Research note

Preliminary Investigation on Nest-Tree and Nest-Cavity Characteristics of the Taiwan Barbet (*Megalaima nuchalis*) in Taipei Botanical Garden

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【Summary】

Taiwan Barbet (*Megalaima nuchalis*) is the only species of the Ramphastidae found in Taiwan and is endemic to the island. *Megalaima nuchalis* is found at low to mid elevations and is typically seen in the mid-canopy layer of broadleaf forests. During the breeding season, *M*. *nuchalis* excavates its own nest cavity in tree trunks or branches; therefore, it is closely associated with forests. From March to September of 2008, we investigated the characteristics of nest trees and nest cavities of *M*. *nuchalis* in Taipei Botanical Garden (TBG). The measured variables were nest tree species, tree height, tree diameter at breast height, nest height, tree diameter at nest, diameter of the cavity entrance, length of the horizontal passage, depth of the hole, and orientation of the cavity entrance. In total, we found 27 nest holes in 12 trees, which included 8 different tree species dominated by camphor (*Cinnamomum camphora* (L.) Presl). *Megalaima nuchalis* excavated nests in dead trees or in dead branches of living trees, and very few of the nest trees were monocotyledons. The nest cavities were found either on the main tree trunk or on side limbs, and the nest locations seemed to be related to the location of dead limbs on the nest tree and nest tree height. The shape of most cavity entrances was almost circular, and the size corresponded well to the body size of the birds themselves, as this prevents the invasion by natural enemies. The cavity entrances were mainly orientated towards the northwest to southwest, as these directions might have good air flow and could keep the nests well-ventilated and dry. The removal of dead trees and dead limbs from *M*. *nuchalis* habitats is disadvantageous during their breeding season. We recommend preserving dead trees and dead limbs which pose no danger in urban green areas as they provide nest cavities and resting holes for *M*. *nuchalis* and other secondary cavity nesters - in order to maintain and even enhance urban animal biodiversity.

Key words: *Megalaima nuchalis*, nest cavity, nest tree, Taipei Botanical Garden.

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研究簡報

台北植物園台灣擬啄木繁殖巢樹及巢洞初探

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摘　要

台灣擬啄木(*Megalaima nuchalis*)屬於鬚鴷科(Ramphastidae)，在台灣係唯一的一種，並且為特有種。台灣擬啄木分布於中低海拔山區，常見於茂密樹林區的中上層，繁殖季時在樹幹鑿洞做巢，一般認為其與森林關係密切。雖然族群數量普遍，但有關研究極少。本研究於2008年3至9月調查台北植物園的台灣擬啄木繁殖巢樹及巢洞，包括鑑定繁殖巢樹種類及測量其高度、胸高直徑、巢位高度、直徑及巢洞直徑、水平通道長度、深度、方位等。我們總共發現12棵巢樹上的27個巢洞，結果顯示台灣擬啄木所使用的巢樹種類包括以樟樹(*Cinnamomum camphora* (L.) Presl)為主的8種，單子葉植物極少。台灣擬啄木只在全枯木或有部份枯枝的生立木上做巢，巢洞部位包括主幹及枝條；巢洞位置與樹木的乾枯部位及巢樹高度有關。巢洞口為圓形，大小與鳥的體型大小有關，可以防止天敵的入侵或破壞。巢洞多選擇在西北至西南的方向開口，可能因通風良好而利於保持洞內的乾燥。環境中的枯木或枯枝過少將不利台灣擬啄木的繁殖，建議都市綠地儘量保留無礙遊客安全的枯木或枯枝，可提供台灣擬啄木及其他二級樹洞使用者繁殖或棲息用，進而保持或提高環境中的動物多樣性。

