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The White-throated Rail *Dryolimnas cuvieri* on Aldabra

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Contents

The White-throated Rail of Aldabra, *Dryolimnas cuvieri aldabranus*, is the last surviving flightless bird in the western Indian Ocean. Their numbers are estimated very approximately as at least 1000 birds, mostly found on Middle Island but also on Polymnie, Ile aux Cèdres, Michel, and many of the small islets off the lagoon shore of Middle Island. The adults have no serious predators in their present range, but were probably exterminated from South and West Islands by cats. Rails apparently thrive in areas with quite high populations of rats. They are omnivorous, though preferentially insectivorous and occasionally scavenging. They often feed by following tortoises, taking invertebrates from the disturbed litter. The range of calls is wide, and those recognized are listed with their suggested functions. Pair formation was not seen, and evidently takes place well before September. The pairs remain intact at least until February, when the chicks are nearly full grown. Monogamy is the rule although one exception to this is described. Display is described, particularly the aggressive defence of the nest.

Two clutches were found, of three and four eggs. The development of the chicks is described; they are nidifugous, and are fed by their parents at least while still in down. It is suggested that some young at least may stay with their parents until the start of the next breeding season. The mortality of young birds is probably very high.

Masses, measurements, and moult of trapped birds are given, and criteria given for separating the sexes. Sightings of marked birds indicated that while most birds are sedentary and territorial during the breeding season, some are transient and may move as far as $1\frac{1}{2}$ km.

Conservation is discussed, with particular reference to the postponed military development. Although the species apparently thrives in its present range, it is so restricted as to give rise to grave concern for its future.

1. Introduction

Benson (1967) has given an account of the systematics of the genus *Dryolimnas*, and has reviewed its past status in the Aldabra archipelago. *D. cuvieri* has been separated into three subspecies, of which the nominate survives on Madagascar but is extinct on Mauritius, *abbotti*

is extinct on Assumption and also on Cosmoledo and Astove, if indeed it was this subspecies which occurred on the latter two islands, and *aldabranus* survives on parts of Aldabra. From the measurements given by Benson (1967) it might be inferred that *abbotti*, with a longer wing, was more strongly flighted than *aldabranus* is today. Both *abbotti* and nominate *cuvieri* have a much shorter tarsus than *aldabranus*. *D. aldabranus* is very quick on its feet, but does not use its wings in normal running; in scaling rocks and tree stumps, however, it shows the flying abilities of the average domestic hen, using the wings to assist it in jumping. As the last surviving flightless bird of the western Indian Ocean it is clearly worthy of more detailed study than we were able to undertake.

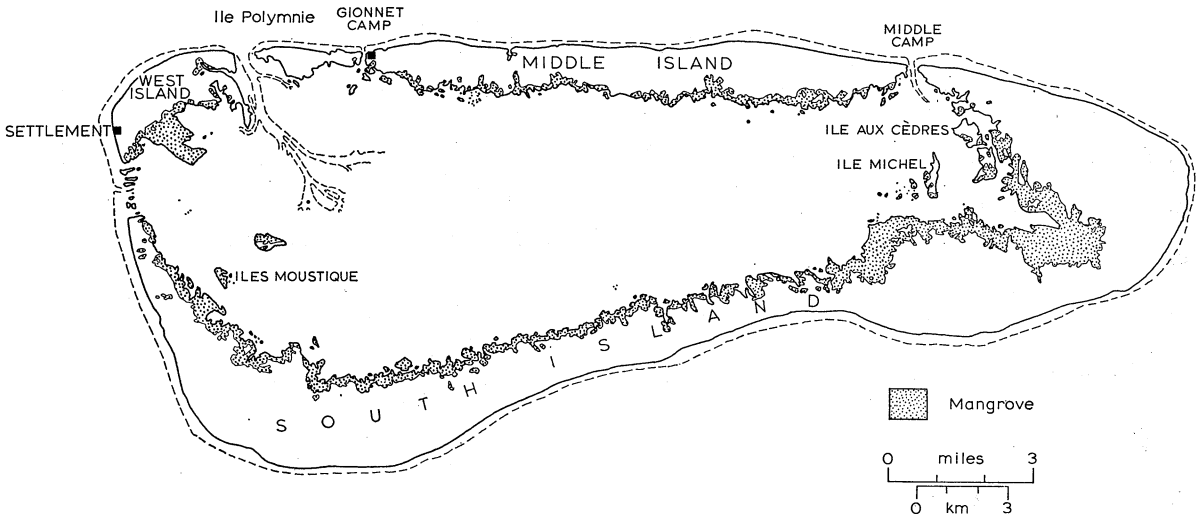

FIGURE 1

Evans (1898) lists the less recently extinct birds of the region; the literature on the rails is sparse and for the most part restricted to brief descriptions by the earlier travellers such as Nicoll (1906) and Meade-Waldo (1908). Rand (1936) gives a fairly comprehensive account of *D. c. cuvieri*, including notes of some of its calls,† from which it appears that *D. c. aldabranus*, apart from its loss of flight, is very similar to the Madagascar form. Streseman (1932) comments on the modifications of plumage which accompany flightlessness.

The principal aim of the study was to investigate the numbers, distribution, and ecology of the rails. Initially there was some urgency in establishing the basis for a conservation programme as the development of an air staging-post on the atoll was imminent. When this development was postponed, the scope of the work was changed slightly with a view to a longer-term study.

Both authors were principally concerned with other groups, Penny with shore birds and Diamond with sea birds, so that observations on rails were intermittent. Penny was on Aldabra from September to the end of December 1967, and Diamond from September 1967 to March 1968 (chiefly on Middle Island where the rail is most abundant). C. W. Benson worked on land birds for part of this period, and has passed on many valuable observations. Additional information came from other members of the expedition and some has been used in this paper.

Field observations of a more or less random nature, including those made in the course of

† Van Someren (1947) also describes the call of *D. c. cuvieri*, but his description is unlike anything we heard at Aldabra.

other activities, made up the bulk of our work. In addition, we trapped birds around two camps on Middle Island, at Middle Camp at the east end and Gionnet at the west, and marked them with individual combinations of coloured rings. Subsequent observations of these birds gave valuable information about territorial and sexual behaviour and, if observations are continued in the future, will lead to estimates of the birds' longevity.

2. Distribution and numbers

Rails occur on two of the major islands of Aldabra, Middle Island and Polymnie, on mangrove-covered islets in the lagoon permanently separated from Middle Island by water, and on Michel and Ile aux Cèdres off South Island.

The major vegetation zones on Middle Island are the mangroves, which fringe the lagoon shore and are also found in pockets inland, the dense scrub of *Pemphis acidula* which covers most of the interior, and the more open mixed-species bush along the north coast, including the low ridge running the length of the island. Rails occur in all these habitats, and also on the pebble beaches in Passe Gionnet and the occasional sand beaches along the north coast. The sea shore is relatively inaccessible to them, being fringed with overhanging cliffs for most of the length of Middle Island and Polymnie, but where beaches exist the rails will go down to the edge of the sea. Rails were not recorded on West Island or South Island, although they almost certainly existed there in the past (Ridgway 1895; Voeltzkow 1897). We could not confirm the rumour that some birds survive on Iles Moustique; since the whole of this islet is flooded at high spring tides it seems unlikely that they would ever have occurred there.

