BEHAVIOUR AND NESTING OF FIJIAN WHITE-BREASTED WOODSWALLOWS

By FERGUS CLUNIE

ABSTRACT

White-breasted Woodswallows in Fiji nest in trees and on cliffs. Small sexually-mixed groups select the site, build a series of preliminary nests and the nest proper, copulate indiscriminately, and cooperate in incubation and raising the young. Detailed descriptions are given of observations of behaviour (including preening, scratching, hunting for food, song, roosting and defence) and of nesting (including site selection and building, copulation, incubation and care of young).

CONTENTS

INTRODUCTION

Woodswallows (Artamidae) occur from India through southeast Asia and the Australian region eastward into the southwest Pacific to Fiji. The White-breasted Woodswallow *(Artamus leucorhynchus mentalis)* is present in Fiji, other races being found in New Caledonia and the New Hebrides through Australia to Borneo and the Philippines.

All woodswallows exhibit highly developed social behaviour. Some years ago, Immelmann (1966) discussed this for *Artamus leucorhynchus, A. cinereus* and *A. minor* in Australia, many of his observations being applicable to *A. leucorhynchus* in Fiji. However, there appear to be major differences in breeding behaviour between Fijian White-breasted Woodswallows and Australian ones.

METHODS

A group of White-breasted Woodswallows was studied between 8 May to 5 June 1973, 21 June to 5 July 1973, and from 20 August to 7 November 1973. The breaks between study periods and the limited time available — usually from late afternoon until dark — means the information gained is only an outline of nesting behaviour. Some 80 hours were spent observing the birds. The semi-tameness of these urban-dwelling woodswallows enabled close observation without undue disturbance.

Sexing was based on copulatory behaviour, this woodswallow species not exhibiting sexual dimorphism. I was, thus, never aware of the sex of any individual for more than a few minutes. Sufficient definite observations were made of two males interacting with one or more females, and vice-versa, for some positive general conclusions to be drawn.

HABITAT

White-breasted Woodswallows occur in all habitats on many minor and most major Fijian islands. They are absent from Kadavu in the south, and the Lau islands of eastern Fiji.

The Suva peninsula in southern Viti Levu with a population of some 70,000 people is well wooded with trees and gardens. It has a heavy average annual rainfall of 3,000 mm without really marked wet or dry seasons.

Several small woodswallow groups occur in Suva. A large raintree *(Samanea saman)* overhanging a major crossroad just outside the commercial heart of the city has been the night roost and nesting tree for the group of woodswallows studied here for at least five years (Clunie 1973). From this they venture out at least 1.5 km and probably further.

COMPOSITION OF WOODSWALLOW GROUP

In Fiji White-breasted Woodswallows occur in groups of three to nine birds, large groups being common in Australia (Immelmann 1966).

The group studied varied in numbers, five birds being present from 5 to 22 May, six from 23 to 29 May, five from 30 May to 24 September, and only four thereafter. All were in adult plumage, although there are often juveniles in such groups. Two males and two females were always present, the sex of the other two birds being unknown. I could not determine if more than four birds ever took part in nesting activities.

BEHAVIOUR

Allo-preening

The woodswallows allo-preened frequently and indiscriminately within the group. Two flanking birds often preened a middle one simultaneously. Allo-preening was usually restricted to the head, upper back, throat and breast but unlike Immelmann's (1966) Australian woodswallows they also quite frequently preened each other's flight feathers. Two birds occasionally perched head to tail to preen one another's tail feathers.

Headscratching

They invariably scratched their heads by the indirect method; first lowering one wing, then bringing the leg on that side of the body up behind and over it.

Casting

White-breasted Woodswallows cast small food-remain pellets, coughing them out with a slow head-shaking which continues for a moment afterwards. The ground beneath favoured perches is often littered with these pellets.

Hunting and food

The woodswallows fed on a variety of insects with moths, butterflies, dragonflies and grasshoppers as staples. Large hawk moths, a butterfly *(Hypolimna bolina)*, the American Cockroach *(Periplaneta americana)*, and a hornet *(Polistes olivaceus)* were common prey.

