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THE KALIJ PHEASANT, A NEWLY ESTABLISHED GAME BIRD ON THE ISLAND OF HAWAII

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Kalij Pheasants (*Lophura leucomelana* ssp.) comprise a complex of nine subspecies within the gallopheasant group whose distribution extends from the Indus River of Pakistan in the western Himalayas, eastward through northern India, Nepal, Sikkim, Bhutan, and south through Burma to western Thailand (Delacour 1949). They are sedentary in forested foothills and mountainous country from 600–3400 m elev. along woodland roads, brushy ravines, and at the edges of forest clearings, but may move to lower elevations during winter (Bump and Bohl 1961, Bohl 1971).

Kalij Pheasants are easily raised in captivity and were present in European avicultural collections as early as 1857 (Gerrits 1974). They subsequently became common in American game farms, and following the turn of the century were first liberated into North American forests by the Connecticut Game Commission. Between 1962 and 1976 they were released in Tennessee, Virginia, Oregon, Washington, and British Columbia (Bohl and Bump 1970, Bohl 1971, Banks 1981). Apparently no sustained breeding populations resulted from these releases. In 1962 Kalij Pheasants were one of the many species of exotic game birds released at Puu Waawaa Ranch on the Island of Hawaii as part of the extensive liberation program conducted by the owners of the ranch (Lewin 1971). The present population on the Island of Hawaii is believed to have been derived solely from this release which consisted of 67 birds taken from Michigan and Texas game farms. Following release, Kalij Pheasants became so widespread and abundant that they were declared a legal game species in 1977.

Kalij live in close proximity to several endangered endemic forest birds (van Riper 1973, Sakai and Ralph 1978, van Riper and Scott 1979) on Hawaii island and are being considered for release at other locations within the State. However, nothing is known of their basic biology and the possible impact they might have on native fauna or flora via their food preferences, as reservoirs of disease (especially malaria), or indirectly by seed dissemination of exotic plant pests. It was for these reasons that we undertook to describe the successful colonization, food habits, behavior, and reproductive phenology of Kalij Pheasants on Hawaii island.

METHODS

Kalij Pheasants were studied from 29 January–25 June 1981. Forty-four pheasants were collected from widely separated areas on Hawaii island; however, most were from the Kona

Coast (36 were taken from the Makaula Ooma Forest Reserve, 5 from the Honaunau Forest, 1 from Manuka Forest Reserve, 2 from the Hamakua Coast, and 1 each from Humuula and Laupahoehoe forest reserves).

All pheasants were necropsied between 1–4 h after collection. Parasites were collected by standard techniques and results are reported separately (Lewin and Mahrt 1983). Standard body measurements were recorded, ovaries preserved in 10% formalin and the condition of the pre- and postovulatory follicles determined later under a dissecting microscope. Testes were preserved in Bouin's Solution, sectioned at 7 μ, stained with Heidenhain's Haematoxylin and counterstained with Eosin Y. Dating of ovarian events and determination of stages of spermatogenesis follows Lewin (1963). Contents of the crop and gizzard were preserved in 10% formalin.

Study skins were prepared from 10 pheasants for taxonomic determination. Eight have been deposited in the University of Alberta Museum of Zoology and two are in the Bernice P. Bishop Museum, Honolulu. The history of colonization and present distributional pattern are based on our observations supplemented by information from local biologists, ranchers, and land managers, and from previously published records (Pratt 1976, Katahira 1978, Mull 1978, Paton 1981). Scientific names of plants follows St. John (1973) while common Hawaiian plant names are from Porter (1972).

RESULTS

Taxonomy.—The nomenclature of Delacour (1949) was followed for the subspecies of *Lophura leucomelana.* Identification proved to be difficult as most of six males and four females prepared as study skins appeared to represent intergrades between the White-crested Kalij (*L. l. hamiltoni*) and the Nepal Kalij (*L. l. leucomelana*). These represent the westernmost of the nine subspecies described from their native Asian range. In the Western Himalayas the White-crested Kalij occurs from 366–3353 m elev. and in Nepal the black crested Nepal Kalij occurs from 1219–3048 m.

Dispersal.—The present population of Kalij Pheasants on Hawaii island results from a single release in 1962 at Puu Waawaa Ranch Headquarters of 67 birds. Shortly after their release they established a small breeding population in the exotic silk oak (*Grevillea robusta*) forest immediately above the release site. They were confined to this small plantation for the following 5 years.