The estimation of numbers was extremely difficult. By marking and releasing birds in a study area at Middle Island we established that there was a resident population of at least 11 birds in an area about 400 m square, with as many as six unmarked birds being seen at one time. A bird was regarded as resident if it was seen longer than a month after being marked in the area where it was caught. The birds are evidently not entirely sedentary (see page 545); thus the population in any area is to some extent fluid, apparently even during the breeding season. It is possible that the presence of an inhabited camp at the eastern end of Middle Island may have affected the number of birds in the area over a period of months. The camp at Gionnet, however, was occupied infrequently for a few days at a time and is unlikely to have affected the rail population.

Extrapolation from the figure for the population in the study area gives a total population for the northern edge of Middle Island of about 200 individuals, assuming that the density of birds is uniform throughout the open bush similar to that in the study area. However, in a very much smaller area of superficially comparable bush, bounded by dense *Pemphis* scrub, at Gionnet, there were at least five resident birds, along with three chicks hatched during our visit to the atoll. The clear area around the camp at Gionnet is little more than 100 m square, with an apparent density of rails that is four times the maximum density at Middle Camp. Thus the figure of 200 birds for the mixed bush habitat is only approximate.

Counting rails in the mangroves is impossible without a great deal of very arduous field work. The area of mangrove on the southern edge of Middle Island is at least two or three times that of the open scrub and we have no idea of the density of rails in it, except that they are frequently heard and occasionally seen.

Rails were also recorded in the dense *Pemphis* scrub; they appeared to be sparsely scattered

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

in small numbers, but this impression is probably due in large part to the extreme difficulty of seeing anything in this habitat.

From the inadequate data available, we estimate a population of at least 1000 birds on Middle Island. We have no data for the number of rails on other islands, but they are unlikely to exceed the probable error in the estimate for the Middle Island population.

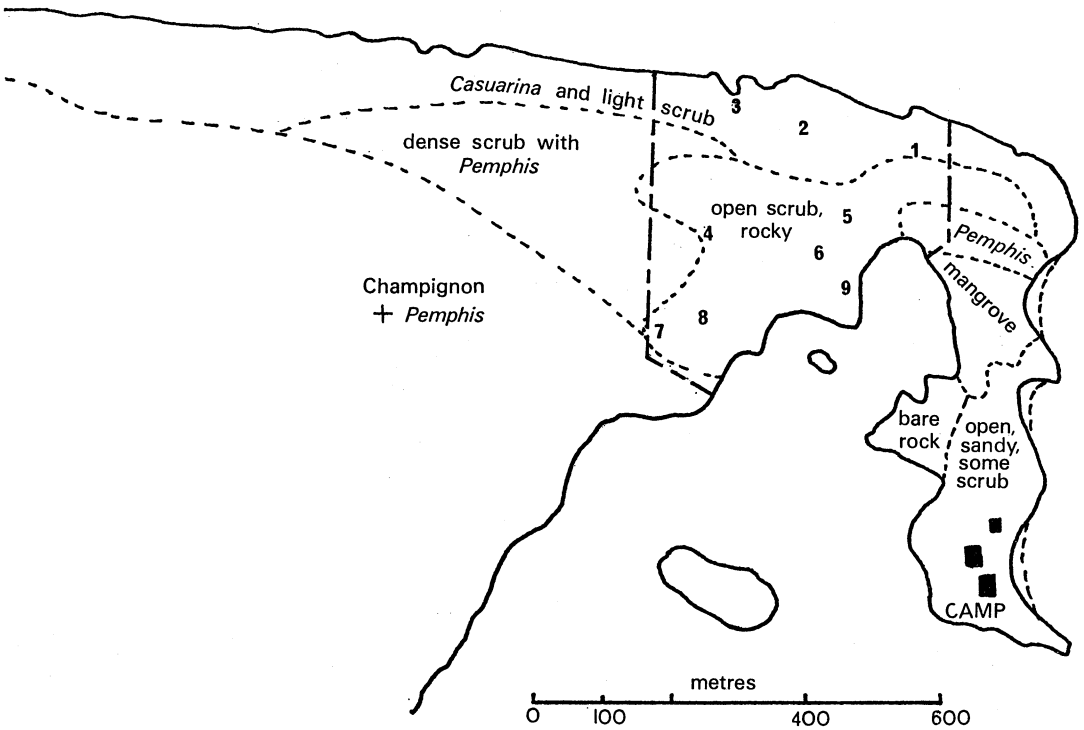

FIGURE 2. Sketch of Middle Island camp and study area; numbers represent labels on prominent trees. Approximate vegetation boundaries shown by dashed lines.

3. FOOD AND FEEDING

Rails are carnivorous, insectivorous, and scavenging; they will investigate any strange object as potential food. Their chief feeding sites are among leaf litter in mixed scrub, in the mud at the base of mangrove trees, and on rocky or sandy shores. They seemed to have a distinct preference for shade, and were very rarely seen feeding in open sunshine.

Food was collected by methodical foraging among leaf litter, including the carpet of *Casuarina* needles covering much of the Middle Island study area, the birds following the line of small rocky outcrops and the bases of trees, and paying particular attention to little pockets of litter in the many small shallow solution holes in the rock surface. Prey species were not collected or closely identified, but in places where birds were seen feeding an assortment of small beetles and other invertebrates was found. On several occasions, rails took Tabanid flies from tortoise carapaces, and one was seen pecking at the head and front legs of a tortoise, which responded by withdrawing into its carapace. Probably flies or mosquitoes, which congregate in the shade of the carapace, were the prey on this occasion. A tortoise which died in the middle of the study area was infested with small beetles and blowflies, and a rail was seen taking these, and the eggs of the flies, but not the flesh of the tortoise (although the flesh of dead crabs was taken when

available). Rails would also follow passing tortoises to feed in the litter disturbed by their passage, rather as Cattle Egrets *Bubulcus ibis* follow ungulates. Rails would respond to any disturbance of the undergrowth by hurrying to the spot to feed. Termites were taken from a dead *Pemphis* branch at Gionnet, and rails also took eggs and larvae, though apparently not adults, of the large red wood ant *Campanotus maculatus* subsp.

Although dead crabs were an effective bait for rails, and formed the staple diet of captive birds, rails were seldom seen to attack live land crabs. One one occasion a female with four young was watched pecking circumspectly at a live shore crab (? sp.) but did not apparently eat it. Other littoral prey included small molluses (*Littorina* sp.) taken from just above the tide line on the rocks, and snails and small crabs from among the roots of mangroves.

Almost any bait would attract rails to traps, including inorganic lures such as silver paper. More natural objects which were taken without hesitation included crushed chiton, broken hermit crabs, and *Conus* molluscs. Biscuits, cheese (especially successful), fruit loaf, cake crumbs, and chopped fish were also taken. The only organic item rejected was the siphon of the broken *Conus*; this is used by the live *Conus* to inject poison into its prey and is presumably unpalatable. It was rejected on several occasions when the rest of the animal was eaten.

On one occasion, a rail was seen to jump up to the lower branches of a small shrub, about a metre high, with the aid of its wings, and clap its bill as if trying to catch insects although none could be found on the branch.

In dealing with hard items of food, the birds had a distinctive method of attack. The food, perhaps a crab's leg or a piece of chiton (or a ball of silver paper) would be placed just in front of the bird's feet, and a series of deliberate pecks delivered from vertically above it. These pecks were at the rate of about one per second, and after every second or third peck the object was examined, and sometimes re-oriented before the next attack. A similar technique was used by a female defending her nest at Gionnet, when she attacked a human intruder, and occasionally by birds in the hand. This method seemed efficient in dealing with small crabs, but on larger specimens, particularly of land crabs with their harder carapace, it proved ineffective.

