12 The Problem of Perfection, or How Can a Clam Mount a Fish on Its Rear End?

IN 1802, Archdeacon Paley set out to glorify God by illustrating the exquisite adaptation of organisms to their appointed roles. The mechanical perfection of the vertebrate eye inspired a rapturous discourse on divine benevolence; the uncanny similarity of certain insects to pieces of dung also excited his admiration, for God must protect all his creatures, great and small. Evolutionary theory eventually unraveled the archdeacon's grand design, but threads of his natural theology survive.

Modern evolutionists cite the same plays and players; only the rules have changed. We are now told, with equal wonder and admiration, that natural selection is the agent of exquisite design. As an intellectual descendant of Darwin, I do not doubt this attribution. But my confidence in the power of natural selection has other roots: it is not based upon "organs of extreme perfection and complication," as Darwin called them. In fact, Darwin saw truly exquisite design as a problem for his theory. He wrote:

> To suppose that the eye with all its inimitable contrivances for adjusting the focus to different distances, for admitting different amounts of light, and for the correction of spherical and chromatic aberration, could have been formed by natural selection, seems, I confess, absurd in the highest degree.

In essay 10, I invoked gall midges to illustrate the opposite problem of adaptation—structures and behaviors that seem senseless. But "organs of extreme perfection" proclaim their value unambiguously; the difficulty lies in explaining how they developed. In Darwinian theory, complex adaptations do not arise in a single step, for natural selection would then be confined to the purely destructive task of eliminating the unfit whenever a better-adapted creature suddenly appeared. Natural selection has a constructive role in Darwin's system: it builds adaptation gradually, through a sequence of intermediate stages, by bringing together in sequential fashion elements that seem to have meaning only as parts of a final product. But how can a series of reasonable intermediate forms be constructed? Of what value could the first tiny step toward an eye be to its possessor? The dung-mimicking insect is well protected, but can there be any edge in looking only 5 percent like a turd? Darwin's critics referred to this dilemma as the problem of assigning adaptive value to "incipient stages of useful structures." And Darwin rebutted by trying to find the intermediate stages and by specifying their utility.

> Reason tells me, that if numerous gradations from a simple and imperfect eye to one complex and perfect can be shown to exist, each grade being useful to its possessor . . . then the difficulty of believing that a perfect and complex eye could be formed by natural selection, though insuperable by our imagination, should not be considered as subversive of the theory.

The argument still rages, and organs of extreme perfection rank high in the arsenal of modern creationists.

Every naturalist has his favorite example of an awe-inspiring adaptation. Mine is the "fish" found in several species of the freshwater mussel *Lampsilis.* Like most clams, *Lampsilis* lives partly buried in bottom sediments, with its posterior end protruding. Riding atop the protruding end is a structure that looks for all the world like a little fish. It has a streamlined body, well-designed side flaps complete with a tail and even an eyespot. And, believe it or not, the flaps undulate with a rhythmic motion that imitates swimming.

Most clams release their eggs directly into the surrounding

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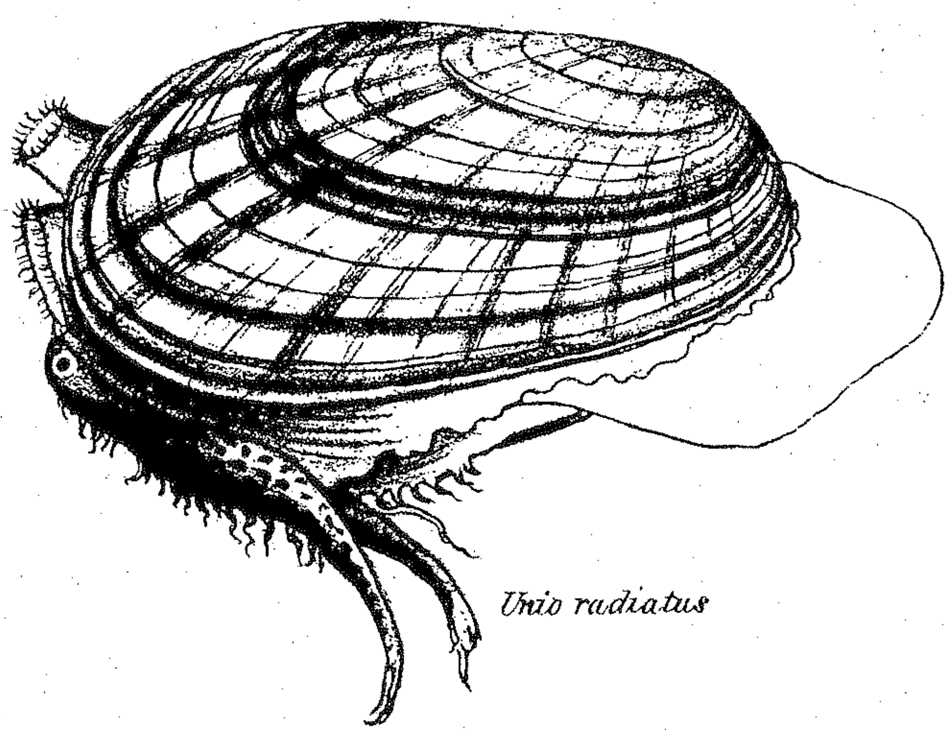
"Fish" with eyespot and tail rides atop Lampsilis ventricosa. *When a fish nears, the clam discharges larvae; some will be ingested by the fish and find their way to its gills, where they will mature.* (John H. Welsh)

