

A CONTRIBUTION TO THE NATURAL HISTORY OF THE FIJI PEREGRINE

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ABSTRACT

The history, distribution, and description of the Fijian race of the Peregrine Falcon, *Falco peregrinus nesiotes*, is given. Based on observations made on Joske's Thumb, a 1430 ft mountain rising from a rugged rainforest area a few miles inland from the south coast of Viti Levu, detailed statements are made on the behaviour of this species, including daily routine, nesting, and food. An analysis of pellets is tabulated and a list is added of other species of birds seen in the area, including many taken by the peregrines as food. This is the first detailed confirmation of the breeding status of the Peregrine in Fiji.

INTRODUCTION

The Fiji Islands mark the extreme eastern penetration of the almost cosmopolitan Peregrine Falcon into Oceania, the local race, *Falco peregrinus nesiotes*, also being found in the New Hebrides, New Caledonia and the Loyalty Islands. So little has been recorded concerning the Peregrine in Fiji that even its presence there has been doubted (Brown & Amadon 1968: 852).

This paper confirms the presence of the Peregrine in Fiji, summarises some of the few widely scattered and little known references to it, and deals with observations which I have made at Joske's Thumb in southern Viti Levu, where Peregrines definitely tried to breed in 1971, the first breeding record from Fiji. During the course of this study, part of a long term field survey of the Fijian raptors being undertaken by the Fiji Museum, information regarding Peregrine diet was gathered, revealing a high proportion of mammalian food in the form of the Flying Fox (*Pteropus tonabus tonganus*) or giant fruit bat. I have been hampered by lack of reference material, so the distribution notes should not be regarded as being fully comprehensive.

The Fijian name for the Peregrine Falcon is "*Ga-ni-vatu*" or "rock duck," although like many Fijian names it can quite probably be applied to other species in some areas, so should be used with caution. An early missionary dictionary (Hazelwood 1850: 314) describes the "*Ganivatu*" as a "Very large bird, perhaps fabulous, said to live in holes and eat men," indicating that the bird was rather dreaded and unfamiliar to the coast peoples among whom the missionaries lived. In the highlands of Viti Levu the bird was generally left alone, the Fijians being chary of climbing near its dangerously situated nests (Brewster, Document 24) and was venerated to a certain degree, being the totem of some of the fiercest mountain tribes.

The name obviously stems from its cliff habitat and its compact body, Brewster saying that Fijians described the bird as being "Short-set and squat, with legs in the same proportion to the body as a duck's, and with broad outspreading talons." (Brewster 1922: 110).

DISTRIBUTION OF THE FIJI PEREGRINE

In the past Peregrines have been recorded with certainty from only the three largest islands of the Fiji Group (Fig. 1): Viti Levu (4,011 sq. ml.; 10429 km²), Vanua Levu (2,137 sq. ml.; 5556 km²), and Taveuni (168 sq. ml.; 437 km²), all of which are rugged, volcanic islands with suitable breeding cliffs. The small island of Wakaya (3 sq. ml.; 7.8 km²), some ten miles east of Ovalau (see Fig. 1), can now be added, as I saw an adult Peregrine in flight over sea cliffs there on 30 April 1971. Ovalau itself, a mountainous island, almost certainly has a Peregrine population, both my own informants and those of the late bird artist W. J. Belcher (Painting No. 24, 1925) claiming that it is present there. Belcher was also told that they occur on Beqa off the south coast of Viti Levu. During 1970 members of the Ornithological Society of N.Z. expedition thought they saw a Peregrine over cliffs near Vunisea, Kadavu, in the extreme south of the Group (Blackburn 1971: 154).

Records from Viti Levu are the most numerous, although even these are scanty. Most sightings have been near cliffs, but in September 1971 an adult Peregrine was seen perched in a kapok tree at Koronivia in the densely cultivated Rewa Valley (E. J. H. Berwick, pers. comm.), and within recent years one was seen perched on the old fire-station building in central Suva (R. Mercer, pers. comm.). During the early part of this century several sightings were made in the Suva Harbour area (Bahr 1912). It is quite possible that Joske's Thumb birds were involved in these sightings at Rewa and Suva, as Joske's Thumb is the nearest known Peregrine site.

Mountain sightings have occurred at Narokorokoyawa (Ansdell 1882: 59), Nasoqo (Brewster Doc. 24), Namosi (Belcher, painting 24, 1925; Derrick 1951: 157) where a priest had a tame bird, and more recently in the Nausori Highlands (Blackburn 1971: 154). I have seen Peregrines at Joske's Thumb every year since 1969, and in November 1968 saw a pair of adult birds on rocks at the summit of Mount Korobaba (1408'; 429m) near Suva, five miles (8 km) east of Joske's Thumb, and have since found that they roost on the Korobaba cliffs occasionally. On Mt Koroimaia (2030'; 618.7 m) in 1971 I saw fresh mutes (droppings) on rocks, and was told that a pair of Peregrines lived on cliffs near the summit, and was given a graphic description of the birds and their flight (Tui Namataku, pers. comm.).

In view of this widespread distribution in both coastal areas and in the interior of Viti Levu, it would seem that most of the large cliff systems in Fiji are worthy of investigation, as they have probably supported Peregrines at some time.

