GENERAL NOTES

Growth and development of major body components in the Monk Parakeet.—
The growth rates of a considerable number of bird species have been summarized (Ricklefs, Ibis 110:419–451, 1968; Ibis 115:177–201, 1973), yet among these there are few records for hole-nesting species and none for parrots. Caccamise and Alexandro (Wilson Bull. 88:495–497, 1976) have since published information on the growth rate of Monk Parakeets (*Myiopsitta monachus*), but they considered only age-specific changes in body weight. This paper provides information on egg size and nestling development and analyzes growth rates of major skeletal elements of Monk Parakeets.

While most species of parrots are hole or cavity nesters, Monk Parakeets are unique in building large enclosed stick nests, often communally (Caccamise and Weathers, Wilson Bull. 89:346–349, 1977; Forshaw, Parrots of the World, Doubleday and Co., New York, New York, 1973). These nests are occupied all year by mated pairs and by the young of the year for a considerable time beyond fledging (Alexandro, M.S. thesis, Rutgers Univ., New Brunswick, New Jersey, 1977). In a strict sense this species is not a true hole-nester since the nests are constructed of sticks. Considering the often massive size (200 kg) and sturdy construction of the nests (Roscoe et al., N. Y. State Fish and Game J., 1973), however, it is not surprising that this species demonstrates the large clutch-size (5–9 eggs) and slow growth rate common in many hole-nesting species (Lack, Ibis 90:25–45, 1946; Ricklefs 1968).

Methods.—Successive measurements were made on 2 young in 1975 and 3 young in 1976, that were reared in the outdoor flight cage described by Weathers and Caccamise (Oecologia 18:329–342, 1974). During both years the pair producing the young were part of a group of 6 birds collectively housed. I supplied freshly cut privit (*Ligustrum* sp.) twigs for nesting material. These birds used to construct the characteristic enclosed nest. The birds were provided with water, sunflower seeds, white bread and dry dog food ad libitum. Vitamins were added to the water, and fresh apples were placed occasionally in the cage. Though growth data were collected from nestlings in only 2 nests, 9 nests were under observation at various times during this study. One of these nests was built by free-living birds in New Jersey (Caccamise and Alexandro 1976). The others were the result of pairings by the remaining birds in the cage. Data were collected on rates of egg-laying and egg morphology from all nests.

In 1975, egg-laying was first observed during the first week in April when 2 eggs were discovered in the nest. This initial attempt failed, when the female of the pair died. After another pairing, a second clutch was begun on 3 May. Of the 5 eggs in this clutch only 3 hatched, 1 each day on 27, 28 and 29 May.

In 1976, the first nesting attempt began during the first week in April when 3 eggs were laid. This attempt failed when the pair undertook reconstruction of their nest on 13 April. The second clutch was begun on 5 May, with 8 eggs laid by 15 May. The first young hatched on 30 May. The other 3 eggs that hatched did so over the succeeding 3 days. One nestling (9 days old) died on 8 June.

Measurements of elements representing maximum perpendicular distance between articular surfaces of bones were taken regularly on live specimens throughout the growth period. They included bill width (at base where bill emerges from skin); bill length (tip of upper rhamphotheca to distal edge of cere); bill depth (perpendicular distance from distal edge of cere to ventral surface of lower mandible); and digit span (for this foot placed on flat surface and second and third toes aligned) which was recorded as the distance between distal ends of terminal phalanges of toes 2 and 3. Body length was the distance from the top of the head

(with bill held perpendicular to the long axis of the body) to the posterior end of the pygostyle. Also, feather length was taken from the distal end to the point of emergence from the skin. Measurements also were taken from 9 caged adults.

Results.—Eggs from 3 nests were measured within 3 days of laying. For 28 eggs, the mean length (±SE) was 27.2 ± 0.20 mm (range 25.0–29.7 mm) and the mean width was 20.5 ± 0.15 mm (range 19.2–23.4 mm). The mean weight of 14 eggs was 6.10 ± 0.01 g (range 5.48–6.55 g).

Incubation apparently began with the first egg. During egg-laying females spend considerable time in the nest, occasionally leaving for very short feeding bouts (Alexandro 1977). Hatching is asynchronous, and a wide disparity in nestling size is typical.

At hatching, nestlings had only a sparse covering of yellowish down, were incapable of locomotion and were blind with eyelids fused. They did gape, but seemed unable to raise their heads. I first heard a nestling vocalize on day 2. That comprised a short 0.5 sec *see-ee-ep* given repeatedly at 0.25 sec intervals.

By day 4 nestlings showed limited coordinated activity, only able to squat with their ventral surface on the substrate. They commonly rolled their heads from side to side, using the bill as a pivot against the substrate, but I never saw a head lifted at this age.

