Photo by Val Clear

A well camouflaged Darwin's finch

Darwin's Finches

by Val Clear, Ph.D.
Anderson, Indiana

Photo by Val Clear

Darwin's finch nest

It was about 150 years ago that Charles Darwin met the thirteen species of finches on the Galapagos Islands. The encounter was to shake the world, but it took twenty-five years for the ideas to germinate into his theory of evolution. Even in 1985 the furious debate continues. Darwin himself said that his new understanding seemed to him like confessing a murder because it challenged the whole framework of the philosophical basis for understanding human life.

The most intense period of controversy came in the 1920s and 1930s, culminating in the confrontation be-

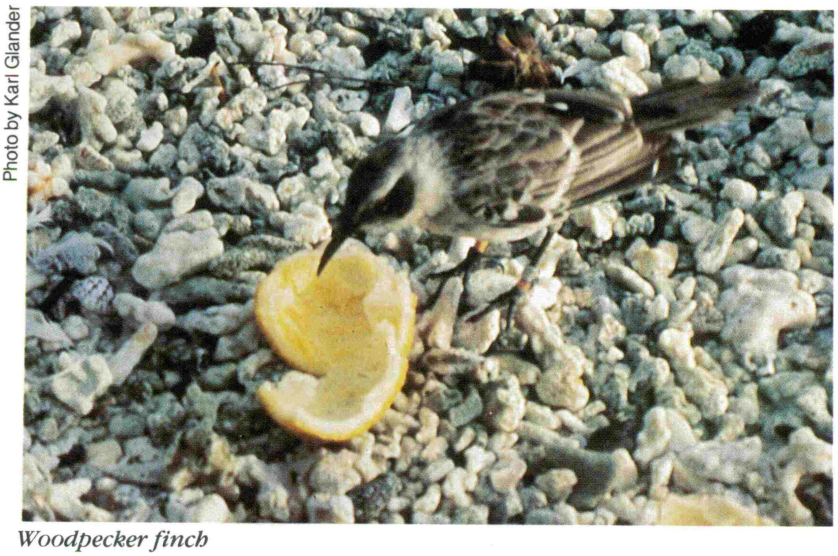
Photo by David Day

Sharp beaked ground finch, Tower Island

Photo by David Day

Medium ground finch, Academe Bay, Santa Cruz Island

Photo by Karl Glander



Woodpecker finch

tween two lawyers, Clarence Darrow and William Jennings Bryan, in the Scopes "monkey trial," that humankind evolved from a lower form of life rather than being created human by God. The jury found for God in that trial, but the issue continues to split the academic world in many parts of the country. What would Darwin say?

In short, he said that the thirteen species of Galapagos finches apparently had a common ancestry, and that they had become separate species because they spread to different environments that required different feeding skills. Since certain variations would give the possessor an advantage over competing individuals, the ones possessing advantages adaptive to the environment would survive and thus would reproduce better than less fortunate specimens. As the offspring inheriting the advantage increased in the gene pool, a new species eventuated. This came to be referred to as the survival of the fittest. What was his evidence?

Of the thirteen Galapagos finches known to Darwin, all can still be seen on the islands, although some are few and elusive. In 1938 David Lack, the English ornithologist, studied them on the site and said that they were dull to look at and dull to listen to. "Only the variety of their beaks and the number of their species excite attention — small finch-like beaks, huge finch-like beaks, parrot-like beaks, straight wood-boring beaks, decurved flower-probing beaks, slender warbler-like beaks, species which look very different and species which look very similar." (p. 11; David Lack, *Darwin's Finches,* New York, Cambridge University Press, Revised, 1983, 208 pp.)

Shapes and relative sizes of the finches' beaks resemble the mandibles of warblers and grosbeaks — and everything between. Heavy beaks are used to crack hard seeds. Long beaks penetrate cactus flowers. Small beaks feed on concealed insects. Roger Tory Peterson watched a large cactus finch use its sturdy beak to toss rocks in search of food. Some of the rocks weighed fifteen times the weight of the bird. That's equivalent to a 130-pound woman moving a ton!

The woodpecker finch has a longish beak but augments this by cutting a cactus spine to force grubs out of holes. As mentioned, the sharp-beaked ground finch snips the fresh feather of a larger bird and drinks the blood. The specialization in food made possible by beak evolution has separated the species remarkably.

