

Dietary characteristics of the Malayan Night Heron (*Gorsachius melanolophus*) in the Yaeyama Islands, southern Japan

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Abstract The Malayan Night Heron (*Gorsachius melanolophus*) inhabits a range of tropical and subtropical zones in South, Southeast and East Asia. As this heron breeds singularly in dense forests, its detailed ecology is not well known and only piecemeal information on its diet is available. Thus, we quantitatively estimated its diet menu with an analysis of pellets and stomach contents in the subtropical Yaeyama Islands of southern Japan. The results showed that the heron frequently foraged on land snails, arachnids, freshwater crabs and insects; no fish were detected. Although the earthworm was believed to be a primary dietary source of this species, it was not detected in our results, as it does not remain in pellets due to its high digestibility. This indicated that this bird dominantly depends on soil animals that inhabit humid forest floors. While the heron does not directly utilize aquatic habitats, they likely prefer moist forests caused by watery environments such as streams and swamps. Wet forests should be conserved for maintaining populations of this heron species.

Keywords diet, *Gorsachius melanolophus*, pellet analysis, soil animal

Introduction

The Malayan Night Heron (*Gorsachius melanolophus*) inhabits a range of environments from India and Sri Lanka to Southeast Asia, southern China, Malaysia, Thailand, Taiwan, Indonesia, the Philippines and Japan (del Hoyo et al., 1992; The Ornithological Society of Japan, 2000). This species prefers tropical and subtropical wet forests as its breeding habitats (Hancock et al., 1978; del Hoyo et al., 1992). While it is a migratory bird in some areas (Hancock et al., 1978), it is a resident species in Japan (The Ornithological Society of Japan, 2000). Its distribution in Japan is usually restricted to the Yaeyama and Miyako islands, Okinawa Prefecture (Kawakami and Fujita, 2005). This heron is considered to be uncommon throughout much

of its range (Kushlan and Hancock, 2005) and is classified as a vulnerable species in the Japanese Red List released in 2006. Understanding the diet of such a species is a very important issue for conservation because it relates closely to a species' ecological niche.

Little is known about the ecology of this heron species and only piecemeal information on its diet has been available, as this species breeds singularly, does not make a colony or communal roost, and inhabits shadowy forests. Shen and Chen (1996) described that 93% of the diet of the Malayan Night Heron were earthworms based on direct observation. Kushlan and Hancock (2005) estimated that the herons specialized in capturing frogs and very large earthworms, and also preyed on beetles, mollusks, crabs, snakes, lizards, birds and small fish. Regarding to the Japanese population, their diet has been seldom documented except for occasional reports (e.g. Makihara and Kawakami, 2005). However, no quantitative information of their food items has been available. The results of direct observations might bias towards large and noticeable objects at well-lighted area, and the proportion of inconspicuous items is very likely to be underestimated. To

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show a detailed dietary composition, we collected pellets regurgitated by the herons and stomach contents of dead individuals, because these analyses could provide quantitative estimation without the influence of ease of observation. In this paper, the dietary composition of the heron is described and its foraging microhabitats and circadian activity are discussed in light of dietary preference.

Methods

Pellets cast by Malayan Night Herons were collected under their roosts with the aid of mesh nets. Plastic mesh nets of 2 m × 2 m were located under the roost at a 1 m height from the ground and the pellets cast on the nets were collected after a period of days. The herons roost alone on trees at deciduous forests in the islands. The samples were kept in a freezer until the subsequent analysis. Collections were conducted in natural dense humid forests (Mt. Banna-dake) and riparian forests (Miyara River) on Ishigaki Island in March and April 2002 and in a secondary forest on Kohama Island in March 2003 (Fig. 1). The vegetation was mainly deciduous evergreen forest consisting of *Castanopsis sieboldii*, *Quercus Miyagii*, *Hibiscus tiliaceus*

and *Ficus* trees. Additionally, the stomach contents of five dead birds were analyzed, four of them found on Ishigaki Island and one on Panari Island (Table 1). Three carcasses collected on Ishigaki Island were roadkill and one was rescued infirm. We extracted fragmented animal remains from the pellets and stomach contents, identified them to the lowest possible taxonomic level with the stereomicroscope, and counted the minimum number of each species found in each pellet.