About day 10 the eyelids began to open. Now nestlings could unsteadily hold up their heads. By day 16 nestlings held up their heads without wavering but, as their legs remained fairly weak and of limited coordination, they were capable of only limited locomotion. The rectrices were conspicuously emerged by this time but natal down still covered the remainder of the body. By day 18 the eyes were fully open, and primaries had begun to emerge. By day 20 nestlings were able to stand steadily and firmly grasp a perch with their feet. They were quite active and could use the bill for grasping.

The major feather tracts of the body were well delineated by day 24. The feathers of the head and wings were fully emerged, while many contour feathers of the body were still in sheaths. On day 27 I first heard a nestling emit an alarm call essentially similar to that of the adult. At this age the nestlings were very active, flapping their partially feathered wings and walking very quickly and strongly. At day 28 the body feathering was about half developed, although much natal down remained (except on the head).

By day 37 most contour feathering was complete, and little down remained. The flight feathers were still emerging from sheaths, being less than 50% of adult size at this time. The earliest fledging was observed on day 40.

For each body component growth was relatively uniform throughout the first 35 days of development, after which growth slowed considerably (Figs. 1, 2). Linear regressions of age (through day 35) and percent adult size (Table 1) were highly significant ($P < 0.01$). While the growth rate was probably not uniform throughout this period, as required for a truly linear relationship, the high r^2 values indicated that the deviations from linearity were small.

The slope of these regression equations provided an estimate of the overall growth rate during the initial stages of development (Table 1). With the exception of the tarsometatarsus, the skeletal elements grew at very similar rates of 2–2.5% per day. The tarsometatarsus grew at rates significantly lower than all other leg and wing elements except the tibiotarsus, which was intermediate in value. The bill dimensions grew more slowly at a rate of about 1.5% per day. Growth rates of the 10th primary and the innermost rectrix were taken, beginning from the time they emerged from the skin (day 10 and 18, respectively); thus the growth rates of these feathers did not correspond to the same period of development as the other measurements.

Estimates of relative levels of maturation at the end of the linear portion of the growth curve were indicated by the ratio of the mean nestling size at 35 days to the mean adult size (Table 1). In terms of linear dimensions, the wing was somewhat more developed than the
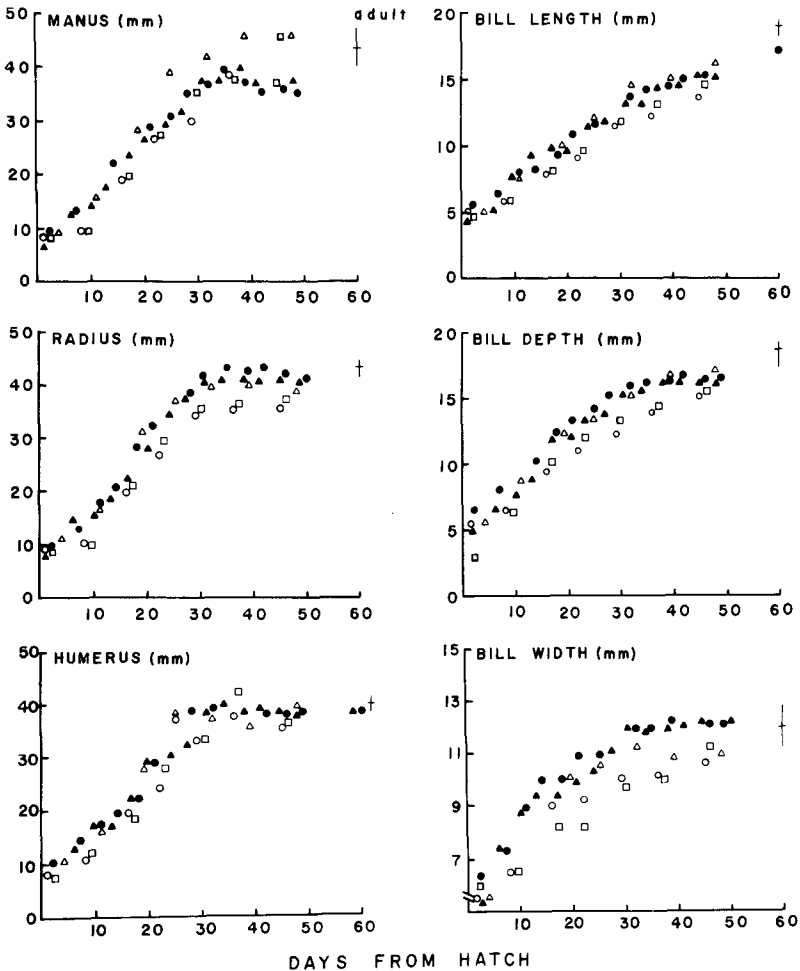
FIG. 1.   Size of body components relative to the number of days from the date of hatching. Open symbols represent the 1975 brood, and closed symbols the 1976 brood. The mean and range are indicated for the adult measurements.

leg. For the leg and wing, both the proximal and the most distal segments most closely approached adult dimensions. The bill grew relatively slowly, and at 35 days it was still well below adult size in both length and depth, while width was 92% of adult size. By day 35 primary 10 and the inner rectrix were only 42% and 30% of adult size, respectively.

