A Brief History *of the* Paradox

Philosophy and the Labyrinths of the Mind

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To
those who never
have a book dedicated to them.

There are two famous labyrinths where our reason very often goes astray: one concerns the great question of the Free and the Necessary, above all in the production and the origin of Evil; the other consists in the discussion of continuity and of the indivisibles which appear to be the elements thereof, and where the consideration of the infinite must enter in. The first perplexes almost all the human race, the other exercises philosophers only.

—Gottfried Leibniz, *Theodicy*

Here and elsewhere we shall not obtain the best insight into things until we actually see them growing from the beginning . . .

—Aristotle, *Politics*

ONE

Anaximander and the Riddle of Origin

"... *5, 1, 4, 1, 3—Done!*" exclaims a haggard old man.

"You look exhausted, what have you been doing?"

"Reciting the complete decimal expansion of π *backwards."*

So goes one of Ludwig Wittgenstein's philosophical jokes. A beginningless individual borders on contradiction. Yet philosophy itself may have begun by embracing this absurdity. For this is Anaximander's (ca. 610 B.C.–585 B.C.) solution to the first paradox in recorded history.

WHERE DO WE COME FROM?

People are interested in tracing their ancestral lines. Anaximander generalized this curiosity. He notes that each human being begins as a baby who survives only if nurtured. Anaximander infers that the first human beings were cared for by animals. The Greeks knew of sharks that gave birth to live, autonomous young. Anaximander conjectured that the first human beings were born from aquatic creatures who then reared them.

But where did our animal ancestors come from? Here again, Anaximander seems ahead of his time. He infers that these creatures had inanimate precursors.

What were the precursors of *those* precursors? However long we continue the series, it makes sense to ask, what happened before that? Yet it seems impossible for history to be without a beginning. Isn't that the point of Wittgenstein's joke?

Perhaps some of Anaximander's contemporaries tried to precisely formulate the absurdity as an impossible wait: If there is an infinite past, then an infinite amount of time would have had to elapse to reach the present moment. An infinite wait is endless. But here we are at the present moment! Therefore, the past must have a beginning.

Unlike Anaximander, readers of this book are at home with negative numbers. We can model an infinite past by letting 0 represent the present moment, -1 represent yesterday, -2 the day before yesterday, and so on. For us, the fact that there are infinitely many numbers before 0 does not raise a mystery about how 0 can be reached. Why should an infinite past be any more puzzling than the infinite sequence of negative integers?

This mathematical model seems apt for an infinite future. +1 could be tomorrow, +2 could represent the day after tomorrow, and so on. You can imagine encountering an immortal destined to count forever. Each positive integer will be counted by this number god.

But negative numbers are not enough to solve the paradox of origin. There is a "something from nothing" feel about the claim to have recited infinitely many digits.

WHAT IS A PARADOX?

When discussing whether the barbarians originated philosophy, Diogenes Laertius reports, "As to the Gymnosophists and Druids we are told that they uttered their philosophy in riddles . . . " I take paradoxes to be a species of riddle. The oldest philosophical questions evolved from folklore and show vestiges of the verbal games that generated them.

Seduction riddles are constructed to make a bad answer appear as a good answer. How much dirt is in a hole two meters wide, two meters long, and two meters deep? This question entices us to answer, eight cubic meters of dirt. The riddler then reminds us that no dirt is in a *hole.*

Mystery riddles, in contrast, appear to have no answer. One way to achieve this aura of insolubility is by describing an object in an apparently contradictory way. As a boy, Anaximander must have been asked the ancient Greek riddle, "What has a mouth but never eats, a bed but never sleeps?" (Answer: A river.) Literary riddles elaborate the genres found in folklore. Anaximander probably learned of the riddle of the Sphinx from Hesiod's *Theogony.* We know it best from Sophocles' play *Oedipus the King.* The Sphinx is a monster who challenges travelers with a riddle she learned from the Muses: "What goes on four legs in the morning, two legs in the afternoon, three legs in the evening?" She wants her victims to remain ignorant of the underlying metaphors.