Rails kept in captivity in large cages at Settlement did well on a diet of freshly killed shore and land crabs, supplemented with biscuits, pieces of raw fish, and table scraps. These birds were given supplies of both salt and fresh water and drank both although the fresh water was preferred both for drinking and for bathing.

4. Breeding season and nesting

Two nests were found during our visit, one at Gionnet on 9 December with two (later three) eggs, and the other in the Middle Island study area, in construction on 22 November, and with four eggs on 15 December.

The nest at Middle Island was being built of *Casuarina* needles and grass, bunches being laid into the junction of a fallen tree with a small shrub. The nest was almost at ground level, but very well concealed by the foliage of the bush. The nest at Gionnet was also very well concealed, being at ground-level among the stems of a small shrub, and invisible from outside; the materials were similar, although *Casuarina* was a less important ingredient.

Both completed nests were in the form of a very deep cup, from the top of which only the bill of the incubating bird protruded.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

5. Predation

Although the concealment of the nest points to some predation in the past history of the species (and predators are numerous on Madagascar), the adults have no known predators at Aldabra. The only introduced predator whose range overlaps with that of the rail is the rat *Rattus rattus*, which is abundant at least at the eastern end of Middle Island, and all over South and West Islands. Rats must surely take some eggs from nests, and may also kill young chicks. No adult rails were seen with more than one chick older than a few weeks, so if clutches of three or four are typical,† then most chicks must die soon after leaving the nest. If the cause of death is predation, then rats would seem to be the most likely culprits, although the land crab *Cardisoma carnifex* may also find young chicks easy prey.

However, there is no reason to think that rails cannot withstand this putative predation, as there is no reason to believe that they are decreasing on Middle Island. But rats and cats may have been responsible for the extinction of rails on South and West Islands. Abbott (1893) stated that they had been exterminated by cats on South Island, and Fryer (1911) likewise around Takamaka. One sighting of a cat has been reported from Middle Island, but if cats are present there the number must be very small, or the rail would not still be surviving there. A bird such as this, which defends its nest vigorously, would be easy prey for cats, and it is easy to visualize a very few cats wiping out all the nesting rails within range. Cats are of course extremely difficult to see in the thick scrub generally prevalent on Aldabra.

Human predation is no doubt important in a very few areas at times, as the Seychellois labourers enjoy chasing rails and will eat them if they can catch them; but our general conclusion is that, although rails can withstand predation by a considerable population of rats, and possibly by land crabs and human beings as well, the introduction of cats will exterminate them.

6. Voice

Rails as a family have a wide vocabulary, and the Aldabra Rail is no exception. The calls we could recognize clearly are listed below, with their suggested functions.

(*a*) *Social calls*

'mping. The sound made almost continually by undisturbed birds in the undergrowth, especially when apparently alone, is a low-pitched staccato grunt, ' 'mp', which does not carry far to human ears. When this sound is made, the movements of the chest can be seen at a distance, and can be felt if a bird calls while being handled. This call may function as a contact-signal between birds out of sight of each other, perhaps between members of a pair. The female gives a call slightly higher in pitch than that of the male when the two are together. Rails will frequently come out of cover in response to imitations of this call. It is probably the call described for *D. c. cuvieri* by Rand (1936) as 'gub-gub-gub'.

Purring. Pairs foraging close together and in sight of each other give an almost continual low rasping sound; it is accompanied by visible movements of the throat but is rarely audible to human ears except at very close quarters. This call was only made by couples which for other reasons were considered to be paired.

† Abbott (see Bendire 1894) collected three $C = 2$, one $C = 3$, and one $C = 4$, but some of these may not be complete, having been collected between 13 and 22 December. In Ridgway 1895, Abbott is reported as finding $C = 3$ most common, with some $C = 4$. We found one $C = 3$ and one $C = 4$.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

Questing call. A call heard from both sexes, most often after the mate had just moved out of sight, was expressed in field notes as 'boomp wheeew?' or 'boop yeah?'. It is a plaintive, slightly trilled, throaty whistle, following an ' 'mp' as described above. It sounds like the beginning of the song, but is more contained and hesitant. Such a call was heard on one occasion without the introductory ' 'mp', but the circumstances suggested that it was functionally the same call. Rand (1936) describes a 'low plaintive call' for *D. c. cuvieri*.

(*b*) *Alarm calls*

Squeals. If a rail makes any vocal response at all to handling, it is a series of high-pitched, drawn-out squeals, delivered with the bill open. This must be classified as a distress call rather than an alarm proper, since it has the effect of bringing nearby birds running to the spot (Boudreau 1968). It was heard in the field only from birds which had been trapped except on one occasion when it was given by a female which had been sleeping under a bush and was disturbed by a passing tortoise. In this case the series was very short, and the bird almost immediately set off after the tortoise, feeding in its wake among the leaf litter.

When a cat approached a cage containing two captive rails one of the birds uttered a rapid high-pitched two-note 'wolf whistle', one note rising and the other falling. This was heard several times during the first few days of the birds' captivity, and may have been a true alarm call, but it was never heard in the field. Rand (1936) notes a similar call in *D. c. cuvieri* as 'tsikeu', given when a bird is surprised at close range.

(*c*) *Location call*

'*mpclick*. A call heard only rarely consisted of combined 'mp and click sounds, sounding like a snort through the bill. Its function was not clear, but it sounded like heavy sticks being tapped gently together, and it is tempting to regard it as the connexion between the success of stick-tapping in assembling rails, as frequently reported, and the birds' own vocabulary. It was heard in four situations in the field:

(i) Female in process of being ringed; mate, already ringed, prying round trap, removes bait and leaves clearing. Female, released, does not run (they rarely did), but stalks around clearing, giving 'mpclicks. Shortly afterwards she disappears purposefully. Pair later found together nearby, singing and later copulating.

(ii) Male and female moving about together, feeding. Male stops to climb into lower branches of small shrub. Female wanders about nearby, giving questing call. Male eventually descends and follows female, giving the 'mpclick call.

(iii) Two males disputing a territorial boundary. Pursuer gives 'mpclick call as he approaches intruder to drive him away.

(iv) Female, surprised during incubation, attacks observer fiercely, giving this call.

In the first two of these cases, the nearest human equivalent seems to be 'where are you?' or 'come back!'. In the latter two there is a strongly aggressive component, defending in one case a territory and in the other the nest. It is difficult to reconcile these two functions for the one call, so for the time being we can only place it very tentatively in the category of location call (which it seems to be at least in the first two of the above instances).

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

(*d*) *Sexual call—duetting*

The characteristic and most conspicuous call of the rail from early October to the beginning of February (when it was last heard) was the shrill and far-carrying song. This takes the form of a duet between the two members of a pair, usually, though not necessarily, in sight of each other.