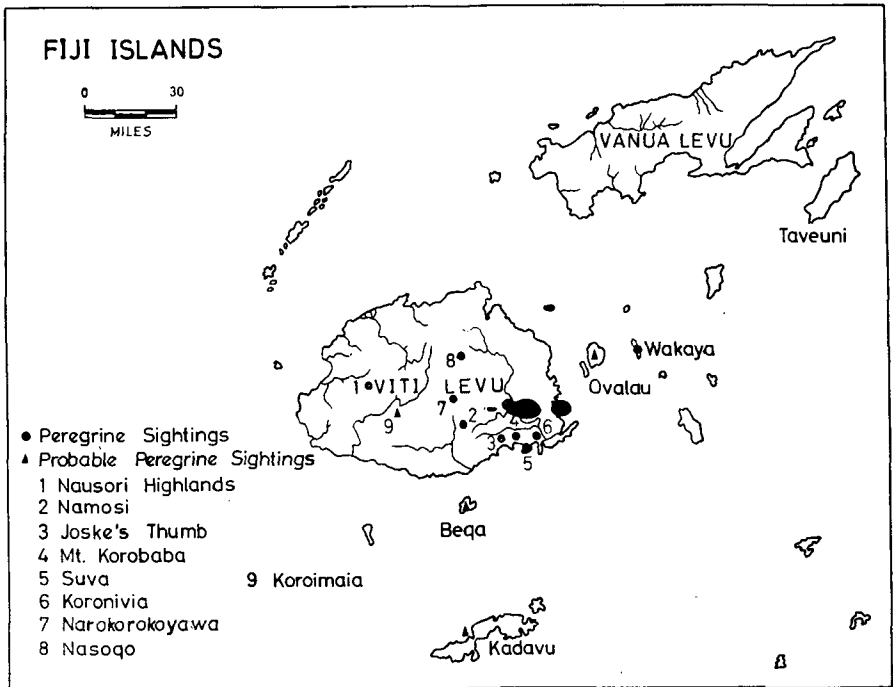


FIGURE 1 — Map of the Fiji Islands.

THE JOSKE'S THUMB PEREGRINES

Since early 1969 I have often seen individuals, pairs, and on two occasions trios of Peregrines in the vicinity of Joske's Thumb. During 1971 the Fiji Museum began a long term field study of the Fijian raptors, and as part of this programme I commenced work on Joske's Thumb, visiting the mountain at least once a week between 6 June and 26 September, after which the Peregrines left following their breeding failure. Regular trips are still made to the area so that studies can be resumed on their return.

Methods:

Most field observations were made with 10 x 40 binoculars although 8 x 30s were used in the first few weeks. Most of my time was spent on the seaward side of the mountain, on a rock knoll commanding fine views of favourite roosting and feeding ledges, the approaches to the eyrie, and a large expanse of open sky. Other observations were made from a bush-covered ledge near the eyrie, but here vision was restricted. I was unable, however, to stay in the area overnight on any occasion.

Identification of prey, mainly in the form of plucked plumage from kills, and cast pellets, was made by comparison with specimens in the Fiji Museum's small skin collection. The bulk of remains was identified, but the others will have to await the building up of more comprehensive skin and skeletal collections. Fur from pellets and other mammalian remains were identified by comparison with Fiji Museum specimens.

Habitat and Environment:

Joske's Thumb or Rama, a prominent Suva harbour landmark, is a 1450' (442 m) volcanic plug three miles (4.8 km) inland from the southern Viti Levu coast (Fig. 2). It holds a commanding position, the mountains of the interior, including the known Peregrine site of Mt Voma, Namosi, being clearly visible from the summit, as are the broad, flat expanses of the lower Navua and Rewa Valleys, the last said in legend to have been formed by the lusty wingbeats of a godly Peregrine from Ovalau thrusting the hills apart (Brewster 1922: 111-112). On clear days the suspected Peregrine centres of Beqa, Ovalau and Kadavu are easily discernible.

The mountain juts starkly from a rugged rainforest area, the rock plug being but thinly vegetated, with large areas of bare, sheer cliffs, overhung in places to shelter dry ledges much favoured by the Peregrines as roosting, feeding and nesting sites, and littered with their mutes, kill debris and moulted feathers. Dense rainforest stretches away over the uninhabited upper Waimanu River valley only two miles (3.2 km) to the north, and across the higher ranges beyond; while to east and west it runs down the hills for miles (Fig. 3). A dairy farm lies only a mile (1.6 km) to the south, however, on what was originally a pandanus swamp stretching to the coastal mangrove belt. Patches of the pandanus swamp still survive. An area of intermittently cultivated native gardens interspersed with the light, stunted bush typical of areas subjected to frequent flooding extends up the valley of the Nailagosakelo Creek system, reaching still closer to the mountain and forming a narrow tongue into the dense rainforest area.

Rainfall is very heavy, certainly considerably heavier than that of Suva (c. 120"; 3048 mm) which averages at least a trace of rain on two out of every three days (Derrick 1951: 104). Strong winds frequently sweep the south and southeast faces above 500' (152 m) and dense cloud often shrouds the cliffs.

Bird life in the native gardens and forest is rich and varied, the introduced species being entirely replaced by native ones as the true forest is met (see Appendix I). About the cliffs there is a variety of lizard species ranging from small skinks to a large rock gecko. A rat of as yet undetermined species is found on the cliffs, especially about Peregrine feeding ledges, while the introduced mongoose occurs in the forest about Joske's Thumb. The giant fruit bat or Flying Fox (*Pteropus tonabius tonganus*) has a haunt several miles east of the mountain, and flies through the Joske's Thumb area in large numbers during the late afternoon and early evening.



FIGURE 2 — Joske's Thumb from the dairy farm lying to the north.

Photo: F. Clunie



FIGURE 3 — Rain forest hill country to the west of Joske's Thumb over which the Peregrines do much of their hunting.