關鍵詞：台灣擬啄木、巢洞、巢樹、台北植物園。

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The Taiwan Barbet (*Megalaima nuchalis*), an endemic bird species in Taiwan (Feinstein et al. 2008), is a poorly understood species as only 1 study focused on its biology in Taiwan's Yangmingshan National Park (Ho 1990). The breeding season of *M. nuchalis* begins in March and ends at the end of August (Ho 1990). During the breeding season, mature male and female *M. nuchalis* alternate excavating nest cavities in dead trunks and branches. *Megalaima nuchalis* is often found in forested areas; therefore, Taipei Botanical Garden (TBG) is considered a suitable habitat for this species to live and breed. According to the database of the Wild Bird Society of Ilan (http://wildbird.e-land.gov.tw), there are records of *M. nuchalis* observed almost every month in TBG from December 2003 to October 2005; therefore, there should be a stable population living in TBG. Furthermore, a high abundance and diversity of woody plants in TBG provide an excellent selection of nest trees for *M. nuchalis*, and this allows scientists to study the characteristics of their nest trees and cavities. The goals of this research were to provide information on the preferred habitats of *M. nuchalis* and contribute to the conservation of *M. nuchalis* in Taiwan.

From March to August 2008, 1~3 d were spent each week along the pathways of TBG searching for signs of excavated holes on nest trees. Trees with newly formed nest holes were recorded, marked, and kept track of. Nest trees used prior to 2008 were recorded and marked. Measurable physical variables of new and old nest trees included the tree species, tree height, tree diameter at breast height (DBH), nest height, tree diameter at the nest site, nest entrance orientation, horizontal and vertical diameters of the entrance hole, length of the horizontal passage, depth of the hole (from the entrance hole to the nest base), and status of the nest tree. The status of the nest tree was categorized into 5 levels based on its physical appearance: (1) a live tree with no dead limbs; (2) a live tree with 1 or more dead limbs; (3) a dead standing tree which retained most of its branches; (4) a dead standing tree with few or no branches; and (5) a dead standing tree with damage to its trunk.

In TBG and its surrounding sidewalks, 12 nest trees with 27 nest holes were found (Table 1). Five trees' nest cavities were freshly excavated by *M. nuchalis* in 2008, and the remaining 7 cavities were made prior to 2008. The nest tree species included *Cinnamomum*

Table 1. Nest-tree and nest-cavity characteristics of *Megalaima nuchalis* in Taipei Botanical Garden

Tree species	Tree height (cm)	DBH (cm)	Nest height (cm)	Tree diameter at nest (cm)	Tree status[1)]	Horizontal diameter of entrance hole (cm)	Vertical diameter of entrance hole (cm)	Length of horizontal passage (cm)	Depth of hole (cm)	Compass orientation of entrance (°)	Number of holes in nest tree
Alstinia scholaris R. Br.	712	35.9	662	27.5	5	4.7	5.5	12.5	36.1	284	2
Archontophoenix alexandrae Wendi	727	28.1	583	17.1	5	5.0	4.5	11.3	22.2	208	2
Cinnamomum camphora (L.) Presl	190	66.8	1132	37.0	2	5.0	5.5	11.4	40.2	240	3
Cinnamomum camphora (L.) Presl	131	49.6	905	14.1	2	5.0	5.5	9.0	33.0	128	2
Cinnamomum camphora (L.) Presl	1530	66.0	1100	14.8	2	5.0	5.5	9.0	30.1	200	1
Cinnamomum camphora (L.) Presl	1000	38.7	715	24.0	2	5.1	5.3	11.0	28.2	266	3
Cinnamomum camphora (L.) Presl	1450	46.0	700	25.0	2	5.2	5.5	12.2	33.0	114	1
Crateva adansonii DC. subsp. *formosensis* Jacobs	1299	25.1	370	14.5	2	5.1	5.6	12.7	36.3	260	4
Diospyros philippensis (Desr.) Gurke	108	37.8	350	32.0	5	5.1	5.3	11.7	32.0	60	4
Ficus superba (Miq.) Miq. var. *japonica* Miq.	370	25.0	280	25.0	5	4.7	5.5	9.5	31.0	270	1
Pterocarpus indicus Willd.	1650	57.6	765	15.1	2	5.0	4.5	11.0	38.0	200	3
Semecarpus gigantifolia Vidal	407	31.3	319	22.5	5	5.0	4.5	12.4	28.0	246	1
Mean	1120.0	42.32	656.8	22.38	-	5.39	5.79	11.14	32.3	-	2.3
Standard deviation (SD)	490.1	14.94	292.1	7.49	-	0.36	0.44	1.32	5.0	-	1.1