The duet starts when one of the partners gives a series of 'mps, increasing in intensity and tempo, and rising slightly in pitch. This is followed by a series of rising notes, hesitant and slightly hoarse at first. We dubbed this the 'warming-up' period. Usually the other partner joins in at about this point, with or often without the preliminary 'mping; if the other does not join in, it utters a similar series of rising notes, and after five or ten asynchronous sets, the pair falls into step and the duet increases in intensity and pitch, the notes getting longer and the later ones being yodelled on two distinct notes, the second higher. Eventually a climax is reached, at which both partners, their heads tilted back, are producing shrill and extremely loud notes synchronously, nodding their beaks slightly as each note is produced. This may continue for a longer or shorter period, but eventually the calls of one partner tail off, leaving the other singing alone for a while before it too tails off into silence, the notes getting hoarser and fainter. The whole sequence may last more than a minute from beginning to end.†

This sequence of events was watched on several occasions, and followed a fairly consistent pattern. The birds usually started by facing one another, close together; as the sequence progressed their bills were progressively opened and raised until, at the end, they were wide open and pointing up at an angle of about 60°. On several occasions the duet was followed immediately by copulation.

Duetting was heard at all times of day, but especially at sunset. Rand (1936) notes that the 'long-drawn whistled calls' were particularly in evidence at dusk in *D. c. cuvieri*, and Abbott (in Ridgway 1895) comments that duetting in *D. c. aldabranus* is heard most commonly in the early morning and evening. It was heard several times at night, the latest time being 00h15 and the earliest 06h00, both at Gionnet. On 28 October, immediately after a light shower at 15h35, many pairs began duetting in a small area near Middle Camp. Social facilitation of this type was noticed frequently in the field, an outbreak of duetting spreading through the area at unpredictable times. If one of the two pairs in captivity at Settlement started singing, the other was very likely to strike up as well.

On several occasions duets were performed by quite widely separated birds, single birds being seen to begin duets in which they were joined by another, invisible to the observer. Once a pair duetted from opposite sides of the Gionnet camp site, separated by at least 10 m. This was a very short session, and the birds could probably see each other. This was unusual in another respect, in that the male, who crossed the site to mount the female (who submitted while he was still 2 m away) was not her accustomed mate, who had been ringed earlier.

(*e*) *Location call of chicks*

Chicks following an adult gave a continuous high rhythmic twittering call.

† The above description is by Penny, who watched duetting birds more closely and more often. Diamond's description differs only in that, in the early stages, one bird calls fast and the other slow; he is not clear whether this difference in tempo is maintained in the shrill climax of the song, or whether the birds become truly synchronous as described by Penny. Diamond also noted the sex of the bird giving the 'mp call during the duet, on two occasions involving two different pairs; on one occasion it was the male, on the other the female.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

7. Pair formation and territory

The first birds were ringed in October and many pairs had clearly been formed before then; several birds of each sex were seen only in the company of a second bird which, if it had been marked, was always identifiable as the same individual. Pairs were still intact after the young hatched in December and January. Evidently we were not on Aldabra early enough to see the formation of pairs (which may, of course, be stable for life once established), so we have no records of this, unless the 'extramarital' association at Gionnet, noted above, was a late and atypical pair-formation involving a female already mated but for some reason still receptive to another male.

Territories seem to conform to the 'neighbourhood' pattern of dispersion described by Fisher (1954), with groups of breeding territories dispersed within a matrix of common foraging ground. Marked birds were usually seen within a fairly restricted area, although some were occasionally seen outside it, but without encroaching on the area exclusive to another pair. One bird which was marked during an exploratory walk along the north coast of Middle Island, merely to avoid trapping the same bird on the way back, turned up in January in the middle of the study area at least $1\frac{1}{2}$ km from the place where it had been marked.

Fights were seen occasionally between males and birds of either sex, but always at the same place, on one side of a large clearing on the ridge in the study area. The defending male, unmarked, may have been the unmarked male of the pair which was later found nesting nearby. The intruding female was usually the same bird, and was marked. The intruding male involved in one or two of these incidents was also marked, and was the mate of the marked female.

Field observations indicated that pairs were stable, with the notable exception of the apparent polyandry seen at Gionnet. The pair which we trapped and ringed together on 24 November were seen calling and copulating when we returned on 9 December, and also on the following evening, when the female was seen after a duetting session running into thick cover carrying a large dead leaf. The following day (11 December) at 14h00, after a duet at long range, an unmarked male mounted the female and then left; ten minutes later the ringed male arrived and duetted with her, but they did not copulate. At 09h30 on 12 December, an unringed male again mounted the ringed female.

Observations in the Gionnet area, including the dense *Pemphis* bush inland from the camp site, accounted for 15 different birds between 9 and 12 December, of which two were seen in a patch of mangrove some distance away and separated from the rest of the area by dense scrub in which no birds were seen. Seven birds were seen in the immediate area of the camp, and six around two small dried-out pools in the *Pemphis* within 200 m of the coastal clearing. Of the birds within reach of the camp area eight were male and five female. The sexes can be distinguished by a difference in the colour of the upper mandible, as explained on page 541.

8. Display

If, as seems likely, the duet is a mechanism for the maintenance of pairs rather than their formation, then we must have missed the formation of pairs which might take place in or before September. We first saw copulation on 12 October at Gionnet, by which time birds were already in pairs both there and at Middle Camp. Thus we saw nothing we could recognize

as courtship; although the two types of display described immediately below may have been courtship activities, they are more likely to have contributed to the maintenance of the pair bond.

(*a*) *Allopreening*

This was first seen on 21 and 28 October, in two different pairs. In both, the female was preening round the head and particularly the eyes of the male, using secretions from her own preen gland. The male stood quite still, with head slightly lowered, and held this position as though hypnotized even when the female crouched in front of him, apparently soliciting copulation. After preening the male, and before crouching, the female had walked round him several times, her body touching his. Before preening started on the first occasion, the female took a small piece of food from the bill of the male; a similar movement was seen during the preening, although at that time neither bird had food in its bill and their bills touched only briefly. In the second pair, the allopreening was much simpler, consisting only of the female preening the head and eye of the male.

(*b*) *Greeting*

Displays which were apparently a form of greeting were seen on several occasions in the middle of November, between paired birds. When the pair met during foraging they would sometimes stand quite still, facing each other very close together, with their necks extended vertically and bills horizontal for a few seconds. No call was associated with this posture, but afterwards the birds would separate to feed and purring could be heard from both. This action was the only part of their behaviour in which the white throat patch was used in display, although, being visible from the side, it might well function at other times as a signal between birds especially in dark cover.

(*c*) *Climbing*

Another piece of behaviour which was seen once but whose significance is obscure may have been connected with the choice of nest site. The male of a foraging pair climbed up into the top of a small shrub, about 1 m high, and perched under the canopy of creeper where he was almost invisible. He sat there giving the questing call, while the female fed around the base of the shrub, apparently unimpressed by this unwonted display of agility. The end of the performance was spoiled by the observer's sudden movement, at which another pair nearby began duetting, and the male of the pair under observation descended and duetted with this mate. The following day a pair of rails was seen at the same place, and the male was again showing interest in the lower branches of a shrub, but this time he was jumping up at them as if trying to catch an insect, and did not attempt to climb.

(*d*) *Postcoital display*

After copulations seen at the Middle Island study area the pair separated and fed in the normal way; but after the unmarked male at Gionnet (noted above) had mounted the marked female, on both occasions he left in the same unusual way, walking with the head held down and wings slightly raised and spread to the level of his back. The significance of this posture is not clear, though it had much in common with the posture adopted by captive rails after bathing. It is most probably connected with the male's status as an intruder in an occupied territory and was thus an appeasement posture. A rather similar action is described by Wiens (1966) in a note on the distraction display of the Virginia Rail, *Rallus l. limicola*.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

(e) *Nest defence*

Rails feeding or nest building are not timid, although they usually keep out of the observer's way and are difficult to catch by hand. If the observer stays still they will approach and peck at him, but circumspectly and apparently out of curiosity.