Oedipus answers by *decoding* the question: At the dawn of life, a baby begins life on all fours, then learns to walk upright on two legs, and finally spends his twilight years hobbling around with a cane. Tragically, Oedipus fails to solve deeper question of his own origin (continuously posed by the blind prophet Tiresias in his "riddling speech").

With most mystery riddles, there is little hope of understanding the question until after the answer is revealed. Two weeks before flying a plane into one of the World Trade Center's towers, Mohammed Atta phoned Ramzi Binalshibh asking help with a riddle: Two sticks, a dash and a cake with a stick down—what is it? Binalshibh was baffled. After the attack on September 11, he realized that two sticks stand for 11, a dash is a dash and a cake with a stick down signifies 9.

Sometimes the riddler himself is in the dark. When the Mad Hatter asks Alice, "Why is a raven like a writing desk?," he has no idea of what the answer is. Neither did the creator of the Mad Hatter, the logician Lewis Carroll.

The poser of a paradox need not drape its meaning behind ambiguities and metaphor. He can afford to be open because the riddle works by overburdening the audience with too many good answers. Consider the folk paradox, "Which came first, the chicken or the egg?" The egg answer is backed by an apparently compelling principle: Every chicken comes from an egg. The trouble is that there is an equally compelling principle supporting the opposite answer: Every egg comes from a chicken.

Bodies of conflicting evidence are usually unstable. Our ambivalence gets washed away by further witnesses, new measurements, and recalculations. In contrast, paradoxes are exceptionally bouyant. Whenever one side seems to prevail, balance is restored by a counterdevelopment. From engineering, we know that this kind of dynamic equilibrium is most simply achieved by symmetry. When two boards are propped up against each other (like this: /\), their equal but opposed forces keep the pair standing. This symmetry is evident in the chicken or egg riddle. But we will also encounter more complex configurations.

The Greeks were fascinated by antagonistic struggle. They admired questions that are sustained by a balance of power between rival answers. Their playwrights became adept at smelting the ore of paradoxes.

The paradox lover delights in an unexpectedly even match—especially when his audience can foretell the rightful outcome. Children know the answers to Zeno's paradoxes of motion: Can you walk out of a room? Can an arrow travel through the air? If a slow tortoise is given a small head start, can the fleet-footed Achilles overtake the tortoise? Zeno confounds his audience by arguing logically for a *no* answer to each of these questions. Like Lewis Carroll's Alice, children know "there is a mistake somewhere"—but they cannot quite put their fingers on it.

Paradoxes can often be "dissolved" by showing that a precondition for a solution fails to hold. Developers of the logic of questions define a *direct answer* as an answer that offers exactly as much information as the questioner requested, neither more nor less. When I ask, "Was Anaximander or his teacher Thales the first Greek to map the stars?" I present you with two direct answers and request that you pick the correct answer (or *a* correct answer). You completely comply with my request by asserting, "Anaximander was the first Greek to map the stars." In a fill-in-the-blank question, such as "What is the ratio of the earth's height to its diameter?" you are presented with an infinite range of values. Anaximander chose "The ratio of the earth's height to its diameter is 1:3." (Anaximander thought that the earth had the shape of a dog's water bowl; a cylinder, curved in at the top to prevent spillage.) If none of the direct answers to the question are true, you can only truthfully respond by challenging the presupposition that one of the direct answers is correct.

Parts of a riddle are sometimes identified as *the* paradox: the most surprising possible *answer* or the *support* for that answer or even the whole *set* of possible answers.

Gareth Matthews, for instance, defines a paradox as a statement that conflicts with a conceptual truth. His example is the Stoic doctrine that those and only those are free who know that they are not free.

Most philosophers agree arguments play an essential role in paradox. R. M. Sainsbury identifies the paradox with the unacceptable *conclusion* of an argument that has acceptable premises and an acceptable inference pattern. J. L. Mackie says the paradox is the whole *argument.*

The remaining philosophers say a paradox is a *set* of individually plausible but jointly inconsistent propositions. According to Nicholas Rescher, philosophical positions can be classified as different ways of solving the paradox by rejecting a member of the set. This set could be considered as the answer set of a tidier paradox whose form is, Which, if any, of the following propositions is true? This useful format has no presuppositions and so limits the respondent's options to direct answers. The Greeks invented this tool and I regularly employ it in this book.

