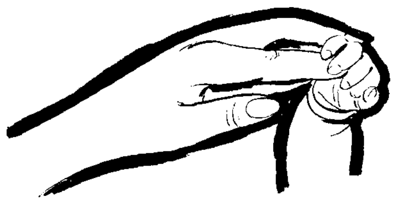
THE CHILD



ALMOST 2,000 years of telling have left the story of the Christmas child a still fragmented tale. When and where the child was born remain uncertain. Scholars say it could have happened at either of two times twelve years apart, and in either one of two places: Nazareth or Bethlehem. Some aspects of the story that have become well established are seldom heard. Carols refer to a firstborn son. But how many other children were there? Certainly four boys—Jacob (or James), Joseph, Simeon, Judah—and at least two girls. That the father, Joseph the carpenter, died when the Christmas child was nearing puberty has been deduced from the disappearance of Joseph's name from the story about that time. Only the mother, Miriam (or Mary), continues as a character in the several biblical accounts. Such a circumstance could explain why the Christmas child in adulthood had such a deep and everlasting concern for widows and orphans.

If the most often repeated of all stories of a child is imperfectly known even now, it is not surprising that the collective story of earth's multitude of children still should be so much conjecture.

—J.L.

1. His Ancient Inheritance

By N. J. BERRILL

EVERY human being is a miracle of existence. Each has a past going back generation by generation, tissue from tissue, in an unbroken line for thousands of millions of years to the beginning of life on earth. Each individually begins with the development of a microscopic outcome of an unforeseeable chance meeting of a particular egg and a particular sperm, of one egg out of hundreds that might have ripened and descended to the womb and of one sperm out of millions that ascended to meet it.

The person develops in the womb not at once but belatedly, gradually, and in a self-creative way. The person develops in a fashion that echoes the evolutionary journey his ancestors took millions of years to travel. Yet his development is far from being a straightforward condensation of the old story. In the first place, there is no time for it in the nine months he spends within the womb. Secondly, the main business of the human egg is to develop into a human being able to walk around and raise his voice. Every conceivable shortcut is taken. Departures and innovations occur at every turn. Time itself gets out of joint. Certain things that appear fairly late in the course of his evolution show up very early in development.

The developing egg gives us tantalizing glimpses of the path we all have taken, as fish in the sea and four-footed creatures on land. We do not find a fish stage or a reptile stage in the literal sense of finding fish or reptile shapes, but we do find structures that mean "fish" and "reptile." The developing skeleton shows this clearly. The first sign of it in the human embryo is a rod of cells lying in the position of the backbone-to-be called the notochord. It was the original and all-sufficient skeleton of our earliest swimming forebears. In all vertebrate animals, including ourselves, it is the first skeletal trace to appear in the embryo. We have to look at some of the very earliest stages in order to find it, for it is recognizable only in embryos no more than a fraction of an inch long. Thereafter, the notochord's function is rapidly replaced by harder and more complex materials; a series of vertebrae are laid down around the notochord, first as gristly cartilage, than as harder bone.

WE are more fishlike when we are a quarter inch long than at any time after that. To students of human development, this is undoubtedly the most fascinating stage of all. Not only are we all there in every important way, in spite of the miniature scale, but it is almost impossible at this stage to distinguish a human embryo from that of any other mammal, whether it be an elephant or a mouse, a rabbit or a chimpanzee. They all look alike, and only slowly and gradually do the essential differences become apparent.

The reason, of course, is clear. All warm-blooded mammals are the descendants of some primitive kind of reptile, and reptiles in turn are descendants of a primitive group of fish. So it is not surprising that we all travel much the same path up to a certain point during our growth as individuals. As long as we overlook the absence of a fishy shape, we can say that the fish stage exists for a time during the early development of all land vertebrate animals. The streamlined form admittedly is missing, and the embryo does not swim, although there is enough salt liquid around it to wriggle in if it were able. But everything else that makes a fish a fish is there, even in human embryos.

