A CHALLENGE TO A CLASSIC EXAMPLE OF THE SURVIVAL OF THE FITTEST DOCTRINE: THE DODO AND THE PASSENGER PIGEON STORY

JERRY BERGMAN*

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Abstract

Careful re-evaluation of the Dodo by several contemporary researchers has found that many of the widely accepted conclusions about it are wrong. It was not a fat, slow, inferior, defenseless bird, but a swift and fierce fighter if it perceived that it was threatened. The common conclusion that it was defenseless is partly due to the fact that it did not have a natural fear of humans or many animals. Often given as the prime example of how evolution prunes out the weak, it was concluded that its extinction was not because of inferiority, but due to the wanton disregard of life by humans. Often regarded by contemporaries as a wonderful, magnificent creature, its loss proves not the efficacy of natural selection, but the depravity of its caretaker. In contrast the Passenger Pigeon was widely regarded as one of the most fit and evolutionarily successful birds; yet it became extinct. This case also eloquently illustrates the depravity of the Passenger Pigeon's caretaker.

Introduction

The classic example of evolution in action, the most widely known symbol of extinction, is the Dodo bird (Austin, 1961). The Dodo bird (*Raphus cucullatus*) is a member of the idae family, order Columbiformes, meaning a dove shaped bird. This non-flying, allegedly "obviously unfit" bird became extinct as evolution would expect, and it is used as a prime example of natural selection and proof of how evolution works (Livezey, 1993). The demise of the Dodo has become a fixture of our language, and a symbol of extinction. The term is often used to refer to something that is enormously inefficient or someone who is grossly incompetent or stupid. Examples such as auto safety expert Clarence Ditlow III's statement that if the American car industry does not build a better car, "they'll go the way of the Dodo bird" are common. From the animal has come such expressions as "dead as a Dodo" referring to something that is forever gone and very much a thing of the past (Evans, 1970; Terres, 1987). The term Dodo as applied to a person refers to one who is dumb, addled or looks silly.

They were once sketched, painted, and lampooned—just the right bird for Lewis Carroll's *Alice in Wonderland's* menagerie of off-beat animals. The Dodo that Alice met was "…faintly absurd...[and] spoke in words of many syllables" (Silverberg, 1967). The most famous reconstruction was done by the taxidermy studio of Roland Ward of London. It is now in the American Museum of Natural History Flying Bird Hall, located near a completely restored skeleton (Edwards, 1958). Illustrations and reconstructions often show it as a magnificently overweight pigeon-like bird which allegedly had a "large body and small wings, far too small to permit him to fly" (Funk, 1978, p.194).

*Jerry Bergman, Ph.D., Northwest State College, archbold, OH 43502-9542.

The Dodo is probably not only the best known extinct modern species, but a prime exhibit of the efficacy of natural selection to prune out weak animals and those that fail to accommodate to changed conditions. Extinction thereby creates an ecological niche into which the "superior" animals can spread (Eldredge, 1991). In fact, the loss of the Dodo has not created an ecological niche, but has adversely affected other life. The endemic sapotaceous tree *Calvaria* is now nearly extinct because its seeds require passing "…through the digestive tract of the now extinct dodo, *Raphus cucullatus,* to overcome the persistent seed coat dormancy caused by a specially thickened endocarp" (Temple, 1977, p. 885)

Romer (1941; 1968, p. 223) has long argued that the Dodo was clear proof of the advantage of flight-showing that birds that lost the ability to fly were evolutionarily inferior, and were thus selected out. This seems contrary to the conclusion that selection evolved them to be flightless birds in the first place. It is also contradicted by the fact that these Dodo birds had no enemies, feared no creature and thus would not normally have flown away from "enemies" even if it could.

Williams concluded that the bird became extinct, not because it could not fly, but because it was stupid. Darwin predicted that the Falkand Island fox would soon be "…classed with the Dodo as an animal which has perished from the earth" (Williams, 1951, p. 8). Some scientists go even further, using evolution to justify or at least condone the extinction of the Dodo and other animals:

> Extinction is a natural process essential to evolution... man's role in it, and ethical implications...is a difficult subject for me to write about. Many conservationists will not like what I say. But the subject is evolution-related, and I have to treat it. Man's evolution, multipli-

> cation, and occupation of the world have inevitably caused the extinction of many plants and animals, directly or indirectly. Man has hunted or is hunting many animals to extinction, either for food (for example, the Dodo on Mauritius, some of the giant tortoises on the Galapagos and probably the moas in New Zealand), for sport (for example, the Ostrich in Arabia), or in self-defense (for example, the Lion, which has been retreating before man for 2000 years). Current lists of extinct and vanished species include many more examples. But it has been man's role in changing the face of the earth that has caused the most massive extinctions (Darlington, 1988, p. 246).