Photo: F. Clunie

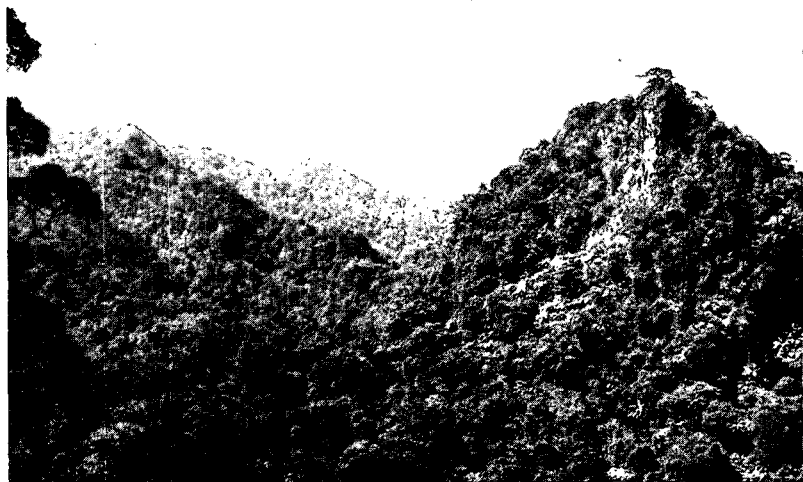


FIGURE 4 — Rugged country to the east of Joske's Thumb over which the Peregrines hunt. The trees on the peak of the right hand crag are favourite roosts and soaring displays between Peregrines were quite often observed there. Photo: F. Clunie

Peregrines do not normally inhabit such densely forested zones, and are possibly only found in the Joske's Thumb and other forested areas in Fiji because of the suitable breeding cliffs. Indeed, the abandonment of the mountain by the Peregrines after their breeding failure, and the recent sighting of a Peregrine at Koronivia, might suggest that they prefer more open areas, and hunt them outside the breeding season.

DESCRIPTION OF THE FIJI PEREGRINE

A detailed description of the Fiji Peregrine is not generally available, so one of the Joske's Thumb birds should be of some aid to the field worker, especially since comparisons drawn recently with an Australian race (Blackburn 1971: 154) are slightly misleading. The Fijian race is much closer in appearance to *F. p. ernesti* of the New Guinea-Indonesia area, the major difference being that the former is not quite so dark, and has more of a rufous wash to the breast (Brown & Amadon 1968: 852).

Adult birds are very dark, almost black above, with a few brown lights to the plumage. Head and cheeks are black hooded with chin and throat light cream fading to a light pinkish-brown or rufous breast. Belly, flanks and thighs are grey, heavily barred with black, as are the underwing coverts. The eye is dark brown, the beak dark grey, and claws black; the cere, orbital ring and feet are yellow. As with other races of Peregrine, the female is markedly larger than the male.



FIGURE 5 — Overhanging cliff ledges, Joske's Thumb, favourite roosting and feeding places of Peregrine Falcons.

Photo: F. Clunie

The male at Joske's Thumb was darker and more handsomely marked than the female, in which the rufous colouring of the breast was much more noticeable, extending down onto the barred belly. The cere, orbital ring and feet of the male were a bright orangeish-yellow, in contrast to those of the female, which were a pale lemon yellow.

I have not as yet seen an immature Peregrine at close quarters, the following description being based on W. J. Belcher's painting of a 10-month-old Namosi bird (Belcher painting No. 24, 1925). Back, head and cheeks as for adult; breast, belly and flanks a rich orangeish-buff, darkening downwards, with black streaking which becomes heavier downwards; thighs deep buff with black, arrowhead streaking; black tail tipped with white, and faintly barred with grey; eye dark brown; feet pale yellow; cere, beak and bare patch of skin about eyes light grey.

GENERAL CHARACTERISTICS

It is not proposed to go into any great detail concerning daily routine and general habits, Peregrine Falcons having been studied so extensively elsewhere in the world, and the Fiji race merely echoing many of the oft-described behavioural traits.

Daily Routine:

The Peregrines usually spent much of their day perched singly or in pairs on commanding rock ledges, on small trees jutting out from cliff faces, or in open-foliaged trees in conspicuous positions (Fig. 4). Here they would gaze about, preen and occasionally doze off, often remaining for several hours at a time. One or both birds were normally perched in this way when I arrived about an hour after sunrise, and would remain for up to three hours or more. They could be found perching for extended periods at any time of day, typically standing one-legged with the other leg tucked up under the belly. Hunting seemed to take place at any time, the Peregrines being seen feeding on fresh kills in both early morning and in the afternoon. It was impossible to estimate how long birds spent hunting, however, as they were usually out of sight, and could well have perched for long periods elsewhere.

While perched the Peregrines often demonstrated their fine sense of vision, and each could follow the progress of its partner long after it had been lost to my view.

Flight:

The typical Peregrine flight of a succession of quick wing-beats followed by long glides with the wings extended was commonly witnessed, although long flights without gliding were seen frequently, and sustained soaring over the summit and valleys about the mountain took place occasionally. Flight control was almost uncanny, the birds often diving at speed with the wings half folded until only a few feet from the cliffs, swinging away or braking at the last moment, and apparently taking full advantage of air currents rising up the rock faces.