However, the two pairs whose nests we found were very fierce and determined in defending their nests; the female in particular showed violent aggressive behaviour.

In the defence display of the female, the wings were held away from the body until they were almost vertical, and spread forward until they formed a ruff behind the head. The head was held low and forward, the bill level and pointing at the intruder, at whom the bird made little rushes with darting movements of the head, striking him several times with the bill and giving the 'mpclick call repeatedly. The bird worked her way around the intruder, sidling so that her head was always towards him; when an irregularity in the ground made it necessary to deflect her body, the wing on the side nearer to the intruder was lowered, so that the ruff was always behind the head, which was turned to face the intruder. As the display proceeded the wing posture was relaxed a little, but a slight movement by the intruder was enough to bring the display to its peak again. On one occasion the female broke off to feed on the eggs and larvae from a nest of ants near the nest.

As a rule, the male was present throughout this display, but he usually kept well in the background, making purring noises and adopting a less intense version of the female's posture. This was his role even when he was at the nest when the intruder appeared; he would usually leave the nest when first disturbed and call shrilly, and the female would come running in response. On one occasion neither parent was incubating when a nest was visited, but on all other visits one was incubating and the other was feeding nearby.

A modified version of this aggressive behaviour was seen in foraging birds from time to time; they would stop feeding and, with the head lowered and bill horizontal, and the feathers of the back slightly raised, advance with slow short steps—apparently at nothing. Meanley (1953) describes a somewhat similar posture at the beginning of a territorial skirmish among *Rallus elegans*, though his birds drew in the neck. However, few territorial encounters were seen in the Aldabra Rail, and those nearly all at the same place, on one side of a clearing where several nesting territories were probably distributed among the surrounding bushes. Such encounters were usually between males, but one female in particular seemed to have a penchant for trespass and was regularly driven off by an unmarked male; her mate was also the commonest intruder among the males. We concluded that this pair probably occupied the adjacent territory.

These territorial attacks were not ritualized in the same way as the nest defence. The defending male would run at the intruder with head down and bill out, and the back feathers slightly ruffled, whereupon the intruder took to his heels. On only one occasion was the pursuer seen to strike the departing invader; the feet were never used as weapons, nor was the small claw which all rails carry on the bastard wing. In the hand, however, the feet were frequently kicked vigorously in an attempt to break free. Abbott, in Ridgway (1895), describes Aldabra rails 'flying at each other like game cocks' and fighting vigorously, but without causing much injury (p. 528). We saw no fights as violent as this; in most cases the defeated bird retreated without any blows being struck.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

9. Care and development of young

(*a*) *Care*

Rails are nidifugous; chicks in the black downy stage were seen following their parents, and juveniles were found alone, away from their parents, at the age of about 6 weeks (although they might also be found with their parents after this stage). By this time, when they are about three-quarters grown, they are evidently capable of feeding themselves; one such bird was seen eating a dead crab. While they are still downy, however, the chicks follow the parents around very closely, to the extent that sometimes the adult seems to trip over the young. In a family with three downy chicks at Gionnet, only once were all three chicks seen with one adult; usually, one chick would go off with one adult, the other parent looking after the remaining two young. The adults fed normally, turning leaves vigorously, and occasionally picking out prey; some of these were placed in the end of the chick's bill. On one occasion an adult, with three chicks in attendance, was seen prodding rather hesitantly at a crab in which two of the chicks were showing interest. The crab was not trying to escape, probably having been stunned by blows from the adult, but it was apparently not eaten. The same adult was later seen with the chicks, drinking from a pool of salt water. At Middle Island, an adult and a fully-feathered juvenile were seen feeding together in the mud among mangrove roots.

We do not know for how long the fledged young remain with their parents, but they may well remain until the onset of the next breeding season. Two different pairs were seen to tolerate the presence of a small bright-billed bird; in the case of the pair at Middle Camp, this third bird was not seen after the downy chick appeared. These may have been young of the previous season which had not separated from their parents; in both such trios, the third bird had a bill much brighter in colour even than that of the female of the pair.

(*b*) *Development*

The chicks hatch covered in shiny black down, tinged with olive; the legs, feet and bill are black or dark brown, and the iris olive-green. Over the next few weeks the down becomes dull brown with a strong olive tinge, and the feathers of the upperparts begin to show through the down. On the face, dirty white feathers appear over the ear-coverts, and later around the eye and on the cheeks and malar region. The head is a uniform olive-brown by the time the chick's mass is 110 g, possibly due to abrasion of pale tips of the feathers (Staples & Harrison 1949), but the chin and throat remain whitish (clean white in a few individuals, but rarely as strikingly white as in the adult). The breast shows a reddish tinge on a predominantly greenish-olive base from mass 160 g or earlier, but the full adult colour of bright chestnut is presumably not acquired until the post-juvenal (basic) moult. The fully feathered juveniles are always clearly distinguishable from the adults by their generally duller colouring.

The colour of the iris evidently changes in the first few months of life. In the adult the iris is chestnut to orange in colour; in three chicks for which it was recorded it was olive in two birds of mass 53 and 65 g, and greenish brown (probably merely an alternative description of the same colour) in another of 163 g. This last bird was caught three weeks later, of mass 198 g and with measurements within the range of adult females, and the iris was recorded as 'yellowish olive'; a week later its mass was 183 g (i.e. it had reached the asymptote of its mass increase) and the iris colour was unchanged. Presumably the olive colour is overlaid progressively by yellow pigment until the adult colour is attained.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

In all the rails which were examined for it, a digital claw was present just distal to the bastard wing, in chicks as well as adults. This claw is about 10 mm long and is not conspicuous, but can be felt against the base of the first primary. It was apparently not used in either locomotion or fighting.

10. Marked birds

Thirty-six birds were trapped, marked and released at two sites, as follows:

	♂♂	♀♀	unsexed	chicks	total
Middle Island	12	10	—	1	23
Gionnet	4	3	3	3	13
total	16	13	3	4	36

The birds were caught by one of three methods: in a drop-trap of wire netting, with one edge held off the ground by a stick attached to a piece of string which, when pulled, jerked the stick from under the edge of the trap and so dropped the trap over the bird; in a funnel trap made of wire netting; or by being driven into a mist-net pegged to the ground. The last method was the only one successful in catching chicks; the adults were so inquisitive that a piece of silver paper or a dish of water glinting in the sun was usually sufficient to bring them into the catching area. In addition to these methods, one chick was caught under a well-aimed straw hat, an adult caught its foot in the string leading to a drop-trap, and another was cornered inside a tent.

The trick of banging sticks or turtle bones together to attract rails is often quoted in the literature, and is certainly effective; but birds would come out of cover to investigate almost any disturbance in the undergrowth. The best attraction seemed to be the squeals of a bird in the hand, which on one occasion brought five adults to the scene. The attraction of disturbances in the undergrowth may be connected with the birds' feeding behaviour, in which they will follow a Giant Tortoise to collect the insects disturbed by its passage.