1) The status of the nest tree was categorized into 5 levels based on physical appearances: (1) a live tree with no dead limbs; (2) a live tree with 1 or more dead limbs; (3) a dead standing tree retaining most of its branches; (4) a dead standing tree with few or no branches; and (5) a dead standing tree with damage to its trunk.

camphora (L.) Presl, *Alstonia scholaris* R. Br., *Semecarpus gigantifolia* Vidal, *Diospyros philippensis* (Desr.) Gurke, *Archontophoenix alexandrae* Wendi, *Ficus superba* (Miq.) Miq. var. *japonica* Miq., *Pterocarpus indicus* Willd., and *Crateva adansonii* DC. subsp. *formosensis* Jacobs. In total, 91.7% of nest trees were dicotyledons, and 41.7% of the nests were on *C. camphora*. Several studies on the nest cavities of woodpeckers showed that the wood hardness affects the selection of nest trees by woodpeckers (Conner et al. 1976, Schepps et al. 1999, Jackson and Jackson 2004, Matsuoka 2008); therefore, perhaps *C. camphora* trees in TBG have lower wood hardness than other tree species and thus are favored by *M. nuchalis* as nest trees. Further research and evidence are needed to support this hypothesis.

In Yangmingshan National Park where *Pinus elliottii* Engelm. is the dominant tree species, Ho (1990) found that 42.9% of the nest trees used by *M. nuchalis* were *P. elliottii*. Therefore, Ho (1990) speculated that *M. nuchalis* has no preference of 1 tree species over another. In TBG, the dominant monocotyledons include *Livistona chinensis* R. Br. var. *subglobosa* (Mart.) Becc. (127 trees), *Arc. alexandrae* (111 trees), *Roystonea regia* (H. B. *et* K.) Cook. (106 trees), *Araucaria cunninghamii* D. Don (92 trees), and others. On the other hand, the dominant dicotyledons are *Machilus japonica* Siebold & Zucc. var. *kusanoi* (Hayata) J.C. Liao (65 trees) and *C. camphora* (53 trees). Our results show that *M. nuchalis* did have some nest tree preference by tree species. Although *M. nuchalis* made attempts to excavate nests in monocotyledon plant species, such as *L. chinensis*, no completed nest cavities were ever found. Therefore, monocotyledon plant species are not considered to be good nest trees for *M. nuchalis*. On the campus of Chulalongkorn University in Thailand, Meckvichai (1998) observed the Coppersmith Barbet, *M. haemacephala*, for 4 breeding seasons. *Megalaima haemacephala* was found to excavate nest cavities in *Samanea saman* and 18 other dicotyledons and none on monocotyledons. Future comparative research is needed to test wood characteristics between monocotyledons and used nest trees.

Ho (1990) found that 97.3% of *M. nuchalis* nest cavities were situated in branches of dead or living trees; however, this study found that 66.7% of nest cavities were in the main tree trunk. Furthermore, 58.3% of nest cavities were in living trees with some dead branches, and 41.7% were in dead standing trees. Other barbet species such as *M. rubricapilla* and *M. haemacephala* were found to nest on the sides of dead branches, while *M. viridis* likes to excavate nests on the underside of horizontal dead branches (Yahya 1988, Meckvichai 1998). One thing for certain is the favored selection of dead wood as nesting cavities by *M. nuchalis*. Therefore, the lack of dead trees or dead branches in *M. nuchalis* habitats is disadvantageous for their breeding and survival. To maintain or increase populations of *M. nuchalis*, dead trees and dead branches which pose no danger should not be removed as they provide nesting and resting places for *M. nuchalis* and other secondary nest cavity users.

