

Breeding season prey items of young Northern Goshawks *Accipiter gentilis* in central Tokyo

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1. Abstract

In 2015 and 2016, I investigated prey items delivered to young Goshawk during breeding season at an urban park and Meiji shrine. In the urban park, direct observation was made for one pair of goshawk from mid-May to mid-August 2015. In the shrine, I collected pluckings and pellets around a nest from 24 May to 5 July and 5 June to 5 July 2016, respectively. Prey items mainly White-cheeked Starlings *Spodiopsar cineraceus*, Feral Pigeons *Columba livia* and mammals.

2. Introduction

The Northern Goshawk *Accipiter gentilis* has been at risk of extinction in Japan. By 1993, it was designated as nationally endangered species of wild fauna and flora (Ministry of the Environment 2016). However, the species population and distribution have recently expanded (Kawakami & Higuchi 2003), including in urban areas (Horie & Endo 2013). Even in the special wards of Tokyo, representing the metropolises of Japan, the goshawk population has increased (Kawachi 2012).

It is known that by the late 20th century in Europe, abundance and distribution of Northern Goshawks had increased compared to the past century (Rutz et al. 2006). Moreover, during the last 30 years, the species has colonized urban environments throughout Europe (Rutz et al. 2006). One of the factors of urban colonization in Hamburg was the increase in avian prey abundance (Rutz 2008). This species was much more flexible in its choice of nesting and foraging habitat (Rutz et al. 2006). Thus, existence of available prey species and diet adaptation is one of the substantial characteristics of urban colonized goshawk. To understand its urban colonization, diet information is important. However, urban breeding goshawk diet has not been reported in Japan.

Fortunately, I had a good opportunity to study prey items delivered to nestlings by a pair of goshawks at an urban park (surveyed in 2015) and Meiji shrine (surveyed in 2016) in central Tokyo. Here, I reported the results obtained through direct observation, pellet

collecting and Plucking scanning.

3. Study sites and methods

3.1 Study sites

The study areas are located in an urban park in Nerima Ward (35° 44' N, 139° 39' E) and Meiji shrine (35°67'N, 139°69'E) in Shibuya Ward, in the special wards of Tokyo (Fig. 1). The details of the urban park nest site was not disclosed based from the request of the local cooperators and to protect the goshawk nesting from many photographers and birdwatchers.

Nerima ward has a land area of 48.08 km², total human population of 727,252, population density of 15,126 persons/km² (Tokyo Statistics Division Bureau of General Affairs 2016). On the other hand, Shibuya ward has a total population of 217,456 persons, land area of 15.11 km² and population density of 14,392 persons/km² (Tokyo Statistics Division Bureau of General Affairs 2016).

The urban park has a land area of 60.8 ha, including 7.6 ha amenity grassland and 23.7 ha of continuous plant coverage. Japanese False Oak *Lithocarpus edulis* and Chinese Hackberry *Celtis sinensis* are the dominant species in the vegetation (Tokyo Metropolitan Park Association 2016). The park is isolated from other large parks and vegetated areas by urban land use. In a 1-km radius around the goshawk nest, land use composition comprises 80.6% urban (residential and industrial), 12.9% forest (deciduous broad-leaved secondary forest, vegetated parks, and cemeteries), 5.0% amenity grassland, 1.3% farmland, and 0.2% water bodies. This land use composition was calculated using vegetation maps (Biodiversity Center of Japan 2016) at a scale of 1:25,000, using ArcGIS Version 10.2.2 (ESRI 2014).

Meiji shrine has a total land area of 70 ha, mainly covered by evergreen broad-leaved forests and dominated by Camphor Laurel *Cinnamomum camphora* and Japanese Chinquapin *Castanopsis cuspidata*. Majority of the forests are restricted to citizens. The nest was located on a Sawara cypress

Chamaecypris pisifera. Residential and commercial buildings, as well as tower buildings and the Yoyogi park (54.1 ha land area) surrounded the shrine. The land use composition consists of a 1 km radius around the Goshawk nest, 64.9% urban land use (residential and industrial area), 32.8% forests (evergreen broad-leaved forest, deciduous broad-leaved tree secondary forest, vegetated parks and cemeteries), 1.6% grassland (lawns), 0.4% water body and 0.3% farmland.