Comfort movements:

Whilst perched the Peregrines often preened and stretched extensively, scratching their heads most violently at frequent intervals. In flight too, the birds were sometimes seen to nibble at a foot or wing. Downy contour feathers which became stuck in the beak would be hooked free by the middle claw of one foot, and on one occasion the male bird was seen to hook at his beak like this while making belching motions a few seconds prior to casting. After feeding the birds would "feet" (or strop their beaks) on branches or nearby rocks.

Voice:

The Peregrines were generally silent when alone but extremely vocal in each other's company. This was especially true of the female, which would call to her mate whenever he was in sight. Sometimes her calls seemed inspired by movements on his part, often rising to

fever-pitch if he flexed his wings, but she would scream at him for no apparent reason just as frequently. She seemed aware if he flew off determinedly, as when hunting, and would not call after him, but if he was merely gliding about the cliffs she called whenever he strayed into her line of vision.

As with other Peregrines (cf. Brown & Amadon 1968: 852), the female's voice was lower-pitched than that of the male, both birds giving a harsh "kew" call, usually repeated several times and varying greatly in volume and speed of delivery. The female used this call most often, but also had a soft mewing call, and was capable of the high piercing "tchik!" much favoured by the male. On recognition and when presenting food he used a chittering call very similar to the creaking of a metal pulley. He also had a whistling "her-cheep" which he gave once while perched above the eyrie, and on one occasion, as I descended a cliff on the north face, flew straight at me uttering a soft "tchuk tchuk tchuck" before flinging away when only a few feet from my face. The chattering "hek kek ek ek ek ek" for which the aggressive Peregrine is so noted was used once by the female in attacking me.

Curiosity:

The Peregrines seemed extremely curious of humans and would rarely fly if I surprised them at close range until they had had a clear view of me, but would sit bobbing their heads, gazing intently at the bushes if I moved. Such curiosity was twice exhibited on the summit of the mountain in 1969. On both these occasions a companion and I sat quietly on rocks, and turning, were surprised to see an adult Peregrine staring intently at us from a dead tree not twenty feet away. The bird flew immediately on being seen.

NESTING

A single egg was laid by the Joske's Thumb Peregrines during 1971, but was broken prior to hatching. This is the first definite record of Peregrine Falcons attempting to breed in Fiji, and thus extends the breeding range some 500 miles (860 km) further east into Oceania than was previously known. The egg had a white shell speckled with olivish brown blotches. The clutch size is small for Peregrines, which normally lay between two and five eggs (Brown & Amadon 1968: 854). Indeed, Belcher (Painting 25, 1925) recorded that nests of the Fijian race normally contain three eggs, but he did not say where or how he came by this information.

Nesting has definitely taken place at Joske's Thumb in the past, as amongst the rubble on a sheltered ledge near the 1971 eyrie several old fragments of egg shell were found. In addition, groups of three or more Peregrines almost invariably consist of adult(s) and juvenile(s) (L. H. Brown, pers. comm.) so that trios seen in November 1969, and on 21 February 1971 can probably be taken as indicating breeding success in the 1969 and 1970 seasons.

The 1971 nesting site was located on an overhung ledge with sheer cliffs falling away beneath it to steep, jungle-clad slopes.

The ledge was well protected from rain and the prevailing south-easterlies, but was exposed to direct sunlight on fine afternoons. Several rocks fallen from the overhanging cliff lay scattered about the ledge, the largest one being propped up on several others, thus forming a miniature cave spacious enough to admit a mature Peregrine. The enclosed space offered total protection from the afternoon sun, and the egg was laid within it. The Peregrines did not make any perceivable scrape, the floor of the nest being littered with rough rock fragments. Old pellets, moulted Peregrine feathers, and feathers and a few bones from kills were scattered about the ledge, some obviously having lain there for a considerable time.

Unfortunately observations of the nesting birds were hampered by several factors:

- (a) a rock outcrop hid the eyrie from my usual observation post, and a route to the eyrie ledge, from which the nest could be seen from under cover was not found until well into the nesting period.
- (b) the true structure of the eyrie was not realised until I climbed to it following its desertion.
- (c) the rocks of the eyrie ledge obscured my view of feeding and food presentations.

Defence of eyrie:

The eyrie was evidently selected some time in early June, display flights being witnessed in the morning of 12 June 1971 from the Nailagosakelo Creek. Through 8 x 30 glasses the anchor-shaped silhouettes of the Peregrines were easily discernible, flying to the southwest of the mountain. The flights consisted of long, shallow but fast gliding dives at the cliffs from several hundred yards out, the birds flinging up at the last moment, shooting up the cliff face, then flying back out to repeat the performance. Sometimes they tailed each other closely, but often only one was in sight, especially for the last few minutes, when a lone bird was seen. These flights took place near the eyrie, as did those of 20 June in which the male made sweeping, gliding flights, calling frequently. More definite developments occurred on 26 June, both birds being extremely active and vocal, and spending much time near the eyrie, singly or together. The female was seen diving at it, but pulled away at the last moment as the male swept round the cliffs, uttering a high, metallic, pulleying cry as he passed the nesting site. Both birds then flew off in company. The male later landed at the eyrie unobserved, for twice when the female flew past it his pulley cry arose from it, and when she landed there she was greeted by an excited pulleying and chittering. The male flew out a few minutes later, landing in a small tree jutting from the cliffs directly above the eyrie, where he began to preen. This little tree and a small ledge a few yards east of the eyrie, but hidden from it by a rock outcrop, were his favourite lookout posts throughout the nesting period.