Nesting habits of Darwin's finches are interesting. In most species, the single or mated male builds the nest — in fact, may build as many as eight nests. He displays near his nest, and may even display near a nest built by another species. They are so interchangeable that the nest finally chosen by the pair for laying and raising the brood may have been built by the male of another species.

The number of eggs laid is influenced by food supply. If too few eggs are laid, the species cannot be perpetuated, but if so many are laid and hatched that the food supply is inadequate, all babies will starve in the nest. Breeding occurs in the Galapagos only during the rainy season, usually December through March.

Galapagos wildlife is not exported, so the birds are not known to exotic aviculture, but some of the Darwin finches resemble species from the mainland, in particular the blue-black grassquit or jacarini *(Volatinia jacarini)* or the parrot-billed seedeater *(Neorynchus peruviensis),* two species I have tried to cage-breed for years without success.

In general, Darwin's finches can be described as greyish-brown and short-tailed. Some are monomorphic, some dimorphic. They build large roofed nests, are monogamous and are quite territorial. The main distinction between the species, the factor which caught Darwin's attention, is the beak, as described above by Lack.

A generally accepted theory is that every creature occupies an ecological niche in the environment, that where two species compete for the same food

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supply or nesting site, in time the one that is best adapted will overcome the second-best. The latter will do one of three things: it will perish, it will move to an environment where there is less competition, or it will change its feeding or breeding habits through adaptation.

The latter option was what fascinated Darwin as he studied his finches. The vegetarian tree finch, the insectivorous tree finch and the woodpecker finch may occur in the same habitat; they are not competitive. Adaption in feeding skills, particularly in beak formation, enables them to coexist without contest.

The Galapagos Islands vary from lush, tropical vegetation to sparse and arid, which makes for a wide range of possibilities. On any given island there may be elevations or water/wind currents that alter the environmental pattern, as well. Ornithological charts show clearly where certain species are found, and in the briefing session led by the naturalist guide before going ashore, the distribution of birds on each island is predicted with accuracy. Just a hundred yards on foot may carry the visitor into or out of the range of some species.

Lack found that the Galapagos races of avian species existing also on the mainland tend to be less colorful. He took several specimens of four species into captivity at the California Institute of Technology in 1938 and found that it took males four years to reach full black status (except for white under tail). This helps explain why males in juvenile plumage are found nesting on the islands. They are sexually mature. Dimorphic females are almost indistinguishable from closely related females.

This similarity of appearance is confusing to any observer of the birds. How do the birds themselves distinguish between closely related species? By the beak, says Lack. When an intruder invades a male's territory, he responds immediately and aggressively, but as soon as he sees the beak, he relaxes if it is different from his own. For Darwin's finches, the beak performs the key to species identification provided in other settings by wing bars, crests, colors or tail patterns. The beak differences in these closely related species are so great that at one time taxonomists classified them in seven different genera.

Some years ago I was visiting the Nairobi laboratory of L.S.B. Leakey, the archaeologist, in Kenya. He came into the room as excited as a proper Englishman ever can be, bubbling with the announcement that his associate, Jane Goodall, who was living with a colony of wild chimpanzees, had found them constructing and using tools by cutting a stiff grass stem and thrusting it into a termite nest, impaling and extracting termites. It was as if Leakey had just discovered the missing link. Here was a primate doing what had always been the distinguishing mark of humanity: it invented a tool. Had I known then what I know now, I could have deflated the venerable archaeologist.

The Woodpecker Finch *(Camarynchus pallidus)* does not possess a long and sticky tongue, as do true woodpeckers, for extracting insects from holes which woodpeckers characteristically drill. The woodpecker finch does next-best. In arid areas, it picks a spine from a cactus. In other environments it breaks a twig from a bush. This probe is used to force an insect out of a crevice, so that it can be seized in the open. So much for mankind's unique tool-making trait!

Lack speculates on an interesting point. It appears that Darwin's finches were on the Galapagos Islands long before many of the other species appeared, because had the other species been established in their ecological niches, the finches would not have been able to spread into those niches, already occupied by well adapted competitive species.

The naturalist guides explain that the remarkable tameness of all the birds on the islands is the almost complete absence of natural enemies; they have not learned fear. Some islands have acquired a limited number of owls and hawks, but their presence has not yet worked its way into instinctive responses.

This produces magnificent pictures of doves, mockingbirds and boobies taken by visitors, but not of Darwin's finches, unfortunately. I took several pictures within three feet of a bird, but it is almost indistinguishable from the rock or shrub background because of great camouflage markings. Only a studio picture can show the bird clearly.

