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Say It With Bowers

If male bowerbirds build it, females will come. But in the mountains of New Guinea, one species is sending mixed messages.

By J. Albert C. Uy

The first Westerners to penetrate the rugged interior of New Guinea encountered a world of plants and animals new to them. One of the earliest European naturalists to explore the inland mountains was Odoardo Beccari, who set out in 1872 to climb the Arfak range in a northwestern peninsula of the island. Before his ascent, Beccari had heard stories of a small mountain bird with prodigious architectural talents, and in the Arfaks he found both the bird and its structures. They proved to live up to the rumors.

Hut bowers are an engineering feat for birds weighing less than five and a half ounces.

Photo by J. Albert C. Uy

Now known as the Vogelkop bowerbird, this uniformly brown creature was scientifically christened *Amblyornis inornatus*, its species name taken from the Latin for "unadorned." Its behavior, however, is reflected in the name used by local New Guineans: *burung pintar*, or "clever bird." It was this reputation that first led me to New Guinea to study the Vogelkops. In 1994, along with my then doctoral advisor, Gerald Borgia, a biologist who had already spent more than twenty years studying various bowerbirds, I climbed up the Arfak slopes.

Found only on the large island of New Guinea and in Australia, bowerbirds comprise nineteen species. Males of all but three species are polygynous, meaning that they try to mate with as many females as possible. In some species, one male can mate with as many as twenty females in a single season, while the majority fail to mate at all. Of the polygynous species, fourteen have the peculiar habit of building ground-based structures, called bowers, solely to attract the opposite sex. Bower design and decoration are specific to each kind of bowerbird. For example, the satin bowerbird, which inhabits the dry woodlands of eastern Australia, erects two parallel walls of sticks on top of a circular platform, also made of sticks. The walls flank a path that visiting females step onto. Adorning the platform in front of the path are objects such as assorted blue parrot feathers, white snail shells, and yellow and purple blossoms from wild tobacco. Other species of bowerbirds build towers; some simply clear leaf litter from the ground to form a court where the male dances for visiting females. In their own way, most bowerbirds are skilled architects, but none can rival the plain brown Vogelkop.

A male Vogelkop selects a forest sapling and tightly weaves sticks around it, shaping a

conical hut that can reach six feet in width and four feet in height. Huts typically have a single doorway, neatly trimmed to form a perfect arch, which opens out onto a thick carpet of moss up to six feet square, also laid by the industrious male. On this mossy stage, the male displays thousands of objects he has collected from the surrounding forest, including orange rhododendron flowers, yellow leaves, blue fruits, red ginger berries, iridescent blue beetle carapaces, A male Vogelkop selects a forest sapling and tightly weaves sticks around it, shaping a conical hut that can reach six feet in width and four feet in height. Huts typically have a single doorway, neatly trimmed to form a perfect arch, which opens out onto a thick carpet of moss up to six feet square, also laid by the industrious male. On this mossy stage, the male displays thousands of objects he has collected from the surrounding forest, including orange rhododendron flowers, yellow leaves, blue fruits, red ginger berries, iridescent blue beetle carapaces, shiny fungi, and feathers from other birds, such as birds of paradise. (At one site we studied, a male pilfered a strip of blue tarp from our camp and laid it under his doorway; another stole a pair of knee-high green socks with bright yellow stripes.) Males arrange these objects according to color and size and promptly remove any that decay. In fact, the best way to coerce a male to come down from the forest canopy and onto his bower is to mix up his decorations. He quickly returns and puts everything back in order, sometimes in the presence of a surprised spectator.

The Vogelkops of the Fakfak Mountains are minimalists. Although tall, their spire bowers are wall-less and spare, the decorations dark and subdued.

Photo by J. Albert C. Uy

The dimensions of a Vogelkop bower are even more impressive given the size of the builder. Weighing less than five and a half ounces, a Vogelkop male is not much bigger than an American robin. Great time and energy are thus invested in constructing and maintaining the relatively colossal bowers, illustrating the lengths to which the birds go to attract females. The bower is not used as a roost or a nest site. Females, which usually mate with only one male in a season, rear their young on their own, building simple bowl-shaped nests six inches in diameter and six to ten feet up in a tree.

