

AMERICAN MUSEUM NOVITATES

Published by
Number 1073 THE AMERICAN MUSEUM OF NATURAL HISTORY June 26, 1940
New York City

RESULTS OF THE ARCHBOLD EXPEDITIONS. NO 26.

BREEDING HABITS OF THE BIRDS OF PARADISE: *MACGREGORIA* AND *DIPHYLLODES*

By A. L. RAND

This is one of the preliminary papers of the 1938-1939 Expedition which co-operated with the Netherland Indian Government as the Indisch-Amerikaansche Expeditie.

The results given in this paper further illustrate the diversity of the courtship and nesting behavior of the members of the family Paradisaeidae. The courtship of the birds of paradise, which is as diverse as their morphological structure, has long attracted attention, but until we have more precise data it is useless to attempt to generalize about it.

The present paper shows that in *Macgregoria*, in which species male and female share nest duties, there is a communal display, in which males and females take part. Sometimes it takes place near the nesting site of one pair but its meaning is still obscure. The second species considered, *Diphyllodes*, appears to have a more easily understood courtship, comparable with that of the manakin (*Manacus*) of the New World tropics. The male selects a solitary court and improves it so that his colors show to better advantage, he announces his presence to the female by loud calls, and when the female comes to the court she is displayed to, she approaches the male and a further, more spectacular display stimulates her to take part in copulation. After the female leaves the court the male apparently plays no further part in her life. In this species it is apparently natural selection that has developed the specialized structures and coördinated habits.

Macgregoria pulchra De Vis

Macgregor's bird of paradise is one of the least known birds of paradise. It is a

specialized member of the family with no near relatives.¹ Both sexes are velvety black with an orange band in the wing and an orange eye wattle. The female is slightly smaller than the male, a size difference great enough to be discernible in the field when the sexes are together. Though common in the forests above 2900 meters in the mountains of east New Guinea and the Snow Mountains, its range has been so inaccessible that few white men had seen the bird alive until Mr. Shaw Mayer brought a living bird to Europe in 1937 (1938, *Avicultural Magazine*, London, p. 65, also plate).

I studied this species in east New Guinea in 1933 and in the Snow Mountains in 1938 while with the Archbold Expeditions. My note on its habits in east New Guinea (1937, *Bull. Amer. Mus. Nat. Hist.*, p. 200) was all that has been known about its activities. In 1938, in the vicinity of Lake Habbema, Snow Mountains, I discovered the nest, egg and young of this species, and watched its display and the activities of the birds about the nest. This forms the basis of the present paper.

Junge (1939, *Nova Guinea*, p. 82) described the immature bird as covered with fluffy, sooty brown feathers, emerging wing and tail as adult.

DESCRIPTION OF NESTLING.—This young bird was removed from the nest August 22, 1938, at Lake Habbema. It was at least twelve days old, but was surprisingly small, with eyes not yet open. Its tarsus measured 35 mm., bill 19; plumage partly clothed the bird, the primaries were just

¹ The genus contains but a single species, *pulchra*, which is broken up into two slightly differentiated races: *pulchra* De Vis, southeast New Guinea; *caroliniae* Junge, Snow Mountains, distinguished by its smaller size.

breaking their sheaths. This plumage was all dull black. The wattle was well developed, measuring 13 mm. in total length.

Down was absent from the underparts, but was fairly plentiful on the ends of the feathers of the upperparts; it occurred on crown, nape, back, rump, humeral and femoral tracts, and was also present on the tips of the greater wing-coverts, primaries, secondaries and some upper tail-coverts. The down was especially plentiful on the femoral tract and rump, where it reached a length of 15 mm., and on the top of the head, where it was about 8 mm. long. The down was of a sooty black color.

COLOR OF SOFT PARTS.—Wattle and bare skin of side of head dull yellow, bill blackish, streaked yellowish, a small white egg tooth present, feet greenish yellow, nails grayish, inside of mouth orange-yellow. There was but a single young in the nest.

EGG.—Collected August 14, 1938, Lake Habbema; color, earthy pink, sparsely marked with spots of light brown, many overlaid with the color of the shell to give secondary purplish-black spots, the markings well distributed over the egg, but more common about the larger end and with a slight concentration about the small end; shape, ovate; texture, many slight irregularities on the shell give a slightly rough feel; gloss, slight; measurements, 39×27.5 . There was but one egg in the nest.

NEST.—The nest collected on August 14 at Lake Habbema was about 50 ft. up in the top of a *Podocarpus*. This tree towered up through an area of low mossy forest and was somewhat isolated from similar tall trees.

The nest itself was a bulky, fairly firm cup-shaped structure in a multiple upright fork of a small branch in the crown of the tree. The outside of the nest was composed chiefly of a coarse moss, mixed with some herbaceous and woody stems; the inside of the nest was a firm cup with walls 10–20 mm. in thickness at the top though very thin in the bottom of the nest, composed of slender herbaceous and woody stems. The lining of the nest was composed of

slender, unbranched woody stems firmly put together. In the bottom of the nest were a considerable number of broad phylloides of the conifer *Phyllocladus*. The nest measured: outside, 190×240 mm. wide; inside, 90×130 mm. wide. The other nest collected on August 22 at Lake Habbema was about thirty-five feet up on a lateral bough of a *Podocarpus* tree, where many small, upward bending branches offered a secure site. This tree was in the edge of a small clump of trees of the same species, near the forest in the edge of an extensive grass area. The nest itself was similar to that collected on August 14 but with a much more bulky foundation of moss, in which the firm inner cup was placed; the lining was of a different material, being semi-woody, and the small oval leaves in the bottom of the nest were from some shrub, an angiosperm. It measured: outside, $300\text{--}330 \times 190$ mm. deep; inside, 130×90 mm. deep.