Results

Thirty-eight pellets were collected on Ishigaki Island and five on Kohama Island, respectively. All pellets included a mass of sands and gravels, which were estimated to be swallowed with soil animals. The undigested remains of land snails, chilopods, arachnids, crabs, insects and reptiles were found among them (Table 2). Forty-three individuals of snails were found in 47% of the analyzed pellets and all of them were *Acusta despecta*. Two individuals of Chilopoda were found in one pellet on Ishigaki Island. Eight whip scorpions, nine spiders and unidentified arachnids were found in 30% of the pellets. The whip scorpions

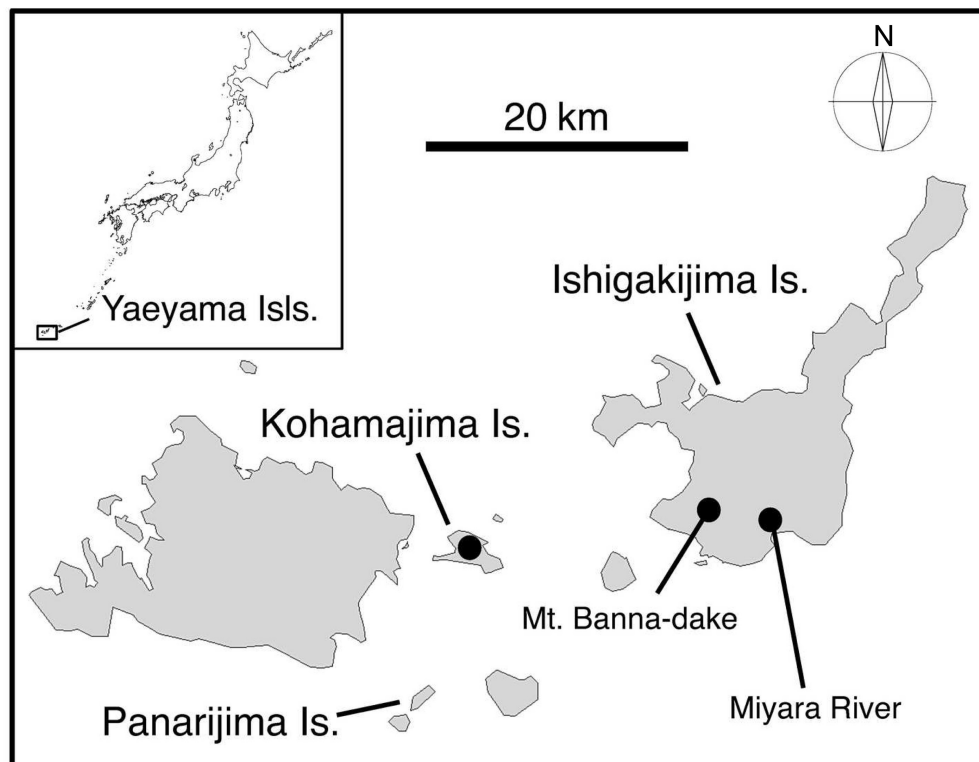


Fig. 1 Map of the Yaeyama Islands, Japan. The black circles show the locations of pellet collection survey.

Table 1 Resume of examined carcasses

No.	Date	Place	Sex	Age	Cause of death
1	1997-11-28	Maesato, Ishigaki Is.	F	Adult	Roadkill
2	1999-4-21	Shiraho, Ishigaki Is.	F	Adult	Debilitation
3	2000-6-2	Mt. Bannadake, Ishigaki Is.	M	Juvenile	Roadkill
4	2002-3-2	Mt. Maese-dake, Ishigaki Is.	U	Juvenile	Roadkill
5	2004-11-17	Panari Is.	U	Nestling	Unknown

Table 2 The species composition found in the pellets and stomach contents of Malayan Night Herons. Each number shows the number of individuals for each food item. The number in brackets is the percent occurrence of samples containing items for each taxon.