Detailed records were kept of 329 attacks on insects, 101 or over 30% being successful.

The basic hunting method was to hawk after flying insects from a prominent lookout. Most attacks took place well clear of the ground and obstructions, but many were made just above the ground, the birds almost brushing the grass. Another method was to sweep low over blossoming mango *(Mangifera indica)* trees to snap at insects, the birds' bellies scraping the flowers. Similar flights were made along building walls, whereas hovering was used to pick an insect off a wall, when attacking a slow-flying insect, and before banana flowers. Rarely a woodswallow landed on a branch to peck at insects, and once one landed in grass to search for a moth sheltering there.

If the first pass failed the woodswallow often attacked repeatedly, pursuing its quarry many metres. Two or more birds frequently converged on a single target, criss-crossing skilfully as they made their passes, unsuccessful individuals sometimes following successful ones to beg for the prey. Insects were taken with an audible snap of mandibles and if very small were sometimes swallowed in flight, but were usually carried to a perch and eaten. Large insects were often transferred to the feet and carried struggling to a perch, the bird sometimes repeatedly dropping and recatching them or transferring them from bill to feet as it flew.

Most prey was swallowed whole but large and active insects were battered against a branch or held in the feet and pecked to death. Particularly large prey was held in the foot against the perch and dismembered with the bill. Dragonflies were usually plucked before being swallowed, the bird sometimes removing and discarding all the wings and legs, but more often only one wing or the wings from one side of the body.

Having fed the woodswallow wiped its beak on its perch, unsuccessful begging birds doing likewise.

Mutual feeding and food theft

Mutual feeding occured throughout the long nesting period and was not linked with pre or post-copulatory behaviour. I have seen woodswallows feed each other in most months and do not regard it as courtship feeding. A wounded bird incapable of capturing prey must have been fed by other members of the group despite the presence of young in the nest, for it survived. The feeding of sick woodswallows by other adults has been recorded elsewhere (Immelmann 1966).

Typically a bird hawked out and returned with an insect, whereupon another cheeped and fluttered like a nestling. Often the bird with the insect approached to feed the beggar, first battering the insect if it were large, and then sometimes flying out for another insect and again feeding the beggar. Frequently begging birds were ignored, and flew to the successful one, pursuing it from wire to wire, begging plaintively. A persistent beggar usually attracted another, which begged and pursued as industriously. One bird which had been pursued and begged for several minutes hovered over its beggar with its butterfly dangling from its bill as if to encourage further pursuit, before landing to eat the butterfly. This suggests an element of play, the tempting birds perhaps wanting to be chased, and food theft may be related to this. It is possible that birds repeatedly dropping and recatching large prey in flight, or transferring it from bill to feet, may have been trying to attract attention. Other woodswallows often circled them as they approached, landing beside them, begging and pursuing them from wire to wire. Two cases of prey theft may have been in play. Two woodswallows converged on a hawk moth near the nest tree, one seizing it and flying towards the tree. The unsuccessful bird pursued the other in a wild aerial chase, the latter dodging and transferring the moth to its feet. The pursuer snapped unsuccessfully at it, came in again, and snatched it from the other's feet, transferring it to its own as it fled. The robbed bird chased it around the tree and nearby buildings repeatedly trying to seize the moth. Suddenly a third woodswallow darted from the nest tree and in a clean sweep seized the moth in its bill, transferred it to its feet, and fled. The other two did not pursue but landed in the tree, even though the fresh robber slowed and transferred the moth from bill to feet several times as if luring pursuit, before making off.

In the second case a woodswallow leaned forward to feed a begging companion. A third woodswallow swept between them, seized the insect, and flew to the other side of the tree to eat it. The begging bird continued soliciting and was soon joined in this by the robber bird which returned after it had fed and begged from the original captor for several seconds.

Attempts at food theft also occured if a woodswallow dropped an insect, others darting in immediately to seize it. They also seized prey being clumsily pursued by pedestrian mynahs *(Acridotheres fuscus* and *A. tristis)* and hawking Red-vented Bulbuls *(Pycnonotus cafer)*.