Macgregor's bird of paradise is a forest bird found from 2900 meters to timber line (which varies from 3700 to 4000 meters in east New Guinea and the Snow Mountains).

In east New Guinea it favors especially *Podocarpus* forests and when in that habitat feeds exclusively on their fruit. In east New Guinea where the timber line is lower than in the Snow Mountains (possibly the result of fire) *Podocarpus* forests go to timber line and I then thought the species restricted to forest of which *Podocarpus* was a component. The same impression was given by the local distribution of these birds at Lake Habbema. Much of the country there was covered by a stand in which *Libocedrus* was the only dominant tree in an open stand, with low shrubbery below. Only here and there were patches of denser true mossy forest in which *Podocarpus* was common. It was only in these areas of *Podocarpus* that *Macgregoria* occurred and it was common there. (This was also true for the local distribution of many other species of forest birds at Habbema.) But when we went higher than Habbema, to 3600 and 3800 meter camps near Mt. Wilhelmina, and left the coniferous forests behind, *Mac-*

gregoria continued to be a fairly common breeding bird. Feeding and perching in the ends of branches, not being shy and having a noisy flight all made it easy to find. Its orange wattle helps to make it easy to see when perched quietly in a tree, but there was a commonly flowering tree orchid whose orange bloom matched the wattle of this bird and sometimes caused momentary confusion.

These birds of paradise were usually in couples (even when not breeding as in east New Guinea in 1933). It was an active bird, continually hopping about through the tree tops, or flying from tree to tree; even when not moving it was continually flitting wings and tail. Its flight usually consisted of a dozen or so heavy strokes and then a short glide on outspread wings. The wing strokes give a heavy rustling, audible for a considerable distance, and the glide a loud continued "zing-g-g-g." This noise can be modified considerably, particularly noticeable with mating and nesting birds. These birds feed by hopping about the ends of branches, peering among the leafy tips for the fruit. Sometimes they poke among the moss on tree trunks, and pull off moss and bark as though searching for insects, but all the stomachs I have examined contained only fruit. When in forests where *Podocarpus* occurred the stomach contents consisted of their fruit exclusively.

It has two calls, a low sharp "klik" or a "click-click" repeated a number of times, and a low plaintive "queee," neither possessing much volume and both chiefly used when mating. Sometimes they give a wheezy "cheu."

BREEDING SEASON.—In east New Guinea in 1933 these birds were not breeding in June and July. At Lake Habbema they were breeding in August, 1938.

TERRITORY.—This species is monogamous, the male accompanying the female on her nest building trips, on her trips in search of food when she leaves the eggs she is incubating, and he helps to feed the young. But the male does not establish a territory. Six birds were seen to indulge in sexual flight in the area in which a nest was found in construction six days

later, and during three days of observation during the construction of this nest seven to eight birds in all were giving their sexual flight in the immediate vicinity of the nest, sometimes as close as twenty yards to it. The building bird and her mate consorted amicably with these others. During incubation I saw the male of the pair indulge in a sexual flight with another bird within 100 yards of the nest. This was the only intruder of this species I saw near the nest during the incubation period. There was no attempt to drive this bird away, it being a rather deliberate sexual flight.

At the nest where both male and female were feeding young no other *Macgregoria* was seen in the vicinity.

While this indicates there is no territory in this species it is interesting to note that at the nest with a fairly fresh egg the male sometimes drove away big honeyeaters (*Melidectes* and *Oreornis*) and crested starlings (*Paramythia*) that were fifty yards or more from the nest. The same sometimes happened at the nest containing young.

THE DISPLAY AND ITS RELATION TO THE NEST.—The display of this species consisted of a "chase" or "sexual flight" in which usually only two or occasionally three birds took part. Sometimes six to eight birds congregated in a small area 100 yards or so across for displaying but then they usually broke up into units of two for indulging in the chase. Both males and females took part in these chases; on one occasion when four couples were "chasing," one couple collected proved to be both males; on another occasion one of a couple chasing was a female (collected); at other times I was able to identify females provisionally by their smaller size. The chase was not an attempt by one bird to drive another from an area. The chase was characterized by frequent rests during which the birds feed and preen amicably together (I watched one chasing for a couple of hours); it may sometimes be the pursuit of a female by the male as a preliminary to coition. On one occasion I saw two males start to chase and a female join in and follow through the chase. Sometimes the chase appeared initiated by

the leading bird flying a short distance to another perch and giving a low plaintive "queee," an invitation to start the chase by following it. This invitation was frequently accepted.