water, where they are fertilized and undergo their embryonic development. But female unionids (the technical name for freshwater mussels) retain their eggs within their bodies, where they are fertilized by sperm released into the water by nearby males. The fertilized eggs develop in tubes within the gills, forming a brood pouch, or marsupium.

In *Lampsilis,* the inflated marsupium of gravid females forms the "body" of its ersatz fish. Surrounding the fish, symmetrically on both sides, are extensions of the mantle, the "skin" that encloses the soft parts of all clams and usually ends at the shell margin. These extensions are elaborately shaped and colored to resemble a fish, with a definite, often flaring "tail" at one end and an "eyespot" at the other. A special ganglion located inside the mantle edge innervates these flaps. As the flaps move rhythmically, a pulse, beginning at the tail, moves slowly forward to propel a bulge in the flaps along the entire body. This intricate apparatus, formed by the marsupium and mantle flaps, not only looks like a fish but also moves like one.

Why would a clam mount a fish on its rear end? The unusual reproductive biology of *Lampsilis* supplies an answer. The larvae of unionids cannot develop without a free ride upon fishes during their early growth. Most unionid larvae possess two little hooks. When released from their mother's marsupium, they fall to the bottom of the stream and await a passing fish. But the larvae of *Lampsilis* lack these hooks and cannot actively attach themselves. In order to survive, they must enter a fish's mouth and move to favored sites on the gills. The ersatz fish of *Lampsilis* is an animated decoy, simulating both the form and movement of the animal it must attract. When a fish approaches, *Lampsilis* discharges larvae



Isaac Lea published this figure of the decoy "fish" in 1838. I thank John H. Welsh for sending this figure to me.

from the marsupium; some of them will be swallowed by the fish and find their way to its gills.

The strategem of *Cyprogenia,* a related genus, emphasizes the importance of attracting a host. These mussels "go fishing" in a manner subsequently reinvented by disciples of Izaak Walton. The larvae attach themselves to a bright red "worm" formed by a protein manufactured within the mother's body. The "worms" are extruded through the exhalant siphon. Several observers report that fish seek out and eat these "worms," often pulling them, when only partly extruded, from the female's siphon.

We can scarcely doubt the adaptive significance of the decoy "fish," but how could it ever evolve? How did the marsupium and mantle flap come together to effect their ruse? Lucky accident or preordained direction may appeal more to our intuition than gradual construction by natural selection through some intermediate forms that, at least in their initial stages, could not have looked much like a fish. The intricate fish of *Lampsilis* is a classic illustration of a deep dilemma in Darwinism. Can we possibly devise an adaptive significance for the incipient stages of this useful structure?

The general principle advanced by modern evolutionists to solve this dilemma calls upon a concept with the unfortunate name of "preadaptation." (I say unfortunate because the term implies that species adapt in advance to impending events in their evolutionary history, when exactly the opposite meaning is intended.) The success of a scientific hypothesis often involves an element of surprise. Solutions often arise from a subtle reformulation of the question, not from the diligent collection of new information in an old framework. With preadaptation, we cut through the dilemma of a function for incipient stages by accepting the standard objection and admitting that intermediate forms did not work in the same way as their perfected descendants. We avoid the excellent question, What good is 5 percent of an eye? by arguing that the possessor of such an incipient structure did not use it for sight.