Other scientists have argued that the Dodo was an evolutionary link that "was of considerable importance" (Brom and Prins, 1980, p. 236)

The Origin of the Dodo

The Dodo's origin can only be speculated and has been a subject of controversy for decades. The birds, which were once called "gentle Doves," Kitchener concluded "…probably evolved from African fruit pigeons of the genus *Treron* which became stranded on the blissfully predator-free island of Mauritius" (1993, p. 24). Whitlock speculated that they are related to pigeons or perhaps rails and are now usually classified among the pigeons (1981, p. 16). Study of its feathers, though, finds it has unique traits not found in "any other bird" (Brom and Prins, 1989). Dodo evolution is largely speculation due to a complete lack of transitional forms and no evidence yet of evolution in the fossil record (Livezey, 1993). Even the derivation of the name *Dodo* is in question. The word is Portuguese for simpleton, but the Portuguese did not remain on Mauritius island after discovering them, and evidently no references to Dodo birds have been located in Portuguese writings of the time; (Greenway, 1967, p 120). Others argue that the word Dodo is simply a rendering of its call, an onomatopoeia (Quammen, 1996)

The Dodo lived on the small island of Mauritius, 500 miles east of Madagascar in the Indian Ocean. Fortunately, many complete Dodo skeletons also exist, mostly assembled from bones found in the late 1800's. Of the solitaire Dodo, only a large number of bone fragments exist, and for the white Dodo, not even bones exist.

A careful recent examination of the Dodo has revealed that many of the common perceptions about the bird are probably incorrect (Hoffman, 1991). In the words of Maddox, "…the Dodo deserves a better press" (1993, p. 291). Specifically, recent studies, such as those by Livezey on almost 400 Dodo skeletal fragments and Kitchener at the