Song

Immelmann (1966) discussed woodswallow song and its possible motivations. I only heard a woodswallow sing once. On the evening of 16 May a lone woodswallow sang between hawking sorties from powerlines near the nesting tree. The song was very soft and continuous, being a medley of chortles and whistles faintly reminiscent of the Australian magpies *(Gymnorhina sp.)* and quite unlike the usual harsh chattering call notes.

Clustering

White-breasted Woodswallows frequently cluster in tightly packed rows along branches or power-lines. The woodswallows of the study group perched in pairs or clusters on prominent lookouts. Clustering or cuddling took place at any time, in sunlight or drizzle, and with no apparent regard to sex. Individuals often seemed reluctant to cuddle and hopped away a metre or so when approached. The approaching bird then hopped over and gently nudged the other in the side with its bill, and moved away a little, at which it invariably hopped over and cuddled up. The middle birds of clusters often jumped out to join the end of the line, while individuals broke ranks and hawked out at will.

Roosting

The woodswallow group roosted nightly in a tight cluster, all roosts except those used in storms being near the nest fork. Storm roosts were further down in the tree, which is used as a roost all year. Roosts were located either in a bend of a branch or crotch of a fork, the birds clustering about the bend so that they faced outward in a slight semi-circle. This gave the group as a whole a far wider view of the tree's approaches, and could feasibly serve as a defence against predators, Fijian raptors hunting until dark.

As the evening darkened the woodswallows closed in to hunt near the roosting tree, one or two eventually flying up to a roosting branch, cuddling and calling, gradually being joined by the others. Individuals and sometimes the entire group frequently flew noisily out then returned to cluster. Each newcomer was met with a chorus of calls. After some movement and adjusting of positions the birds fell silent. Clustering to roost usually took about ten minutes, but

if the birds returned late to the roost in a body they clustered immediately with little ceremony.

Often the woodswallows were settled just after or even before sunset, at other times not until it was dark. If only one bird was there at dark it grew agitated, calling and moving about in the tree as if trying to attract its companions. A lone bird often sailed over the canopy or perched calling nearby for several minutes after the group clustered, eventually joining the cluster to a welcoming chorus.

On the evening of 3 June most or all of the birds took strands of dead grass to the roost and clustered there holding them in their feet. Black-faced Woodswallows *(Artamus melanops)* in Australia frequently carry twigs to their night roosts and drop them on arrival. Immelmann (1960), discussing this, mentioned that African social weaver birds carry nest materials to the roost, an act of obvious significance in communal nesting birds. He thought the reason less clear in Black-faced Woodswallows, which build individual nests. It is significant that White-breasted Woodswallows in Fiji, which build communal nests, should also carry nest materials to the roost sometimes.

Night roosts centred on a traditional roosting branch near the nest fork, which was used repeatedly through the study period, although it was often abandoned for nearby branches for several nights in succession. When a new roosting branch was selected, several of the birds congregated in the general roosting area, flying from branch to branch and clustering noisily on each momentarily (c.f. nest site selection). They seemed torn between the new roost thus selected and the traditional roost, one or two birds often perching at the old roost long after the rest had settled on the new branch, only joining the cluster at dark.

After the start of incubation the birds invariably clustered on a branch about 1 m from the nest.

Defence

From the early stages of nestbuilding onwards I recorded details of over 100 attacks by the woodswallows on birds and mammals which ventured near the nest tree. Other attacks occurred but I could not determine the species involved.

Repeated passes over long periods were made against predators, fierce attacks on raptors being typical of woodswallows (Immelmann 1966). Seven series of attacks on Fiji Goshawks *(Accipiter rufitorques)* were recorded, hawks invariably being attacked within 150 m of the nest tree. A woodswallow flew up with a loud " wit wit wit wit wit " of alarm on sighting goshawks or on hearing a Wattled Honeyeater *(Foulehaio carunculata)* alarm call. This immediately brought in all woodswallows in the vicinity to jointly attack the hawk in flight, driving it away. Perched hawks were harder to shift and were methodically harrassed, the woodswallows circling overhead and peeling

off one after the other, diving low over its head or back, chattering harshly as they pulled up, then peeling off and diving again. Individuals proved especially aggressive, almost striking the hawk.