Although I think paradoxes are riddles, I also think parts of a paradox can be called paradoxes in the same spirit that parts of a rose can be called a rose. A rose is a shrub of the

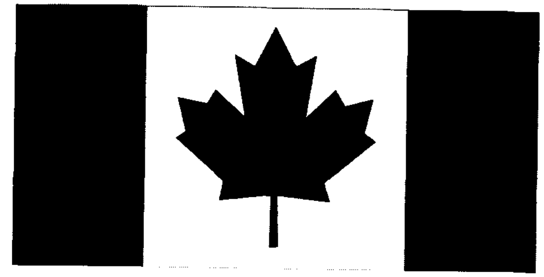

Fig. 1.1

Rosa genus. But it is pedantic to deny that the cut flowers of the shrub are roses.

The rose analogy puts me in mind of an exchange between Bertrand Russell and Wittgenstein. As a student, Wittgenstein would think ferociously about a problem and then just proclaim his solution, rather like an edict from the czar. Russell chided him for not including the reasoning behind his conclusions. Wittgenstein wondered aloud whether, when he gave Russell a rose, he should give him the roots as well.

Philosophers read arguments into an amazing variety of phenomena: explanations, predictions, thought experiments, even history itself (as if war were just a heated stretch of a great debate). I would not be surprised if it was a philosopher who first pointed out that the Canadian flag (fig. 1.1) harbors a hidden argument. Look at the white area at the top left and the top right. By reversing figure and ground, you can see these two regions as a pair of contentious heads tilted down at a 45-degree angle.

My account does not require that any of the good answers to a paradox be based on arguments. A good answer might

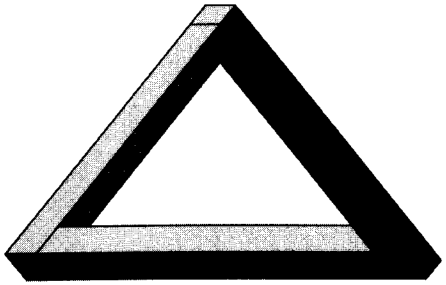

Fig. 1.2

rest on what you see or on common sense. Is the moon closer to the earth when near the earth's horizon? Aristotle's eyes said yes, but his astronomical theory said no. After gazing at a waterfall, Aristotle saw the bank of a river apparently moving—while simultaneously appearing stationary! Here, an inconsistency seems to occur *within* a single perception. Argument-based definitions of paradox go against the psychologist's description of such illusions as "visual paradoxes," such as Roger Penrose's triangle (fig. 1.2). The triangle has three equal sides and therefore three equal angles. Yet if asked how big the angles are, you just "see" that each is bigger than 60 degrees. Since the angles of a triangle must add up to 180 degrees, you only half-believe the angles are bigger than 60 degrees. But you cannot shake the visual impression. Psychologists think the dissonance is irresolvable because our visual systems are compartmentalized. Each mental module contains, as it were, a little man (a homunculus) who makes rudimentary judgments. How does the homunculus make judgments? Well, each little man is composed of yet littler men (who are even less sophisticated). The hierarchy reaches

bottom when we reach behavior that can be explained mechanically. The little man dedicated to judging angles cannot communicate with the other little men who specialize in judging lengths. The angle-judging homunculus always gives the same verdict even after you measure the angles with a protractor. For the sake of speed, the judgments of homunculi are based on a small number of criteria and a few simple rules for processing the limited data. There is no time for communication and deliberation. Consequently, homunculi are dogmatic. They often lock into disagreement. Illusion is the price that must be paid to evolve perceptions that can keep up with a dynamic environment.

When all the good answers to a riddle are the verdicts of a system composed of homunculi (such as the ones undergirding vision and speech), then the conflict is not rationally resolvable. The paradox might go away because something *causes* the conflicting homunculi to stop judging. Some perceptual illusions disappear as we age. A paradox might also be tolerable because we can hold an irrational tendency in check (as when a self-controlled air traveler ignores his fear of falling) or because we come to embrace it (as when a lover embraces his jealousy). But there is no *reasoning* with homunculi.