The month-old embryo has a head and neck region, a trunk, and something of a tail. The trunk bears two pairs of lobelike limbs, and there is nothing to show whether they are destined to be fins or arms and legs. The sides of the neck each have several deep grooves that look exactly like those which in a fish embryo are destined to develop into gill passages. In fact, the only difference lies in what happens later on, for embryonic gills they truly are. And each swelling before or behind each gill passage contains a supporting bar of cartilaginous skeleton, like the gill bars of embryonic fish. Even the heart is more fishlike than human at this stage, and it has already been beating rhythmically for a week or more. It bulges way out from the chest, and it consists of two chambers only, not the four chambers we are born with. For at first it is a simple double-action pump that forces blood through a vessel below the gill region up the sides of the neck between the gill passages to reach the great artery that runs beneath the spine. It looks like the heart of an embryonic fish, and it acts like one. Not until the human embryo is an inch in length does an internal wall transform the two-chambered heart into a four-chambered one. The wall forms slowly during the fifth to the eighth week of development, a three-week period that represents in terms of heart evolution something like one or two hundred million years.

Much of the history of backboned creatures is the history of eggs: the shift from the sea to the rivers, when eggs changed from microscopic specks to eggs like those of frogs, which can divide—without any external nourishment—into more than a million cells; the shift from freshwater to the land, when eggs became relatively enormous and yolky and confined within a calcareous shell capable of developing out of water and protected from the soil; and the shift from large eggs that are laid to eggs that are retained, with consequent loss of shell and yolk. Each kind set the stage for the next. Were it not for the egg of the reptile, which is to be seen virtually unchanged in the egg of a hen, our mammalian brand of reproduction and development would never have evolved. For you cannot enclose a large, yolky egg within a rigid shell without serious consequences, no matter how necessary such a shell may be.

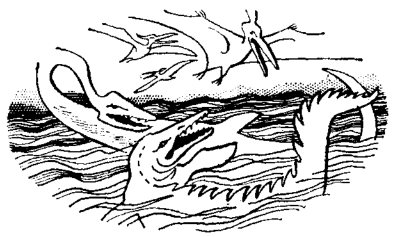
FISH and semiterrestrial creatures such as frogs and salamanders shed both eggs and sperm in water in the old-fashioned way. The parents have no more to do with the process of fertilization. Wrapping a shell around an egg just before it is laid, as in reptiles and birds, requires previous fertilization if the egg is to develop. Once the shell is formed it is too late. So in reptiles and in their descendants, the birds and mammals, the male must introduce sperm into the female reproductive tract in such a way and at such a time that sperm reach an egg when the egg enters the oviductal tube, before it descends to where the shell is added. The happy event that we know as sex comes from this ancient requirement.

Confinement of the egg had other consequences, which were coped with successfully or we wouldn't be here to talk about them. One of these was that the embryo could not grow freely from the surface of the mass of yolk. The shell formed a ceiling overhead and, in the process of sinking down instead of rising up, the embryo became enfolded by membranes that made a sort of water jacket around it. If you open a hen's egg after a week or so of incubation, you can see the chick embryo within its jacket—the amnion—not only well protected in its bath but rhythmically rocked by the pulsating, membranes.

The other two major problems caused by confinement of the egg—the storing of watery waste and obtaining the all-essential oxygen—were solved as one. A sac grew out of the hinder end of the embryo and did double duty in holding waste until hatching time and in supplying a large surface rich in blood vessels, a sort of external lung called the allantoic sac.

Such was the developing egg the earliest mammals retained within the maternal body. The shell became no longer needed, a bother to make, and now more of a liability than an asset. The shell-less egg continued its development safely in the lower part of the reproductive tract, where the shell used to be added. Then, presumably as nourishment to the developing embryo gradually became available directly from the surrounding maternal tissue, the need for yolk diminished and so did the yolk. Finally, what had been a substantial egg, comparable to those of reptiles now living, became reduced to the microscopic proportions typical of true mammals. Only the essence was retained, the spark of life that may become a bat, a whale, or a man, according to the species.