To invoke a standard example, the first fishes did not have jaws. How could such an intricate device, consisting of several interlocking bones, ever evolve from scratch? "From scratch" turns out to be a red herring. The bones were present in ancestors, but they were doing something else—they were supporting a gill arch located just behind the mouth. They were well designed for their respiratory role; they had been selected for this alone and "knew" nothing of any future function. In hindsight, the bones were admirably preadapted to become jaws. The intricate device was already assembled, but it was being used for breathing, not eating.

Similarly, how could a fish's fin ever become a terrestrial limb? Most fishes build their fins from slender parallel rays that could not support an animal's weight on land. But one peculiar group of freshwater, bottom-dwelling fishes—our ancestors—evolved a fin with a strong central axis and only a few radiating projections. It was admirably preadapted to become a terrestrial leg, but it had evolved purely for its own purposes in water—presumably for scuttling along the bottom by sharp rotation of the central axis against the substrate.

In short, the principle of preadaptation simply asserts that a structure can change its function radically without altering its form as much. We can bridge the limbo of intermediate stages by arguing for a retention of old functions while new ones are developing.

Will preadaptation help us to understand how *Lampsilis* got its fish? It might if we can meet two conditions: (1) We must find an intermediate form using at least some elements of the fish for different purposes; (2) We must specify functions other than visual decoy that the proto-fish could fulfill while it gradually acquired its uncanny resemblance.

Ligumia nasuta, a "cousin" of *Lampsilis,* seems to satisfy the first condition. Gravid females of this species do not have mantle flaps, but they do possess darkly pigmented, ribbon-like membranes that bridge the gap between partly opened shells. *Ligumia* uses these membranes to produce an unusual, rhythmic motion. The opposing edges of the ribbons part to form a gap several millimeters in length at the mid-part of the shell. Through this gap, the white color of the interior soft parts stands out against the dark pigment of the ribbon. This white spot appears to move toward the back of the shell, as a wave of separation propagates itself along the membranes. These waves may repeat about once every two seconds. J.H. Welsh wrote in the May 1969 issue of *Natural History:*

> The regularity of the rhythm is remarkably constant. To a human observer, and perhaps to a fish, the eye-catching feature here is the white spot that appears to move against the dark background of the mussel and the substrate in which it is half buried. Certainly this could be a lure to host fish and may represent a specialized adaptation from which the more elaborate, fishlike lure evolved.

We are still dealing with a device to attract fish, but the mechanism is abstract, regular motion, not visual mimicry. If this device operated while the flaps were evolving and slowly building their resemblance to a fish, then we have no problem of incipient stages. Motion of the mantle attracted fish from the start; the slow development of an "alternate technology" only enhanced the process.

Lampsilis itself fulfills the second condition. Although no one has denied the significance of visual resemblance as a lure, our leading student of *Lampsilis,* L.R. Kraemer, questions the common assumption that "flapping" of the body serves only to simulate the movements of a fish. She believes that flapping may have evolved either to aerate the larvae within the marsupium or to keep them suspended in the water after their release. Again, if flapping provided these other advantages from the start, then the fortuitous resemblance of flaps to fish might be a preadaptation. The initial, imperfect mimicry could be improved by natural selection while the flaps performed other important functions.

Common sense is a very poor guide to scientific insight for it represents cultural prejudice more often than it reflects the native honesty of a small boy before the naked emperor. Common sense dictated to Darwin's critics that a gradual change in form must indicate a progressive building of function. Since they could assign no adaptive value to early and imperfect stages of a function, they assumed either that early stages had never existed (and that perfect forms had be created all at once) or that they had not arisen by natu selection. The principle of preadaptation—functior change in structural continuity—can resolve this dilemm Darwin ended his paragraph on the eye with this percepti evaluation of "common sense":

> When it was first said that the sun stood still and the world turned round, the common sense of mankind declared the doctrine false; but the old saying of *Vox populi, vox Dei* [the voice of the people is the voice of God], as every philosopher knows, cannot be trusted in science.