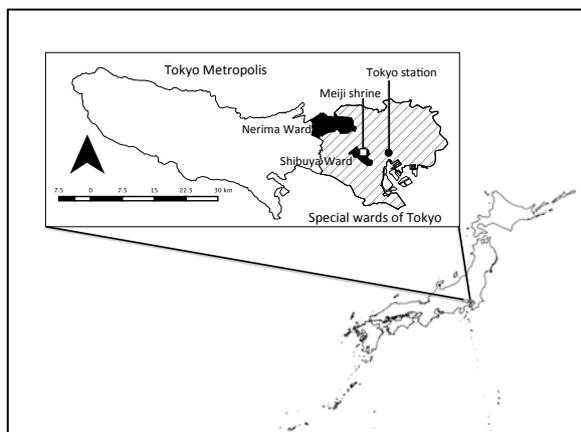


Fig. 1. Map showing the location of the study sites. The area of diagonal lines corresponds to the 23 special wards of Tokyo Metropolis, and the black-shaded area is Nerima Ward and Shibuya Ward. The white square is Meiji shrine.

3.2 Prey item analysis

In the urban park, Prey item delivery was observed daily from hatching to dispersal within May 13, 2015, to August 14, 2015 (except for May 14 and 15) at an approximate distance of 60 m from the nest tree during the daytime (from 0500 to 1800). Prey items were photographed whenever possible.

In the Meiji shrine, pellet collecting under the nest and plucking scanning around the nest were conducted from approximately 7 days after hatching to 7 days after fledging. Pellet collecting and plucking scanning were conducted from 5 June to 5 July and 24 May to 5 July, respectively. Plucking scanning and pellet collecting were conducted once a day, three to four times a week. Both site pairs reproduced successfully and three young ultimately fledged, respectively.

Pellets were analyzed based on Sabo & Laybourne (1994). Hot water and gentle soap (liquid dawn) used to wash and recover the feathers and bones. In Meiji shrine, for each method (pellet collecting and plucking scanning) and when pooling prey items based on both methods, items were identified

assuming the minimum possible number of individuals per collection event (Marchesi et al. 2002).

I identified each prey species when possible. When I was unable to identify an item to species, I used any diagnostic part to categorize the item into a more general category (e.g. genus or family). Several unknown bird species used as prey items were classified as either small birds or minimum-sized birds, which comprised of birds similar in size to the White-cheeked Starling *Spodiopsar cineraceus* and Eurasian Tree Sparrow *Passer montanus*, respectively. Small bird biomass values were expressed in terms of White-cheeked Starling biomass and minimum-sized bird biomass values in terms of Eurasian Tree Sparrow biomass. Biomass values for birds of identifiable species, Brown Rat *Rattus norvegicus* and Small Japanese Mole *Mogera imaizumii* were determined according to reports by Enomoto (1941), the National Institute for Environmental Studies (2012), and the Forestry and Forest Products Research Institute (2007), respectively. Small-sized mammals biomass values were expressed in terms of Brown Rat biomass. The biomass of Eastern Spot-billed Duck *Anas zonorhyncha* nestlings was estimated based on predation photographs, and the biomass of adult White-cheeked Starlings, which were approximately equivalent in size. I was unable to identify the Rose-ringed Parakeet *Psittacula krameri manillensis* biomass information, hence I used Azure-winged Magpie *Cyanopica cyanus* biomass. Both species are similar in size. In central Tokyo, *Corvus* species is approximately identified like Large-billed Crow *Corvus macrorhynchos*. I used its biomass for *Corvus* sp. biomass. The taxonomy and nomenclature used were based on the Check-list of Japanese Birds 7th Revised Edition (The Ornithological Society of Japan 2012).

4. Result

According to the observations, 300 items of seven prey species were collected in the urban park (Table 1.). Prey consisted of birds (88.3% of the total number of prey items), mammals (two species; 4%), and unknown species (7.7%). The diet was dominated by White-cheeked Starlings and pigeons (mainly Feral Pigeon), which together accounted for 81% of the 7 total prey items.

In the shrine, I collected 32 pellets and 32 pluckings and totally 111 items of seven prey species were identified (Table 1.). Many of the prey items were Feral Pigeons *Columba livia* (18.9% in number and

32.6% in biomass), mammals (23.4% in number and 29.4% in biomass) and White-cheeked Starlings (29.7% in number and 18.3% in biomass) (Fig. 2).

Table. 1. Prey item numbers and biomass for breeding Northern Goshawks *Accipiter gentilis* in central Tokyo, from May 13 to August 14 2015 (Urban park) and May 25 to 5 July 2016 (Meiji shrine). The total number of each prey species is listed (N) and the percentage contribution to the goshawk diet is given for each (total percentage does not add up to 100% due to rounding). % Mass contributions to total biomass were calculated using the masses for each prey species (masses based on previous studies and our own observations). Pooled shows added the pellets and pluckings number (Calculated by pooling pellets and prey remains and assuming the smallest possible number of individuals per prey species per collection event.).