Discussion.—Based on studies of growth in 3 species of altricial passerines, O'Connor (Ibis 119:147–166, 1977) stated: ". . . resources are allocated at any time to the growth of the components with the currently highest functional priority, though with due regard for future needs." Monk Parakeets fledge at 35–40 days. At the younger end of this range, which
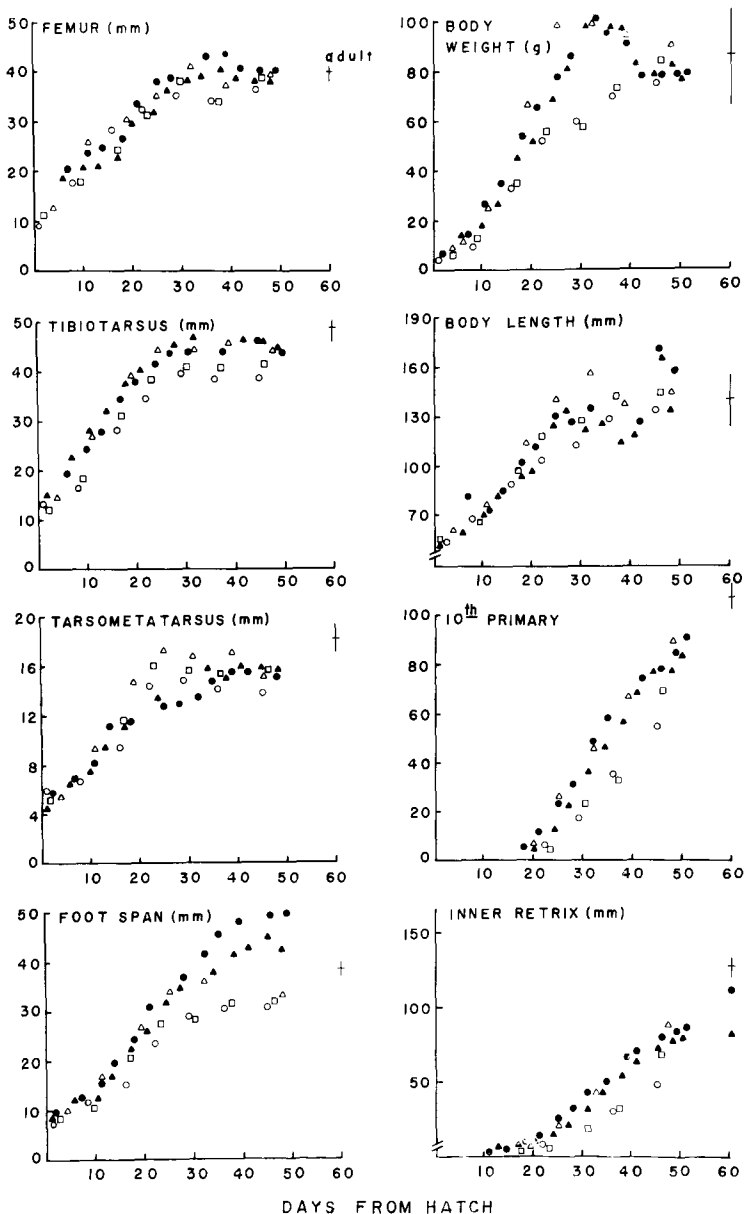
FIG. 2. Size of body components, body weight and feather lengths relative to the number of days from the date of hatching. Open symbols represent the 1975 brood, and closed symbols the 1976 brood. The mean and range are indicated for the adult measurements.

TABLE 1

REGRESSIONS OF BODY COMPONENT SIZE (PERCENT OF MEAN ADULT SIZE) ON AGE;
PERCENT OF MEAN ADULT SIZE AT 35 DAYS

Body component	a^1	b^2	$S_b{}^3$	r^{2*}	% mean adult size at 35 days
Humerus	15.4	2.6	0.11	0.94	100
Radius	12.8	2.5	0.10	0.95	90
Manus	12.2	2.3	0.10	0.94	96
Femur	28.2	2.3	0.10	0.94	97
Tarsometatarsus	27.4	1.9	0.14	0.85	84
Tibiotarsus	27.4	2.2	0.11	0.92	89
Toe span	13.2	2.6	0.14	0.92	99
Bill length	22.3	1.5	0.06	0.96	71
Bill width	49.4	1.5	0.12	0.82	92
Bill depth	26.6	1.8	0.08	0.93	82
Tenth primary	−50.0	2.7	0.31	0.82	42
Inner rectrix	−20.9	1.4	0.16	0.79	30
Body length	32.3	2.1	0.12	0.91	99

[1] a = Y-intercept from the regression equation.
[2] b = slope from regression equation.
[3] S_b = standard error of the slope.
* All $r^2 = P \leqslant 0.01$.

corresponds with the age of maximum weight, the body components of greatest functional priority, and hence greatest survival value would be expected to be the most nearly full grown. Comparisons of the percent mean adult size with nestlings at an age of 35 days provide an indication of the state of maturation, at least in terms of size, at about the time of fledging.