By 27 June the female was firmly established at the eyrie, and an aerial food exchange was witnessed at 1 p.m. on this day. The male bird flew rapidly at the eyrie, uttering the pulley call, carrying his kill beneath his tail. Suddenly he spun around and made rapidly away, closely pursued by the female which had been waiting there. She flew a couple of feet above him and lowered her talons, but was ignored, whereon she flew beneath him and turning on her back again extended her talons. At this the male bird lowered his own talons, passing the kill to her in a neat manoeuvre in which both birds had a simultaneous hold on the carcase for a moment, before the female righted herself and flew screaming harshly into the eyrie with the kill, while the male landed in the small tree above it, where he sat gazing about, sometimes looking down at his mate, and quietly answering her cries.

On 4 July, the birds were very restless, spending much time perched in trees on the eastern face of the mountain, calling, but a week later they had settled down to a routine, with the female waiting at the eyrie for the male to bring in kills, and only venturing forth herself upon occasions, when the male would sometimes take up her vigil at the nest. Throughout the nesting period the inactive female was moulting flight feathers, while the active male was in perfect plumage.

The male usually announced his arrival at the eyrie by a high pulley call, to be greeted by the harsher cries of the female, their calls becoming quite hysteric at times. He would normally fly out from the eyrie within a few minutes of his return, taking up position on one of his lookouts where he would rest for varying periods, preening, gazing about and dozing off from time to time. Most of the kills he brought in were easily manageable, but one was so large as to slow him down and render his flight very heavy and clumsy. Usually he approached the eyrie from slightly below, swinging up into it over the last few yards of flight. Once, however, he was seen to stoop or dive down the cliffs at a very steep angle and at great speed, only spreading his wings to break his fall in the last few feet.

A change in the female's behaviour was noted on 24 July. On catching sight of the returning male she would fly out several hundred yards to meet him, then follow him to the eyrie. Here the usual hubbub of cries would arise, and the male would emerge after a few minutes, taking up position on one of his lookouts.

On this day I found a route to the ledge near the eyrie, and from then on could watch the activities there from the cover of dense bushes. The female would wait on a rock for the male to bring in a kill, usually remaining alert but practically motionless, and only preening or scratching her head infrequently. On sighting the male, which she could do at great distance, and long before I could, she would utter a few harsh "kew" calls and fly out to meet him, both birds returning together, with the male in the lead. The birds would call excitedly, the male with his high, chittering, pulley calls,

and the female with her harsher "kews." She would sit on a rock a few feet from him while he presented his kill. Unfortunately this ceremony was almost totally obscured by rocks but he seemed to bow slowly up and down, calling periodically, as has been noted for other races of Peregrine (Brown & Amadon 1968: 854). It is quite possible that he sampled his kills on these occasions, as he often feaked on a nearby rock before flying off to one of his nearby lookouts, accompanied by the screams of his mate. While the male remained in sight the female never touched a kill, but sat calling to him. If he perched in the little tree jutting from the overhanging cliff she would fling her head back, and gazing up at him, call almost incessantly for up to an hour, receiving only an occasional reply. When he passed from view, however, she almost invariably fell silent immediately, and would pass down among the rocks to feed, raising her head and gazing about every so often.

The egg was probably laid between 2 and 8 August 1971, for on the latter date the male was seen to relieve the female at the nest at 2.15 p.m. and clambered into the actual nest, apparently to incubate. He was seen to repeat this at 1.45 p.m. on 14 August. The female, however, was not seen to make any attempt to incubate or even enter the nest shelter, spending the bulk of her time perched on a nearby rock. The egg was apparently broken sometime between 14 and 22 August, although the female still roosted there occasionally and both birds could be seen on nearby ledges, until they left Joske's Thumb sometime after 26 September. Indeed, the female was seen to defend the ledge against a helicopter as late as 12 September and display flights took place near the eyrie on that day. The first display flight witnessed was in the form of a rapid pursuit of the female by the male, which she escaped by diving into a Casuarina tree, while he swept by pulleying excitedly. At 3 p.m. she was sitting in a small tree above the eyrie, quiet but alert, when she saw the male out to the east, and with a strident call flew with clumsy, laboured wing beats toward him. As he approached she swung about and darted in a barbed, gliding dive round the cliffs, with him in close pursuit, pulley calling.

The last sighting of the Peregrines at Joske's Thumb was at about 2 p.m. on 26 September 1971, when the two birds flew into the eyrie together, calling excitedly as they had done during breeding. After a few minutes the male emerged alone and flew to land in a tree below the eastern cliffs, where the birds had often perched when first occupying the eyrie.

Aggression about eyrie:

At 2.30 p.m. on 12 June 1971 I surprised the female Peregrine feeding off a bloody carcase on a ledge some sixty yards from the eyrie. She glared at me for several seconds from about thirty feet away, then spun round and flew out from the cliffs, still clutching her kill, for about a hundred yards, uttering two harsh "kew"

calls. She turned then, and came flying straight at me at speed, uttering a chattering "Hek kek ek ek ek ek." When only a few yards from me she swung clear and repeated the performance twice more before flying off in the general direction of the eyrie, and falling silent. As this threat display took place before the birds were firmly established at the eyrie, it was quite possibly a reaction in defence of her kill.

Despite precautions the male was twice disturbed at the actual eyrie, on both occasions in the temporary absence of the female, when he would relieve at the nesting site occasionally in the afternoons. On the first occasion he flew in to the deserted eyrie as I was tying back some reeds to gain a less restricted view. When he saw me he crouched down on his belly amongst the rocks and stared at me, absolutely motionless, as I beat a slow retreat out of sight.