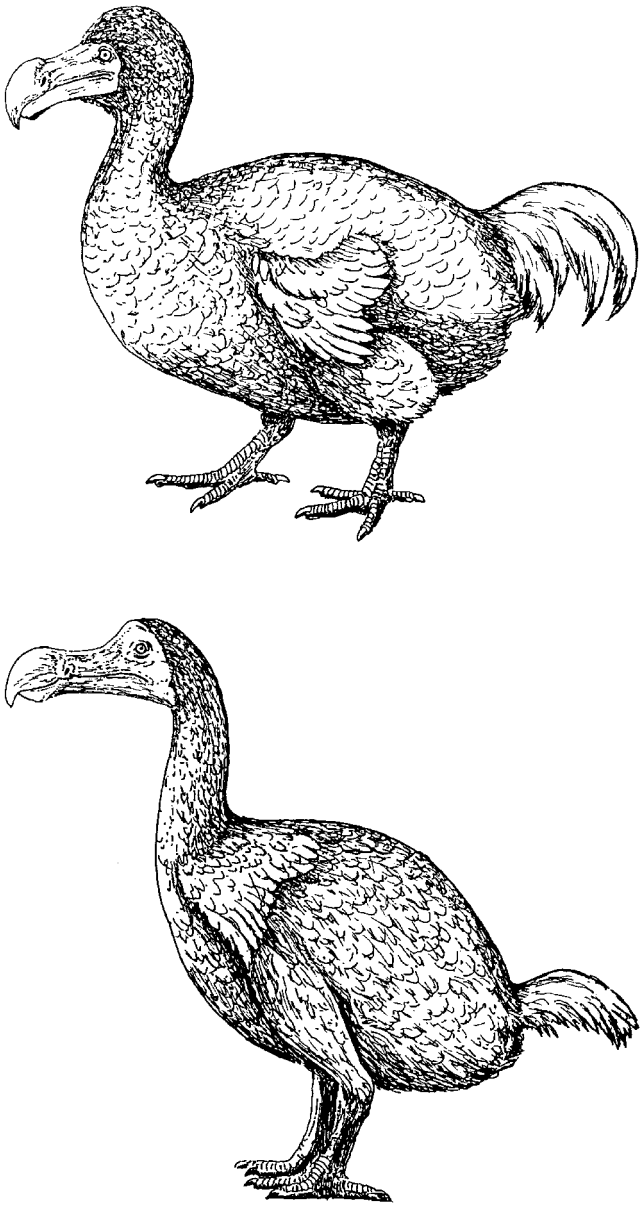

Figure 1. Artist's conceptions of the dodo bird, as it probably appeared in captivity (above) and in the wild (below). According to Kitchener (1993a), Dodos kept in captivity were fed a high fat diet and weighed more than they did in the wild. Illustration adapted by Rich Greer from an article by Paul Hoffman: "A New and Improved Dodo," *Discover* 12(4):16, April 1991.

Royal Museum of Scotland, have radically changed our view about the bird. This latter work has questioned the role of the bird in evolutionary history:

> Rivaling the dinosaurs as a symbol of extinction, the Dodo is renown for being slow, stupid and fat. An evolutionary disaster, *Raphus cucullatus* was doomed to extinction from the day it was discovered by hungry Dutch sailors in the forest of Mauritius in 1589. Wasn't it? Maybe not (Kitchener, 1993, p. 24).

Kitchener's work is based on detailed study of the bones and the dried head specimens. He has shown that the Dodo was much thinner arid sleeker than previously believed (Figure 1). Many of our modern conclusions about the Dodo's appearance were based on 17th century oil paintings of overweight, under-exercised birds—a condition which resulted from their being kept by wealthy Europeans who fed them a high fat diet (Kitchener, 1993a). Their pet Dodos ballooned up to almost double what they normally would have weighed in the wild. At their normal 30 pounds they were good sized birds, but not much heavier than a comparably-sized bird such as a swan.

Even minor details that gave the birds a "stupid" look, in harmony with their historical image, are being modified with our new understanding. We now realize that its tail, often shown as a sparse collection of feathers located rather high on the bird's back, was likely much fuller and far more dignified. The existing reconstructions, which Edwards (1958, p. 834) stated have caused the bird to look "sedately amusing" and produced "vast amusement" for observers, may now all have to be reexamined.

The Dodo species actually consisted of at least four similar flightless birds: The Dodo of Mauritius, the White Dodo, the Solitaire of Reunion (once called Baurbon), and the Rodriguez Solitaire that lived on tiny Rodriguez island. The Mauritius Dodo's bill was as long as nine inches and was prominently hooked downward at the tip. The beak and the area up to and behind the eyes lacked plumage, the feet and legs were yellow, and the skin was light ash in color. Further, as a 1634 account stated, their irises were a whitish color; their eyes were round, small, and bright as diamonds; and their covering was of the "finest downe" (quoted in Gosse, 1861, p. 75). The Dodos also ate "stones" which they used in their gizzards to crush food (Day, 1989, p. 32). Their diet included plants; most likely seeds, fruit, and foliage (Richards, 1991).

Mauritius, Reunion and Rodriguez are a group of volcanic upthrust islands located between Madagascar and Australia. These widely separated small neighboring islands—Mauritius is only 809 square miles in area—stand alone in a water wilderness thousands of miles from any neighboring island or land. The birds evidently thrived in their habitat on a set of islands collectively called the Mascarenes (Greenway, 1967). Like many small remote islands, the Mascarenes did not contain mammals and the only vertebrates were a few reptiles and many birds. The varieties of birds included parrots, crows, sparrows, owls, geese, ducks and doves (Day, 1989). Their isolated homeland contained no animal predators or human inhabitants for eons.

The Mauritius Dodos were discovered in 1507 by the Portuguese, and in a mere 174 years they became extinct. The enormous slaughter during this brief time decimated this very remarkable bird" which once "existed in considerable abundance" (Gosse, 1861, p. 74). Contemporary accounts claim that sailors killed as many as 50 large birds a day, and often about half were Dodos (Greenway, 1967).