Hut-building Vogelkops inhabit New Guinea's Tamrau and Wandammen Mountains as well as the Arfak range. In 1981 physiologist Jared Diamond, of the University of California, Los Angeles, found an isolated population of Vogelkop bowerbirds in the Kumawa Mountains, about 100 miles south of the Arfaks. The Vogelkops of Kumawa (and the adjacent Fakfak range) construct strikingly different bowers. Instead of elaborate huts, these birds erect five-foot-high, spindly spires. Made of sticks loosely interwoven around a sapling, the spire resembles a dry Christmas tree. At the base of the spire, the male neatly lays a circular carpet, usually of black moss. The decorations are spartan, consisting exclusively of drab objects such as brown bamboo bark, black seedpods, and brown snail shells, all arranged by color and type near the carpet's perimeter. Given their distinct bower styles and color preferences, and the species-

specific character of most bowers, one might guess that spire builders and hut builders are two kinds of bowerbirds. Yet they are physically identical and are classified as the same species.

Because Vogelkops build the most elaborate structures of all bowerbirds, they were an important element in Borgia's and my study, which was aimed at understanding how bower building evolved. We decided to focus on the Arfak hut builders and the Fakfak spire builders. But these two populations also presented another opportunity. We realized that they could be used to test an idea first posited by Charles Darwin more than a century ago and still being debated. Today one of the hottest topics in the field of evolutionary biology is how species originate. Researchers agree that new species arise when one population of a species splits off from the rest. Just how these changes occur remains a contentious issue. Darwin championed the idea that new species often evolve when populations of one species become geographically isolated—by mountain formation, by changes in the course of rivers, or by emigration to an island, for instance. Gradually, a population may change in order to make the most of any new resources, such as food, in the environment. In the case of birds, a larger bill, for example, may enable some individuals to take advantage of particular seeds. Over time, bigger-billed members of that population may thrive, while those not as well equipped will be weeded out. This phenomenon, known as natural selection, can lead to the evolution of a new species when the changes in an isolated population become so great that its members no longer recognize individuals of the original population as potential mates. Studies by several biologists, including the long-term work of Rosemary and Peter Grant on Galápagos finches, provide solid support for this theory.

Darwin also alluded to another process by which new species could form, in this case in the absence of adaptations to new resources. Creatures use various signals to find and recognize others of the same species. For instance, in several species of freshwater cichlid fish in African lakes, distinct color patterns and courtship dances allow individuals to recognize conspecifics. If such traits should begin to diverge between populations, then the criteria for choosing a mate would change, and some populations that once mated freely would become reproductively isolated. During the early and mid twentieth century, this idea was overshadowed by Darwin's theory of speciation by natural selection. Recently, biologists are showing renewed interest in the alternate or additional possibility of speciation by sexual selection, wherein changes in mating signals drive the formation of species. Studies of certain Hawaiian fruit flies and of Hawaiian and North American crickets, as well as African cichlids, are beginning to provide support for this phenomenon, but hard evidence remains rare, especially in birds, which inspired much of Darwin's thought on the matter.

If bower size and color serve as mate magnets, a Fakfak bower might not hold much appeal for an Arfak female.

Photo by J. Albert C. Uy

The hut-building and spire-building populations of Vogelkop bowerbirds show no signs of changes in bill structure, plumage, wing shape, or other features that would indicate they are adapting to new conditions in their mountain habitats. But their mating signals—bowers—vary dramatically. Could these birds and their bowers be an example of sexual selection leading to the formation of new species? We began field studies to test whether this could be the case.