Alternatively the woodswallows perched on a prominent lookout and attacked from there, occasionally regrouping on it before re-attacking. Individuals broke off to hunt, sometimes leaving a lone bird to continue the harrassing, but rejoining it regularly to dive and chatter at the hawk. Hawks responded to close passes by ducking violently, and were generally nervous and agitated when under attack. After a series of attacks a hawk either flew off or moved into thicker cover. One, however, flew directly at a diving woodswallow and attempted to seize it, the other woodswallows converging on the hawk and driving it away.

Cats were attacked within 50 m of the nest tree, dogs when passing directly beneath it. The same " wit wit wit wit wit " alarm call as given for hawks was used when rallying to attack cats, but rarely for other species. Attacks on cats usually involved the entire group and were as hard-pressed as those on hawks. One cat fled, but others leapt and clawed at the woodswallows. Eight attacks on dogs were seen, the dogs usually trotting on unperturbed, but two snapped at the birds.

Such reckless attacks against dangerous enemies seem to keep them away from the nest tree, but they probably cause occasional casualties among the woodswallows. Goshawks and Peregrines *(Falco peregrinus)* pursue and nearly capture attacking woodswallows, and one of the woodswallows from the nest was badly wounded when attacking a cat, losing the inner primaries and outer secondaries from one wing.

Attacks on raptors are not confined to the nesting area — they are harrassed wherever they appear.

People were generally ignored by these semi-tame urban woodswallows — one bird made a single pass at me as I stood near the nest tree during 80 hours of observations.

More than 80% of defensive attacks were against small birds, chiefly passerines. Red-vented Bulbuls, Indian and Jungle Mynahs, Malay Turtle Doves *(Streptopelia chinensis)*, Wattled Honeyeaters, Vanikoro Broadbills *(Myiagra vanikorensis)* and tiny Orange-breasted Honeyeaters *(Myzomela jugularis)* were regularly attacked and driven from the nest tree. These attacks occurred within 25 m of the tree, and usually within a few metres of the nest. A bird 2 m from the nest would sometimes be ignored, another of the same species 5 m away viciously attacked. Individual woodswallows were especially aggressive, repeatedly attacking birds the others ignored. Not all attacks were pressed home, but some, particularly on the very aggressive Wattled Honeyeater, and on mynahs and bulbuls, were as fierce as those against hawks. Birds had to leap aside to avoid collision, take

shelter on the ground or under bushes, or flee closely pursued for 100 m or more into another tree. The Orange-breasted Honeyeater was frightened of woodswallows, and gave loud alarm calls when one pursued other birds. One Indian Mynah, forced to earth by repeated attacks, leapt hawk-like with feet extended at a diving woodswallow, and was not reattacked. Once a woodswallow collided and grappled with a bulbul, the birds falling struggling to the ground, where they separated. The entire woodswallow group closed in and drove the bulbul into dense cover.

Despite repeated attacks a pair of Indian Mynahs and a pair of bulbuls established nests in the same tree as the woodswallows.

NESTING

Nest site selection and nest building

August to September has been regarded as the nesting season for Fijian White-breasted Woodswallows (Layard 1875; Belcher 1931; Blackburn 1971). My observations suggest it begins in May continuing to November, when the young fledge but are still dependent. Other woodswallows in Suva gathered nest materials in May, while on 29 and 30 June, 1974, two groups of four woodswallows were seen building nests on Vorovoro and Mali islands off the north coast of Vanua Levu. The nesting season therefore extends over half the year, eggs only being laid in its later stages. Nest records for December (Clunie 1973) were probably the result of a hurricane destroying earlier broods.

Woodswallows in Fiji nest exposed to the sun on top of pandanus trees (Wood 1926) and also sheltered in the canopy of large, fairly open foliaged trees. The Vorovoro and Mali woodswallows built in small holes in coastal cliffs (cf *Artamus minor* according to Immelmann 1966).