In contrast to the evidence remaining about the Mauritius Dodo, the Solitaire of Reunion and the white Dodo are known only from osseous remains or written descriptions plus drawings made by contemporary travelers. The Reunion Solitaire had been extinct since the end of the 17th century and the Rodriguez Solitaire since the latter half of the 18th century. Since the drawings were completed from live specimens, and travelers' accounts substantially agree on its physical traits, a good understanding of this species.' physiology can now be determined. The major differences in descriptions of the Solitaire pertain to its color, which probably reflect actual color variations in the wild. The Rodriguez Solitaire was, in contrast to the Dodo, "delightfully beautiful" and also "delightfully edible" (Day, 1989, p. 28).

The Myth of the Dodo's Obesity

The bird's obesity, slowness, and lack of flight and intelligence are all commonly given as reasons for its alleged evolutionary inferiority (Darlington, 1980). Dodos were believed to be not just large, but grossly overweight to the point that they could not fly and consequently lost this ability for the reason that they could not escape from their ground enemies. Kitchener, though, in studying their history, found that the *earliest* Dodo drawings showed rather thin birds—and only those paintings completed later display the familiar pudgy variety (1993). Over 12 original pictures (both drawings and paintings) of the Dodo now exist (Ley, 1948, p. 230). Kitchener further found that while the thin Dodos were drawn by those who had actually visited Mauritius, the plump portraits were produced mostly by artists working in Europe. This factor has led to speculation that Dodos brought to Europe were fattened by their owners.

Kitchener next evaluated the hundreds of Dodo bones that have been unearthed. Using the methods developed by criminologists and archeologists to reconstruct flesh on bones, he was able to determine that the skeletal pattern produced a bird "remarkably similar" to the early drawings of the Dodo; i.e. thinner, far less obese birds. Kitchener (1993a) concluded from his work that the actual weight of the wild Dodo was probably between 12 and 16 kilograms. This is close to the weight of a male great bustard, the heaviest flying bird alive today. Even an obese Dodo, Kitchener estimated, would weigh only 21.7 to 27.8 kg. This number com-

pares closely with the only published record of a Dodo body weight that he could locate, a 1634 estimate of 23 kg. (50 lbs.) which may represent the upper limit.

Relying upon research with living birds which demonstrated that a bird's skeleton accounts for a fixed proportion of its body weight, Kitchener estimated a value of just under 12 kg. He concluded that although this value may be an underestimate, it still supports the smaller values. These estimates held up even when he compared bone-body weight ratios of flying and non-flying birds, such as that of a flightless kakapo, the world's largest parrot.

An evaluation of egg shells also can produce a body weight index because the mass of the eggshell varies in proportion to the mass of the bird that lays it. No known surviving Dodo bird egg exists, but from descriptions of their eggs in the literature, Kitchener was able to estimate the Dodo's weight at about 13.7 kg—the same value that he obtained from an analysis of the relationship between the length of the leg bone and other bone measurements (Kitchener, 1993a). The leg bone analysis method is based on a direct relationship between leg bones and the weight that they must carry, a relationship that holds for every size of bird from a hummingbird to an ostrich (Kitchener, 1993, p. 26).

Kitchener thus concluded that "…according to four different methods, all based on the Dodo's bones, the famous flightless pigeon weighed between 10.6 and 17.5 kg" (1993, p. 26). Further evaluation of the cantilever strength of leg bones produced a relationship which can be used to determine the running abilities of different size animals. This method provided evidence that they were indeed "swift of foot"—a conclusion which corresponds with eyewitness accounts stating that the Dodo "could run very fast" (quoted in Kitchener, 1993, p. 296).

While his analysis is not without problems, it has produced very reasonable conclusion, especially in view of the fact that the opposite thesis has little empirical evidence in its favor. Since Kitchener's first evaluation, original unpublished Dodo drawings from the early 1600's were rediscovered in a Hague, Netherlands museum, supporting Kitchener's earlier conclusions. The Dodos in the drawings are thinner than those in European paintings, and the femur design was tilted downward, reducing the bending forces on it and allowing it to shift its center of gravity (1993 a, p. 297-299). This evidence demonstrates that the Dodo was an effective, fast runner Kitchener concluded that

> …for more than 350 years the Dodo has been thoroughly misrepresented as plump and immobile. The reality is, however, that in the forests of Mauritius it was lithe and active. Like other Mauritian birds it would have undergone a seasonal fat cycle to overcome shortages of food, but never to the extent that those wonderful oil paintings suggest (1993, p. 27).