Order	Family	Species	In pellets	In stomach contents
Gastropoda				
Stylommatophora	Bradybaenidae	<i>Acusta despecta</i>	43	
			Subtotal	43 (47)
Chilopoda				
Unknown	Unknown	Gen sp.	2	
			Subtotal	2 (2)
Arachnida				
Uropygi	Thelyphonidae	<i>Typopeltis crucifer</i>	8	
Araneae	Ctenizidae	<i>Latouchia formosensis hyla</i>	3	
	Ctenidae	<i>Ctenus yaeyamensis</i>	1	
	Oonopidae	<i>Orchestina</i> sp.	1	
	Unknown	Gen sp.	4	
Unknown	Unknown	Gen sp.	5	1
			Subtotal	22 (30)
Malacostraca				
Brachyura	Isolapotamidae	<i>Ryukyum yaeyamense</i> ?	1	
	Potamidae	<i>Geothelphusa</i> sp.	2	
	Potamidae	Gen sp.	17	
	Unknown	Gen sp.	2	
			Subtotal	22 (47)
Insecta				
Blattaria	Blaberidae	<i>Pycnoscelus surinamensis</i>	3	1
	Unknown	Gen sp. (imago and egg)	13	3
Hymenoptera	Formicidae	Gen sp.	2	
Coleoptera	Bolboceratidae	<i>Bolbochromus ryukyuensis</i> (imago)	1	
	Scarabaeidae	<i>Holotrichia loochooana</i> (imago)	3	1
	Scarabaeidae	<i>Oxycetonia forticula</i> (imago and larva)	4	
	Scarabaeidae	<i>Maladera</i> sp. (imago)	3	
	Scarabaeidae	<i>Brahmina sakishimana</i> (imago)		1
	Scarabaeidae	Gen sp. (imago)	1	

(To be continued)

Table 2 (continued)

	Buprestidae	<i>Chrysodema lewisii</i> (imago)	1	
	Elateridae	<i>Agrypnus sakaguchii</i> (larva)	1	
	Elateridae	<i>Agrypnus scutellaris hamai</i> (larva)	1	1
	Elateridae	<i>Agrypnus</i> sp. (larva)	1	
	Elateridae	<i>Priopus ferrugineipennis ferrugineipennis</i> (larva)	1	
	Elateridae	<i>Priopus</i> sp. (larva)	1	
	Elateridae	<i>Cryptalaus larvatus pini</i> (larva)	1	
	Elateridae	<i>Mulsanteus rubiginosus</i> (larva)		1
	Elateridae	<i>Melanotus sakishimensis</i> (larva)	2	
	Elateridae	<i>Melanotus</i> sp. (larva)	1	
	Elateridae	<i>Campsosternus matsumurae</i> (larva)	2	1
	Tenebrionidae	<i>Amarygminae</i> sp. (larva)	1	
	Tenebrionidae	Gen sp. (imago and larva)	3	
	Cerambycidae	<i>Megopsis sinica</i> (larva)	4	
	Curculionidae	<i>Cryptorhynchinae</i> sp. (imago)	1	
	Curculionidae	Gen sp. (imago)	1	
	Unknown	Gen sp. (imago and larva)	10	
Orthoptera	Tettigoniidae	<i>Mecopoda elongata</i> (Linnaeus)		1
	Tettigoniidae	Gen sp.		1
	Gryllidae	<i>Phaloria ryukyuensis</i> (imago)	1	
	Gryllidae	Gen sp.	1	1
	Unknown	Gen sp. (imago and larva)	3	5
Diptera	Tipulidae	Gen sp. (larva)	1	
	Unknown	Gen sp. (imago and larva)	1	1
		Subtotal	69 (65)	18 (100)
Reptilia				
Squamata	Gekkonidae	Gen sp.	1	
	Agamidae	<i>Japalura polygonata</i>	4	
	Unknown	Gen sp.	4	
		Subtotal	9 (19)	0 (0)
Amphibia				
Anura	Ranidae	<i>Fejevaryia sakishimaensis</i>		1
		Subtotal	0 (0)	1 (20)
Unknown				
			7	
		Total	174	20
		Number of samples	43	5

were certain to be *Typopeltis crucifer*, as no other species has been observed on the island. Twenty-two crabs were detected from 47% of the pellets, while all of the identified crabs were freshwater and 19 of them were of the family Potamidae. At least 69 individuals of 21 species of insects

were detected from 65% of the pellets. Blattaria, Elateridae and Scarabaeidae were dominant and covered 55% of the total number of individuals. Nine reptiles were detected in 19% of all pellets and the dominant species was an agama lizard, *Japalura polygonata ishigakiensis*.

In the stomach contents of five carcasses, an arm of a frog *Fejervarya sakishimaensis* and several insects were detected (Table 2). The frog was estimated to be an adult and about 10 cm in its entire length. The dominant insects were cockroaches and grasshoppers, which were each detected in four of the five carcasses.

Discussion

Land snails, freshwater crabs and insects were dominantly detected in the diet of Malayan Night Herons. In insect species, cockroaches, click beetles and scarabs were the major prey organisms found in the pellets, whereas the proportions of cockroaches and grasshoppers detected were high in the stomach contents of carcasses. Most of the carcasses were collected in open areas, while pellets were found in forests. As grasshoppers frequently inhabit grasslands, the differences among them were consistent with their habitat uses.