To be resolvable, a paradox must have a cognitive element. So philosophers are attracted to paradoxes that have answers that can be believed or disbelieved on the basis of reasons. Further, they relativize *paradox* to the best available reasoners. What counts is what stymies those in the best position to answer.

Although I think philosophers exaggerate the role of arguments in paradoxes, I have personally found their argument-based definitions of paradox to be educational. Philosophy only became comprehensible to me after I got into the habit of casting issues in logical molds. Instead of approaching great thinkers with diffuse curiosity, I could study them with a specific agenda. The history of philosophy became visible through the prism of paradox.

THE OLDEST RECORDED PARADOX

Anaximander's paradox is, Does each thing have an origin? He answers *no*: there is an infinite being that sustains everything else but which is not grounded in any other thing. Anaximander's reasoning can be reconstructed as an escape from an infinite regress: There are some things that now exist but have not always existed. Anything which has a beginning owes its existence to another thing that existed before it. Therefore, there is something that lacks an origin.

Until Christianity, there was consensus that the universe cannot have a beginning. The only worry was whether there was a loophole in Anaximander's argument for an uncaused cause. For instance, some philosophers wondered whether there could instead be an infinite sequence of finite things. Each negative integer is finitely far from 0 and "comes from" a predecessor that is itself only finitely far from 0: -1 is preceded by -2, -2 is preceded by -3, . . . Every member of this infinite sequence has an origin (its predecessor) and is only finitely far from the present (zero) even though there is no starting point for the sequence as a whole.

This suggests an alternate solution to the problem of the origin of man. Instead of following Anaximander's postulation of an infinite *thing*, assume an infinite *relationship* between finite things. In particular, if there is an infinite sequence of parents and children, a parent could care for each child and

there is no need to postulate an animal origin for human beings. Aristotle favored this dissolution. He believed that each species is infinitely old. Thus, Aristotle believes that the riddle "Which came first, the chicken or the egg?" rests on a false presupposition. Neither came first because each chicken comes from an egg and each egg comes from a chicken.

Charles Darwin eventually vindicated Anaximander's presupposition; chickens and eggs have only been around for a finite amount of time. Therefore, eggs must have preceded chickens or vice versa.

Anaximander's views on the origin of man apply equally to the origin of chickens. Eggs need to be hatched and chicks need to be reared. Therefore, some nonchicken must have served as a parent. Consequently, there was a chicken egg before there were any adult chickens.

Anaximander thought some aquatic creature reared human babies. Relative to modern biology, that is silly. But I think contemporary evolutionary theory concurs with Anaximander on the priority of the egg. Given Gregor Mendel's theory of inheritance, the transition to chickenhood can only take place between an egg-layer and its egg. For a particular organism cannot change its species membership during its lifetime. It is genetically fixed. However, evolutionary theory assures us that organisms can fail to breed true. So, although it is indeterminate as to which particular egg was the first chicken egg, we can know that whichever egg that may be, it precedes the first chicken—whichever that may be. The egg's precedence is a biological rather than a logical necessity. Given Jean Lamarck's theory of acquired traits, the chicken could have come first.

Since Anaximander did not know the necessary biology, his solution to the chicken or egg riddle was a lucky guess.

But he deserves much credit for creating a rational basis for his conjecture.

IMPLICATIONS OF THE UNCAUSED CAUSE

Anaximander's infinite being tells us something about the past. But what about the future? Does each thing end? That seems impossible because we can always ask, What is next? An endless future is also vaguely dissatisfying because of its incompleteness. We are shaky with all species of indeterminacy: infinity, vagueness, randomness. These concepts are particularly paradox-prone. But sometimes there is no avoiding them. Having accepted the "boundless" apeiron as the universal origin of everything, Anaximander also accepts it as universal destiny. Our finite world is sandwiched between two infinities.

According to Anaximander, our present environment emerged from the infinite source through a process of separation. If you take a tube, and blow earth, sand, and fine particles into a body of water, the bubbling solution is initially an undifferentiated mixture. But then the air rises out of the water. The coarsest particles sink to the bottom. These particles are followed by finer elements. The finest are left on top. Like has gone to like. Similarly, the earth arose from watery beginnings through a process of sedimentation. As the water receded, land was exposed.