The means of nest tree height, DBH, height of the nest cavity, and tree diameter at the nest cavity were 1120 (SD = 490.1), 42.32 (SD = 14.94), 657 (SD = 292.1), and 22.38 (SD = 7.49) cm, respectively. The heights of the nest cavities ranged 280~1132 cm. The location of dead and decaying parts of a living tree should greatly affect where the nest cavity is excavated by *M. nuchalis*. In this study, a seemingly dense and live *P. indicus* tree had 1 dead branch, and on this particular branch, there were 3 holes made by *M. nuchalis*. This example shows that dead branches have an impact on the location and height of the nest cavities excavated by *M. nuchalis.* Meckvichai (1998) showed that the height of the nest cavity of *M. haemacephala* was determined by the height of the nest tree. This idea was also supported by this study as there was a positive correlation between nest tree height and nest cavity height (Pearson correlation coefficient = 0.76, $p < 0.01$).

The nest cavity entrances were all almost circular in shape, with horizontal and vertical diameters of 5.39 (SD = 0.36) and 5.79 (SD = 0.44) cm, respectively. There was no significant difference between the 2 diameters ($p < 0.05$), and the entrance allows for the entry and exit of 1 *M. nuchalis* at a time. Compared to other species in the genus *Megalaima*, the nest entrances of *M. nuchalis* were more similar to those of *M. viridis* (mean entrance diameter of 5.10 cm) (Yahya 1988). On the other hand, the nest entrances of the smaller *M. rubricapilla* and *M. haemacephala* were 3.66 and 3.85 cm, respectively (Yahya 1988, Meckvichai 1998). The main difference should be related to the birds' body size as *M. nuchalis* and *M. viridis* have body lengths about 20 and 23 cm long, respectively, which are both longer than *M. rubricapilla* (17 cm) and *M. haemacephala* (15 cm), hence the wider nest entrance (Wang et al. 1991, Grimmett et al. 1999). To prevent squirrels, raptors, and other predators from invading the nest cavity, bird species in the family Capitonidae usually design the entrance size according to the body size of their mate and themselves (Yahya 1988). Based on field observations, potential predators of *M. nuchalis*, such as the Formosan red-bellied tree squirrel (*Callosciurus erythraeus*) and Crested Goshawk (*Accipiter trivirgatus*), can only watch their preys from outside the nest and can not successfully enter the nest cavity.

The interior of the nest cavity has a horizontal tubular passage, which then bends vertically downward and enlarges into a bag-shaped cavity (Fig. 1). The length of the horizontal passage was 11.14 (SD = 1.32) cm, and the total depth of the hole (including the initial horizontal passage) was 32.34 (SD = 4.96) cm. Comparing the total depth of the hole with those of other barbet species, the nest cavity of *M. nuchalis* was most similar to that of *M. viridis* (a mean depth of 32.23 cm), and was deeper than the nests of both *M. haemacephala* (18.12 cm) and *M. rubricapilla* (16.95 cm) (Yahya 1988, Meckvichai 1998). Since the body lengths of the former 2

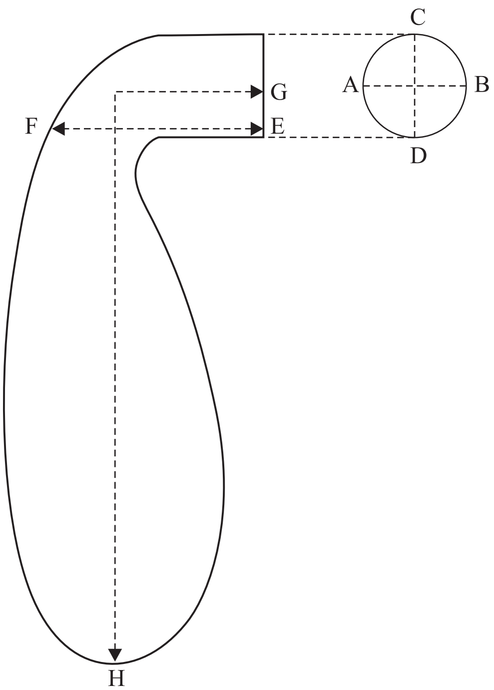

Fig. 1. Longitudinal section of a *Megalaima nuchalis*'s nest in a branch showing the bag-shaped chamber of the nest. AB, the horizontal diameter of the entrance hole; CD, the vertical diameter of the entrance hole; EF, the length of the horizontal passage, GH, the depth of the hole.

species are larger than the latter 2 species, it seems that the depth of the hole is related to the body length of the particular nest builder. Ho (1990) found the length of the horizontal passage and the total depth of the hole to be 10.50 (SD = 0.67) and 26.36 (SD = 3.60) cm, respectively, which greatly differed from the results obtained in this study. The reason for the differences could be due to the different methods of measurements, as this study measured the total depth of the hole from the hole entrance to the base of the cavity along the back of the interior wall, while Ho (1990) measured the depth of the hole along the front of the interior wall.