Several other studies have also confirmed Kitchener's results. Livezey (1993), in a study of 387 skeletal elements, concluded that the body mass of the Dodo was 21 kg for males and 17 kg for females. And Lindstedt and Calder (1976) estimated 15 kg for the Dodo and 17 kg for the solitaire. A problem in obtaining weight estimates is that the Dodo exhibited great seasonal variation in deposition of body fat and considerable intrageneric and intergeneric diversity in body mass (Livezey, 1993, p 262, 281).

The History of Mankind's Treatment of the Dodos

The earliest accounts of the Dodos date from 1598 and the Dutch navigator, Admiral Jacob Comeliszoon van Neck. The Dodos were found on an island he named Mauritius in honor of his patron, Prince Maurice of Nassau, ruler of the Netherlands (Panati, 1989, p. 202). Since Arab ships sailed the Indian Ocean as early as the middle ages, it is quite likely that they were aware of the bird, but left no known written records. The three islands on which Dodos lived, Mauritius, Reunion, and Rodriguez, lacked names then, or had names which we have not yet identified today.

The admiral reported that the island had abundant ebony tree forests and exotic wildlife which he described extensively. He also discussed in some detail the Dodos. He claimed that they were quite unlike any other bird with which he was familiar. Having no predators, the birds did not fear humans. when the soldiers looked through low lying nests for chicks, though, the birds pecked "mighty hard" (Panati, 1989, p. 202). They also could bite hard with their "remarkably strong" bill, and run fast with their strong legs (Brom and Prins, 1980, p. 233; Ley, 1948, p. 232). The crew killed many of the birds and soon found that, although their flesh was tough and bitter, the longer they were cooked, the more palatable their flesh became. They also took home a pair of adults, one of which ended up in the Netherlands. The birds were a sensation in Europe and were described in a fair amount of detail in numerous contemporary accounts. These records were critical in Kitchener's reassessment of the bird.

Emperor Rudolph of Germany also purchased one, and soon had its portrait painted in oils. Pictures of the birds rapidly circulated throughout Europe, and the demand for them was so great that ships soon began bringing them back to Europe for sale to the wealthy or to naturalists (Panati, 1989, p. 202). They were evidently also shipped to India, Java and Japan (Brom and Prins, 1989). Many Dodos died

en-route, and only about 12 reached Europe alive before they became extinct (Silverberg, 1967, p. 30). The original Netherlands bird was honored with 14 oil and watercolor portraits before it died. Further, the Dodos were excellent subjects for portraits-once posed, they remained virtually motionless until the picture was completed.

Unfortunately, these paintings cannot be relied upon exclusively because artists at times took "considerable anatomical license," some making the birds' hooked beak "more fearsome" and turning "their forked dove-like feet into the webbed toes of a duck" (Panati, 1989, p. 202). Nonetheless, enough paintings exist to provide clear evidence to help us piece together a picture of them.

The Last Survivors

Since the birds were easy to capture, within a short time the Dutch colonists along with sailors and visitors soon consumed most of the Dodo population. The animals that they brought with them, especially dogs, cats, monkeys', farm hogs, and the inevitable rat, ate the fledglings and broke the Dodo eggs open to consume the yolks. By 1681 the Mauritius Dodo was extinct, and the white Dodo became extinct in 1770. Rather than demonstrate their weakness, the history of the Dodos effectively argues for the gross irresponsibility and even viciousness of their caretakers (Quammen, 1996). Actually, despite the unceasing slaughter of wildlife carried out "by the hundreds of European ships that visited Mauritius, the Dodo survived for generations" (Day, 1989, p. 28).

It was only when the colonists "displayed a grim dedication to the cause of exterminating the Dodo" that their demise was sealed. According to Panati "not a single naturalist had attempted to mate any of the captive Dodos; they left no descendants" (1989, p. 203). The sailors would arrive at the island, not caring if a breeding stock remained because most were not animal connoisseurs, and few had any plans to return anyway. Even if a ship crew insured that breeding stock remained, the next shipload of sailors would nullify their forethought. Further, many persons then did not consider the total extinction of any animal type a possibility (Whitlock, 1981, p. 118). Most sailors were confined to meager rations on the ship, and no doubt relished their sojourn to a set of islands that contained much fresh meat (Day, 1989).