The woodswallow group studied here built their nest 15 m above ground level in the under canopy of a large raintree overhanging a busy highway. The nest was built in the same fork used in December 1972 (Clunie 1973), another nest being built in it in 1974.

On 8 May 1973 a woodswallow demolished the rotting remains of the previous year's nest, tugging at it with its bill, dropping the fragments as they came free.

Early on 10 May, four woodswallows examined potential nest sites in the tree. They moved about the under canopy from branch to branch, one with a twig in its bill. Each moved independently, then they clustered in a branch fork, chattered, and broke apart, only to regroup in another fork. This was repeated several times, the birds seeming attracted to the previous year's nest fork. Individuals frequently flew to the old nest fork, nestling in it in an incubating position. If a bird settled there, the others performed a procession about the tree, one flying to a branch and calling, being joined by the others, flying to another branch and so on. Occasionally one flew

over and replaced the bird lying in the old nest fork, which immediately joined the others for a " follow the leader " procession from branch to branch. After 20 minutes of this they clustered on a branch near the nest fork, fell silent and allo-preened. They showed a similar attraction to the old nest site as they did to the traditional night roost when engaged in selecting an alternative one.

Next day four woodswallows began building the first of a series of preliminary nests in the old nest fork. They came singly with strands of dead grass, laying them in the fork and weaving them together with the bill. The nest was seen substantial enough for the birds to stand in while they worked. On that day copulation was seen for the first time.

On 12 May no nesting activity was seen, but on 13 May at least three birds were attracted to the nest fork, despite the disappearance of all nesting materials. They nestled in the fork as if incubating, relieving each other there from time to time and defending the area against other bird species.

On 14 May three woodswallows moved restlessly about the tree, one nestling in the nest fork as a fourth flew in with a strand of nesting material and landed beside it, when all congregated about the fork. The bird with the nesting material sidled close to the nest then back along the branch, as the other three hopped over each other's backs excitedly. All four then flew out, returning to the tree individually, one to nestle in the nest fork. The last bird to return brought in a strand of dead grass and joined the bird in the nest fork, the other two joining them immediately. The procession or " follow the leader " activity of 10 May was repeated, one bird flying from branch to branch followed by the others, clustering and calling on each branch. This was repeated several times, the birds breaking up for a few minutes then returning to the tree for another procession. A fifth woodswallow hunting in the area took no part in proceedings.

On 15 May at least two woodswallows were hanging about the nest fork, settling in it occasionally, but no further nesting activity was seen until 21 May, when a woodswallow came calling to the nest fork with a strand of dead grass, but flew off without depositing it. No further nesting activity was seen until 24 May, when three birds proceeded noisily about the branches near the nest fork, congregating and " following the leader " in the way already described. Nest building began again on 27th May, at least three individuals bringing in materials, two sometimes working on the nest together. Nothing further was seen until 2 June, when two woodswallows at least worked actively on the nest as they did next day, the birds roosting that evening with strands of dry grass clutched in their feet. Next day building was still in progress and one bird settled on the nest as if incubating. Despite frequent copulation no nest building occurred on 5 June, and I was away until 20 June. A considerable nest was built on 21 June by at least three birds. This disappeared next

day and no further nesting activity was see till 25 June, when the basic makings of a nest were present, and no nest making activity was seen for four more days. On 1 July nest building was again in progress, but the only sign of it during the next three days was on 3 July, when a bird brought in a strand of grass but did not deposit it.

I was away from 6 July to 24 August but on 25 August at least three woodswallows were bringing materials to a substantial nest which proved to be the nest proper. Nest building continued daily until 31 August and irregularly after that until 10 September, when all building activity ceased. Birds bringing in materials often lay in the cup as they worked on the nest rim.

