

maneuver. It is not common to see a single bird performing a "dumping" maneuver in a landing flock. Item 5 (table 1) shows that the grand mean fraction of "dumping" birds, of all birds filmed, is 36%, but the mean of percentages of "dumping" birds in each flock was 54%. Since the latter is a weighted figure reflecting a difference in the size of the flocks filmed, this difference in means signifies that the proportion of birds displaying "dumping" behavior is greater in smaller flocks than in larger flocks.

Among the possible functions of this "dumping" flight, testable through future observations, are the following:

1. The birds are sideslipping, or flying inverted to lose altitude, to avoid overshooting a landing point. Leopold (A Sand County almanac, Oxford Univ. Press, New York, 1949) offered this view. Whereas it is true that our data suggest that birds performing "dumping" maneuvers do usually lose altitude relative to other birds, the significant fraction which gain altitude must be accounted for.

2. The birds are being upset, or bounced by strong local gusts. But the films suggest that the birds initiate the movement by folding the wing on the side toward which the bird will roll.

3. The birds are performing these maneuvers to adjust their position in the flock laterally. The films indicate there is some lateral movement during "dumping" maneuvers, but there are other, easier ways to shift laterally, such as using the trailing edges of the wings as ailerons.

4. The incoming birds are conveying some type of information to birds on the ground, analogous to the "waggle" dance of bees. The information might be about location of good feeding sites. We have seen birds displaying "dumping" maneuvers at all

times of the day, including just before sunset, when the birds were coming in for the night.

5. The incoming birds might be requesting information, by means of a wing signal, from birds on the ground or water. In particular, some response from birds on the ground suggesting that they are not decoys. If this were the case, "dumping" would have had to evolve since men started using decoys. It might be possible to examine very old hunting stories to see if there was mention of the behavior a hundred or more years ago. We have seen the behavior demonstrated only when other birds are on the ground or water. It might be possible to test this hypothesis by simultaneously filming landing birds and landed birds, to see if there is some response by birds on the ground to the sight of birds displaying a "dumping" maneuver.

6. The birds might be performing violent evasive maneuvers to avoid collision. While this is undoubtedly a possibility in some cases, a cursory look at the films shows birds "dumping" that are nowhere near another bird.

7. They might be doing it just for their enjoyment. This hypothesis is not testable with present methods, but it is possible that "dumping" shares some functional characteristics with gull soaring, which may also represent a behavior which animals do, for lack of a more rigorous concept, because it feels good.

"Dumping" poses two linked questions: why do geese do it, and why don't they do it all the time?

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THREE ADULT RED-TAILED HAWKS TENDING A NEST

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The occurrence of extra helpers at nests is known for several avian families, notably the Sittidae, Hirundinidae, and Corvidae (Lack 1968). Skutch (1961) listed more than 130 species exhibiting this behavior. Although such situations are not common in the Falconiformes, there are several published reports of helpers at the nests or polygamy in this order: Marsh Harrier (American) (*Circus cyaneus hudsonius*; Hecht 1951, Reindahl 1941, Yocom 1944, Balfour 1957, Hamerstrom 1969), Hen Harrier (*Circus cyaneus cyaneus*; Jourdain 1924, van der Kraan and van Strien 1969), Montagu's Harrier (*Circus pygargus*; Jourdain 1924, Hens 1926, Dent 1939), Marsh Harrier (*Circus aeruginosus*) (Bengtson 1967), European Sparrow Hawk (*Accipiter nisus*; Balfour 1924, Greeves 1926, Jourdain 1928, Young 1973), and European Kestrel (*Falco tinnunculus*; Mathew 1882). Reports of polyandry are few: Harris' Hawk (*Parabuteo unicinctus*; Mader, pers. comm.) and Galapagos Hawk (*Buteo galapagoensis*; de Vries, unpubl. data). Clayton White (pers. comm.) observed three adult Bald Eagles (*Haliaeetus leucocephalus*)

attending nests in the Aleutian Islands although sex of the adults was not determined. My purpose here is to describe an instance of three Red-tailed Hawks (*Buteo jamaicensis*) attending one nest.

Observations were made at approximately 3-day intervals from March through July 1973 incidental to a population study of Red-shouldered (*Buteo lineatus*) and Red-tailed Hawks in Orange County, California. On 7 March I found a Red-tailed Hawk's nest in a narrow oak grove which followed a dry stream bed through a 2.1-km long canyon. This canyon intersected a larger canyon approximately 450 m downstream from the nest tree. The larger canyon had a permanent stream and a broad, wooded flood plain. The nest was exposed at the top of an 11.6-m live oak (*Quercus wislizenii*).