Their subsequent dispersal across the island was reconstructed from 360 sight records collected since pheasants began their movements from Puu Waawaa (Fig. 1). Dispersal was in four directions, and by 1966 they had moved southward around both sides of Mt. Hualalai. By 1971 they were established on the upper Kona Coast above Kailua, after which they spread rapidly southward through the mid-elevation forests. By 1979 a few had dispersed around the southern flank of Mauna Loa and were seen only rarely at the southeastern margin of the Kau Forest. At present they are apparently absent from the central Kau Forest.

The eastern half of the island was populated by Kalij Pheasants which

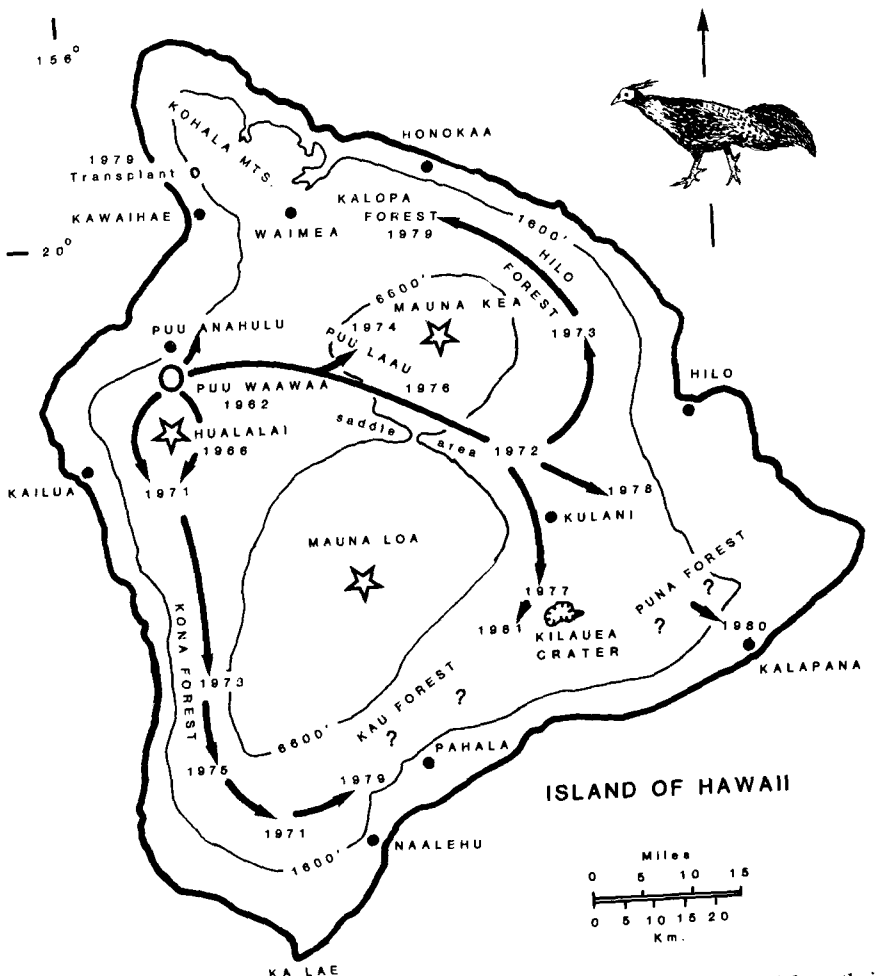

FIG. 1. Routes and dates of Kalij Pheasant dispersal on the Island of Hawaii from their original release site at Puu Waawaa.

moved from Puu Waawaa eastward through the drier saddle region (Fig. 1). By 1972 they had reached the mesic Hilo Forest which contained their preferred dense forest habitat. They subsequently moved southwest to the eastern edge of the Kau Forest (1981); southeast to the Kulani area (1978); and then rounded the eastern flank of Mauna Kea (1973). They reached their northernmost extension in 1979 at Kalopa Forest on the upper Hamakua Coast, where they are now common. The three extralimital

records of Kalij at Ka Lae, Kalapana (Paton 1981) and Hilo were of single adults near sea level, all at least 24 km from the main part of the inhabited range.