The following are detailed instances of observations on the sexual flights; the most complete observations were for a period of two hours or so, on August 11 near the outlet of Lake Habbema, in the edge of an open *Podocarpus* forest with dense undergrowth, which was typical of others seen. I stood by a tree trunk and the birds paid no attention to me. When I first arrived there were four birds, segregated into two couples, each occupied with itself. Shortly, after ten or twenty minutes, one bird disappeared and the three remaining birds chased as a unit. These three appeared to be two males and one female, judging by size. All were equally active in the "display chase." There were no actors and spectators. The chase was not with the intention of capture, fighting or driving away of any bird; there was an air of excitement in the chase. The birds stayed within a radius of twenty-five yards during the time I watched.

The "display chase" consisted of one bird followed by the other one hopping through the tree tops, thus travelling considerable distances rapidly on foot and flying with a great rustling noise across open spaces back and forth through the forest. Sometimes when descending across an open space the birds glided, with fully extended wings, the air whistling past the widely separated tips of the primaries, making a loud ripping "zing." Sometimes, in the midst of the chase, the birds give a sharp, not very loud "chic chic chic chic" or "chick-chick chick-chick" call, but for the most part the noise is mechanical. Frequently the birds descended into the undergrowth and the chase continued there, apparently much as in the tree tops, judging by the noise and the occasional glimpses of the birds.

This appeared to be the complete display and though simple, without posturings, the black birds with orange trimmings were strikingly beautiful things.

Especially in flight are the orange wattles, the upper edge of which stands clear of the head, and the orange wing patch, very conspicuous. The noise of the wings can be varied to a considerable extent at will and during these display chases it is very loud. Sometimes the mere flicking of the wings produced a sound of considerable volume.

After fifteen minutes or so one bird disappeared (a female?) and the remaining three birds continued the chase as a unit. Judging by size they were two males and a female. After about twenty-five minutes of active chasing, with only short pauses, the three birds sat in the top of the same tree for some time, feeding on the fruit and preening. Then the chase was resumed. This resting during the chase then occurred a number of times. Sometimes it was the leading bird in the chase which initiated the renewed chase. Sometimes it flew a few yards and then gave a low, plaintive "queee" which appeared to be an invitation to chase as another bird flew to it and the chase began, the third bird joining it. Once I saw the two males begin to chase and the smaller bird, presumably the female, join in the chase.

After an hour a fourth bird, presumably a female, came into a nearby tree and fed quietly by itself on the *Podocarpus* fruits. It paid no attention to the chasing birds and was ignored by them.

After watching for about two hours I left during one of the resting periods of the chasing birds. During this time, besides the four birds in my immediate vicinity, I saw two other birds within 300 yards of me. There must have been six birds at least in the area.

While searching the area for nests I found four old nests, probably of this species, within fifty yards of the chasing place but no new nests.

An instance of chasing by a pair of birds during the incubation of a fresh egg is as follows: On August 12, while I was watching a nest with the female brooding, the male came into the nest tree and the female left the nest. A stern chase ensued during which the birds went down into the under-

growth where I could not see them. When I finally saw them again they were feeding side by side in a *Podocarpus*.

Again on August 13 I was watching this nest and the female returned to it after a feeding trip. The male accompanied her to near the nest, then flew to another tree 100 yards away. Very shortly I heard sounds of a chase there and going over found two of these birds indulging in a listless chase. Apparently both were males but there was no attempt on the part of one bird to drive away the other.

On August 14 I collected this nest with the male bird.

Unfortunately I was absent during the next few days but Mr. Wm. B. Richardson, the mammalogist, visited the area on August 15 and found six birds chasing in the tree from which the nest had been taken. I next visited the area on August 20. There were seven birds about the former nest sight, chasing in couples or in threes. One pair I watched for some time. It was a spirited affair for about fifteen minutes; then the birds started to feed near each other in the top of the same *Podocarpus*. After three or four minutes they began to chase again and were collected. Both were males.

On August 21 I returned to the same place and again found seven birds chasing. While watching them I saw one pair (not chasing) fly into a *Podocarpus* and one bird go to a partly finished nest and do some work on it, while the other sat nearby. This was within fifty yards of the site of the nest I collected on August 14. Evidently the female of that nest had remated and was building again, the mate accompanying her on trips to the nest. But when the female left the nest she and her mate flew twenty yards to another tree where a third bird joined them and the three fed peacefully together.

During this time two other couples were chasing spiritedly within fifty yards of these birds and even closer to the nest.

On August 23 I again watched this nest for some time and saw a female, accompanied by a male, make several trips to the nest and yet during this time there were

eight birds in all sporadically chasing within 100 yards of the nest.

I then left this area but the cycle of incubation and feeding the young can be pieced out from the observations of August 12 and August 13, given above, in which it is shown that some chasing occurs during the early stage of incubation, and from the observations made at another nest in which there was a young bird it was seen that both males and females assist in caring for the young and that there was no chasing. Only the male and female (both collected at nest) were seen in the vicinity of this nest.

NEST BUILDING.—On August 21 the female whose nest I had collected and whose mate I had shot on August 14 had remated and was building again. The nest appeared to be about one-third built. On August 23 I saw the female make several trips to the nest. Each time she was accompanied by the male which waited for her in a nearby tree while she went to the nest, and rejoined her after she had left. Shortly afterward on one occasion the male left the female to indulge in a chase with another male (?) which was in the vicinity.

Evidently the female alone builds, while the male accompanies her on her trips with material.