The surprising thing is that we still find the other reptilian development inventions in the development of all



mammalian embryos, including human. Even one as small as one-eighth of an inch has a yolk sac; a water jacket, or fetal membrane; and an outgrowth corresponding to the storage sac. The yolk sac, however, is small, and it shrinks rapidly since it is empty of yolk from the start. The water jacket persists until birth. It gives the unborn fetus support and room to maneuver in, and its membrane rocks the fetus as though it were a prenatal cradle. It is the caul with which some babies are born.

The yolk sac is a relict and nothing more; the water jacket remains unchanged and carries on its original function; and the third device—the storage sac of the reptilian egg—takes over an even more important duty. It no longer stores waste material. Its cavity has disappeared, but the lining of the sac remains, and so does the stalk. The lining serves as the placenta that unites with the lining of the womb and transmits maternal nourishment to the embryo. The stalk becomes the umbilical cord that joins the placenta and embryo together. The cord and the placenta, or afterbirth, are modified reptilian structures, which for a time—from about the second week after conception until birth—are an actual living part of every one of us.

The things that first come to mind when we think of a mammal are hair, warm blood, and milk. Even the most primitive of all living mammals, the duckbill platypus of Australia, which still lays small shelled eggs in the old reptilian way, has these features. Its coat of hair is well formed, although its body is only halfway warm. It has no milk teats; instead, the milk flows from two long grooves extending along the abdominal surface from the chest almost to the groin. The animal itself, apart from certain special features like its snout and tail, is a living relict of a time about two hundred million years ago when the earth was still ruled by dinosaurs.

WE humans are born naked, it is true, but during the fourth month of pregnancy a dense, fine growth of hair known as the lanugo covers the entire body of the human fetus. We lose it later on, and only a scarcely noticeable down on the face remains at the time of birth. Our nakedness seems to be newly won, for at some time in our past we were certainly covered with as good a coat of hair as any other mammal. Whether our present state is an improvement is hard to say. It would undoubtedly be more economical to grow a fur coat than to buy one.

The milk glands of the human appear at a much earlier stage than the lanugo: when the fetus is still less than one inch long and barely two months old. Instead of growing from the beginning as a pair of glands and nipples, where we expect to see them, a milk line forms from the armpits down each side of the body as far as the groin. It is unmistakably the primitive platypus condition, although it fails to last. The breasts develop as a pair of local growths on the line part way down the chest; the rest of the milk line disappears. Sometimes a second smaller pair of nipples grows from the line a little farther down than the first pair, equally a relict of an earlier ancestral stage.

The developmental course of certain other organs also illuminates our more recent past. The male reproductive glands are a good example. In all backboned animals up to and including the more primitive mammals, the male testes and the female ovaries are to be found in the same location: namely, in the abdominal cavity close to the kidneys. This is the primary position for both sexes. In the two-month-old human fetus, the testes are attached to the interior abdominal wall, but by the third month they have already descended into the well of the fetal pelvis, where they remain until the seventh month of fetal life. At this stage the baby could be born prematurely and have a chance to live, but its testes would still be within the body and the thin scrotal sacs would be empty. During the seventh month, however, the testes pass through the inguinal canals, which always remain weak places subject to hernia, and they reach the scrotum by the end of the eighth month. Such is the course of male development. The glands first develop in the old way, in the old place, and only slowly, as the fetus grows, do they move into their new position. It is the course of evolution repeated all over again.

When a baby is born, it still has some way to go before we can say that it has caught up with the times. For an infant, when it does first start to move around, progresses on all fours like a quadruped. Both hands and feet are used for walking—which is not surprising since the legs are weak—but more remarkable, they are used in the same way as by any other four-footed creatures. The right foot and left hand are placed on the ground together, then the left foot and the right hand take their place. Such is the fundamental pattern of walking on four feet. We retain it not only during our first attempts at locomotion, but we keep the pattern even when walking erect. Watch yourself the next time you walk down the street. As your right foot comes down your left arm swings out, and as the left foot descends your right arm goes forward too. Moreover, when a child at last does stand and walk on his hind feet alone, the backbone is still more or less curved in an old-fashioned arch. The final posture, which depends on an S-shaped curve in the backbone, takes several months to acquire. For learning to walk erect took place in the last phase of our evolution, the five or ten million years after we had descended from the trees.