Birds were marked with spirally wound 'Darvic' rings, in one or two of six colours, on one or both legs; each bird was given a different colour combination so that it could be recognized in the field. Birds caught during the second half of the expedition were also given British Trust for Ornithology numbered metal rings which will probably last longer than the coloured rings.

Each bird was weighed and measured, and usually examined for moult, before being released where it had been caught. The colour of the base of the upper mandible was also noted as a guide to the sex of the bird.

The biometrics of all marked birds are given in table 1.

Four birds were kept in large cages at Settlement, originally for shipment to England in case the resident population were threatened by the military development of Aldabra. When this development was postponed, three of these birds were released at Gionnet. One died from unknown causes after several months in captivity, and its skin is at the British Museum (Natural History).

(*a*) *Sex differences*

Birds with a bright pink base to the upper mandible were classed as females, and those with this area dull or dark red as males. This distinction was based on our observations of copulating birds, where the female always had the brighter bill. The two colour groups are just separable by body mass and bill length, the male being larger in both, but these differences are not statistically significant (for bill length, p just exceeds 10 %). The plumage is the same in both sexes,

Table 1. Particulars of marked birds

rings	date	time	mass/g	wing	tail	bill (exposed)	tarsus	toe	moult
			Middle Island: males						
*R.R	21. x. 67	16h15	170	119	32	45.5	44.0	—	—
ED 43011	23. ii. 68	10h30	188	123	46	—	44.5	50	AA.H
†G.L	23. x. 67	09h00	162	116	39	44.5	44.5	—	A.H
SS 45345	13. ii. 68	19h30	191	123	—	44.0	42.5	47	AA.0
‡B.L	23. x. 67	16h20	204	110	31	43.5	42.5	—	AA.0
W.L	24. x. 67	07h55	153	110	31	42.5	42.0	—	AA.0
Y.L	25. x. 67	12h15	145	118	26	43.5	42.0	—	AA.B.TC
RG.R	28. x. 67	11h00	202	112	27	44.5	41.0	—	AA.B
ED 43010	11. ii. 68	10h00	190	121	—	—	41.5	—	AA.0
RB.R	28. x. 67	14h45	173	121	36	46.0	41.5	—	AA.B
Bl.L	30. x. 67	13h45	198	119	42	42.5	41.5	—	H
	31. x. 67	15h10	204	—	—	—	—	—	—
	1. xi. 67	18h00	210	—	—	—	—	—	—
	—	20h45	204	—	—	—	—	—	—
ED 43013	16. i. 68	08h30	190	—	—	—	—	—	—
	—	16h00	199	—	—	—	—	—	—
	27. i. 68	09h00	209	—	—	—	—	—	—
	25. ii. 68	10h15	209	—	—	42.5	(39)	47	*all* but H
R.R(2)	23. xi. 67	12h00	189	111	28	43.5	42.0	—	A.H.B.TC
	12. iv. 68	—	160	122	40	43.0	42.0	45	AA.0
Bl.R(2)	23. xi. 67	12h00	166	111	34	39.5	41.0	—	AA.B
RR.L	23. xi. 67	12h00	185	118	30	47.0	42.5	—	AA.H.B. TC
§GY.R	13. ii. 68	19h30	162	117	—	42.0	39.0	—	—
SS 45346	23. ii. 68	17h40	178	—	—	—	—	—	AA.0
			Middle Island: females						
G.R	3. x. 67	14h00	195	—	—	—	—	—	—
	30. x. 67	08h00	208	110	33	40.0	39.5	—	H
	31. x. 67	15h10	213	—	—	—	—	—	—
ED 43014	3. i. 68	19h30	155	—	—	—	—	—	H
	25. ii. 68	13h50	223	—	—	40.0	39.0	46.5	*all* but H
*Y.R	22. x. 67	11h00	168	110	30	40.5	41.5	—	AA.0
p/c.R	22. x. 67	16h45	160	105	26	39.0	43.0	—	AA.H.TC
R.L	25. x. 67	09h15	160	115	35	39.0	39.0	—	AA.0
SS 45342	11. ii. 68	10h00	170	113	—	40.0	38.0	42	WW
‡Bl.R	27. x. 67	16h45	184	107	29	40.5	41.0	—	AA.H
RY.R	28. x. 67	11h00	202	104	27	41.0	40.0	—	AA.H.B
RR.R	28. x. 67	10h20	138	114	32	41.0	39.5	—	A.0
RW.R	31. x. 67	19h00	170	117	38	41.5	41.0	—	A.H.B. TC¶
†RBl.R	21. xi. 67	10h20	166	106	37	39.0	39.5	—	AA.H.B
§GW.R	23. ii. 68	10h40	163	113	41	39.0	38.5	45	AA.H
ED 43012	—	—	—	—	—	—	—	—	—
			Gionnet: males						
W.R	12. x. 67	07h55	185	120	40	42.5	44.5	—	AA.0
RY.L	24. xi. 67	16h35	181	120	—	45.5	40.5	—	A.H.B.
	10. xii. 67	19h10	184	—	—	—	—	—	B.One TC
	28. i. 68	15h10	189	—	—	—	—	—	W.T. WC.TC
R/Bl.L	10. xii. 67	09h15	194	119	42	45.0	39.0	—	A.B
R/Bl.R	10. xii. 67	09h15	194	119	41	47.0	41.5	—	A.B
**YR.YL	28. i. 68	14h40	218	123	—	45.0	44.5	—	A.0
ED 43007	30. i. 68	11h00	212	—	—	—	—	—	—
	2. ii. 68	10h30	198	—	—	—	—	—	—

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

TABLE 1 (*cont.*)

rings	date	time	mass/g	wing	tail	bill (exposed)	tarsus	toe	moult
				Gionnet: females					
RW.L	24. xi. 67	17h00	160	120	—	38.5	36.5	—	A.H.B
	10. xii. 67	19h30	177	—	37	—	—	—	B
	30. i. 68	11h30	173	—	—	—	—	—	*all* but H
	2. ii. 68	11h15	177	—	—	—	—	—	WW
unmarked	25. xi. 67	09h30	173	114	40	40.5	39.5	—	A.0
R.L(2)	25. xi. 67	09h30	194	123	43	43.0	42.0	—	—
**GR.GL	30. i. 68	16h15	144	121	44	39.5	38.5	—	—
				Gionnet: unsexed					
B.R	11. x. 67	16h40	155	112	45	37.5	47.5	—	AA.H
				Chicks: Middle Island					
Y/Bl.R	3. i. 68	08h45	110	—	—	30.5	40.5	39	—
ED 43009	16. i. 68	16h00	163	95	—	34.0	42.0	—	—
	6. ii. 68	17h55	198	—	—	40.5	41.5	47.5	—
	14. ii. 68	07h10	183	127	47	43.5	43.5	47.5	—
				Chicks: Gionnet					
ED 43004	30. i. 68	11h00	61.5	—	—	24.5	32.5	—	—
	2. ii. 68	10h30	65.5	—	—	25.0	34.5	43	—
ED 43005	2. ii. 68	10h30	53	—	—	24.0	33.5	42.0	—
ED 43006	2. ii. 68	10h30	58.5	—	—	23.5	34.5	42.5	—

Rings are represented by the initial letters of the colours used; thus B = blue, Bl = black, R = red, etc. R (right) and L (left) after the full stop indicate the leg, except when both legs were ringed: then, for example, YR.YL = a yellow ring on both legs. Moult is shown by the initials of the tracts containing pin feathers. H = head, B = breast, TC = tail coverts, WC = wing coverts, WW = wings (and tail). A or AA represents the degree of abrasion, and 0 indicates that no moult was visible.