INCUBATION.—The most complete observations on the rôles of the male and female at a nest containing a slightly incubated egg were made on August 13 from a shelter near the base of the nest tree and are as follows:

2:15 Female returned to brood—no male in sight.

2:30 Female left nest; during the ten minutes she was off nest I occasionally heard a bird fly in the nearby forest.

2:35 Male flew into a tree fifty yards east of nest.

2:40 Female returned alone to nest, flying to the lower part of the crown and then hopping up through it to the nest as is usual; male still in tree fifty yards east of nest. During the seventeen minutes female spent brooding occasionally I heard and saw the male.

2:57 Female left nest, gliding down on partly closed wing, nearly silently. Usually when one of these birds glides the outspread wings make considerable noise. The male joined the female and I followed to find them a few minutes later

sitting close together in a *Podocarpus*. Shortly the female began to feed while the male simply perched.

3:07 Female returned to nest, the male accompanying her to a nearby tree. The male then flew about 100 yards from the nest and commenced a rather deliberate sexual flight with another male (?) which appeared there.

These scanty records indicate that the female broods for about a fifteen-minute period and then leaves the nest for about a ten-minute period. The male does not brood but stays in the vicinity while the female incubates. He sometimes joins her when she leaves the nest to feed.

On another occasion (August 11) the male came into the nest tree, apparently causing the female to leave the nest and then they indulged in a stern sexual flight, the male pursuing. It ended in the dense shrubbery out of sight, possibly in copulation.

CARE OF THE YOUNG.—From a blind about 100 yards from a nest containing one small young I made observations on parts of four days, using 7× binoculars. The nest was near an oft-used native track and the passage of persons along this sometimes disturbed the birds. One period on August 11, from 2:14 to 3:42 P.M., was quite undisturbed and as the actions appeared typical of that cycle the following results are based on that one hour and twenty-eight minute period of observation. During the interval the female brooded for four periods varying from seven to fourteen minutes in length. (Later, on August 21 and 22, I watched the nest for short periods and neither bird was brooding.) The female fed the young on two of her returns from absences from the nest, and on one other occasion during a non-brooding period. The male fed much more often than the female. (This was also true later, on August 21 and 22, when observations for a short period showed female was not brooding.)

During this period the male fed sixteen times, the intervals between feedings varying from one to thirteen minutes. During one fourteen-minute absence of the female the male fed four times at from two to five-minute intervals; during another absence of seven minutes the male was also

absent. When the female was brooding the male fed more regularly, feeding two or three times each period.

The male neither fed the female nor brooded. When the male came to the nest, hopping along the branches, the female left the nest when he was two or three feet away, hopped and flew but a few yards and then returned to the nest as soon as he left. Sometimes she was loathe to leave and the male waited a few moments for her to do so. On two occasions when the female left the nest to feed, it was when the male brought food for the young; on the third occasion he was absent when she left. The male and female paid little attention to each other when the female left the nest. I saw no sexual flights at this time.

The very rapid trips of the male to the nest were possible because sometimes he collected food for the young (fruit of *Podocarpus*?) in the immediate vicinity of the nest. At other times he disappeared into the forest.

I was never able to see anything in the bills of these birds when they came to the nest nor when they left it. Presumably the food was carried in the gullet. Nest sanitation was apparently carried on by both birds, and they evidently eat the excreta of the young. When I collected this nest it was very clean, unsoiled by excrement.

I collected this nest on August 22 and shot both birds. I found that I had correctly identified the sexes by calling the noticeably larger bird the male.

ENEMIES.—A marsh hawk (*Circus*) shot August 19 at Lake Habbema had the remains of a Macgregor's bird of paradise in its stomach.

SUMMARY.—Macgregor's bird of paradise has been one of the least-known species of its family. It is a specialized species with no close relatives. It is restricted to the forests of the high altitudes of east New Guinea and the Snow Mountains. The female differs from the male only in her smaller size. The nestling, egg and nest and general habits are described; the breeding season includes August.

There appears to be no territory. The

display consists of a "chase" which is usually conducted in couples though three or four couples may be chasing in the same area; both males and females take part. They may "chase" in the immediate vicinity of a nest in construction. Once the male of a pair with eggs indulged in a chase with another bird near the nest while the female was brooding.

The female alone builds, the male accompanying her on her trips with material; the female alone incubates, the male waiting in the vicinity and accompanying her when she feeds.

Both male and female care for the young. Only the female broods but the male makes more trips to the nest with food.

Diphyllodes magnificus (Forster)

The magnificent bird of paradise is a very specialized species¹ with a plain, short-tailed female, brown above, and gray and brown barred below, and an ornate male with elaborate breast shield, cape from the back of its head, iridescent spots near the eyes, elongated, narrow, curled central tail-feathers, and a greenish-yellow interior to its bill. All of these ornaments are used in its display. The immature male resembles the female.