Kalij Pheasants dispersed at a rate of approximately 8 km/year and in 14 years colonized a major portion of mid-elevation forests on Hawaii island. Kalij have not yet colonized the central Kau or Puna forests, although this habitat appears suitable, nor have they penetrated farther north on the Kona Coast than Puu Anahulu, presumably because of the dry grassland barrier beyond. Their absence in the Kohala Mountains is apparently due to extensive grassland and sugar cane plantation barriers north of the Kalopa Forest population. However, in 1979, six Kalij Pheasants were transplanted to Konokoa Gulch north of Kawaihae on the west, lower flank of Kohala Mountain. The release site was in dense forest with permanent water. The upper extension of this gulch terminates in grassy pasture, however, and does not afford continuous forest cover with the central and densely forested Kohala range. Kalij, nevertheless, may eventually reach and colonize this extensive forest tract as they are capable of dispersal through marginally suitable terrain.

Analysis of occurrence records by elevation revealed that, although Kalij have been observed from sea level to 2450 m elev., 95% of the sightings were between 450 and 2150 m (Fig. 2). Utilizing the known distribution and elevation of sight records, in conjunction with the distribution of apparently suitable forest habitat, we calculated the total area presently occupied. Kalij Pheasants now occupy approximately 3500 km^2, or one third of the total island area.

Food.—We recovered a number of food items from crops and gizzards of Kalij (Table 1). The omnivorous nature of their diet is evident; however, plant materials comprise the bulk of their food and include fruit, seeds, leaves, flower buds, and starch from trunks of tree fern (*Cibotium* sp.). In addition to the 19 plant foods identified, Kalij were seen feeding on fruits of 'olapa (*Cheirodendron trigynum*), 'ohelo (*Vaccinium reticulatum*), manono (*Gouldia terminalis*), pilo (*Coprosma* sp.), hame (*Antidesma platyphyllum*), and jacaranda (*Jacaranda acutifolia*). A wide variety of animal food was also identified, with preferred items mainly snails (Gastropoda), slugs (Gastropoda), and sowbugs (Isopoda), which were often seen on rotting fruits of banana poka (*Passiflora mollissima*), the birds' main food item. Kalij also consume a wide variety of larval and adult insects, earthworms, and even bird eggs.

Kalij obtain food with their stout bill by overturning small rocks, and pushing them backward toward their feet; digging into hard or moist soil to obtain invertebrates; pecking at the soil surface for seeds or fallen fruit; plucking seeds or buds from small forbs; or, by feeding on fruit in shrubs

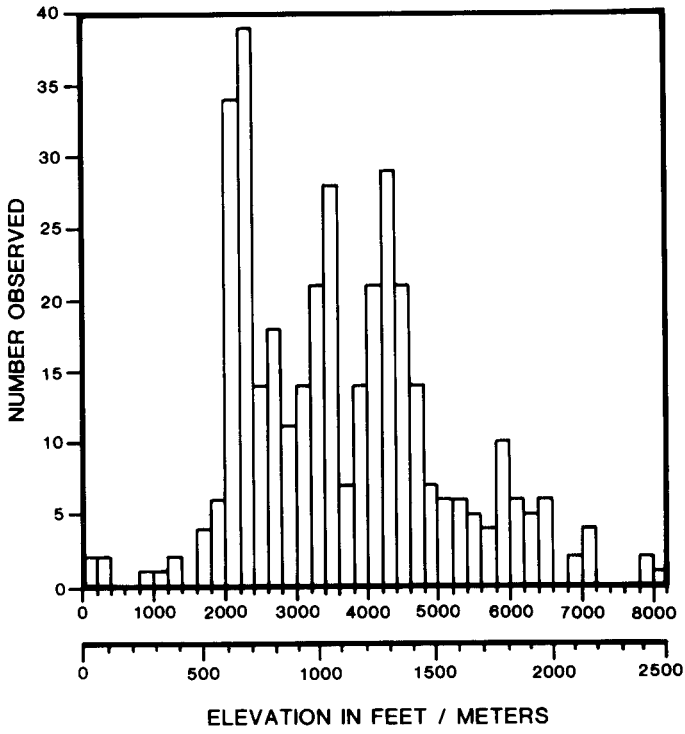

FIG. 2. Elevational distribution of Kalij Pheasants on the Island of Hawaii.

or trees. They are attracted to newly disturbed areas and are known to forage in the vicinity of tree cutting or tree fern harvesting operations within a half hour after the workers have left the area. Both pigs and Kalij forage in these disturbed areas for soil invertebrates and tree fern starch.