On the second occasion he was secreted among the rocks of the ledge, probably feeding, when I again carelessly exposed myself. This time he took off, and flying back and forth above me gave loud, ringing calls, evidently trying to recall his mate. He was soon joined by the female, who gave a few loud "kews," soon after which the male fell silent and landed in a small tree jutting out from the cliffs about fifty feet (15 m) above the eyrie, where he sat quietly, very alert.

The female reacted in a similar manner when a helicopter circled the mountain on 12 September 1971. She was sitting on a ledge near the now abandoned eyrie, when the helicopter approached and began to circle the mountain at close range. As it came into view around the cliffs the female, which had been gazing in the direction of the sound, took off and flew out about thirty yards from the cliff, and began flying back and forth in front of the eyrie. The helicopter circled the mountain twice, and neither time did the bird try to escape or follow it, maintaining station across the approaches to the nesting site. As the helicopter moved away she flew back to the ledge on which she had been perched, called quietly a few times, then settled down again.

During the period in which the eyrie was being defended no other raptors were seen in the immediate vicinity of Joske's Thumb. They were quite possibly kept at bay by the Peregrines, which are typically very aggressive about the nest. After the eyrie's abandonment a large Swamp Harrier (*Circus approximans*) frequently hunted through the forest canopy at the foot of the mountain, and was once seen carrying a Pacific Boa (*Enygrus bibronii*) of some thirty inches (726 mm) length in its talons. The male Peregrine undoubtedly saw this Harrier on at least one occasion, but seemed to ignore it. No Goshawk was seen about the mountain itself, although an immature one was glimpsed infrequently in the native gardens.

FOOD

The following evidence was amassed during the course of the study from kills, feathers from kills and cast pellets, the bulk of the information coming from the last two. Nearly all of the material was of unknown age, some obviously dating back over a considerable period. The major collecting areas were the overhung, sheltered ledges on which the Peregrines spent so much of their time (Fig. 5).

In addition, a wealth of skeletal evidence was collected during archaeological excavations in sheltered holes high on the eastern cliffs, some of which contained the skeletons of human infants, possibly sacrifice victims, along with the remains of birds and Flying Foxes, evidently old Peregrine kills. A large shelter nearby was probably once used as an eyrie, and contained hundreds of bones. Unfortunately there is no adequate reference collection of skeletal material available, so identification will have to await the building up of such a collection, a project currently being undertaken by Fiji Museum. As the removal of the material from these holes or shelters was done by archaeological methods, it would have been recovered in chronological order, and may provide a record of Peregrine diet dating back well over a century. Comparison with bones from recent kills should determine whether these really are the remains of Peregrine kills. The absence of any crania, and the fact that Peregrines still roost and feed on some of these shelters suggest that they are.

Mr R. J. Scarlett of the Canterbury Museum, Christchurch, has kindly identified some bones, with the result that the White-throated Pigeon (*Columba vitiensis*) and a Petrel of uncertain subspecies (*Pterodroma hypoleuca*?) can be tentatively added to the list of Peregrine prey. I have not as yet seen any petrels or petrel burrows near Joske's Thumb, but parts of the terrain are suitable (J. B. Smart, pers. comm.) and they may yet nest in the area, despite the presence of the mongoose.

Kills:

At 11 a.m. on 6 June 1971 I found the fresh carcase of a Jungle Mynah (*Acridotheres fuscus*) on a sheltered ledge low on the eastern cliffs. All flight and most contour feathers had been plucked at some other place. The bird was decapitated and had a deep stab wound high on the back, just to the right of the spine, evidently caused by a Peregrine talon. The left leg was broken but the skin unperforated, while the right leg was entirely missing, revealing the bowels which were untouched.

Near the Jungle Mynah carcase lay the skeletal remains of a Flying Fox, consisting mainly of wing and limb bones. The skull was missing. A pair of dry wings from another Flying Fox lay a few yards away, the flesh having been stripped from the long bones. Comparison with a stuffed specimen in Fiji Museum shows that the wings came from a bat with a wing span exceeding thirty inches (762 mm).

On 4 July a Flying Fox skull was recovered from a ledge beneath a plucking post on the southeast slopes of the mountain, where it had apparently lain for a number of days. The skin had been pushed down towards the snout, revealing the bare bone of the cranium, which was punctured on the left side by a jagged hole, with a smaller hole on the opposite side. The brain was gone.

The skeletal remains of the wings and breast bone of an as yet unidentified bird were found beneath a Casuarina tree on the northern side of the mountain, while from the ledge near the eyrie the leg of a small lory was recovered. This leg was far too lightly built to have come from a Collared Lory and had red feathers about the thigh, so must therefore have come from the rarer Red-throated Lory (*Vini amabilis*), a bird I have not seen in this area.

Other kills were seen but defied identification, being plucked and decapitated carcasses being carried or eaten by Peregrines. Evidence that the Peregrine hides or caches a kill and returns to it later was seen at 3.20 p.m. on 24 July when the female landed on a small ledge and gazed about for several seconds before walking to a small crevice into which she put her head, and pulled out a carcass with her beak. She then held it down with one foot, took a few beakfuls, then flew with it to the eyrie.

Feather evidence:

Although the Peregrines seem frequently to pluck their prey before bringing it in to the feeding ledges, the eyrie ledge and the ledge near it were littered with feathers from which a variety of prey was identified, ranging from tiny birds to those the size of a dove. On the other hand, the eastern ledges were extremely poor in feather material. The feathers of a large, as yet unidentified bird were recovered from a plucking post on the southeast slopes of the mountain.