The magnificent bird of paradise is one of the better known species. Its habitat, the lower mountain forest, is comparatively accessible and many living birds have been brought to Europe and America. Its display in captivity has been described and figured by Seth-Smith (1923, P. Z. S., pp. 609-613), its display area has been described long ago by Beccari (1875, Ann. del. Mus. Civ. di Genova, VII, p. 712, and 1876, Ibis, p. 251), its eggs described by Schonwetter (1929, Nov. Zool., p. 208), its nest described and the supposition advanced that after copulation the male has no further role in the process of reproduction (Stresemann, 1930, Nov. Zool., pp. 6-15, and Rothschild, 1930, Nov. Zool., pp. 16, 17). The frequency with which hybridization with other genera occurs

supports this hypothesis (Stresemann and Rothschild, loc. cit.).

In 1939, with the Archbold Expedition on the slopes above the Idenburg River in Netherland New Guinea, I found this bird common, discovered four display areas, and from "blinds" placed at the edges of the display areas watched the birds come to the display areas, saw the displays of the males and their behavior toward female plumaged birds. This forms the basis of the following account.

The magnificent bird of paradise is a common forest bird of the mountain slopes between 800 and 1200 meters over most of New Guinea, though in places it comes to near sea level. It is an active bird, spending much of its time high in the tree tops or substage where it feeds on the fruits of trees. It sometimes comes to fig trees where many other species of birds are feeding. Sometimes insects were found in stomach contents. Now and then small parties of 4-6 of these birds in female plumage are encountered moving through the forest. Its loud ringing calls carry far and are a characteristic sound of the forest.

BREEDING SEASON.—On the slopes above the Idenburg I found this species in breeding condition in February, March and April. In southeast New Guinea I took birds in breeding condition in September and October.

I examined one display ground at 1200 meters and three at 800 meters. Of these four display grounds three appeared to be in daily use during the period I examined them: between March 2 and April 6.

These three display grounds, widely separated from each other, were very similar in general location and appearance. The fourth bower was only 70 yards from one of the old, well-established bowers. It appeared to have been started recently and then abandoned.

This last well-established bower, though in use, had recently been disturbed by natives who had thrown brush into it. Perhaps it had been abandoned for a time, the new bower started and then the bird had reverted to the original bower.

Two of the bowers were found acciden-

¹ The genus containing but one species which is divisible into a number of races, all living in the lower mountain forest up to 1200 meters in New Guinea. *Schlegelia respublica* (Bonap.) from Waigiu is closely related.

tally; two by deliberate search, following up calling birds. The noise of a calling bird was loud and carried far through the forest. One bower I found by sitting on a ridge top and listening to a calling bird until I was sure it was not moving about. I approached the bird until I was within sight of its display ground, the bird calling from low in the shrubbery the while. When I was within a few yards of the display ground the adult male present flew low from the bower and hopped and flew through the nearby forest giving low,



Fig. 1. Display ground of *Diphyllodes magnifica* showing the cleared area and the vertical sticks on which the bird displays.

hoarse, scolding notes. This I found to be typical of a male disturbed at a display ground.

At each of the three well-established bowers I built a small, palm leaf blind. The birds paid little or no attention to the blinds and from them I was able to watch the attendant male work at clearing and enlarging the display area, and to watch it display at a distance of only a few yards.

Observations were carried on during parts of thirteen days between March 2

and April 5. The periods spent watching during the day varied with my other duties but fell between the periods of 6:45 or 7:45 A.M. to 10:00 or 11:00 A.M. and 1 or 2 P.M. to 4 or 4:30 P.M.

DISPLAY GROUND.—On the steep forested slopes at these altitudes there are always small areas where the soil is eroding and slipping so fast that forest cannot establish itself. These areas are covered with low forest regrowth. It was in such places that the display grounds were situated. Three of them were of considerable age and had apparently been used for at least several seasons.

The display area in each case consisted of a more or less circular area on the ground about 15 to 20 feet across from which all leaves, twigs and small plants had been removed. These lay in a wind-row at the lower edge of the display ground. Only a few larger sticks and logs interrupted the smoothness of the ground. Numbers of saplings, mostly dead, stood in the display ground. Above the display ground the leaves had been plucked from the saplings and lower trees, and in places the bark plucked from stems so they were frayed. Probably the dead saplings in the display ground were killed in this way by the bird. The result was a clear cone through which light from the sky reached the ground unimpeded. This would be an advantage to the displaying bird in increasing the brilliancy of its colors.

While watching at one bower I occasionally heard another bird calling in the distance when the attendant male was at the display area in front of me, but from the absence of continued calling from one place I think there was no other display area in use within ear shot of any other display areas in use.

The bowers did not all face the same direction. One was on a slope facing the east, one the north and two the west.

MAKING THE DISPLAY GROUND.—This display ground is the work of a single male adult. I never saw more than one adult male at a display ground at one time, and the female plumaged bird which visited it never worked at clearing the display ground. While I have not

seen the complete construction of such a display ground I have seen what appeared to be a recently started one and while watching from a blind at a completed bower I found that the adult male in attendance spent much time clearing the display ground, picking up leaves and twigs that had fallen and with a flick of his head throwing them down to join the windrow of rotting debris at bottom edge of bower. Sometimes when an object did not reach the lower edge of the display ground the first throw the male followed it

sticks, trying to break them off. Sometimes the sound of its blows on the wood could be plainly heard in the blind where I was hidden ten or fifteen feet away.

When I approached a display ground occupied by a male it usually flew up from somewhere low in or near the bower and hopped and flew away through the trees, scolding and calling.