During my first visit to the nest area, I observed one adult Red-tailed Hawk nest-building. On 17 March I observed an adult incubating. Four eggs were present on 30 March. Again, I saw only one adult (later determined to be a female from the distinctive plumage). She was moderately defensive, circling low overhead and calling with low-intensity defense vocalizations.

I noted a plumage difference in the incubating birds on different days but paid only casual attention to this observation, thinking it was merely a difference between the male and the female. On 24 April, when I climbed the nest tree again, I realized that three birds were defending the nest area. Judging from their relative body sizes and behavior, the three

TABLE 1. Feeding rates at three Red-tailed Hawk nests in Orange County, California, 1973^a.

Nest	Week	Hour of Observation	Prey/hr	Prey/hr/chick	G/hr	G/hr/chick
A ^b	1	0	—	—	—	—
	2	7.7	0.52	0.17	28.6	9.5
	3	10.3	0.49	0.16	47.5	15.8
	4	8.2	0.61	0.20	43.4	14.5
	5	10.1	0.59	0.20	47.0	15.7
B ^b	1	0	—	—	—	—
	2	0	—	—	—	—
	3	6.3	0.64	0.21	42.9	143.
	4	5.1	0.59	0.19	47.0	15.7
	5	11.9	0.50	0.17	40.7	13.6
C ^c	1	0	—	—	—	—
	2	7.2	1.53	0.38	79.8	20.0
	3	5.3	1.32	0.33	80.9	20.2
	4	0	—	—	—	—
	5	0	—	—	—	—

^a Observations made between 05:30–11:30 from blinds placed 10–21 m from nests.

^b Two adults, three chicks.

^c Three adults, four chicks.

birds were two females and one male, all in adult plumage. The features of plumage that made individual identification possible included the following: (1) male—nearly entirely dark brown, appearing black from a distance; (2) female A—very dark upperparts, light breast, and dark band across abdomen and lower chest; and (3) female B—light breast with indistinct darker band on lower abdomen.

The two females appeared equally aggressive during my intrusions. Both brushed my clothing during dives from a low overhead flight that alternated between soaring and rapid flapping. Both females gave high intensity defense calls, persisting until I left the nest tree. The male was less aggressive, soaring at a greater altitude and giving less intense territorial defense calls. After approximately 5 min, he landed about 35 m away but continued calling.

On 24 April the nest contained four chicks. The hatching date of the oldest was calculated as 19 April. The age of the chicks corresponded to the normal hatching pattern of a single clutch.

I watched subsequently from a blind placed on the canyon wall 21 m from the nest and level with it. Both females brooded, female A 59.5% and female B 40.5% of the time. The male was not observed brooding, but on three occasions he brought food to the nest; twice while female A was brooding, and once while female B was brooding.

On four occasions one or the other of the brooding females flew to an exchange perch 20 m from the nest tree, where the male had arrived with food. Apparently, the male accepted either female. No agonistic behavior was exhibited during food exchanges. On two occasions I saw all of the adults on the nest.

My other observations were made when the chicks were approximately three weeks old and the adults were no longer brooding. Female A and female B were perched 35 and 40 m, respectively, from the nest tree at midday (12:30) when the male flew into the nest with food. Both females then flew to the nest. Female B took the food item calmly from the male and immediately began feeding the nestlings. The male left as soon as the food was taken from him. Female A remained at the nest and also fed the nestlings from a carcass brought to the nest sometime earlier. Female B left after 5 min. Female

A remained about 2 min longer to finish feeding the chicks and to search the nest for food scraps.

The females apparently hunted in two distinct areas. Female A was observed consistently hunting more than 500 m from the nest on the flood plain in the larger canyon; she was not observed hunting within the nesting canyon. Female B was seen hunting only within the nesting canyon, usually within 800 m of the nest. Neither female hunted the area used by the other. The male hunted in the nesting canyon, on surrounding hilltops, and in a narrow section of flood plain where the nest canyon intersected the larger canyon. All three adults fed the nestlings, although the male did so only occasionally. Although I spent only 12.5 hr observing the nest from the blind, it was evident that feeding rates were higher than those at two nests with normal two-adult attendance (table 1). With two adults hunting rather than one during the brooding period, and thereafter three adults hunting, the biomass brought to the three-adult nest was considerably increased over that at the two-adult nests. Apparently there was a superabundance of food for the nestlings, as checks of the nest contents invariably revealed uneaten food. Frequently I saw the adults consuming prey at the nest, where it had been rejected by the satiated chicks. The chicks from this nest averaged about 9.4% heavier than the mean weight of 51 comparable-aged nestlings from three-chick nests. This might have resulted from higher feeding rates at the three-adult nest.