The land snails found in the pellets were major terrestrial species found on the forest floor of Ishigaki Island. Freshwater crabs inhabit streams and the ground nearby. The main microhabitats of the detected cockroaches, click beetles, whip scorpions, spiders, and *Scolopendra* were litter, soil, and fallen and decaying trees, indicating that the herons prefer to forage on soil animals on the forest floor. Though the agama lizard is arboreal, they often use ground for movement. The scarabs are arboreal and aerial, but observing them walking along the ground is not uncommon. Since the night herons were unlikely to forage on trees, they probably occasionally preyed on scarabs on the ground. Such arboreal animals are suggested to contribute the diet menu of the birds as well as soil animals. Especially, the contribution of the lizards ought to be larger than the other species due to their larger body masses.

Acusta despecta detected in the pellets has nocturnal activity as with other various terrestrial mollusks (Kurozumi, 1997; Cook, 2001). Freshwater crabs are primarily nocturnal and remain hidden during the day in sheltered places (Yeo et al., 2008). The identified Coleoptera, Orthoptera and Blattaria are also nocturnal, which get active from evening. On the other hand, the agama lizards are diurnal (Tanaka, 1986). The herons had been considered to be generally crepuscular or nocturnal, while diurnal activities have been frequently observed (Brazil, 1991; del Hoyo et al., 1992). The current results implied that the herons spend both day and night times for foraging in response to the prey activities.

Although Kushlan and Hancock (2005) suggested that the herons foraged on fish in aquatic environments, dis-

tinct aquatic animals were not detected in the current study, while freshwater crabs and partial aquatic species were frequently found. The beak of this heron is shorter and thicker than that of typical herons, while other heron species generally have straight and pointed bills (del Hoyo et al., 1992), which are considered to be adapted to preying on fish. The bill morphology of the Malayan Night Heron is similar to that of the Japanese Night Heron (*Gorsachius goisagi*), which is considered to be adapted for foraging on soil animals by digging (Kawakami et al., 2005). Freshwater crabs are frequently found in litter layers around streams. Chang (2000) also noted that the Malayan Night Heron rarely foraged on fish. The current result and the morphological character imply that the dominant diet of the Malayan Night Heron consists of small animals in litter layers.

On the other hand, some distinct items, such as aquatic animals, might have been overestimated in their diet menu in the previous studies. The main component of their pellets was sand and gravels, which made the pellets breakable and indistinctive. When the pellets would go into the ground, they ought to be easy to break into pieces. It becomes hard to detect the inconspicuous components such as soil insects due to their naturalness on the ground. Conversely, remains of aquatic animals should be distinct, because it is unnatural that such items are there. In order to avoid overestimation, pellet traps with plastic mesh nets are effective.

The herons appear to prefer wet ground, sometimes near streams, as foraging habitat, where they can capture land snails and freshwater crabs. Since we could not detect fully aquatic animals, the heron was suggested not to directly utilize aquatic habitats. They are believed to prefer moist forests associated with watery environments such as streams and swamps because of the availability of soil animals. These results are consistent with the foraging preferences of the congeneric Japanese Night Heron, which breeds on the mainland of Japan (Kawakami et al., 2005). To conserve the Malayan Night Heron, forests with well developed litter layers and fallen and decaying trees, which are generally rich in the biomass of soil animals, must be maintained.

Malayan Night Herons were described to mainly forage on earthworms based on direct observation (Shen and Chen, 1996; Chang, 2000), although we did not detect any because they have few indigestible parts. However, earthworms were also not observed in the carcasses analyzed in this study. Though the night herons should presumably forage on earthworms, the frequency is likely to vary according to habitat. Confirmation is needed as to how important earthworms are in the diet of the Malayan Night

Heron. Combination of multiple methods is required in order to show the actual diet composition.

Frogs were not frequently detected in the current study, although Kushlan and Hancock (2005) estimated that they were one of the heron's main diet sources in forests. This might be caused by the above-mentioned overestimation of eye-catching items, while it is possibly attributed to seasonal variation of food availability. Herons generally have variable diets related to availability of prey in their habitat (del Hoyo et al., 1992) and can seasonally change their diet menus (e.g., Marquiss and Leitch, 1990; Rodriguez et al., 2007). Frogs become active during and after rain events in general and the biomass seasonally undergoes a complete change. Thus, although the herons may often forage on frogs in rainy seasons, all of the pellets analyzed in the current study were collected during the same period, i.e., spring. In addition to the seasonal variation of diet menu, the potential for variation exists depending on location. The dietary menu of the Malayan Night Heron in other seasons and places should be systematically investigated as the next step.