Any aviculturist knows that birds are creatures of habit, and changing them from an accustomed practice is difficult. Many a pet-store bird dies because the new owner does not ask what to feed it. Nevertheless, with patience and understanding, diets can be changed. Greater Indian hill mynahs were reprehensible living-room guests

until someone developed their pellets, and no parrot eats sunflower in the wild. When I get a new psittacine I gradually change its diet to safflower-based. Under proper conditions, birds can change established habits.

Thus it was with Darwin's finches. In the remote origins, individuals developed slightly better skills in a competitive environment. Surviving better, they passed on those traits to their progeny, the best of which in turn passed on the traits to even better adapted offspring. This produced in a few thousand years by natural selection the same kind of result that planned selection produces in a white-breasted Lady Gould or a blue ringneck parakeet, taking only a few years. The Great Aviculturist in the Sky takes longer, but the process is essentially the same.

Hybridization between species is sometimes suggested as the source of new species, but Lack thinks it is not a valid theory. Except for hybridizing between the common house sparrow and the Spanish sparrow in Northern Africa, no example of significant wild hybridization is known, and he finds no example of this in the Galapagos. Aviculturists know that two birds of closely related species will fight furiously but two of quite widely separated species may get along well. To put a pair of Cuban melodious finches and a pair of olivaceous finches in the same cage is to create mayhem. They occupy the same ecological niche, so are highly competitive. Put an insectivorous Pekin robin with either pair: no problem.

So in the wild, birds that are close enough genetically to hybridize are too close ecologically to tolerate each other. In captivity it is possible to hybridize deliberately due to artificial conditions, but it is not likely among feral populations.

All the preceding questions had perplexed the scientific world for generations, and Lack decided to find the answers. Field research was too uncontrolled, however, so he resolved to create his own laboratory. He secured a collection of wild Darwin's finches from the Galapagos Islands in order to establish a captive breeding colony to study the behavior of the birds. However, while sailing from the islands to Panama, the morbidity rate was so high and war clouds were gathering in Europe, so he detoured to California, where he left them with the Academy of Science in San Francisco.

Because of Lack's sudden change in plans, the arrival of the birds caught the Academy of Sciences unprepared to house and care for them. Fortunately, there was an aviculturist in Marin County who had spent years developing softbill diets and who was able to keep the collection until the Academy could prepare for them.

Eric C. Kinsey had the necessary skill and successfully cared for the birds during the crucial early days of settling-in to captivity. He was well known to world aviculture and the birds were in good hands.

His formula consisted of cottage cheese, pound cake, canned minced liver, soya millet bread, Stewart's Formula, minced nuts (usually walnuts), banana, apple, pear and a coloring to make it more attractive. Mealworms were scattered atop the mixture. It worked exceptionally well.

Dr. Robert T. Orr was the head of the experiment that materialized from the importation of the birds. There were thirty individuals divided among four species. His account, published in the September-October 1945 issue of *The Condor,* demonstrates how useful avicultural techniques can be to scientific research projects. Dr. Orr graciously acknowledges his indebtedness to the late Eric C. Kinsey, Sr., a Marin County aviculturist, for valuable help in solving husbandry problems encountered. Eventually, flights were constructed on the roof of the North American Hall at the Academy of Science and the experiments were conducted there.

The four species were the large ground finch *(Geospiza magnirostris),* the medium ground finch *(G. fortis),* the small ground finch *(G. fuliginosa)* and the cactus finch *(G. scandens)*. These all were taken from Indefatigible and Chatham Islands.

The first year was hard on the birds; eight died, about 25%. But during the following two years, only two died and these were more than replaced by a good first breeding season.

An aviculturist can sympathize with Dr. Orr's lament that the wrong ones died. He had plans to test hybridization of the two *fortis* males with other species, but one of them died and the other was so wild that it would not accept any of the females with which it was placed. What aviculturist has not had those problems?

Ten separate flights were constructed on the roof, each 4' x 10' x 7' high. The back wall was concrete and the back 4' of the roof was covered to protect feeding and nesting sites. The floor had

a 2" layer of gravel.

In the wild, Darwin's finches feed on fruit, berries, flowers, nectar, vegetation, insects and seeds. The captive diet reflects what was being fed by English aviculturists at that time: berries, greens, honey, Mellin's Food, and evaporated milk. Dr. Orr found that dandelion flowers and lettuce would be eaten when berries were not available. Some of the birds overate seeds and became so obese they could not fly, so seeds were carefully rationed. Dried grasshoppers (sold for fish bait) and hard-boiled egg were fed during breeding seasons.