Feathers collected from the eyrie resulted in the identification of the following species:—

Collared Lory (*Phigys solitarius*); Golden Whistler, female (*Pachycephala pectoralis*); White-rumped Swiftlet (*Collocalia spodiopygia*); Red-headed Parrot Finch (*Erythrura cyanovirens*); Orange-breasted Honeyeater (*Myzomela jugularis*); Jungle Mynah (*Acridotheres fuscus*).

Feathers from the ledge near the eyrie resulted in the following species being identified:—

Collared Lory; Golden Whistler, male; Many-coloured Fruit Dove, male (*Ptilinopus perousii*); 2 White-collared Kingfishers (*Halcyon chloris*); Wattled Honeyeater (*Foulehaio carunculata*); Polynesian Triller (*Lalage maculosa*); Jungle Mynah; White-rumped Swiftlet; Vanikoro Broadbill (*Myiagra vanikorensis*); Red-headed Parrot Finch; Orange-breasted Honeyeater.

On both the above ledges several unidentified feathers were found.

From the ledge low on the eastern cliffs the feathers of the following species were recovered:—

Golden Whistler, female; White-collared Kingfisher, Collared Lory.

The feathers of at least one more Collared Lory were recovered from a large hole in the cliff above this ledge.

Pellet evidence:

In all, 49 cast pellets were recovered from the eyrie (14), the ledge near the eyrie (17), from a rock on the summit (13), from the ledge low on the eastern cliffs (4), and from a shelter high on the eastern cliffs (1). With the exception of the rock on the summit, all these are sheltered and overhung areas. Most of the pellets were of unknown vintage, some obviously being very old and badly battered. However, 25 were in good order, their mean and extreme measurements being:

Length	35 mm (12 mm - 61 mm)
Width	14.1 mm (8 mm - 19 mm)
Dry weight	0.81 g (0.25 g - 2.60 g)

The pellets varied somewhat, most being cigar-like or shaped like elongated tear-drops, while four were quite rounded. Flying Fox fur in pellets was always in good condition and easily identified. Miscellaneous skeletal fragments including claws, teeth, broken long bones, and vertebrae were found in most pellets and provided additional evidence. The feathers were usually badly broken down into crumbling black or grey fragments, but in a few cases survived extremely well and were identified as those of:

Collared Lory; White-collared Kingfisher; Many-coloured Fruit Dove; Golden Dove (*Ptilinopus luteovirens*) and Peale's Pigeon (*Ducula latrans*).

A small unidentified fragment of beak, bird claws, including the entire foot of a Peale's Pigeon, and bird bones were found in various pellets. Grit similar to that of the feeding ledges was found in several pellets and was probably ingested while feeding, while vegetable matter in some of the pellets could well have come from the gut of prey. Insect remains found in one pellet could have come from the crop of prey, but the Peregrines probably take insects from time to time.

Pellet analysis resulted in a truly surprising predominance of Flying Fox remains, no less than 27 of the 49 pellets containing Flying Fox remains only, while a further 14 contained a bulk of Flying Fox material together with bird remains. Only 8 pellets contained bird remains with no trace of Flying Fox.

It is obvious from both the pellet and the limited kill evidence that the Flying Fox is one of the staples of the Joske's Thumb Peregrines. Their dietary habits are thus aberrant (L. H. Brown,

Area Collected	Pellet No.	Flying-Fox Remains	Bird Remains	Vegetable Matter	Insect Remains
Byrie	1	*			
	2	*			
	3	*			
	4	*			
	5	*			
	6	*		*	
	7	*		*	
	8	*	*	*	
	9	*	*	*	
	10	*		*	*
	11	*	* A	*	
	12		*		
	13		*		
	14		*		
Ledge near Byrie	15	*			
	16	*			
	17	*			
	18	*			
	19	*		*	
	20	*	*		
	21	*	*		
	22	*	*	*	
	23	*	*		
	24	*	* B	*	
	25	*	* C		
	26	*	* A & D		
	27	*	* B	*	
	28		*		
	29		* A		
	30		* B		
	31		* E		
Summit	32	*			
	33	*			
	34	*			
	35	*			
	36	*			
	37	*			
	38	*			
	39	*			
	40	*		*	
	41	*			
	42	*			
	44	*			
	44	*	* A		
Eastern Ledge	45	*			
	46	*		*	
	47	*	*	*	
	48	*	*	*	
Eastern Shelter	49		*		

KEY: A = Collard Lory; B = Kingfisher; C = Many Coloured Fruit Dove;
D = Golden Dove; E = Peale's Pigeon

TABLE 1 — ANALYSIS OF PELLET CONTENTS

pers. comm.), other races of Peregrine subsisting mainly on birds. Lanner Falcons (*Falco biarmicus*) in Africa also eat fruit bats, but these are of the smaller genus *Eidolon* (Brown, pers. comm.). The aberrant feeding habits of the Peregrines at Joske's Thumb could well have developed in response to their rainforest environment.