Measurements in millimetres.

*†‡§ known pairs marked with matching symbols.

¶ Possibly a juvenile.

and the behaviour was different only in the nesting season when the female was markedly more aggressive. Some individuals had to be classed as 'zeroes' in the field, as their bill colour was intermediate (see table 1). One individual, classed as a female, settled down in captivity with a female after fighting with a male; this may possibly have been a first-year bird in which the bill colour had not yet become differentiated.

The mean masses and measurements of trapped birds are given in table 2. The number of wing and tail measurements is small, because the wings and tails of most birds were so abraded that their measurements were difficult to take and were not meaningful. Only birds whose remiges and rectrices were fresh or only lightly worn are therefore included. The length of the middle toe was measured in some birds, for comparison with the figures given by Benson (1967); the males appear to have longer toes. (C. W. Benson (personal communication) has pointed out that *D. c. aldabranus* has a shorter middle toe than *D. c. cuvieri*, possibly as an adaptation to its drier habitat.)

In general, the females are smaller, but by margins which are variable and not statistically significant.

TABLE 2

(*a*) measurements of soft parts

	males				females			
	n	mean	range	s.d.	*n*	mean	range	s.d.
bill	17	44.1	39.5–47.0	1.94	14	40.2	39.0–43.0	1.21
tarsus	17	41.9	39.0–44.5	1.58	14	39.9	36.5–43.0	1.73
toe	4	47.3	45.0–50.0	—	3	44.5	42.0–46.5	—
ratio toe/tarsus	4	1.11	1.07–1.14	—	3	1.15	1.11–1.18	—

(*b*) average mass by month and sex

	males				females			
month	*n*	mean	range	s.d.	*n*	mean	range	s.d.
Oct.	10	179.6	145–204	22.14	10	179.8	138–208	24.50
Nov.	6	189.2	166–210	15.97	4	173.2	160–194	—
Dec.	3	190.6	184–194	—	1	(177.0)	—	—
Jan.	6	202.8	189–218	12.03	3	157.3	144–173	—
Feb.	7	188.0	162–209	14.89	4	183.2	163–223	—
aggregates	32	188.6	145–218	17.82	22	176.0	138–223	21.96

(*c*) average wing and tail measurements for birds whose flights were lightly abraded (A in table 1) or not abraded

wing	7	118.1	111–123	3.76	5	115.0	110–120	3.74
tail	5	38.4	28–42	5.94	5	36.0	32–40	3.39

TABLE 3. NUMBERS OF BIRDS WITH GIVEN TRACTS IN MOULTS, BY MONTH

	October	November	December	January	February
none	6	1	—	1	4
head	7	7	—	—	2
breast	4	8	4	—	2
tail-coverts	3	3	1	2	2
remiges	—	—	—	2	4
rectrices	—	—	—	2	2
wing-coverts	—	—	—	2	2
general body	—	—	—	1	3
	22	17	5	10	21

(*b*) *Mass*

The mass of individuals varied very widely, showing no correlation with time of day, season or sex. The greatest variation was found in a female, trapped five times between October and February, which varied between 155 and 223 g, i.e. by 44 % of the lowest mass. This range seems abnormal for a bird of this size (Nice 1938), but it is possible that the bird may have been carrying eggs when at her highest mass.

(*c*) *Moult*

A striking feature of nearly all the birds handled was the extreme abrasion of the flight feathers, which often had the frayed and tattered appearance of those of a caged bird. This may be due in part to the degeneration of the structure of these feathers as a concomitant of flightlessness (Stresemann 1932), coupled with movement through dense undergrowth.

From October to the end of December the only tracts in moult were the head, breast and under tail-coverts (table 3). In five birds trapped during this period, the wings were remarkably unabraded; but in one the thighs were nearly devoid of feathers. These may have been birds

of the year, just finishing the moult into adult plumage; but two of them had the faded bill colour typical of adult males and were more probably adult.

In January and February four birds were caught in advanced wing-moult. The primaries and secondaries moulted concurrently but in irregular sequence; groups of two to four feathers were dropped simultaneously from different parts of the wing. A typical record of such a bird in active wing-moult is given below:

		secondaries	distal:proximal	primaries
ring	date	9 8 7 6 5 4 3 2 1		1 2 3 4 5 6 7 8 9 10
RW.L	30. i. 68	1 1 1 0 0 3 0 0 0	left	1 1 1 1 x x x 1 1 1
		1 1 1 1 1 1 0 0 0	right	1 1 1 1 0 0 0 0 1 1

0, old feather; x, missing; growing feathers scored 1–5, 1 being a feather still in pin and 5 being full-grown.

Stresemann & Stresemann (1966) include *D. cuvieri* in their list of birds which moult simultaneously, on the basis of one specimen from Assumption, collected in March 1906, in which the primaries and secondaries are in pin, from 0.5 to 2.5 cm in length. Our records agree with this, although they show that the moult is not entirely simultaneous. Nicoll (1906), who probably collected the specimen examined by the Stresemanns, states that on Assumption all the wing feathers are moulted at once.

In three birds trapped by us on 23 February the feathers of the mantle were so worn as to give the appearance of pale scalloping against the dark background of the underlying feathers.

(*d*) *Movements*

Of the 22 adults marked in the Middle Island study area, 11 were seen again for more than 10 days afterwards; of these, 10 were seen for more than 3 weeks and eight for more than a month after marking. These 11 birds were classed as resident in the area, although the three not seen later than a month after marking may not have been truly resident. The remaining 11 were considered to be transient, although they may have been present throughout our study; direct evidence of transient individuals came from the bird which was marked $1\frac{1}{2}$ km away and was later seen in the study area (see p. 537). One of these 11 birds is of unknown status because it was marked temporarily with a pipecleaner wound round its leg and was not seen later than 5 days after it was marked, probably because the pipe-cleaner had dropped off.

Some of the birds were seen in fairly limited areas, and these were considered to be holding nesting territories; but others were seen apparently at random over the study area. The areas covered by the various pairs are shown in figure 3. The numbers represent numbered plastic sheets nailed to trees as landmarks. Sightings of marked individuals are given in table 4. The camp site and north coast birds are not included in the study area population. Two pairs, one at Middle Camp and the other on the north coast, each had a third small bright-billed bird in attendance until December, which may have been a young bird of the previous year (see page 540). Four other pairs were identified, being seen regularly together but not with other birds. Although their ranges overlapped from time to time, each pair seemed to hold exclusive rights over a part of its range.

At Gionnet, fewer birds were trapped in a much smaller area of open scrub. Of the five birds marked near the camp, all were seen again more than a month later. A bird which had been held captive at Settlement, and which had been trapped originally in the Middle Island

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

study area, was released at Gionnet on 9 December and was seen again on the beach where it had been released on 2 February.