Although individuals differed, in general it was found that two males of the same species would fight when placed in the same flight, especially while breeding, but those of different species would not. As an experiment, Oregon juncos and Allen hummingbirds were released in the flight and the Darwin's finches showed normal curiosity toward the Juncos and chased the hummingbirds as they did moths, but the finches do not have very well developed skills on the wing and could not meet the challenge.

In the Galapagos, breeding season comes with the rains, usually December to April, but there is scattered nesting throughout the year. The onset of the breeding season in California came in March and was foretold by increased singing and vigorous activity by the male, sometimes followed by chasing the female about the flight. The male would carry nesting material aimlessly until the female was ready, at which time the pair would settle down to serious business.

As part of the experiment, pairs were split up and placed with new mates in the midst of the cycle. Although not always, on some occasions there was acceptance and copulation within seconds, followed by a new nest built by both birds, and eggs in a few days.

Song is an important tool for a wild bird to circumscribe his territory, and differences between species are usually easily recognized even by human ornithologists. Among Darwin's finches, however, there is more difference between individuals of the same species than there is between species. It would be interesting to see what the new ornithological research would do with spectrum analysis of individuals and species. This scientific technique was not available in 1939.

But whereas distinct song is used among wild birds for species recognition, Lack found that among Darwin's finches the beak was the ethnic measure; an attack might begin, but when a male saw his opponent's beak and recognized him as a different species, the attack ceased. Orr tested this perception by camouflaging the beak of an intruder. When the beak was recognized, aggression stopped.

Part of the courtship process in many species entails a nuptial ritual, and Darwin's finches are not exceptions. The male characteristically takes nesting material in his beak (similar to several African and Asian species) and sways with it. Orr noted a behavior in captivity which Lack had not seen in the wild. Taking place only on or very near to the nest, the male and female would crouch facing each other, swaying, with beaks open and neck arched.

The ability of the birds to recognize others was tested in various ways. On one occasion a stuffed female *(G. scandens)* was placed on the floor of a male's cage. He immediately attempted to copulate. Then a stuffed female *(G. fortis)* replaced the first female and the male repeated his attempt. After a cooling-off period, both were returned to his cage, deliberately placing *G. fortis* less accessibly, and he made his preference obvious by seeking out the species most nearly like himself. The only difference visible to the researchers was the beak, which apparently was the male's basis of selection as well. A mirror placed in the cage produced furious and endless conflict during breeding season, but not much attention the rest of the year.

As the breeding season approached, ample amounts of sisal hemp fiber and dry grass were provided. Two months before the female was ready, the male would be building nests. Like a zebra finch, he loved to construct, destroy and rebuild nests. When the female was ready she would make her selection, finish the chosen nest to her own pleasure, and lay. Most of the nests described by Orr were similar to what I saw on the islands: global structures about a foot in diameter, with an entrance on one side. However, Orr also had cup-shaped nests and global nests with two entrances.

Courtship feeding is with regurgitated food, most frequently by the male at the feet of the female, but sometimes from beak to beak. At such times the female would flutter as a baby bird begging for food.

There were from one to five eggs laid before 9:00 a.m. on successive days. Incubation started with the first egg and averaged twelve days. Anyone

who has tried to slow down an over-productive zebra finch egg-machine will sympathize with Orr. One female laid 31 eggs in ten clutches in seven months, and he stopped her only by removing all nesting material. If this were happening today, those 31 eggs would have been placed under Bengalese foster parents.

There was a high percentage of infertile eggs. Beebe has an interesting theory. This, he says, is nature's way of offsetting the absence of natural enemies. If too many young survive, all birds starve. To prevent this, nature has some species with small clutches (doves lay two eggs), and some species lay a large percentage of infertile eggs. The next time you broken-heartedly dump a nest of blank eggs, remember Beebe.

Young Darwin's finches are born naked and light colored. The eyes of those raised at the Academy opened on the fifth day and the egg tooth was still visible. Prior to the ninth day the babies would open their mouths when the nest was touched but on the ninth day they developed fears. When the nest was touched lightly, they opened their mouths for food but if it were touched roughly, they would crouch. By the thirteenth day some fledged but were able only to hop, not fly. For about two weeks parents fed the young but by the fourth week, babies began picking up food for themselves.

