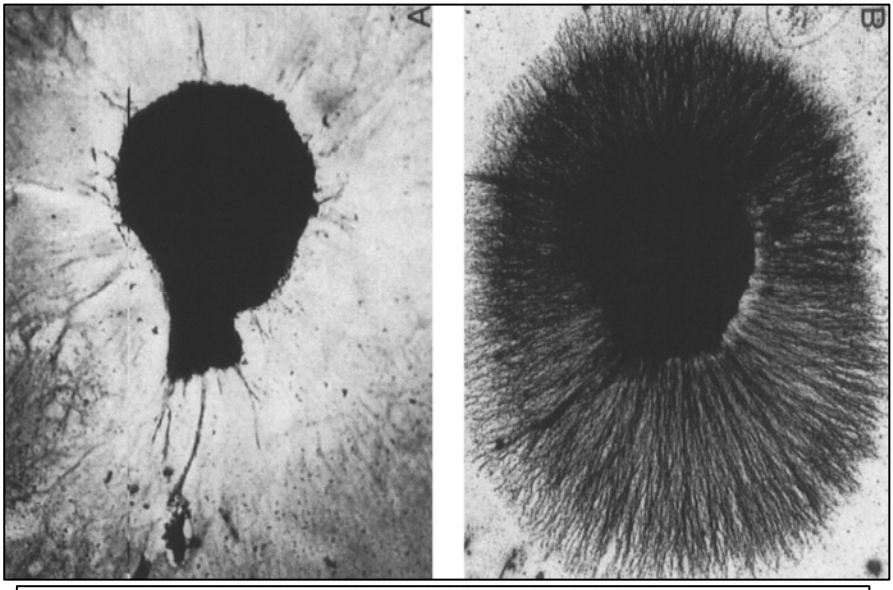
Dr. Stanley Cohen inspiring high school students.
Courtesy: Dana Johnson, Vanderbilt University Medical Center

COLLECTING NIGHTCRAWLERS AT THE UNIVERSITY OF MICHIGAN-ANN ARBOR

"I (Dr. Stanley Cohen) remember spending my nights collecting over 5000 worms from the University (of Michigan) campus green. I believe it was my ability to stomach – tube earthworms that convinced Dr. Harry Gordon to offer me my first job in the Pediatrics and Biochemistry Departments of the University of Colorado. I left Colorado and went to Washington University in 1952. I learned isotope methodology while studying carbon dioxide fixation in frog eggs and embryos, and also derived a priceless education participating in the journal club administered by Dr. Arthur Kornberg who had just arrived at Washington University." *Nobelprize.org Autobiography.*

"He would arrive in the morning with a pipe in his mouth, limping slightly because he had had polio as a child, after traveling the short distance that

separated his cottage from the campus and Rebstock Hall where our institute was. He was followed by Smog, the sweetest and most mongrel dog I ever saw. Smog used to lie down at Stan's feet when he sat at his desk, and kept a loving eye on him, or slept when he fidgeted with test tubes or relaxed playing the flute." Stan and the NGF, p. 163. *In Praise of Imperfection*, Rita Levi-Montalcini.



*A NERVE GROWTH-STIMULATING FACTOR ISOLATED FROM SNAKE VENOM**

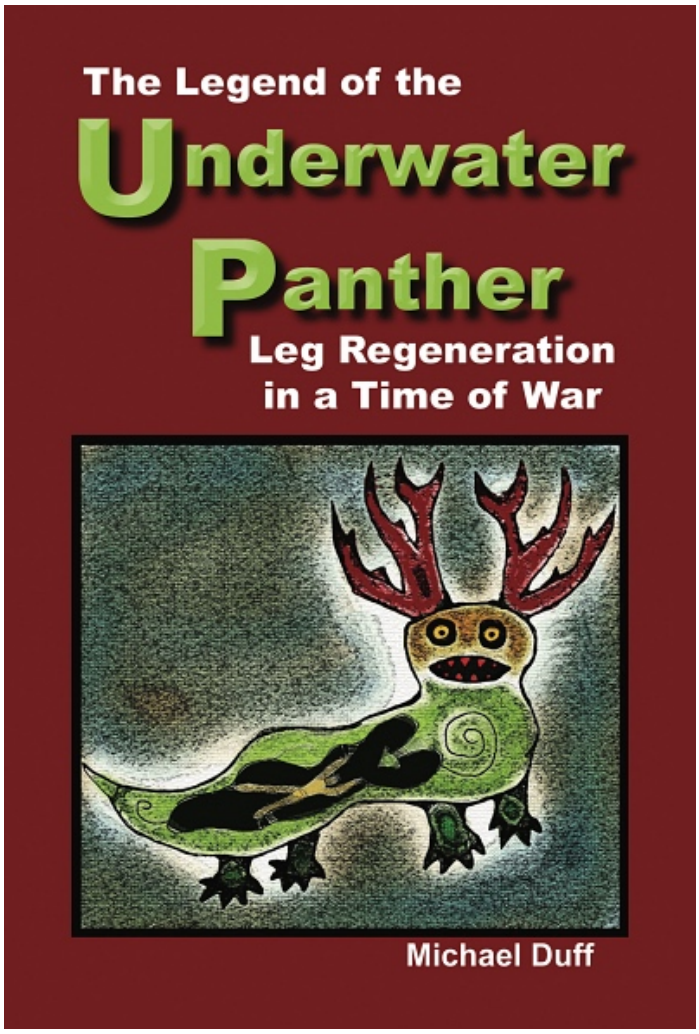
By Stanley Cohen and Rita Levi-Montalcini

Department of Zoölogy, Washington University, St. Louis, Missouri

Communicated by V. Hamburger, July 19, 1956

COTTONMOUTH VENOM AND THE NOBEL PRIZE

This clever group of scientists discovered the factor attracting dorsal ganglia sensory and sympathetic nerve growth in chick embryos and found high concentrations of the substance in cottonmouth moccasin (*Agkistrodon piscivorus leucostoma*) venom and submaxillary glands (and saliva) of mice. It was first thought to be a



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