Anaximander drew the first world map of these land masses. Herodotus describes the map in such detail that scholars have redrawn it. Anaximander invokes balance to explain why the earth does not fall endlessly into space. The nature of this equilibrium has received several interpretations. Aristotle says that Anaximander appealed to the symmetry of forces that are acting upon the earth. Since there is no more reason for it to move in one direction rather than another, it stays where it is.

WHEN DOES A PARADOX BECOME A FALLACY?

Anaximander explained changes in our present epoch as a battle between opposites. The heat of the day gives way to the cold of night. The moist dew in the morning gives way to the dryness of the midday sun. Winter must give way to summer and then summer to winter. Everything evens out. This is the point of the single sentence that is preserved from Anaximander's book *The Nature of Things*: "In to those things from which existing things have their coming into being, their passing away, too, takes place, according to what must be; for they make a reparation to one another for their injustice according to the ordinance of time." Unlike contemporary physicists who strike a posture of value-neutrality, Anaximander frames his law normatively: Opposites *ought* to balance out. Health is a balancing of the bitter and sweet, the hot and the cold, and so on. All change involves righting a previous wrong. If one opposite were able to permanently prevail, there would be a destruction of the world order.

People of Anaximander's era believed that good fortune and bad fortune balanced out. Herodotus reports that in 540 B.C., Polycrates seized power in Samos with the help of his brothers. After securing his position by murdering one brother and sending the other into exile, Polycrates made a pact with the Egyptian ruler Amasis. Polycrates then embarked on a phenomenally successful policy of conquest.

Amasis became worried: He wrote Polycrates a friendly warning:

> It is pleasant to learn that a friend and ally is doing well. But I do not like these great successes of yours; for I know the gods, how jealous they are, and I desire somehow that both I and those for whom I care succeed in some affairs, fail in others, and thus pass life faring differently by turns, rather than succeed at everything. For from all I have heard I know of no man whom continual good fortune did not bring in the end to evil, and utter destruction. Therefore if you will be ruled by me do this regarding your successes: consider what you hold most precious and what you will be sorriest to lose, and cast it away so that it shall never again be seen among men; then, if after this the successes that come to you are not mixed with mischances, strive to mend the matter as I have counselled you.
>
> (Herodotus 1920, iii, 40)

Polycrates felt that the loss of his signet ring would cause him the greatest grief. So he summoned a galley and set out to sea. Before the whole crew, Polycrates threw the ring into water. Five or six days later, a fisherman caught a large fish. It was such a fine fish that he offered it to Polycrates. Polycrates accepted the gift and invited the fisherman to dine on the fish with him. When Polycrates's servants cut open the fish, they discovered the lost ring and returned it to him. When Amasis learned of this amazing turn of events, he concluded that it was impossible to save a man from his destiny and predicted that Polycrates would soon fall into grave misfortune. And indeed, when Polycrates sailed to Magnesia at the invitation of the Persian governor, he was brutally murdered.

Did Amasis commit the gambler's fallacy? This is the mistake of assuming that the law of averages works by compensation rather than by swamping. A fair coin should land heads 50 percent of the tosses and tails 50 percent of the tosses. If the coin lands heads five times in a row, is it more likely to land tails on the sixth toss? If the law of averages works by compensation, then the answer is yes. The surplus of heads needs to be evened out by a surplus of tails. But chance has no memory. The law of averages actually works by swamping. In the long run, the percentage of heads and tails tends toward 50 percent because lucky stretches become dwarfed by the large number of cases.

Fallacies differ from paradoxes in being clearly diagnosed errors. By "clear" I mean clear to the experts. Modern casinos are filled with people who still commit the gambler's fallacy. Surprisingly, this confusion about the law of averages was only straightened out in the seventeenth century. It is hard to avoid anachronism when analyzing Anaximander's mix-up between swamping and compensation. The label "compensation paradox" better fits his era. Our reexplanation of his "cosmic justice" as the effects of mindless swamping would have struck Anaximander as a radical extension of his own demythologizing methodology.