In the mornings the bird was always present at the display ground when I arrived. Usually after about 9:00 A.M. it appeared to leave the bower, only oc-

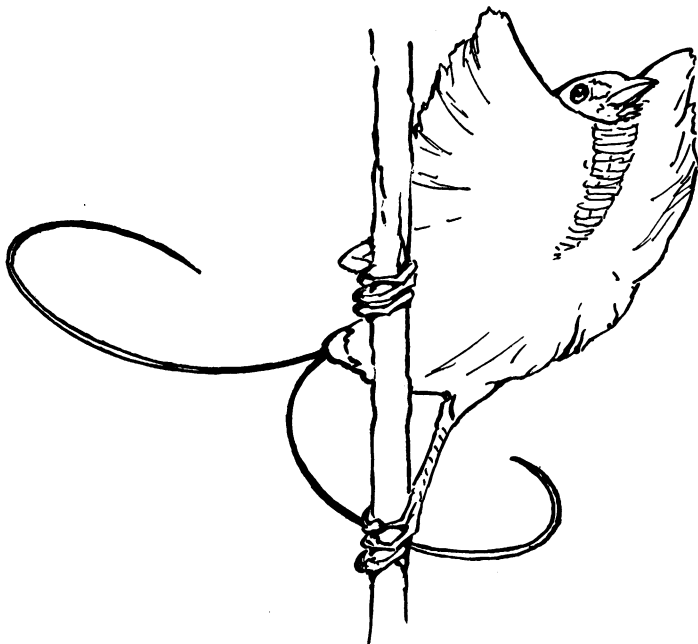


Fig. 2. The preliminary display in which the breast shield is pulsed. (Drawn from photograph.)

down, to give it another throw until it reached the bottom. Sometimes when pecking at moss it was removing no object I could see and it really appeared to be grooming or combing the moss carpeting the ground.

Less often the male mounted into the saplings and plucked off leaves above and about the edge of the bower. When the leaves fell into the bower they were later thrown out.

Sometimes the male pecked off bits of bark from a sapling, worried at the ends of

casionaly visiting the bower between 9:00 and 11:00 A.M. In the afternoons it was usually present throughout my period of watching and was still there when I left.

When the male was alone it usually spent most of its time sitting on one or another perch, near the edge of the bower and from two to fifteen feet above the ground. It often sat thus for long periods, sometimes up to thirty to forty minutes at a time. Much of this time was spent preening its feathers. The body plumage and wing

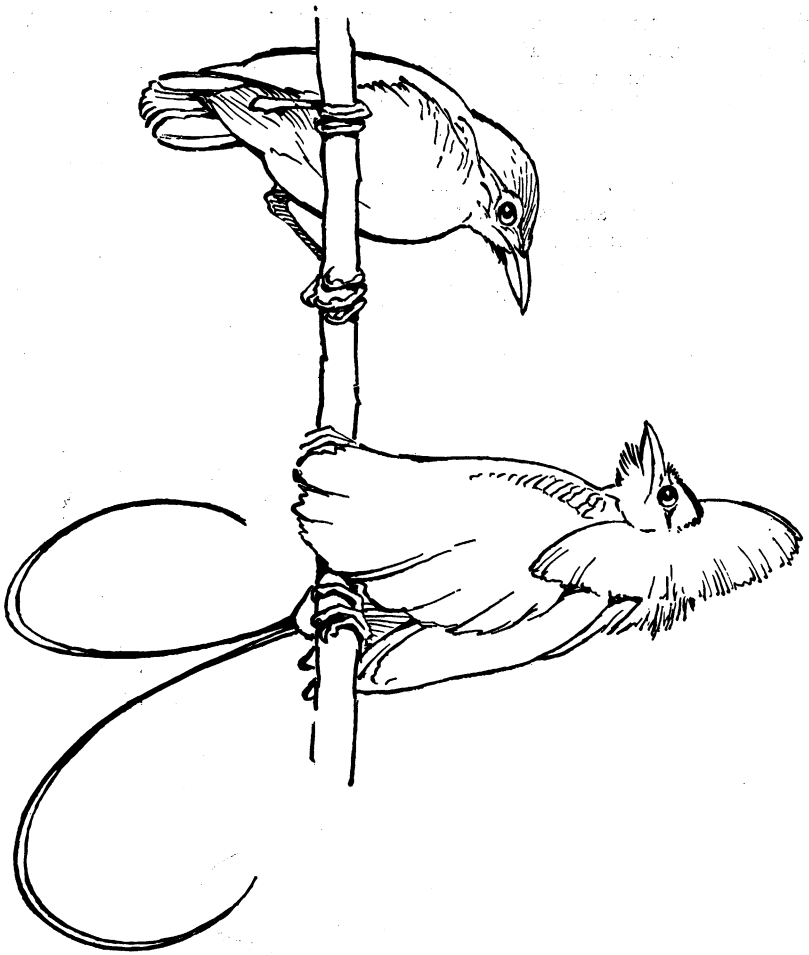


Fig. 3. The male giving the horizontal type of display to the female, preceding copulation. (Male drawn from photograph.)

feathers were carefully gone over and the bird frequently stretched, when the wings were carried over the back and the cape shot forward over the head. I never saw it preen or stretch while in the display area. The adult male frequently called from its perch near the edge of the display ground. These loud, far-carrying calls are apparently for the purpose of advertising the bird's presence. They were rarely given while the bird was actually in the display ground.