The woodswallows had built quite a substantial cupped nest in a forked branch, supported from below by the branches of the fork, the rim standing firmly upright. It was well sheltered by the foliage of the tree canopy. Materials used included strands of dead grass, coconut fibre, small twigs, fern rootlets, and cotton thread. Nesting materials were collected within 200 m of the nest tree, most from within 50 m. When collecting materials the woodswallows usually hovered to pick them up with the bill, but they also landed to pick up materials, and settled on branches to tug free fern rootlets. Strands of dead grass were sometimes picked up in the bill in a long low swoop, the bird hardly pausing in flight. Material was usually carried in the bill but the feet were used for larger pieces.

When adjusting materials at the nest, loose strands often fell free, but were invariably caught as they fell and returned. The birds often hovered about the nest and pulled free loose strands, replacing them in the nest or flying with them to a branch, holding them in the feet, and pulling at them with the bill. Freshly gathered strands of material were likewise pulled and pecked at, being rejected or carried to the nest. Once a bird took a strand from the nest to a nearby branch. Another bird took the other end of the strand in its bill. After a few seconds both dropped the strand, which was not retrieved. In another incident, a woodswallow removed a strand from the nest and flew to a nearby powerline, holding it in its bill. One of the others flew down, took the strand gently in its own bill, pulled it free, and took it back to the nest.

Copulation

Copulation occurred on branches near the nest and on nearby powerlines, first being seen on 11 May and continuing until the young hatched. There was an upsurge in the frequency of copulation and intensity of sexual display after the first week in September, when the woodswallows were working on the final nest. Sexual display and copulation revealed that there were always at least two males and two females in the group.

Females invited copulation by extending the wings over the back in a V and quivering them, while waggling the tail and usually

calling "eep eep eep eep eep" quietly. Louder calls were often used at the beginning of the display, perhaps to attract male attention, but early in the nesting season it was usually given in silence. During the first few weeks males often attempted unsolicited copulation, mounting but invariably being shrugged off their partner's back.

The female sexual display was usually given as a male or several woodswallows flew or landed near a perched female, but was sometimes given by a female on landing beside a perched bird. Often she displayed for a minute or more before attracting a male, which would either land on her back without ceremony and copulate, or, more usually, land nearby, watch her display for a few seconds, then mount her. Males sometimes spread their wings slightly and quivered them before mounting but this was unusual. During copulation the female either looked straight ahead or flung her head back with her bill pointing straight up at the downward pointing bill of the male, who fluttered his wings to keep balance. Afterwards the male usually perched beside the female for a short while, whereupon she often repeated the sexual display and was mounted again up to four times in succession. Either or both birds often flew off separately without further ado, however, one female flying out from under a male before he dismounted. Rarely, copulating birds stayed together for several minutes afterwards allopreening, but each was as likely to fly over and preen another woodswallow, abandoning its sexual partner immediately they had copulated. Immelmann's (1966) White-breasted Woodswallow males sometimes fed females after copulation, but the Suva males never did. A male would eat a moth then mount a displaying female, hawk off, and eat another moth.

It soon became clear that the birds were promiscuous, unlike Australian woodswallows (Immelmann 1966), which maintain a strong pair bond. A female would display to a male who had just copulated with another female only a few metres away, and would be mounted by him, both females sometimes displaying simultaneously to the same male. Likewise, two males would copulate with a single female in quick succession and in view of each other. Some aggression was noted, a third bird flying up with a harsh cry as a male approached a displaying female, and once one dashed up and knocked a copulating male off the back of a female. The birds flew up and circled above the nest tree calling, but did not clash further.

Sexual displays were often given between two females, perhaps in confusion, and two homosexual attempts at copulation were seen. Once a female gave the sexual display to a companion which jumped on her head facing her tail, hopped down beside her, and gave the same display.

Copulation frequently took place in the evening on branches near the night roost, but although the sexual display was nearly always given on the roosting branch as the birds clustered, they never copulated then. Sexual display ceased once there were young in the nest.

Incubation

The position of the nest meant I could not determine the incubation period, clutch size, or dates of laying and hatching. In tropical Australia woodswallow eggs generally appear to hatch on the thirteenth morning after the start of incubation (Immelmann 1966), but I suspect it takes longer in Fiji.