EDITOR'S NOTE: N. J. Berrill had been for many years professor of zoology at McGill University in Montreal. He is now on the faculty at Swarthmore College. He is a Fellow of the Royal Society of London and of Canada. The paragraphs above are taken from his latest book, "The Person in the Womb," by permission of the publisher, Dodd, Mead & Co., Inc. Copyright © 1968 by N. J. Berrill.

2. *His Momentary Ancestor*

By JOHN LEAR

THE dreamy essence of human existence, the hopeful reaching out of past frustration toward the promise of the not yet, is nowhere clearer than in the making of a person-to-be.

The eggs that every normal female infant will begin to free more than a dozen years later to be fertilized for the making of her children are nested in her ovaries months before she is born. Her half of the hereditary message is already coded and capsuled while what will become herself still floats unconsciously in her mother's womb.

Thus does the wondrous principle of evolution assure that its successful biological inventions, having repeatedly proved their worth through past eons, will continue to steer the species across the unknown future.

That future will contain one overwhelming certainty—the certainty of change. The evolutionary principle has learned as much by experience, and has taken elaborate steps to prepare the person-to-be to adapt to whatever happens. Though sheltered by the wall of the womb for nine months, the potential embodiment of new life is from the very beginning individual. The embryonic brain and dependent central nervous system, designed to think and imagine and plan against unseen contingencies and so to set their possessor apart from other species of animals, is entirely separate from the brain and central nervous system of the mother. The new brain must have enough oxygen to feed on, or the new life will be vegetable in nature. The evolutionary method provides against such disaster by moving a steady stream of oxygen from the mother's blood into the blood of the prospective new person; but even that vital exchange is arranged by a private nurse empowered to command the mother's body without her conscious knowledge or explicit consent.

This evolutionary functionary is the placenta, a fabulously talented invention that prods the mother's body to take part in metabolic processes which in man's reptilian ancestors were left to the yolk of a hard-shelled egg after the egg was laid. In the multi-million-year history of evolutionary process, the substitution of live birth for the hatching of eggs is a relatively recent innovation; in these terms, the placenta is a newcomer. In another and very personal sense, the placenta is the very oldest organ of each of us. As Dr. Elizabeth M. Ramsey, eminent Carnegie Institution of Washington embryologist, reminded the American Philosophical Society membership in Philadelphia last month: "Before our bodies had attained recognizable shape, before our hearts had even begun to form, let alone to beat, our placentas had commenced their important business of obtaining nutrition for us from our mothers' bloodstreams."

—*Carnegie Institution of Washington.*

Eight-week old aborted fetus sucking thumb in amniotic sac. Placenta holds sac to wall of uterus at left.

ALTHOUGH the role of the placenta has been known in sketchy form since ancient times, the details of its workings are only now becoming well enough understood by specialists on Dr. Ramsey's level to be properly appreciated. The title of Dr. Ramsey's report at the Philadelphia meeting significantly began with the words: "new appraisal."

The fantastic complexity of the system of feedback communication through which the placenta keeps the mother's body at the beck of the new individual planted in the womb can be appreciated only by going back to the seedbeds in the mother's ovaries. Before the mother was born, these beds were in place and filled with nearly 500,000 cells, every one of them a potential egg. They lie there waiting for their host to leave the womb and then to grow for thirteen years. At the end of that time, by some still entirely mysterious process, a single seed is chosen to leave one of the two ovaries. Between 4,000 and 5,000 of the other seeds gather about the chosen one, forming a fluffy ball within which this first egg is nursed in readiness for its journey through the Fallopian tubes to the uterus. As it starts on its way, the egg is a fourth as big as a pinhead, just visible to the unaided eye.

The odds against that very first egg being fertilized are staggering. To begin with, the egg is released within the body of a thirteen-year-old girl. Should she be precocious enough to have a lover, and should one of his sperm meet the egg within forty-eight hours of the egg's departure from its nest, then and only then would the egg have any further history. Failing such an encounter, the egg would disintegrate.

Human nature being what it is, the odds favor penetration of one of her eggs by a spermatazoon sooner or later. The fertilized egg thereby completes a