Scientists have found that in most bowerbird species, the colors of the bower decorations are those that both males and females prefer. But what if spire-building Vogelkop males also prefer colorful decorations but are forced by a lack of these ornaments in their immediate habitat to make do with brown or black bower accents? Jared Diamond first tested this idea in the hut builders of the Wandammens and the spire builders of the Kumawas by offering males poker chips of six different colors. He found that the hut builders strongly preferred bright colors, while the spire builders typically ignored them. To determine if Diamond's results held in our own populations, we undertook similar experiments with the Vogelkop populations of Arfak and Fakfak, using a wider array of colors. We offered males from each population a set of tiles of sixteen different colors. Our results were almost identical to Diamond's: The hut builders of the Arfak Mountains typically ignored drab-colored tiles but were drawn to blue and red ones and were quick to harvest them for placement on their bowers. (The males often began the experiment even before we had a chance to get back to our blinds.) In contrast, the spire builders of Fakfak paid no attention to any of the tiles we placed near their bowers, even when we left them there overnight. The two populations seemed to differ not only in which colors they liked but also in the basic propensity to decorate.

To find out how closely related the hut builders and spire builders are, we turned to genetics. If only distantly related, then they have been distinct species for a long time. In the case of the Vogelkops, this would mean that changes in bower display may not have been involved in the speciation process itself. Our collaborators Ross Crozier and Rab Kusmierski, of La Trobe University in Bundoora, Australia, sequenced a portion of mitochondrial DNA from both populations. The DNA showed only slight genetic differences. The hut- and spire-building populations are closely related, and bower displays may be working as a reproductive wedge. One population may be on the verge of becoming a separate species.

Next we went about setting up experiments to determine if bowers do indeed function as a means of recognizing potential mates. Our ultimate aim was to answer several questions: Does the difference in bower styles act as a reproductive barrier? Would Arfak females recognize Fakfak spires as mating signals, and thus Fakfak males as potential mates? We first set up video cameras at Arfak hut bowers. The cameras were triggered automatically by any movement in the vicinity of the bower, where all courtship and mating take place. This technique allowed us to get continuous and simultaneous video recordings of behavior at sixteen bowers for more than six weeks. From the hundreds of hours of video footage, we were able to determine how successful each Arfak male was in attracting females, and then to relate his success to specific components of his bower display. The video cameras captured a total of thirteen matings. Only half of the sixteen videotaped males mated, with the three most successful males taking part in fully 60

percent of the observed matings. Why the lopsided numbers? Males with the biggest bowers and the most blue decorations were the ones that mated the most. We found that both bower size and abundance of colorful ornaments influenced the mating behavior of females. They appear to use both criteria when choosing a male.

To balance the equation, we will need to compile similar records of mating activity among the spire builders. But Vogelkop bowerbirds are restricted to mountains in western New Guinea, which is now known as Irian Jaya and is administered by Indonesia. Proving more difficult to surmount than any mountain range, political instability and the recent restriction on visits to this region by scientists have prevented us from carrying out these observations. The data we have gathered so far, however, do allow us to make inferences: Spire bowers are substantially smaller than huts and are never decorated with blue or any other colorful ornaments. Because Arfak females prefer showy bowers, they might find these spire bowers unattractive or inadequate, and so might fail to see the architects as potential mates. This suggests the possible presence of reproductive barriers, but only information from the spire-building population will provide direct support for this argument. Given the political situation in Irian Jaya, testing the preferences of Fakfak females and gauging the responses of Arfak females to a Fakfak male and his spire bower may have to wait a few years.

In the meantime, the role of sexual selection in generating biodiversity is gaining attention and stimulating discussion. Current research, including my own, is now exploring *why* mating signals change in the first place. Do visual conditions, such as the play of light and shadow on foliage, select for certain signals that are most effective in those particular environments? Or are these changes arbitrary relative to the habitat, analogous to fads we see in our own society? In the search for answers to how species are generated, creatures as varied as fish, flies, crickets, and bowerbirds are leading the way.

J. Albert C. Uy credits the writings of evolutionary biologist Ernst Mayr with sparking his interest in how new species arise. As a doctoral student at the University of Maryland, Uy began to investigate mate choice and speciation in bowerbirds, working with Gerald Borgia, a specialist in that group of avian architects. Uy, who was born in the Philippines, has done fieldwork in Central America, Ecuador, and the bowerbird lands of Australia, Papua New Guinea, and Irian Jaya, Indonesia. Now a postgraduate fellow at the University of California, Santa Barbara, he is working on speciation in paradise—kingfishers and white—bearded manakins and looking at environmental factors that could drive changes in mating signals.

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