Fully 63% of the plant and 83% of the main animal food (gastropods and isopods) taken by Kalij are exotic species. The primary food of this pheasant is banana poka; 82% of the birds collected contained seeds and fleshy fruit of this vine. The exotic banana poka is regarded as the most important plant pest species in Hawaii (Warshauer et al. 1983). Thimbleberry (*Rubus rosaefolius*), another exotic pest, occurred in 36% of these pheasants. It was not uncommon to recover more than 100 banana poka seeds and several thousand thimbleberry seeds from a single gizzard.

Not all seeds are broken down by the grinding action of the grit in the gizzard, and many, apparently unharmed thimbleberry and banana poka seeds, occurred in the large intestine and feces. A germination test using

TABLE 1

FOOD ITEMS FROM CROPS AND GIZZARDS OF KALIJ PHEASANTS FROM HAWAII ISLAND

Food items	Status	% occurrence
Plant foods		
Banana poka (*Passiflora mollissima*)	exotic	81.8
Thimbleberry, 'ola'a (*Rubus rosaefolius*)	exotic	36.4
Tree fern, hapu'u (*Cibotium* sp.)	native	34.1
Gosmore (*Hypochoeris radicata*)	exotic	25.0
'Ihi (*Oxalis corniculata*)	exotic	18.2
Guava, kuawa (*Psidium guajava*)	exotic	18.2
Pukiawe (*Styphelia tameiameiae*)	native	18.2
Kikuyu grass (*Pennisetum clandestinum*)	exotic	15.9
Hawaiian raspberry, 'akala (*Rubus hawaiiensis*)	native	13.6
Poha (*Physalis peruviana*)	exotic	13.6
Passion fruit, liliko'i (*Passiflora edulis*)	exotic	9.1
'Ohelo (*Vaccinium calycinum*)	native	6.8
Drymaria, pipili (*Drymaria cordata*)	exotic	6.8
Misteltoe, hulumoa (*Korthalsella complanata*)	native	2.3
Candlenut tree, kukui (*Aleurites moluccana*)	exotic	2.3
Cassia (*Cassia bicapsularis*)	exotic	2.3
Air plant (*Kalanchoe pinnata*)	exotic	2.3
Cyanea, haha (*Cyanea pilosa*)	native	2.3
Holly, kawa'u (*Ilex anomala*)	native	2.3
Unidentified (seeds from 11 species, bulbs of one species)		2.3–11.4
Animal foods		
Gastropoda		
Small snail (*Oxychilus alliarius*)	exotic	31.8
Small slug (*Arion* sp.)	exotic	20.5
Large slug (*Limax maximus*)	exotic	18.2
Small snails (*Succinea* or *Catinella* spp.)	native	11.4
Large snail (*Bradybaena similaris*)	exotic	2.3
Isopoda		
Sow bug (*Porcellio* sp.)	exotic	18.2
Insecta		
Beetles, Coleoptera		11.4
Ants, Hymenoptera		2.3
Fly larvae, Diptera		2.3
Grasshoppers, Orthoptera		2.3
Butterfly larvae, Lepidoptera		2.3
Annelida		
Earthworm, Oligochaeta		2.3
Aves		
Bird egg shells		4.5

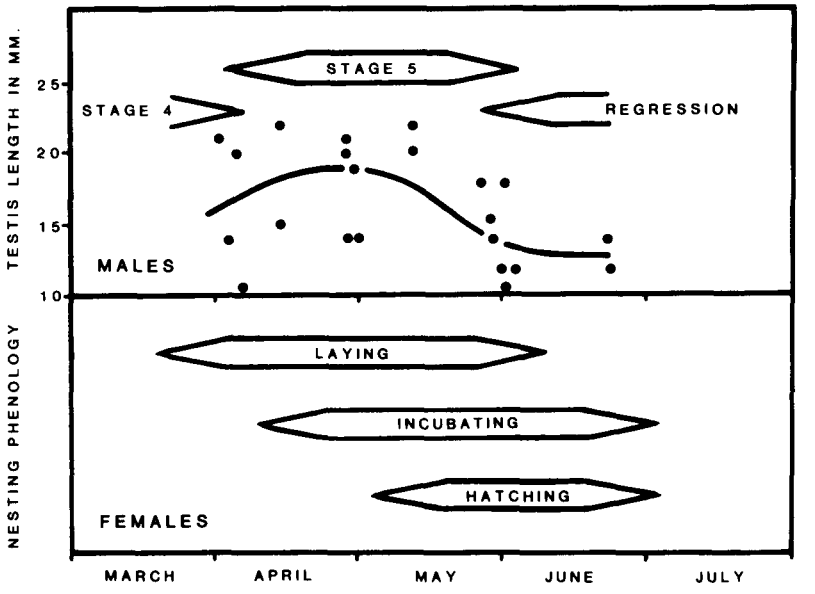

FIG. 3. Nesting phenology and testes size of Kalij Pheasants on the Island of Hawaii. The curve of average testes length is hand fitted to the data.