The last bird in England was stuffed by English naturalist John Tradescant. When Tradescant died in 1662, his entire nature collection was bequeathed to an acquaintance, Elias Ashmole (Brom and Prins, 1980). Due to his irresponsibility and the poor methods of preparing bird skins then, the entire collection's condition greatly deteriorated, and he donated the bird to Oxford University in 1683-two years after the last living Dodo was seen on Mauritius. Even Oxford did not take very good care of the bird-and except for the head and foot which was saved by a foresighted curator, it was burned as trash in 1755 (Panati, 1989, p. 203). Evidently the museum's board of directors "...took one look at the dusty, stupid-looking bird and unanimously voted to discard it" (Wallechinsky and Wallace, 1981, p. 361).

The intrigue over the bird was such that by 1800 ". . .professional naturalists were casting doubt on written descriptions of the bird, as well as on extant drawings." It even became "scientific vogue to deny the bird's existence and to challenge the Oxford head and foot as fakes" (Panati, 1989, p. 203). If it was a genuine bird, the critics reasoned, certainly there would have been extensive systematic efforts to preserve it-at least a good skeleton. A group of zoologists searched Mauritius in 1850 looking for bones-and found none. Soon the Dodo was denounced as a "scientific fraud" (Panati, 1989, p. 203).

Evidence for its existence did not surface until a resident of Mauritius, George Clark, extensively searched the island and eventually discovered numerous scattered bones. His specimens were soon shipped to major museums, and after extensive study they were pronounced authentic. These researchers later attempted to assemble the bone fragments-many in poor condition-into complete Dodo skeletons. They are now recognized as real animals, but the many other myths surrounding them have died slowly. And these myths have unfortunately developed largely to support the theme of evolutionary naturalism (Darlington, 1980). Now that the bird has been extensively studied, we realize it did not support the myth, but eloquently supported the condition of humankind (Whitlock, 1981). We also now know that the bird is much more of a testament of human callousness than evidence for evolution. Not only did the Dodo became extinct on these Mascarene Islands, but Day (1989) claimed that "countless pathetic slaughters wiped out tortoises, gray parrots, blue pigeons and many other birds and reptiles" that once thrived there in peace.

Kitchener argued that it was *not* the Dodo's physical inferiority which caused its extinction, but the "Rats, pigs, and monkeys which arrived with the sailors and pillaged the Dodo's vulnerable ground nests" (1993 p. 24). Smith concluded it became extinct not because of natural selection but ". . .direct predation-as is true of probably all recent cases of extinction by man" (1966, p. 271). Extensive study of the extinction problem by Raup (1991) showed that a number of similar factors were unfortunately responsible for almost all historical extinctions. Even birds which have a reputation quite dramatically opposed to the Dodo's, such as the Bald Eagle, have been threatened with extinction for somewhat

similar reasons. All animals that lay eggs near the ground surface are vulnerable, which is why so many birds have become extinct in modern times. Island birds are especially vulnerable. Of the 171 species of birds known to have become extinct, fully 155 lived and died on islands (Quammen, 1996, p. 262) The false image of the Dodo as a fat, slow, inferior defenseless bird seems to argue for evolution far more effectively than similarly threatened better adapted birds such as the Bald Eagle, the latter which was saved only through deliberate efforts of a large number of concerned individuals. The story of the Passenger Pigeon *(Ectopistes migratorius)* is also an instructive case history in natural selection and evolution.

The Passenger Pigeon

The Passenger Pigeon, which no one claims was an inferior bird, once numbered over 20 billion strong. It was the most abundant bird in America and accounted for over one-quarter of all land birds (Blockstein and Tordoff, 1985). Obviously evolutionarily successful, it also became extinct by the 20th century due to human wanton destruction and greed (Dennis, 1993; Buscemi, 1978). The last one died on September 1,1914, in a Cincinnati, Ohio Zoo (Eckert, 1965). Their decline was rapid, and occurred first in the East, then in the Midwest. It happened at the hands of a mere "1,000 professional pigeoners" (Blockstein and Tordoff, 1985, p. 849). From billions to 1/4 million in 1896, the last one in the wild was shot on March 24, 1900, in Pike County, Ohio. Their story is tragic:

> As late as 1860 any naturalist or layman might easily have argued that the Passenger Pigeon was, in biological terms, the most successful species of bird on earth. Its numbers were so great, its territories so vast, and its strong body so well designed for its needs and habitat, that it is almost incredible that it could have been exterminated within the short space of 50 years ....in the autumn of 1813, that most famous of ornithologists and illustrators, James Audubon, was traveling in a wagon...when a column of Passenger Pigeons filled the sky so the 'light of noonday sun was obscured as by an eclipse.'...For three days other flocks followed this first one (Day, 1989, p. 34-35).

Audubon calculated the size of only one of the bird columns, which was one mile wide and passed overhead for three hours at a speed he estimated at 60 miles per hour. He concluded that over a billion birds were in this flock which would consume over eight million bushels of feed a day. The Passenger Pigeon seemed to be one of the last birds to go extinct for other reasons:

> Passenger Pigeons were strong and swift flyers. They maintained constant speeds of more than 96km (60 miles) per hour, and were capable of flying 1600km (1000 miles) in a day. Thus ...they seemed always capable of finding sufficient food because of their ability to range so widely in a matter of days... It has been well established that these birds look after and take care of all orphan squabs whose parents have been killed or are missing. These birds are long-lived, having been known to live 25 years caged. (Audubon quoted in Day, 1989, p. 34-35).

The traits of the Dodo bird provide a plausible reason for their extinction, but for the Passenger Pigeon, as Blockstein and Tordoff note, "...although there has been much speculation about the extinction of the Passenger Pigeon since that time, most of the proposed explanations are inadequate" (1985, p. 485). The story of their demise is, as Day states, a testament of human greed because it seems inconceivable that a bird as numerous as the Passenger Pigeon could have been exterminated so rapidly.

> ...Sportsmen who indulged in trapshooting bought up perhaps a million birds a year.... nearly all of which would die either by being shot or having their wings or necks broken by being hurled from the catapult traps.... With the advent of the telegraph and the railroad, hunters were able to follow and slaughter the migrating birds wherever they landed. From then on nesting grounds were seldom safe. The birds were searched out, harried and destroyed. Hundreds of railway boxcars were sent with the hunters and waited to be filled with the carcasses. By 1896 there were only 250,000 Passenger Pigeons left. They came together in one last great nesting flock in April of that year...in the forest on Green River near Mammoth Cave. The telegraph lines notified the hunters and the railways brought them in from all parts. The result was devastating-200,000 carcasses were taken, another 40,000 were mutilated and wasted.... The entire kill of this hunt was to be shipped in boxcars to markets ... but there was a derailment...The dead birds packed in the boxcars soon began to putrefy...the rotting carcasses of all 200,000 birds were dumped into a deep ravine a few miles from the railway loading depot (Day, 1989, p. 36-37).

The birds were killed not just for food, but to feed to hogs, even for fertilizer (Hilton, 1987). The level of the hunter's greed was vividly revealed by Johnson as follows:

> Toward the middle of the nesting site sounded the constant ring of axes chopping down trees loaded with

> nests. Duller sounds were made by other men hitting saplings with sledge hammers to shake the squabs out of the nests with sticks. Many of the young birds were so heavy that their bodies broke open when they hit the ground. As the hunters scurried about each downed tree they grabbed the squabs, jerked off their heads, and threw them on the bloody pile of birds near the wagon-loading point. It made little difference here that pigeon blood splattered the bushes and made stinking little pools in the wagon ruts. The instinct of self-preservation in the passengers was subdued by the one which said that their young must be protected! Setting passengers hovered nervously over squirming young and watched the slaughter... The destruction went on for months. At this one nesting site it began in March and continued until August. The only thing that could stop it would be the disappearance of the passengers or a drastic drop in the market price of the birds (1956, p. 85).

Although important, "Overhunting did not exterminate the Passenger Pigeon, as is commonly believed; rather, over two decades, cohorts died without the opportunity to replace themselves" (Blockstein and Tordoff, p. 485). So rapid was their extinction that scientists searched for years to confirm that indeed every last one had died (Hodge, 1912). The major cause of this was:

> ...the relentless disruption of the nesting colonies, which resulted in repeated nesting failures. This was facilitated by the development of the eastern railroad network and the telegraph which made every colony accessible to market harvesting. Instead, Passenger Pigeons became extinct because over a period of about 20 years-twice an individual's lifetime-adults were prevented from replacing themselves, directly by the nestling harvest and indirectly by the shooting, which led to nest abandonment. Had reproduction continued, it is unlikely that netters and shooters away from the nesting sites could have exterminated the Passenger Pigeons. There were simply too many pigeons for the harvest of adults to be complete. (Blockstein and Tordoff, 1985, p. 450-485).