At this time some males began to attack their offspring. Orr speculates that this is functional in the wild, where young birds can flee, but in an aviary there is no place to hide.

By this time the young were in immature plumage, similar to females. At six weeks song began and some individuals were carrying nesting material.

While the young were in the nest, both parents fed them, but the mother progressively diminshed her portion and by the time the young fledged, the father was doing almost all the work. There were individual females, however, that continued to feed their babies even though incubating a new clutch of eggs. Orr speculates that this could have been the result of slow development of the young due to inadequate diet in captivity. Because of this slow development, some aggressive fathers had to be placed in cages in the flight so as not to kill the young, which forced the mother to take on duties normally paternal among Darwin's finches.

The Galapagos Islands straddle the equator. San Francisco lies at 38° North latitude. The move required the birds to adjust to a variety of different environmental factors. They were imported in April, 1939, just at the end of their natural molt, but they entered on schedule the customary September molt experienced by native California birds. In successive years, this same pattern of a natural North American molt continued.

Babies retain post-juvenal plumage for about a year and thereafter there is an annual molt. Two young males were dyed to facilitate study of molt patterns because although skins in the collection of the Academy of Sciences provided laboratory evidence, there were no longitudinal data available on an individual bird. This device to trace dropped and replaced feathers gave insights not otherwise available.

The first-year plumage is completely replaced the second year, characteristically showing black feathers on the head and neck of the male, with the other feathers having larger brown edges as they approach the back end of the bird. Later in the year the bird appears to be darker, but this is due to the wearing away of the buff edge on the feathers. The third-year plumage is all black on head, neck, breast and back, with feathers on posterior parts retaining a buff margin. By the fourth-year plumage the male is all black except for the brown edges on under-tail coverts.

To test whether this color phasing was hormonal in origin, estrogens were administered and the proposition was supported when fully black males produced brownish feathers in the next molt. In another phase of the experiment, intramuscular injections of sex hormones were given. The female showed no effect whatever, and the three males — well, one died and two escaped through a defective cage. Does that remind you of your own history? Before their death/escape, changes seemed to say that the hormones were affecting feather color.

There was a surprising response by the Darwin's finches to the appearance of predators in California. On the islands, there are only two natural enemies, an owl and a hawk, and these have a small population. The finches do not display much of a fear of enemies on the island; it has been thought that they lack instinctive fears of predators. However, when a hawk, vulture or raven came within sight in California, the finches made so much commotion that Orr could hear it in his office downstairs. At that time the nestlings would crouch instinctively. To test the birds, stuffed hawks and owls were placed in view and elicited the same response.

In his summary, Orr weighs the usefulness of captive breeding of birds for an understanding of the wild, and concludes that "there was surprisingly little difference between the reactions and responses of the species studied in captivity and those in the wild state . . . Many such types of experimentation are impossible in the wild." Illustrative of this is the knowledge that it takes four years to attain fully black male plumage.

After the 25% loss of birds the first year, the Darwin's finches that Lack exported from the Galapagos had good longevity. The Academy experiment ended in 1942. Nine specimens were sent to the New York Zoological Society and eight remained in San Francisco. The Bronx Zoo files show that they lost one or two birds a year for five years. This means that the last to die had been in captivity for eight years, a testimony to the good care they had had in San Francisco and New York.

Captive breeding programs have made various major contributions to the management of wild populations. The English have re-established in its homeland an Asian pheasant that was extinct in the wild. There is a request from Venezuelan naturalists to release in its natural habitat a re-seeding of black-capped red siskins, and there is a favorable response from fanciers in this country, who have bred the bird for many generations. The whooping crane is being propagated by captive flocks. Survival in the wild of several psittacine species is dependant upon the release of stock raised in captivity. These are familiar examples of aviculture at the service of the environment.

But the pivotal work done by Charles Darwin on the Galapagos Islands had far-reaching effect upon philosophy, history and theology. The echo of his thesis of the origin of the species still reverberates loudly.

The avicultural experiment by Dr. Robert T. Orr at the California Academy of Science helped in understanding points that Darwin never knew and, in the process, helped aviculturists understand how to care for endangered species.

Note: The author is deeply indebted to Dr. Stephen Bailey, presently a staff member of the California Academy of the Sciences; to Mr. Tom Bruning, Curator of Birds, Bronx Zoo; and to Mr. Eric Kinsey, Jr., for valuable assistance with the research in this project. ●

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