400 thimbleberry seeds kept on moist filter paper in petri dishes resulted in only one germinated seed. However, since large numbers are normally present in Kalij droppings, it seems likely that this bird might serve to disseminate viable exotic plant material via the intestinal tract. Apparently Kalij are also able to disseminate seeds or fruit attached to their feathers as five achenes of *Uncinea uncinata,* an endemic sedge, were found adhered to feathers of one bird's head and neck region.

Kalij use pieces of lava 2–10 mm in diameter as gizzard grit; however, the amount found was highly variable and ranged from 2–300 pieces. The gizzard also contained a variable number of hard seeds (range 0–472) which were usually banana poka, but some were from guava (*Psidium guajava*). Many of these seeds, especially banana poka, had been retained in the gizzard for sufficient time to erode, as the hard outer surface was worn revealing the characteristic pitted layer. By using regression correlation of log-log transformed data we compared the relationship between the number of lava rocks in the gizzard to the number of hard seeds, and found a highly significant negative relationship ($r = -0.612$, $df = 40$, $P < 0.01$). Thus, it appears that Kalij not only use the fruits of these two exotic plants for food, but also retain their hard seeds as gizzard grit.

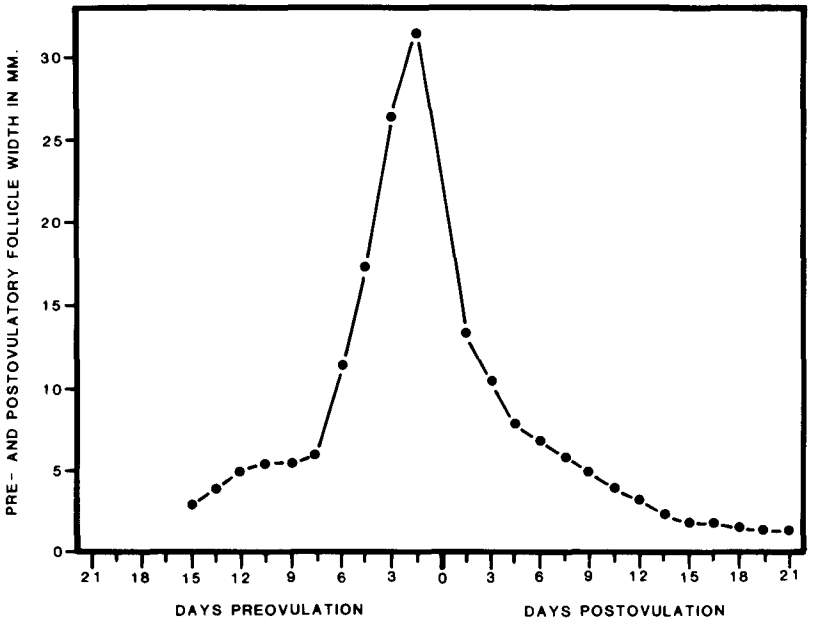

FIG. 4. The growth of the ova and regression of the residual ovarian follicle of Kalij Pheasants.

Reproduction.—Maximum testes growth, to slightly over 20 mm, is achieved by late March, and most males retain fully functional testes throughout April and early May (Fig. 3). During this time the seminiferous tubules are in the stage 5 condition, i.e., maximum numbers of spermatoza are being produced. In late May testes enter the regression stage, and by mid-June are at the overwintering length of about 10 mm.