All four birds incubated. Individuals settled on the nest in an incubating position for periods of several minutes from 31 August, when the nest was still being built. This continued irregularly until 10 September, when all building ceased. Birds bringing materials to the nest sometimes wove it into the rim while another nestled in the cup. The woodswallows continued to sit irregularly until 27 September, when there was a marked change. They then sat far more frequently for periods of up to 15 minutes, and the nest was never vacant for more than 20 minutes. From next day until 15 October they sat almost continuously, the cup never being vacant for longer than 7 minutes. Feeding of sitting birds also began on 28 September. In daylight individuals incubated for periods of less than one to 27 minutes duration, with a 13 minute average.

Incubating birds were visited by others, which conversed quietly with them, but were often left alone for several minutes, when they cheeped quietly. After being relieved at the nest a bird usually preened nearby for a few minutes before hawking out.

A relief usually landed near the nest, waggling its tail and calling, the incubating bird flying off and being replaced. A sitting bird was often reluctant to leave the nest, the relief prodding it with the bill or hovering over it to shift it. Copulation occurred only inches from incubating birds. Once a couple copulated on the nest branch, the female relieving the incubating bird straight afterwards. The latter moved towards the male, gave the female sexual display, and was herself mounted within inches of the nest.

Would-be reliefs frequently settled on the nest beside a stubbornly incubating bird and attempted to force or "elbow" it off the nest. Once a woodswallow forced itself between the incubating bird and the upward curve of the branch fork, settled down as if incubating itself, then shoved strongly with its flank and one leg, attempting to push the incubating bird off the nest. After a short struggle the newcomer spread one wing over the incubating bird for a few seconds, then climbed on top of it and attempted to settle in as incubating position, at which the lower bird flew off and was replaced.

More often two birds sat side by side on the nest, as if dual-incubating, until one flew off.

Incubating birds were fed on the nest, begging with quivering wings, and then either remained on it or were replaced by their feeder. Should a third bird visit the nest it was likely to beg too, and was sometimes fed instead of the begging incubator. An incubating bird once begged a known female.

The sexual display and a less pronounced one where the relief called and quivered its wings slightly, were used when incubating birds refused to leave the nest, with varied success. Visiting birds also begged the incubating bird as if for food. One visitor fed the begging incubator then begged it in turn, at which the incubator flew off with the moth and was replaced on the nest by the new bird.

A marked increase in the regularity of feeding incubating birds, plus an increasing reluctance of incubating birds to leave the nest was noticed from 11 October, and on 15 October nestlings were present and being fed.

Care of young

On 15 October the adult birds approached and left the nest in silence, without the calls which had marked their movements previously, and which did again from the next day on. The three nestlings, which could just raise their heads, were fed by all four adults, all birds sharing in the care of the young. Brooding was more or less continuous for the next four days, after which the young were left alone for long intervals except in bad weather, rarely being brooded after 24 October.

The young were usually fed every few minutes, three adults sometimes queuing at the nest to feed them. When this happened a brooding bird usually moved to a nearby branch, resuming brooding when the others left. Sometimes a brooding adult would beg and be fed by one of the others.

Occasionally a brooding bird would still have to be forced off the nest but it usually flew off calling as the relief appeared carrying food. Once two woodswallows tugged in unison on a dragonfly to dismember it for the young, which were fed by its original captor.

After a few days faeces were removed from the anus of the young by visiting adults, usually immediately after feeding, being carried to a perch 30 m away and dropped. By 7 November the nestlings were defaecating over the nest rim.

The nestlings grew quickly and by 25 October begged loudly if an adult approached the nest. That day they were very active and one of them fell out, being killed instantly on hitting the pavement beneath. The adult birds, returning a few minutes later, did not seem to notice its absence.

By 29 October the two surviving young were only brooded in rain, the adult bird lying half across them and sheltering them beneath an outstretched wing. The nestlings grew increasingly more active and vocal, often standing and fluttering their wings, and perching on the nest rim, but had not left the nest by 7 November, except for short excursions to nearby branches. Unfortunately I had to break off observations then, but it is clear that White-breasted Woodswallows in Fiji remain in and about the nest longer than their Australian

counterparts (cf. Immelmann 1966). By 20 November the two surviving fledglings were flying about the nesting tree in pursuit of their parents, and appeared quite independent of the nest.