We understand Anaximander's error because we are still tempted to commit it ourselves. Even experts commit statistical fallacies when caught off guard. New learning does not erase old approaches. We are compartmentalized. The modern compartment for refined probability techniques exists side by side with the ancient compartment of rules of thumb for coping with chance. When the new compartment is not cued into performance, the old compartment springs into action. Consequently, experts will think like novices when not on their toes.

Anaximander's physics of opposites is a monument to the compensation paradox. A natural quantity such as mass or energy is conserved. But it is a mistake to think that luck is conserved. We care about whether years are dry or wet, hot or cold, and so on. Thus, if we believe that the law of averages works by compensation, then we will think the privation that goes with a dry year will be balanced by the bounty afforded by a wet year. Our preferences will be projected onto nature. We will think that the fundamental forces (not just luck) work by compensation.

Anyone looking for regularities in nature will notice that some things balance out. Human beings achieve equality by monitoring the quantities and then periodically adding or subtracting. They read this balancing act onto the world. Thus we find the Chinese preoccupation with yin and yang and the attention to karma in India. Some people notice that fortunes really do not balance in this life. Their commitment to compensation is so algebraically firm that they solve the inequality by postulating a preexistence or an afterlife.

Compensation requires memory of past transactions. Memory has a function only if inferences can be drawn from what is remembered. Those memories must get their content from earlier perceptions. And that content must be sensitive to my desires if my bad fortunes will be balanced by good fortunes. Thus, Anaximander's law of compensation requires the operation of at least one metaphysical overseer.

True, Anaximander's primary emphasis is on secular explanations. He played down the role of the gods. While his compatriots regarded thunderbolts as Zeus's divine spears, Anaximander says that thunder and lightning are caused by the wind. Nevertheless, Anaximander does ultimately attribute intelligence to the infinite. Given the law of compensation, fortune must have a memory. A good event makes a bad event more likely and vice versa. What goes around comes around. The infinite steers all things in directions we are obliged to follow.

I suspect that Anaximander's unusually small anthropomorphic tendency was nursed into action by the eerie character of a beginningless process. Infinity is humbling. In the course of growing up, we overwrite new tricks on the basic repertoire that all children are allotted. When these grown-up techniques fail us, we revert to this more basic repertoire—we crave parental protection and guidance. Despite extraordinary resistance to anthropomorphism, Anaximander ultimately reads in intentions where there are none.

People still put a human face on infinity. I learned the cosmological argument for God's existence from an older boy on my block. The gist of it was: "Everything has a cause. Something exists. Therefore, something caused everything without itself being caused." Later, also on the street, I heard the objection that the conclusion contradicts the first premise. This inconsistency can be avoided by interpreting the first premise as governing only things that are contingent on the existence of other things. The "first cause" cannot be just another contingent thing. For then its existence would depend on something and so not stop the backward regress. The first cause must be a being that depends on nothing else. Therefore, it is a necessary being upon which everything else ultimately bases its existence. This first cause is commonly nominated for the office of creator.

Indeed, this candidate would win a majority vote in a popular election. The electorate would include luminaries such as the fourth-century philosopher Augustine. He realized that this basic line of reasoning raises many questions.

And many were asked. When young Augustine asked what God was doing before He made the world, he was told: "Preparing hell for people who ask questions like that."

There have been gentler answers. When asked what God was doing before He created the world, the mathematician J. E. Littlewood replied: "Millions of words must have been written: but he was doing Pure Mathematics and thought it would be a pleasant change to do some Applied." (1953, 136)

TWO

Pythagoras's Search for the Common Denominator

Son: Dad, will you help me find the least common denominator in this problem?

Dad: Good heavens, son, don't tell me that hasn't been found. They were looking for it when I was a kid!

Anaximander set an example of how to frame a paradox and how to respond to it. His followers understood that solutions require disciplined reason-giving. But they had not yet developed the practices that constitute *proof* of a proposition. To some degree, astronomy and engineering gave the ancients a running start. But the strongest influence on proof practices came from mathematical lore.