Examination of the ovarian follicles revealed that laying occurred between mid-March and mid-June. By observing the number and size of both pre- and postovulatory follicles, we estimated that these pheasants lay from 10–17 eggs. Ova develop slowly, until about a week prior to laying, then undergo rapid growth and ovulate at a diameter of about 30 mm (Fig. 4). The remaining follicle undergoes resorption and reaches the minimum size in about 2 weeks. This curve may be used to predict the date of ovulation of any developing ovum or to postdate when any postovulatory follicle had ovulated its ovum. Thus, reproductive phenology of this pheasant may be determined by gross examination of female ovarian tissue between the beginning of March and the end of June. Additionally, if the inter-egg interval is 1.5 days and the incubation period is

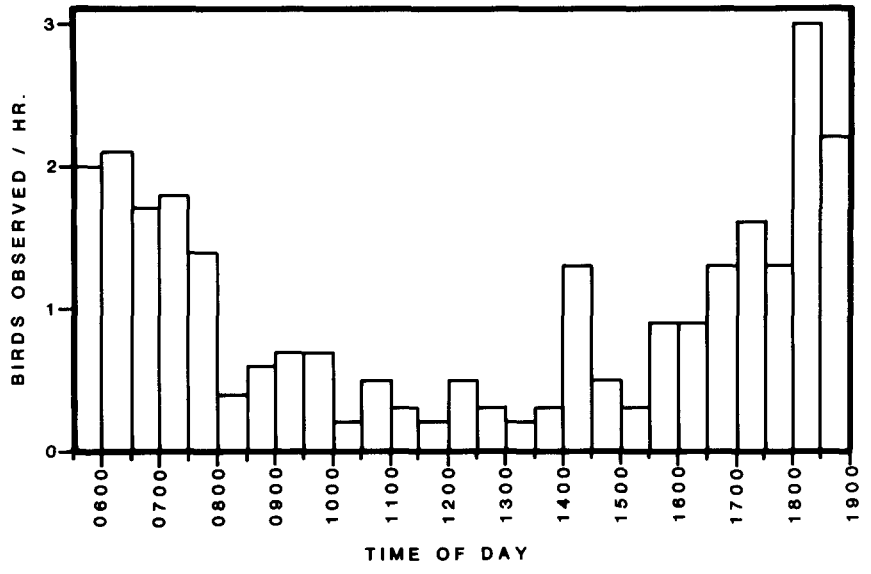

FIG. 5. Daily activity pattern of Kalij Pheasants on the Island of Hawaii between January and June 1981.

24 days (Delacour 1977) then a Kalij hen would take 21 days to lay 10–17 ($\bar{x}$ = 14) eggs and the chicks would hatch 45 days after the first egg was layed. The hatching period for the Hawaiian population was estimated to occur between the first week of May through the first week of July (Fig. 3). The testes and ovaries of all adult pheasants examined were fully functional indicating that all members of this population were capable of breeding as yearlings.

Behavior.—Kalij Pheasants had early morning and late afternoon peaks of foraging with lower levels at mid-day (Fig. 5). This is a typical activity pattern of most game birds. Kalij emerge from the forest at dawn and are particularly attracted to clearings or disturbed areas such as trails, roads, logging areas, and forest clearings. The practice of leaving log piles in newly cleared pasture adjacent to native forest is particularly attractive to these pheasants since they not only use the abundant new crop of exotic forbs but also use the log piles as escape cover. Kalij forage in pasture edges around these piles up to 100 m from thick forest cover.

During the breeding season the female almost always leads her mate by a few meters as they search for food. However, this activity is occasionally interrupted by three common behavioral patterns. "Wing-fluttering" is usually performed by the cock and consists of 8–10 rapid strokes

TABLE 2
SOCIAL ORGANIZATION AND SEX RATIO OF KALIJ PHEASANTS

Associations	Observations		Sex ratio males/females
	No.	%	
♂♀	49	39.2	49/49
♂	37	29.6	37/0
♀	16	12.8	0/16
♂♂♀	6	4.8	12/6
♂♂	4	3.2	8/0
♂♀♀	1	0.8	1/2
♀ + chicks	3	2.4	0/3
♂♀ + chicks	2	1.6	2/2
♂ + chicks	1	0.8	1/0
Sex undetermined	6	4.8	—
Totals	125		110/78 = 1.4 ♂♂/1.0 ♀♀

of half extended wings performed while the body is in an upright posture. It may be repeated up to four times with 30 sec intervals. It was primarily given by mated males but was seen occasionally in lone males and was observed once performed by a hen. It was mainly performed near the hen but in only half of the cases was the cock facing his mate. A male wing-fluttered towards us on one occasion as we closely approached a mated pair. Wing-fluttering may serve to facilitate pair bonding and also serve as a distraction or alarm display.