The commonest orientations (75%) of nest entrances were in a westerly direction from northwest to south (Fig. 2), while 25% of the entrances were orientated towards the northeast to southeast. No entrance was orientated northerly towards the northwest to northeast. Nest hole entrances of *M. nuchalis* in Yangmingshan National Park's Erzihping were orientated mostly towards the northwest to southwest (60%) (Ho 1990). Ho (1990) suggested that the southwest is the driest orientation followed by the west; therefore, *M. nuchalis* chooses the orientation of the nest entrance based on the dryness condition. The results of this study supported this hypothesis. Moreover, during field observations, a female *M. nuchalis* laid 3 eggs, but about 10 d later, a rainstorm flooded the nest cavity and caused the parent barbets to abandon the nest. This particular case study supports the hypothesis that breeding of *M. nuchalis* can be negatively influenced by wet and humid weather conditions.

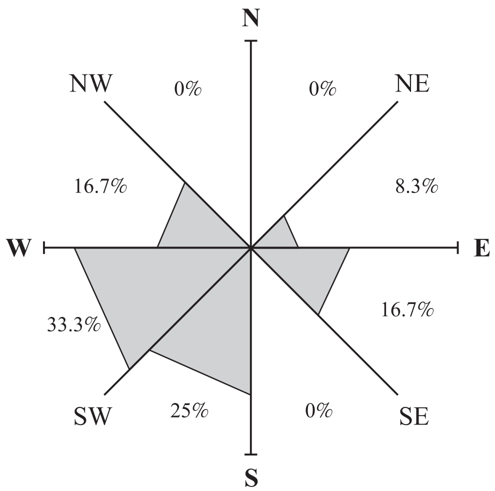

Fig. 2. Directions of *Megalaima nuchalis*'s nests in Taipei Botanical Garden.

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LITERATURE CITED

Conner RN, Miller Jr. OK, Adkisson CS. 1976. Woodpecker dependence on trees infected by fungal heart rots. Wilson Bull 88:575-81.

Feinstein J, Yang X, Li SH. 2008. Molecular systematics and historical biogeography of the Black-browed Barbet species complex (*Megalaima oorti*). Ibis 150:40-9.

Grimmett R, Inskipp C, Inskipp T. 1999. Birds of India: Pakistan, Nepal, Bangladesh, Bhutan, Sri Lanka, and the Maldives. Princeton, NJ: Princeton Univ. Press. 384 p.

Ho YC. 1990. The biological study of Muller's Barbet, *Megalaima oorti nuchalis*, in Yangmingshan National Park [Master's thesis].

Taipei, Taiwan: National Taiwan Univ. 58 p. [in Chinese with English abstract].
Jackson JA, Jackson BJS. 2004. Ecological relationships between fungi and woodpecker cavity sites. Condor 106:37-49.
Matsuoka S. 2008. Wood hardness in nest trees of the Great Spotted Woodpecker *Dendrocopos major*. Ornithol Sci 7:59-66.
Meckvichai W. 1998. Nest characteristics of Coppersmith Barbets (*Megalaima Haimacephala indica*, Latham, 1790). Nat His Bull Siam Soc 46:55-62.
Schepps J, Lohr S, Martin TE. 1999. Does tree hardness influence nest-tree selection by primary cavity nesters? Auk 116:658-65.
Yahya HSA. 1988. Breeding biology of barbets, *Megalaima* spp. (Capitonidae: Piciformes) at Periyar Tiger Reserve, Kerala. J Bom Nat Hist Soc 85:493-511.
Wang CS, et al. 1991. A field guide to the birds of Taiwan. Taipei, Taiwan: Arthur Book. (in Chinese). 274 p.