It appears that almost any animal which flies over the forest canopy during daylight hours is liable to predation, kills ranging from the tiny Orange-breasted Honeyeater to the large Flying Fox. It is significant that birds such as the Collared Lory, which flies in small groups well above the forest canopy, and the White-collared Kingfisher, which is found throughout the bush, perching on conspicuous dead trees protruding above the canopy, should figure so prominently among the kills; such birds being particularly vulnerable to the Peregrine's hunting methods. The Jungle Mynah does not penetrate far into the true forest, so the Peregrines must hunt at least as far as the forest edge. With its white wing patches and habit of flying well clear of cover the Mynah must make a conspicuous target. Small birds such as the Orange-breasted Honeyeater could be taken almost anywhere about the mountain, as they are very common there, while the White-rumped Swiftlet is common everywhere. As might be expected from the Peregrine's manner of hunting, birds which stay close to cover do not seem to be taken commonly, although the high incidence of Golden Whistler kills is slightly puzzling in this regard. Pigeons are common and perch conspicuously, but Peale's Pigeons perched in a tree top did not fly up when a Peregrine passed overhead, and if this is a typical reaction, it should afford them some protection. Their place is perhaps largely filled by the lumbering and easily available Flying Fox, for the number of pigeon kills is surprisingly low. The Flying Fox is not strictly nocturnal, individuals being seen over the canopy in the middle of the day, flapping slowly about with the ruff of blond fur behind the head particularly conspicuous. With their slow flapping flight they must be an easy target for a stooping Peregrine.

Like Peregrines the world over, the Fiji falcons seem to take most of their prey on the wing, although it has been said that they take poultry sometimes (Brewster 1922: 110). The birds were often seen flying back and forth over the forest, usually two or three hundred feet above the canopy, but sometimes much lower, evidently hunting. At other times they would fly low over the cliffs, combing the bush on the less precipitous rock faces and about the summit. No actual kills were witnessed, although on one occasion the male launched himself from the rocks and went into a steep dive or stoop with barbed, partially folded wings. Unfortunately he disappeared behind intervening trees, but evidently killed as he took a kill into the eyrie a few minutes later. Another stoop of several hundred feet was also witnessed, the male bird coming down at tremendous speed at a sharp angle from near the summit, passing a few feet over my

lookout and into the valley beyond, with the sound of the wind in his wings clearly audible. Again the trees blocked my seeing the end result of this dive.

Peregrine diet probably also includes the occasional rat and lizard, as on one occasion one of the birds was seen to leap at and pursue something along a ledge, although it did not catch it. In 1969 a headless rat carcase with the belly eaten out of it was found on a ledge high on the eastern cliffs, and was probably a Peregrine kill, but was not closely examined at the time. Brewster considered the Peregrine an Osprey, as the Fijians insisted it ate fish (Brewster, Document 24). This is a persistent belief, still met with in the Namosi area today, and there may be some truth in it, as it is not entirely unprecedented for Peregrines to take fish (Brown & Amadon 1968: 854).

A list of birds seen within 1½ miles (2.4 km) of Joske's Thumb during my observations of 1971 is given as Appendix I. This not only provides a checklist of the local species but also indicates the range and proportion of species used as food by these Peregrines.

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APPENDIX I

BIRDS SEEN WITHIN 1½ MILES (2.4 KM) of JOSKE'S THUMB
DURING 1971

* Positively identified prey species

† Tentatively identified prey species

Reef Heron	<i>Demigretta sacra</i>
Fiji Goshawk	<i>Accipiter rufitorques</i>
Swamp Harrier	<i>Circus approximans</i>
Peregrine Falcon	<i>Falco peregrinus</i>
* Many-coloured Fruit Dove	<i>Ptilinopus perousii</i>
* Golden Dove	<i>Ptilinopus luteovirens</i>
Friendly Ground Dove	<i>Gallicolumba stairii</i>
* Peale's Pigeon	<i>Ducula latrans</i>
† White-throated Pigeon	<i>Columba vitiensis</i>
* Collared Lory	<i>Phigys solitarius</i>
Yellow-breasted Musk Parrot	<i>Prosopoeia personata</i>
Fantailed Cuckoo	<i>Cacomantis pyrrhophanus</i>
Long-tailed N.Z. Cuckoo	<i>Eudynamis taitensis</i>
Barn Owl	<i>Tyto alba</i>
* White-rumped Swiftlet	<i>Collocalia spodiopygia</i>
* White-collared Kingfisher	<i>Halcyon chloris</i>
White-breasted Wood Swallow	<i>Artamus leucorhynchus</i>
* Polynesian Triller	<i>Lalage maculosa</i>
Island Thrush	<i>Turdus poliocephalus</i>
Fiji Warbler	<i>Vitia ruficapilla</i>
Spotted Fantail	<i>Rhipidura spilodera</i>
Slaty Flycatcher	<i>Mayrornis lessoni</i>
Fiji Shrikebill	<i>Clytorhynchus vitiensis</i>
Black-faced Shrikebill	<i>Clytorhynchus nigrogularis</i>
* Vanikoro Broadbill	<i>Myiagra vanikorensis</i>
Blue-crested Broadbill	<i>Myiagra azureocapilla</i>
Scarlet Robin	<i>Petroica multicolor</i>
* Golden Whistler	<i>Pachycephala pectoralis</i>
* Orange-breasted Honeyeater	<i>Myzomela jugularis</i>
* Wattled Honeyeater	<i>Foulehaio carunculata</i>
Giant Forest Honeyeater	<i>Gymnomyza viridis</i>
Layard's White-eye	<i>Zosterops explorator</i>
Grey-backed White-eye	<i>Zosterops lateralis</i>
* Red-headed Parrot Finch	<i>Erythrura cyanovirens</i>
Pink-billed Parrot Finch	<i>Erythrura kleinschmidti</i>
Pacific Golden Plover	<i>Pluvialis dominica</i>
Strawberry Finch	<i>Amandava amandava</i>
Indian Mynah	<i>Acridotheres tristis</i>
* Jungle Mynah	<i>Acridotheres fuscus</i>
Red-vented Bulbul	<i>Pycnonotus cafer</i>
Malay Turtle Dove	<i>Streptopelia chinensis</i>