We observed the "run-jump" display to be performed only by mated males and was directed toward the hen. A male runs toward the hen from several meters ending the approach with up to four jumps, then turns away from her at a distance of 1 m. If this is performed with greater intensity, the male runs, then jumps toward his mate, circles her twice, then may perform a wing-flutter, but does not necessarily face her.

The "tail-fanning" display is also performed by mated cocks which run several meters toward their mate, to within 1 m, then turn sideways and fan their long, black tail feathers. The pair immediately resumed feeding following all of these displays.

Social structure.—The breeding associations of Kalij Pheasants in their native areas are unknown (Ali and Ripley 1969, Delacour 1977). In Hawaii, mated pairs were observed more often (41%) than any of the other sexual combinations (Table 2). We did note one case involving a male who was seen copulating with a hen while another hen stood immediately beside them. Ali and Ripley (1969) described an observation of a cock

with two hens and a brood of chicks. Monogamy may therefore be the rule in Kalij, with polygamy the exception.

Chicks can be cared for by the mated pair or by either sex alone. Lone cocks will apparently even brood small chicks as we observed a cock walk out of low, wet grass during a rain storm to reveal a brood of dry, downy chicks.

We were able to sex all but 6 of our 194 adult sightings. The sex ratio of these birds was 141 males/100 females. The excess number of males supports the alleged monogamous breeding system.

DISCUSSION

The successful colonization of Hawaii island by Kalij Pheasants can be thought of as a symptom of a degraded ecosystem, because the birds are in large measure dependent on both exotic plants and animals for food and cover. The birds are still rapidly expanding their range and we believe their colonization of this island is not yet complete. The three remaining uninhabited areas (central Kau and Puna forests, and Kohala Mountain), will probably shortly be colonized. It appears that the success of this species will prompt its transplantation to other areas on Hawaii, and possibly to other islands. Kalij apparently have the ability to enhance the establishment of exotic plant pests, and may act as a predator on rare endemic land snails. It is for these reasons, as well as their potential as disease reservoirs (Lewin and Mahrt 1983), that extreme caution is advised prior to transplantation. Certainly, stock should be obtained from areas free of banana poka.

SUMMARY

The colonization of the Island of Hawaii by the Kalij Pheasant (*Lophura leucomelana*) is described. This Himalayan game bird, released in 1962 at Puu Waawaa, has spread at the rate of about 8 km/year and now occupies most of the major forest areas between 450 and 2150 m elev. This population constitutes a new wild breeding species of game bird for the Western Hemisphere. The bird is omnivorous and relies heavily on exotic plants and animals. Their main food item is banana poka (*Passiflora mollissima*) which provides fruit as well as seeds for grit. The Kalij may play a role in seed dissemination of pest plants. The Kalij is mainly monogamous and yearlings can breed. Laying begins in mid-March and hatching terminates by mid-July. Daily activity patterns including foraging, pair bonding, and alarm behavior are described. Due to the potential for dissemination of exotic pests and possible impact on endemic biota, caution is advised on the inter-island transplanting of this exotic game bird.

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GEORGE MIKSCH SUTTON AWARD FOR ORNITHOLOGICAL ART

The Wilson Ornithological Society announces the establishment of the George Miksch Sutton Award for Ornithological Art. The Award will be given for art that would be suitable as a color plate in The Wilson Bulletin. The subject matter and medium are at the artist's discretion. Size of the artwork should be no smaller than 9¼ wide × 14 inches high and no larger than 18⅜ × 27¾. Any artist who has not been represented by a major gallery or who has not been featured in magazines such as Audubon or National Wildlife is eligible to enter. Prior publication of a color plate in a professional journal does not disqualify an artist. In short, the competition is primarily for artists who do not make their living, or a significant portion of it, by painting birds. Artists who question their eligibility should query the Award Committee when requesting entry information. Artwork will be judged by a panel of ornithologists and artists at the June 1985 Wilson Ornithological Society/Cooper Ornithological Society joint annual meeting in Boulder, Colorado. All qualified entries will be on display at the meeting. Artists should insure their entries both to and from the meeting and include a return mailer with postage attached. Matting and/or framing is at the discretion of the artist. The winner of the competition will receive a check for $500, and his/her artwork will appear as a color plate in The Wilson Bulletin. For further information and application form, contact **Phillips B. Street, Chairman, Sutton Award Committee, Lionville Station Road, R. D. 1, Chester Springs, Pa. 19425.**