Of 53 active Red-tailed Hawk nests I observed on the Orange County study area during 1973, three had four-egg clutches. However, only the three-adult nest fledged all four young. Of the other two nests, one failed during incubation and the other hatched only three chicks. General nest success in this area was exceptionally high (93.9%), perhaps as a result of the high prey populations in 1973.

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EXTRA ADULTS AT HARRIS' HAWK NESTS

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Although the Harris' Hawk (*Parabuteo unicinctus*) is a common resident locally in the southwestern deserts of the United States, it has received relatively little study. This paper discusses some unique aspects of the breeding behavior of this species in the Lower Sonoran Life-Zone in the Sonoran Desert as observed in Pima and Pinal counties, Arizona from 1969 to 1975. The biology and nesting behavior of this species are discussed in another paper (Mader 1975).

Most significantly, I found Harris' Hawks commonly nesting in groups of three adults (fig. 1). My observations at three such nests indicated that the extra hawk served as a helper by either feeding the chicks and (or) supplying prey at the nest. The only other hawk known to engage commonly in nest helping roles is the Galapagos Hawk (*Buteo galapagoensis*), a species endemic to the Galapagos Archipelago (de Vries 1973). Galapagos Hawks not only nest in groups of three but also occasionally in fours. Nest helpers among nonraptorial birds are well-known (Skutch 1961).

MATERIALS AND METHODS

I found Harris' Hawks in areas characterized by stands of saguaro cacti (*Carnegiea gigantea*) and palo verde trees (*Cercidium microphyllum* and *C. floridum*) with triangle bur-sage (*Franseria deltoidea*) as the predominant shrub species. Nests were found in saguaros, palo verdes, ironwoods (*Olnya tesota*), a mesquite (*Prosopis juliflora*), and a red-gum eucalyptus tree (*Eucalyptus camaldulensis*).

Nesting success of Harris' Hawk twosomes and threesomes was determined by searching for nests by car and on foot. Nests were checked by using a 7.6-m extension ladder and 1.5-m poles connected together with a mirror at the top. Nesting activities of three threesomes (height of nests ranged from 4.0 m to 5.9 m) were observed from tower blinds, ranging in height from 2.4 m to 4.8 m and placed 12.2 m to

18.6 m from the nests. Two towers were placed on higher ground than the nest site and all blinds afforded the observer a comparatively level view of the nest. Field identification and blind observations were aided by a 30× spotting scope. One of these threesomes (individuals were identified by bands and/or distinctive feathering) nested successfully three times within a 2-year period and was watched from three blinds for a total of 263 hr; 164 hr the first time, 12 hr the second, and 87 hr the third time. I observed the other two threesomes for approximately 18 and 29 hr.

Harris' Hawks were trapped from 1971 to 1974 during the months of October through February. Hawks were trapped by automobile from the road with bal-chatri traps (see Berger and Mueller 1959) baited with starlings and pigeons and sexed in the field by using comparative measurements of 73 museum specimens. There was no overlap in wing and weight measurements among 37 male and 14 female Harris' Hawks trapped in my study.

Data on rainfall were gathered from weather station records near Cortaro, Arizona.

RESULTS

I saw three adults at 23 (46%) of the 50 nests checked. Nests visited three or more times revealed more threesomes present than did those visited less often (table 1). Therefore, it is possible that a few nests ranked as twosomes were really threesomes. I visited the three threesomes that I had observed from blinds 67 times (from the incubation to fledging period). I saw three adults during 54 of my visits, indicating that on one visit an observer had an 81% chance of finding all three hawks present at a threesome. On the other hand, alarm calls by Harris' Hawks or circling flights over nests by individuals can, on a few occasions, attract other Harris' Hawks in the general vicinity, resulting in the appearance of hawks who do not include the resident twosome or threesome. Therefore, it is also possible that some nests ranked as threesomes were really twosomes.

I was unable to check some nests late in the nestling stage to see if the young had fledged. For this reason and to simplify matters for discussion, I considered a nest successful if one chick was raised to an age of at least 28 days. My observations indicated that