At the Middle Island study area up to six unmarked birds were seen during a walk through the area on 4 January; at Gionnet there was at least one unmarked bird in the camp area after marking had ended. The unmarked birds at Middle Island may have been transient visitors

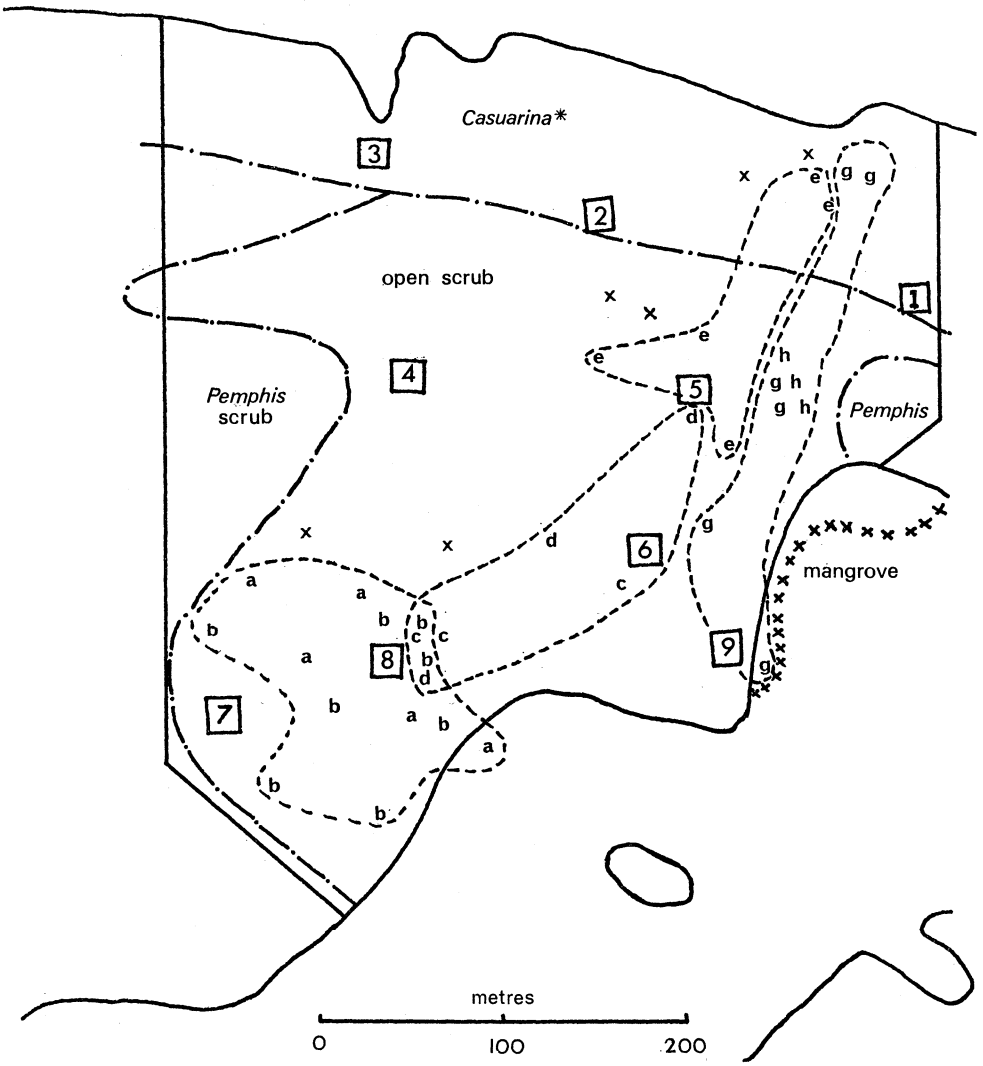

FIGURE 3. Sketch plan of study area, showing positions of trapping and resighting of certain rails whose territories could be defined. a, b; c, d; g, h represent pairs, a, d, and g being the males; e is a female whose partner was not identified. × marks positions of other birds near territories. Territorial boundaries dotted; broken line shows approximate vegetation boundaries. Numbers as in figure 2.

from elsewhere; this seems likely in view of the high intensity of ringing there. The unmarked bird at Gionnet may also have been transient, but neither of the birds marked in the scrub behind the camp appeared near the camp, and it may be that birds cannot move between areas separated by dense *Pemphis* scrub as easily as they can walk along the north coast at the other end of Middle Island.

Table 4. Resightings of marked birds within area of marking

		date ringed	dates resighted	status
		(*a*) Middle Island		
males	R.R	21. x. 67	22. xi., 18. xi. 18. i., 11. ii., 24. ii.	resident
	G.L	23. x. 67	18. xi. to 22. xi. 11. ii.	resident
	B.L	23. x.67	27. x., 18. xi., 19. xi.	?resident
	Y.L	25. x. 67	4. i.	resident
	RG.R	28. x. 67	marked on N coast 16. i., along coast 11. ii., trapped and 24. ii., sighted in area	transient
	Bl.L	30. x. 67	regular to Feb. in Camp	resident
	GY.R	13. ii. 68	24. ii.	?resident
females	G.R	3. x. 67	regular to Feb. in Camp	resident
	Y.R	22. x. 67	23. to 30. x., 19. xi. 23. and 24. ii.	resident
	p/c.R	22. x. 67	24. x., 27. x.	?
	R.L	25. x. 67	30. x. 11. ii., trapped	resident
	Bl.R	27. x. 67	30. x., 18. xi.	?resident
	RBl.R	21. xi. 67	22. xi., 4. i.	resident
	GW.R	23. ii. 68	24. ii.	?
		(*b*) Gionnet		
males	RY.L	24. xi. 67	9 to 11. xii. 29. i. to 2. ii., 15. ii.	resident
	YR.YL	28. i. 68	29 to 30. i., 2. ii. with chicks	resident
females	RW.L	24. xi. 67	9 to 11. xii. 28. i. to 2. ii., 15. ii.	resident
	GR.GL	30. i. 68	2. ii. with YR.YL and chicks	resident
'zero'	B.R	11. x. 67	2.ii.	resident

From the figures for Middle Island, with nine marked residents and up to six unmarked birds seen in the area at once, in an area of side 400 m, the figure of 9 to 12 birds per similar area of scrub was derived from which the estimate of the population was made.

11. Conservation

The proposals for constructing an air staging-post on Aldabra have been outlined by Stoddart (1968). The proposal which would have affected the rails most directly was the construction of a road linking West Island, Polymnie, Middle Island and the east end of South Island, crossing Main, Gionnet and East Channels. This road would have run along the northern edge of the atoll, through mixed scrub. This habitat probably carries the highest density of rails, and a considerable proportion of it would inevitably have been destroyed. Apart from any birds or nests directly destroyed during the construction of the road, many birds would have been forced into neighbouring *Pemphis* scrub, which appears to be a much less suitable habitat for them, and their numbers would certainly have been reduced. Further, the Seychellois labourers who would have presumably have been used in this work are fond of chasing rails and will kill them if they can catch them.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

However, the most important consequence of the construction of the road would have been the introduction of cats to Polymnie and Middle Island. The present precarious distribution of cats and rails has already been mentioned (page 534) and we have no doubt that the establishment of a population of cats on the remaining islets inhabited by rails would have led to the extinction of the rails. We know of no feasible suggestion for preventing cats from using the road to cross between the islands.

Even if no military (or civilian) installation is built on Aldabra, the possibility that cats may reach Middle Island and Polymnie represents a grave risk to the thousand or so remaining flightless birds of the western Indian Ocean. Although the rails are apparently thriving, their very restriction to so few islands is in itself a grave threat to the survival of the species. A few pairs of rails should be brought to Britain to maintain a stock of the species as a precaution against their extinction in the wild, as has already been done for such threatened species as the Hawaiian Goose (*Branta sandvicensis*).

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PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES