

Possums (1952), by Carl G. Hartman

Possums is a 174-page book consisting of a series of essays written about the Virginia opossum (*Didelphis virginiana*), the only living marsupial in the US. The essays were written by Carl Gottfried Hartman, an embryologist at the Carnegie Institute of Washington (CIW), in Baltimore, Maryland, who also worked with another mammal, the rhesus monkey. *Possums* was published in 1952 by Hartman's alma mater, the University of Texas at Austin (UT). Beginning in 1913, while as a graduate student, and later as an instructor at UT, Hartman captured and raised opossums. He was one of the first zoologists to study the intricacies of opossum embryology, leading to an account of the embryology and reproductive physiology of a mammal from the wild, rather than of a mammal bred exclusively for laboratory research. *Possums* culminated Hartman's studies of the marsupial.

Possums consists of twenty-two chapters, some of which are about the natural history and folklore of opossums, going as far back as the sixteenth century, and some of which include recipes for cooking with opossum meat. For the most part, however, *Possums* describes the behavior and habitat preferences of opossums, and many sections of the book cover the animal's reproduction and embryology. Hartman claimed that he collected opossums because there were so many of them in Texas, and through his studies, he discovered that marsupial processes of reproduction and development differ from those of most other mammals. This article focuses on the six chapters in *Possums* in which Hartman describes opossum fertilization, embryology, and birth.

The opossum is a marsupial, a group of mammals for which the neonates develop in a pouch located externally on the mothers' lower abdomens. While this external pouch enable researchers to observe developing opossums, it has also been the focus of stories about how opossums develop. Female opossums have a forked (bifurcated) reproductive tract with two lateral vaginal canals and two uteri. Likewise, male opossums have a bifurcated penis—a common trait among marsupials. These characteristics have been the subject of fables and discredited theories about conception of young opossums through the female's nose.

Hartman begins Chapter 10, "Opossum Embryology in Pictures," by discussing the myths of opossum embryo development. After these stories, he presents seventeen photographs, which he took over the course of years as he studied opossums. The photographs show the details of the first eleven days of embryo development. Although scientists before Hartmann had documented opossum development, the author explains that the information had remained in scientific journals and was not available to general readers. Because of the inaccessibility of accurate information, Hartman contends that many people still held false ideas about opossum development, such as that mother opossums blow their young out of their nostrils and into the pouch.

In Chapter 11, "Birth of the Opossum," Hartman introduces the reader to the myriad of folk tales and natural historians' views on how the young opossum finds its way to the pouch and to the mother's milk. He then discusses embryonic anatomy and the route that embryos take during birth, or parturition. The embryo is surrounded by amniotic fluid, which is enclosed by a thin layer of tissue called the amnion. Surrounding the amnion is another layer of tissue, the chorion, in which blood vessels lie in close contact with the mother's uterine wall. The female opossum has no placenta, so the chorion functions like an umbilical cord, absorbing food for the young and transferring waste materials to the maternal blood stream. The absence of a placenta also means that the opossum embryos must leave the uterus far earlier than do most placental mammals.

On average, opossum embryos develop internally for thirteen days. Intrauterine development ends as the mature embryos migrate out of the uteri and down the vaginal canals. While opossum spermatozoa must travel through vertical and lateral vaginal canals before reaching mature eggs, opossum

embryos travel from the uterus down through a temporary passage that bypasses the lateral vaginal canals. The mother's tissue in the genital tract breaks down, allowing the embryos to travel straight down and out. As the embryos exit the vaginal canal, the mother licks them, tearing the chorions and the amniotic sacs, leaving the neonates exposed to the outside environment.

Chapter 12, "Journey to the Pouch: Fancy," begins with folk stories about opossums. When early naturalists observed small opossums inside their mothers' pouches, the observers wondered how the young opossums got there. No one had seen and described an opossum in the act of giving birth; many descriptions were based on speculations rather than on observations. For many years before Hartman's work, there were two main theories about how opossum young come to occupy their mother's pouch. The first theory was that the female opossum used her mouth to pick up the baby opossums and place them in her pouch. The other theory was that female opossums could bend their bodies in such a way as to bring the birth canal into contact with the pouch. Zoologists and field biologists accepted both theories, but Hartman's observations discredited these theories. During his opossum research, Hartman had placed nearly twenty opossum neonates in a teaspoon and photographed them. Hartman included in Chapter 12 the photo, often captioned "A Spoonful of Opossums," to indicate the small size of newborn opossums. This photograph found its way into many high school biology textbooks, either to demonstrate marsupial reproduction or to compare opossum birth to that of other mammals.

In Chapter 13, "Journey to the Pouch: Fact," Hartman describes what earlier investigators had missed—how blind neonatal opossums make their way to their mother's pouch. Hartman observed a pregnant opossum without break to see the birth and migration of young opossums. He housed the pregnant opossum in a cage located just outside his window, and within a few days, she became restless and began licking her pouch. Hartman then observed the opossum move to the corner of the cage where she sat upright. After several abdominal contractions, the opossum bent forward and licked her vulva. Several tiny opossums appeared and, after the membranes surrounding them broke, the young traveled by their own efforts to the mother's pouch—three inches up, over matted and tangled hair.

Once in the pouch, opossum young locate one of thirteen available mammary nipples. If opossums have more than thirteen young, which they often do, the young that cannot locate a vacant nipple die. Hartman observed that opossum mothers don't assist their young by picking them up in her mouth or laying down a milk trail for the young opossums to follow. Rather, the mother's constant licking of her abdomen seemed to provide a path on which the blind opossum young can navigate.

Hartman also studied how young and blind opossums find which direction to crawl after they exit the vaginal canal. In 1920 he had hypothesized that as the young always crawl upward, perhaps they moved away from the earth's gravity (negative geotropism). Hartman explained how this hypothesis was later nullified by the work of Edward McCrady, Jr., Ernest Glen Wever, and Charles W. Bray, on hearing development in the opossum. In 1937 in the US, these three zoologists showed that newborn opossums have little, if any, hearing capacity. Opossums develop internal and external ear organs beginning on the forty-first day after conception and after they have started suckling. With no semicircular canals to detect gravity, opossums cannot use geotropism to navigate toward their mothers' pouches. Hartman concludes Chapter 13 by discussing the alternative theory that newborns find their way to the pouch because of the young's rather well-developed front legs. As the embryo exits the vaginal canal, the embryo's lower body always swings downward. The opossum then uses its front legs to pull itself forward, which is upward, toward the pouch, while dragging its back legs and posterior. Hartman notes that these front legs and the upward climb are similar in the kangaroo, which leads him to discuss the kangaroo pouch in chapter 14, "Birth of the Kangaroo."

Chapter 15, "The Brood Pouch in Nature," delves into the occurrence of brood pouches or similar structures throughout the animal kingdom. Hartman starts with data on the characteristics of the opossum pouch, which is found on the belly side of the mother's body. In addition to discussing oxygen content of air within the pouch, Hartman describes how he has observed opossum mothers, with their brood, swim in water without their young getting wet. The mother opens and closes the pouch by way of a sphincter muscle, at times forming a watertight compartment. Hartman then delves into examples of other animals with brooding structures, such as frogs that store eggs in their throat or skin.

In chapter 16, "The Pouch Young," Hartman details opossum development after neonates successfully navigate to the pouch. Hartman credits Charles D. Meigs, a nineteenth-century obstetrician in the US, for his descriptions of the opossum young in the brood pouch. Meigs refuted the notion of young opossums as shapeless blobs of life by describing their physical features that include a large head, strong front legs, and large nostrils. Hartman then adds to Meigs's descriptions.

Within this chapter, Hartman details the development of young opossums. For the developing opossums to stay attached to the nipple of the highly mobile mother, they use their fetal tongue and facial muscles. Within one hour after making contact with a nipple, usually on the thirteenth day of development, the opossum begins its sixty to seventy-day stay in the pouch. While in the brood pouch, the opossum grows and its organs begin to function. Hartman found that at about day 7 in the pouch, the opossum can wrap its prehensile tail around a pencil and be lifted up into the air. At day 36, the front limbs can grasp onto the pencil as well. At day 41, the opossum can turn over and right itself, and it can take a few steps without falling over. To Hartman, ambulatory abilities mark the beginning of the development of the semicircular canals in the inner ear. At day 46, the young opossum can cling to a rope but not climb it. At day 50, the opossum reacts to sound. The eyes, however, remain closed until about day 62. At day 67, the opossum has fur and the litter leaves the pouch to climb onto the mother's back by clinging to her hair. The young opossum is fully weaned around day 100, and with that fact, Hartman finishes his discussion of opossum development.

Sources

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