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References

- Brazil MA. 1991. The Birds of Japan. Helm, London.
- Chang CC. 2000. Malayan Night Heron *Gorsachius melanolophus* breeding in immature plumage. Forktail 16:167–168.
- Cook A. 2001. Behavioural ecology: on doing the right thing, in the right place at the right time. In: Baker GM (ed) The Biology of Terrestrial Molluscs. CABI Publishing, New York, pp 447–487.
- del Hoyo J, Elliott A, Sargatal J. 1992. Handbook of the Birds of the World. Vol. 1. Lynx Edicions, Barcelona, Spain.
- Hancock J, Elliott H, Gilmer R. 1978. The Herons of the World. Harper & Row Pub. Inc., New York.
- Kawakami K, Fujita M. 2005. The distribution of the Malayan Night Heron *Gorsachius melanolophus* in the Yaeyama and Miyako islands, southern Japan. Ornithol Sci, 4:73–79.
- Kawakami K, Uchida H, Fujita M. 2005. Diet of the Japanese Night Heron *Gorsachius goesagi* in Japan. Ornithol Sci, 4:173–177.
- Kurozumi T. 1997. Land snails. In: Okutani T, Takeda M, Imafuku M (eds) The Encyclopaedia of Animals in Japan. Heibonsha, Tokyo, pp 81–84. (in Japanese)
- Kushlan JA, Hancock JA. 2005. The Herons. Oxford University Press Inc., New York.
- Makihara H, Kawakami K. 2005. *Bolbochromus ryukyuensis* detected in the pellets of the Malayan Night Heron. Gekkan-Mushi, 418:5–6. (in Japanese)
- Marquiss M, Leitch AF. 1990. The diet of Grey Herons *Ardea cinerea* breeding at Loch Leven Scotland, and the importance of their predation on ducklings. Ibis, 132:535–549.
- Rodriguez A, Rodriguez B, Rumeu B, Nogales M. 2007. Seasonal diet of the Grey Heron *Ardea cinerea* on an oceanic island (Tenerife, Canary Islands): indirect interaction with wild seed plants. Acta Ornithol, 42:77–87.
- Shen RC, Chen LJ. 1996. A preliminary study on the habitat, distribution and breeding behavior of the Tiger Bittern (*Gorsachius melanolophus*) in Taiwan. Ann Taiwan Museum, 39:183–198. (in Chinese)
- Tanaka S. 1986. Thermal ecology of the forest-dwelling agamid lizard, *Japalura polygonata ishigakiensis*. J Herpetol, 20:333–340.
- The Ornithological Society of Japan. 2000. Check-list of Japanese Birds, Sixth Revised Edition. Ornithological Society of Japan, Hokkaido.
- Yeo DCJ, Ng PKL, Cumberlidge N, Magalhães C, Daniels SR, Campos MR. 2008. Global diversity of crabs (Crustacea: Decapoda: Brachyura) in freshwater. Hydrobiologia, 595:275–286.

日本南部八重山群岛黑冠鵞的食性分析

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摘要: 黑冠鵞 (*Gorsachius melanolophus*) 分布于南亚、东南亚及东亚的热带和亚热带地区。由于此鸟种常繁殖于密林中, 对其生态学特征知之甚少, 目前仅有少量关于其食性的信息。我们通过分析日本南部八重山群岛黑

冠鵝食丸和胃的内含物，定量分析了该地区黑冠鵝的食性特征。结果表明，黑冠鵝最喜捕食陆地上的蜗牛、蛛形类、淡水蟹类及昆虫等食物，但不包括鱼类。蚯蚓被普遍认为是该鸟种的一个主要食物，但因蚯蚓的易消化性，极少在食丸中残留，所以我们并未观察黑冠鵝捕食蚯蚓的证据。这表明黑冠鵝主要以活动于湿润森林地表的土壤动物为食。虽然黑冠鵝并不直接栖息于水生环境，但它偏好具有溪流及沼泽等湿地生境的潮湿森林。因此，为更好地维持黑冠鵝的种群，需对环境潮湿的森林加以保护。

关键词：食性，黑冠鵝，食丸分析，土壤动物