The success of the passengers was not due to lack of enemies. They could protect themselves by traveling and nesting in large groups so that most pigeons were effectively shielded from predators, a method called predator satiation. Wherever the pigeons went, there were not enough local predators to seriously detract from their numbers. The pigeon had numerous enemies, aside from man, but there is no reason to believe that they had a material effect on the population. (Schorger, 1955, p. 208). Actually, the Passenger Pigeon was a major source of food for many animals, including the mink, goshawks, wolves, foxes, lynxes, cougars, bears, raccoons, opossums, pole-cats, eagles, and even vultures.

Summary

Some may argue that the humans won and the Dodos lost in the struggle for life. Darwin and the developers of natural selection, since his 1859 *Origin of Species* classic, have defined natural selection in terms of competition between animals for food or mates. The superior, in terms of its ability to gather food and escape enemies, would eventually become dominant and the other animals would become extinct. The Dodo and Passenger Pigeons did not become extinct because humans were competing with them for the same food supply. They became extinct because of greed, carelessness and the contingencies of history (McKinley, 1960).

Human caused animal extinction most always have little to do with direct competition for food, and extinction in the long run causes loss of food supplies and resources for humans. Humans now have the ability to cause most all life to become extinct by virtue of their knowledge of such tools as poisons, guns, and atomic power. It has nothing to do with survival of the fittest or natural selection in the Darwinian sense. Eldredge (1991, p. 205) stated that "...predators generally do not hunt their prey into oblivion," but humans regularly do. Humans are increasingly taking over land that once was dominated by animals, but as ecologists stress, this need not cause the extinction of animals. Only if larger numbers of humans wantonly disregard the welfare of the animals living in an area and refuse cooperation with conservationists would this happen. Selfishness, short sightedness, greed, and lack of planning have caused most recent animal extinctions, not direct human competition with animals in the Darwinian sense. This is supported by the fact that "very many of our game birds, shore birds, and waterfowl, would today be extinct, or near extinction, were it not for coddling through refuges and protective laws" (Babuet, 1990; Schorger, 1955, p. 215). The story of two birds, the Dodo which appeared to be inferior and the Passenger Pigeon which was clearly superior as judged by the evolutionary naturalists of the day, helps us to better assess the role of natural selection in history. Its role seems to be primarily to reduce the rate of harmful mutation accumulation, often call de-evolution, and not the role that Darwin ascribed to it. The Dodo and the Passenger Pigeon example also support Raup's (1991) conclusion from his extensive study of the

cause of extinction, namely that bad luck is by far more important than bad genes. Animals that have become extinct are not in any clear way inferior to those still around today but were the victim of circumstances and chance.

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Errata

All of these are in CRSQ, vol. 33, March, 1997.

p. 234 (inside front cover), the letter *Animal Death and the Curse* was not printed in that issue.

p. 242, right column, line 14, delete the entire sentence beginning "In other words . . . the region now."

The author's address has changed to D. Ashley Robinson, 665 Idlewild Circle, Apt. B10, Birmingham, AL 35205, email: daro@aol.com.

p. 264, the "western banded gecko" is misspelled, line 1, left column.

p. 267, the y-axis in Figure 6A was missing the number 10. Also, the x- and y-axes in Figure 7 were supposed to be scaled by a factor of 10 making it comparable to Figures 5 and 6.

p. 268, left column, line 12, references Wise 1970 should read Wise 1990. Also, page 268, left column, line 16, references Figure 2 which should be Figure 8. The word "chimpanzee" is misspelled in the title of Table III on that same page.

p. 269, line 13 of the right column, the word "Proganochelyidae" is misspelled in the quote. Figures 10a and 10b are sometimes referred to as 10A and 10B when there should be no distinction between capital and lower case letters a and b.

The managing editor apologizes to Mr. D. Ashley Robinson for these errors.