The calls given by the adult males varied considerably. Most of them were loud harsh calls recalling those of related genera.

Those used at the bower to "advertise" its presence I recorded as a violent or strident "ca cru cru cru"; a loud clear "car" or "cre" repeated a number of times; a hoarse or squalling "caaar ca ca, ca." The scolding notes given when the adult male was disturbed at its display area, low spitting and clucking notes and a scolding "chur" I have referred to above. The low soft calls given when a female came to the display area I describe below.

As with many birds of paradise in flight the wings make a heavy rustling sound and when the bird is flying about the display ground this sound is intensified.



Fig. 4. The male giving post-copulation type of display to the female.
Drawings by Francis L. Jaques.

The displays of the adult males of this species I observed may be classified as:

(1) The pulsing of the breast shield, which was variable. I saw it given by the adult male only. The body was held in the normal perching position, the breast shield was more or less expanded and the outer upper corners of the shield were more or less raised so that in extreme cases they stood up on each side of the head. Undulations in the breast shield sent shimmers of iridescence across it. The iridescent spots in front of the eyes sometimes became conspicuous. This was the most commonly seen type of display. It was seen

only when the bird was on a perch in the display ground, within a foot or so of the ground. It was given without any preliminary actions and usually led to no further display. It was sometimes apparently given when the bird was alone. When displayed toward another bird the breast was usually turned toward it. Seth-Smith (*loc. cit.*) has figured variations of this display.

(2) The horizontal display, which was very stereotyped. It was given only by the adult male, except once by an immature male. The bird was always clinging to the side of a sapling a foot or so from the

ground when it very suddenly extended its body horizontally with breast turned upward, the breast shield elongated and flattened, its central iridescent line conspicuous and the yellow cape shot forward under the head in line with the body. This display was seen usually only two or three times a day, even when the male was at the display ground for long periods. I have given below the details of the use of this display in the presence of other birds. When given when the adult male was alone it was always preceded by a period of active clearing of the ground of the display area. Certain of the upright saplings in the display area were favorite places from which the displays were usually given. The immature male which gave this type of display did not precede it by a period of clearing. Seth-Smith (*loc. cit.*) figures the bird in this pose in a vertical position. The displays I saw were similar to the figure published by Seth-Smith, but always in a horizontal position, never vertical.

(3) The pecking display, in which the body was in normal perching position, the tail raised to the vertical to display its metallic upper surface and the inside of the mouth was displayed. This was seen but once, was directed toward a female and followed copulation which had followed the horizontal display (details are given below). This display appears not to have been described.

On several occasions one or two females or immature plumaged males came into the display area while the adult male was present.

On some occasions the male paid little attention to them beyond pulsing its breast (display type No. 1) from the horizontal perch on which it was sitting. Other visiting female plumaged birds received more attention and one female which visited the bower stimulated the male to display (types 1 and 2), coition ensued or was at least attempted and then there ensued further display (type 3). The details of the last follow:

March 28, 2:40 P.M.—I had been watching the bower from the blind since 1:30 P.M. The adult male was about all this

period, in and out of the display ground, clearing it and sitting beside it, calling. Three times he gave the horizontal display, each time after visiting the ground for cleaning. At 2:40 the male was on the ground cleaning when I heard another bird fly to a perch close to the blind. The male was all attention at once and flew up and lit on a perpendicular sapling about a foot above the ground. The female, as it proved to be, then came into the display ground and lit on the same sapling about three feet above the male. The male pulsed his breast (display type No. 1) toward the female, and continued to display his shield to her, turning toward her as she moved from sapling to sapling, keeping about four feet above the ground. Once the male followed her to another sapling, and hopped up toward her, with his breast parallel to and close to the trunk pulsing his shield the while though it was not directly toward her.

Much of this time the male was calling low, enticing, questioning calls of "eek" or "eee." The female sat still and quiet while perched.

Then the female flew to another perch about eight feet away, on the edge of the display ground, as though she was going to leave. The male at once turned his back to her and made as if to hop down to the ground and clean. The female at once came back to directly above him and he at once turned toward her pulsing his breast shield. Again the female flew away to another perch ten feet away and the whole ceremony was repeated. This time, however, while the male was giving his breast pulsing the female began to hop down toward him. He pressed his breast closer to the sapling, pulsing the shield, and gave low, eager, single, little calls. The female paused about one foot above the male, who was about that far above the ground. The male then went into the horizontal display, breast shield lengthened and flattened, the iridescent line down its center visible from where I was, the cape straight out. The tail was in line with the body and was vibrating, possibly from the muscular effort required for the pose, as the dull underside has little orna-

mental effect. Otherwise the bird was motionless. He held this pose for perhaps thirty seconds. The female hopped down closer. The male then abandoned his pose, and rather deliberately hopped up and mounted her. Copulation ensued. The male then dismounted, hopping to perch just below the female. Then display type No. 3 was given.