Since this species is an arboreal nester, fledging age is probably a function of the attainment of flight capabilities. By day 35 both lengths of body and wing components were either of adult size, or nearly so. By comparison, major leg bones had not attained adult length even though these elements at hatching were considerably more advanced than the wing bones. This is evidenced by the much higher Y-intercepts for regressions of leg bone length on age (Table 1).

O'Connor (1977) suggested that early development of the leg, particularly the tarsometatarsus, is important in some altricial species because the nestlings must have the ability to orient and extend themselves towards the adult during begging and feeding. In contrast to the Monk Parakeet, in which leg growth and coordination is late, altricial species discussed by O'Connor (1977) hatch synchronously and are fed by the parents in response to begging behavior. Though feeding of Monk Parakeet nestlings in the nest has not been observed, it seems unlikely that begging is of primary importance in this species, at least early in development, since the young appeared unable to raise their heads until after day 8. In addition, asynchronous hatching of eggs in Monk Parakeets results in a wide disparity in age among the nestlings. Assuming that 1 egg hatches per day, with a 9-egg clutch there would be a considerable disparity in age and size between the oldest and youngest nestling. If begging alone elicited feeding behavior by the parents, the youngest nestling would be at a severe disadvantage under all circumstances, except when all the older siblings were satiated.

By day 35 foot span already averaged 99% of adult size. Rapid attainment of adult foot size likely reflects the importance of the many tasks the foot performs (e.g., perching, climbing, feeding).

At hatching, bill width was already 49.4% of adult size, although, at day 35, bill width was closer to adult size than length or depth. This was the result of a more rapid development in width before hatching, since the growth rates of all bill dimensions were about the same throughout nestling development. Since bill width was measured at the base of the bill, it is about equivalent to gape width. The rapid increase of gape width in other species (Dunn, Condor 77:431–438, 1975; Holcomb, Nebraska Bird Rev. 36:22–32, 1968; Holcomb and Twiest, Ohio J. Sci. 68:277–284, 1968; Royama, Ibis 108:313–347, 1966) has been interpreted (O'Connor, Ibis 119:147–166, 1975) as important in increasing parental feeding efficiency because it allows the young to consume larger food items. Young Monk Parakeets are fed by regurgitation. This material was described as a white, milky fluid (Alexandro 1977). Accordingly, the ability to consume large food items may be of little value to nestlings. Since food is provided by the parents in a rather processed form, there would be little advantage in rapid bill growth for the purpose of processing food items. Fledglings, too, are fed by regurgitation, although they soon begin to do some foraging for themselves. Yet, as Portmann (Proc. 11th Int. Ornithol. Congr. 138–151, 1955) has shown, as the brain develops early, the skull must develop similarly to accommodate it. Thus, the greater maturity in bill width may simply reflect the need for early skull development.

The influence of agriculture on avian communities near Villavicencio, Colombia.—Destruction of natural vegetation to meet demands for increased agricultural production has restricted the distribution of certain avian species in Colombia, while benefiting others (Olivares, Smithson. Contrib. Zool. No. 26:77–87, 1970; Munves, Auk 92:307–321, 1975). In regions where a systematic conversion to agriculture is occurring, studies of the avifauna adapted to the altered habitats would have predictive value. Blydenstein (Ecology 48:1–15, 1967) described a recent westward extension of the savanna as forests were cleared at the western edge of the Llanos Orientales, implying changes in avian community composition. This paper examines habitat usage by bird species on a representative agricultural area in this region and asks: how do present land-use trends affect species abundance and distribution?

Study area.—The western sections of the Department of Meta and the Intendencia of Casanare were formerly covered by a piedmont rain forest which extended eastward from the Andean foothills, gradually merging with the savanna and gallery forests typical of the Colombian Llanos (Bates, Geogr. Rev. 38:555–574, 1948). During the last 3 decades, forests have been diminished greatly in the vicinity of Villavicencio, Meta, and the land converted to the production of rice and cattle. Fieldwork was conducted at the Hacienda La Corocora (3°57′N, 73°24′W; elev. 310 m) 35 km SE of Villavicencio. Detailed descriptions of vegetation and climate in this region are given by Bates (1948) and Blydenstein (1967). Annual precip-