Prey Category	Urban park		Pellets		Meiji shrine		Pooled	
	Observations				Pluckings			
	N (%)	% Mass	N (%)	% Mass	N (%)	% Mass	N (%)	% Mass
Birds:	265 (88.3)	95.0	69 (73.4)	65.1	28 (87.5)	90.3	84 (75.7)	69.8
White-cheeked Starling	150 (50.0)	33.1	25 (26.6)	17.8	15 (46.9)	23.9	33 (29.7)	18.1
Columbidae	93 (31.0)	57.2	17 (18.1)	33.9	6 (18.8)	26.7	21 (18.9)	32.2
Eurasian Tree Sparrow	0 (0.0)		19 (20.2)	3.6	3 (9.4)	1.3	20 (18.0)	2.9
Corvidae	0 (0.0)		1 (1.1)	5.5	3 (9.4)	37.1	3 (2.7)	12.8
Brown-eared Bulbul	5 (1.7)	1.1	6 (6.4)	4.3	0 (0.0)		6 (5.4)	3.3
Rose-ringed Parakeet	0 (0.0)		0 (0.0)		1 (3.1)	1.3	1 (0.9)	0.5
Eastern Spot-billed Duck	2 (0.7)	0.4	0 (0.0)		0 (0.0)		0 (0.0)	
Small-sized birds	14 (4.7)	3.1	0 (0.0)		0 (0.0)		0 (0.0)	
Minimum-sized birds	1 (0.3)	0.1	0 (0.0)		0 (0.0)		0 (0.0)	
Unknown birds	0 (0.0)		1 (1.1)		0 (0.0)		0 (0.0)	
Mammals:	12 (4.0)	5.0	24 (25.5)	34.9	4 (12.5)	9.7	27 (23.4)	30.2
Rattus sp.	10 (3.3)	4.5	0 (0.0)		3 (9.4)	9.7	3 (9.4)	3.4
Mogera sp.	2 (0.7)	0.5	0 (0.0)		0 (0.0)		0 (0.0)	
Small-sized mammals	0 (0.0)		24 (25.5)	34.9	0 (0.0)		24 (25.5)	26.8
Unknown mammals	0 (0.0)		0 (0.0)		1 (3.1)		0 (0.0)	
Unknown	23 (7.7)		1 (1.1)		0 (0.0)		1 (0.9)	
Total	300		94		32		111	

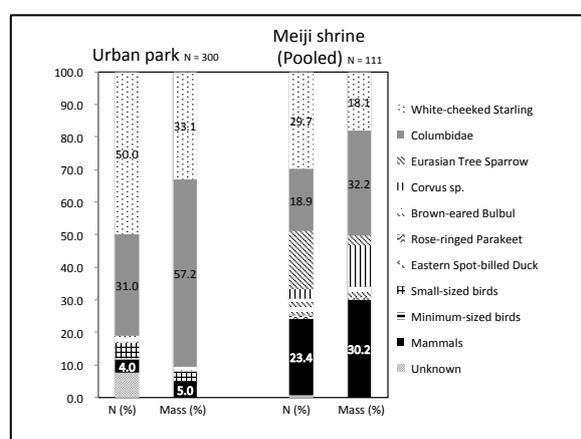


Fig. 2. Prey item composition (%) and biomass (%) of urban park breeding pair and Meiji shrine pair (pooled pellets and pluckings). Each number shows the major prey item category percentages, respectively (total percentage does not add up to 100% due to rounding).

5. Discussion

In both nests, White-cheeked Starlings and Feral Pigeons dominated the diets of the nestling and fledgling goshawks. These species are common in urban areas of Tokyo. Feral Pigeons mainly inhabit

open paved areas, while White-cheeked Starlings use grassland for foraging. Both species form flocks. Goshawks tend to hunt along forest edges and in open habitats (Kenward 1982). Therefore, Northern Goshawks may forage selectively for species that use open habitats and are found in high density at our study site.

However, the two sites had different diet composition. In the urban park, White-cheeked Starlings and pigeons dominated the diet. While in the Meiji shrine, goshawk fed more on other species. Remarkably, Meiji shrine goshawk hunts many mammal species. There is also an environmental difference between the urban park and Meiji shrine. The urban park is surrounded mainly by residential area, while the Meiji shrine is surrounded by commercial area. In addition, it is known that goshawk is flexible in its choice of foraging habitat and opportunistic predator (Rutz et al. 2006; Horie & Ozaki 2008). Thus, each goshawk has adapted to its nest site habitat and hunt more easily to get there.

The goshawks in both sites hunt more amounts of typical Synanthrope species such as Feral pigeon, *Rattus* species and Tree sparrow. Goshawk increasing in urban area may relate to those prey

items population dynamics. Indeed, goshawk changes its prey items with the prey population fluctuation (Linden & Wikman 1983). To demonstrate the goshawk's urban colonization, further researches on the correlation between goshawk urban colonization and prey items population changing in urban area are needed.

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