CONCLUSIONS

White-breasted Woodswallows in Fiji predictably behave much like their Australian relatives, but there appears on present evidence to be marked differences in nesting behaviour.

Not being subjected to the extreme climatic conditions faced by the northern Australian woodswallows studied by Immelmann (1966), the Fijian birds are remarkably sedentary, a group occupying a traditional roosting and nesting tree for several years on end. The nesting season of Fijian woodswallows extends from early May, when the first of a series of preliminary nests is built in a selected nest fork, and continues until November when the young fledge. Up to four birds, two males and two females in the case of the nest studied here, select the nest site, build the preliminary nests and nest proper, copulate apparently indiscriminately within the group, and co-operate in incubating and raising the young. Evidence that similar breeding groups occur generally in Fiji comes from Vorovoro and Mali islands, where two groups of four birds built nests in holes in cliffs. It is not known whether both females actually lay, or whether one of the males tends to dominate.

In Australia, on the other hand, woodswallows establish a strong pair bond (Immelmann 1966) and nest as a pair, although no proper breeding territory is set up and neighbouring pairs visit each other's nests and co-operate in raising the young once they hatch. Harrison (1969) recently summarised knowledge of helpers at the nest in Australian passerines, several species of which appear to behave similarly at the nest to Fiji woodswallows. Probably the most relevant of these are two members of the Grallinidae, the White-winged Chough *(Corcorax melanorhamphus)* and Apostlebird *(Struthidea cinerea)*, small groups of which build and defend a nest and feed the young. In the White-winged Chough the immature young of earlier seasons help the adults, and more than one hen may lay in a nest.

Further and more detailed studies of White-breasted Woodswallows using marked birds are necessary, before any really profound conclusions can be drawn about their nesting, the composition of the breeding groups, and the exact relationship between the sexes in such groups.

ACKNOWLEDGEMENTS

I am grateful to the Australian CSIRO for providing me with a translation of Immelmann's (1966) paper on Woodswallows, and to Mr Ian Rowley for critically reading the manuscript.

LITERATURE CITED

BELCHER, W. J. Collection of bird paintings, Fiji Museum collections.
BLACKBURN, A. 1971. Some notes on Fijian Birds. Notornis 18 (3): 147-174, figs 1-5.
CLUNIE, F. 1973. Nest Helpers at a White-breasted Woodswallow Nest. Notornis 20 (4): 378-380.
HARRISON, C. J. O. 1969. Helpers at the Nest in Australian Passerine Birds. Emu 69 (1): 30-40.
IMMELMANN, K. 1960. Behavioural Observations on Several Species of Western Australian Birds. Emu 60: 237-244.
IMMELMANN, K. 1966. Beobachtungen on Schwalbenstaren. Journal fur Ornithologie 107 (1): 37-69.
LAYARD, E. L. 1875. Ornithological Notes from Fiji with descriptions of supposed new species of Birds. Ibis 1875: 27-30.
WOOD, C. A. 1926. Field observations in WOOD, C. D. & WETMORE, A. A. collection of birds from the Fiji Islands. Part III. Ibis (12) 2 (1): 91-136, text-fig 4.

Fergus Clunie,
Fiji Museum,
P.O. Box 2023,
Suva,
Fiji

★

SHORT NOTE

DUCKS' TAKE-OFF

In the northern hemisphere, ducks take off from their water in a north-westerly direction, no matter in which direction their final destination lies; in the southern hemisphere, they take off to the north-east.

Is it more than a coincidence that this matches the Coriolis force ?

Perhaps it is. For the Coriolis force acts *to the right* of all moving objects in the northern hemisphere, *to the left* in the southern. So that in each case the ducks would, as it were, lean against the Coriolis force until they had found their orientation against the frame of reference of the fixed stars.

R. FRASER

Woburn Masonic Village,
Wai-iti Crescent,
Lower Hutt

[Comments are invited — Ed.]