With tail erected to right angles with the back he vigorously pecked the nape of the female. After each peck the male drew back with widely open mouth, displaying the yellowish-green mouth lining so plainly that I could see it. In a few moments the female flew directly from the display ground. This was about 2:50 P.M. The male remained about the display ground, flying in and out of it, and finally settled on a nearby perch and called loudly for some time. Display type No. 1 had been used when the female was at some distance, type No. 2 had followed when she came closer and had immediately preceded copulation; display type No. 3 had followed copulation, perhaps a post-copulation form of activity.

On another occasion (April 1, 7:10 A.M.) a female came to the display ground, the male being present. The female (?) was more active than the female of March 28, flying from perch to perch from three to five feet above the ground. The male followed her about keeping below her on the perches, giving low eager calls and pulsing his breast shield toward her. Finally the female (?) hopped down to within eighteen inches of the eager male which then went into the horizontal display. The female, however, then flew to a horizontal perch on the edge of the display ground where the male followed her, pulsing his breast shield. He then flew back to his favorite display perch and the female followed to a perch above him. Then she disappeared into the forest and shortly the male also disappeared into the forest, at about 7:20 A.M. On this occasion the male appeared much less eager than on the 28th both in his breast shield pulsings and in his calls. Perhaps the female was not in a condition to be stimulated to copulate.

On March 29, shortly after the male had displayed and was sitting quietly, two female plumaged birds came into the display ground. They were restless and seemed excited. They moved about continually during their short stay in the display ground, perching on the saplings. The adult male stayed on his perch during their visit and only pulsed his breast shield toward them. Possibly they were immature males.

At another bower (1200 meters) several times female plumaged birds visited the bower. This bower was not attended as continually by the adult male as that referred to above. When, as happened several times, the adult male was absent the female plumaged birds (immature males?) stayed but a few moments, looking about, and then left. Once there were two together.

But on one occasion, when an immature male (judging by its later actions) visited the display ground during the adult male's absence, it hopped down to a perpendicular sapling and assumed the horizontal display attitude of the adult male, its breast turned skyward, and the short brown feathers of the back of the head which would form the cape in the adult, erected. It held this pose for a few moments, then left the display ground. This "display" was given without the preliminary "cleaning" which always preceded the display of the adult when no female was present. I never saw an immature male (or a female) do any "cleaning" nor did I hear one call at the display ground.

One immature male (judging by subsequent actions) visited this display ground while the adult male was present. The immature male came into the display ground and perched quietly on a leaning sapling about four feet up. The adult male flew to a perch directly below it, about a foot above the ground, and pulsed its breast shield toward it. This continued for some time, with the immature male sitting immobile. The adult male then made a dash at the immature bird, nearly if not quite striking it. The immature bird remained quiet. The adult then returned to its original perch and gave the

horizontal display. This roused the immature bird which made a dash at the displaying adult, possibly striking it, then flew away into the forest. The adult then went to a perch on the edge of the display ground.

Immature males collected are not infrequently in breeding condition, with enlarged gonads. Possibly they also make and hold bowers but the above suggests that sometimes they take advantage of an adult male's absence to display in its display grounds and perhaps sometimes mate with females which come to such a court.

Visits were occasionally made to the bower by other species of birds: ground pigeons (*Gallicolumba helveventris*), wood shrikes (*Pitohui kirhocephalus* and *Pitohui dichrous*), thickheads (*Pachycephalopsis*), warblers (*Sericornis*), flycatchers (*Micrococa*) and others, but they were ignored.

When I found that the male spent much of his time alone at the display area I tried to gain an insight into his behavior by introducing mounted birds into the display area and watching his actions. Some birds of paradise will display to mounted females (Rifle bird, Crandall and Leister, 1937, *Zoologica*, p. 311) but I had very poor success with my decoys.

On April 3 I drove the male from the display area and put a mounted male attached to the side of a stick, about four feet up, in the center of the display area. In a few moments the male returned, flew to the decoy, lit on it with erected cape for a moment, during which time he pecked it, then flew to one of his nearby, usual perches on the edge of the display area and sat there quietly, only occasionally turning his head, for about 35 minutes. During this time he was facing the decoy, about ten feet away and in full view of it. For

the next hour, during which slight showers fell, the male sat rather quietly on other perches on the edge of the display ground. I then removed the decoy.

A female mounted bird was introduced into the display area at another time and the male simply stayed low in the shrubbery and saplings on the edge of the display area as though waiting for it to make some movement.

EFFECT OF WEATHER.—When sunshine reached the floor of the bower it appeared to make no difference to the bird, which surprised me somewhat. However, even light showers of rain at once sent the bird to a sheltered place. For twenty minutes during a shower one afternoon the male left the bower and stayed almost motionless under the shelter of a clump of moss on a tree trunk near the ground on the edge of the bower.

SUMMARY.—In this specialized species a single adult male makes a display area and cares for it over a long period. During this period much of the day is spent at the bower, and the male frequently calls loudly from near its edge, perhaps to advertise his presence to the females. When the female comes to the display ground the male displays to her presumably to stimulate her to copulate with him. After copulation another type display is given. Apparently the male's rôle in reproduction is finished after insemination of the female, as has been postulated. Immature males are displayed to, perhaps in an effort to determine their sex by their reactions, perhaps to intimidate them. Not more than one adult male was seen at the bower at one time, but when I introduced a mounted adult male it was recognized as a male at once, the attendant male flew to attack it and erected his cape as an intimidation device.