

Bark-stripping behavior of Formosan sambar (*Rusa unicolor swinhoii*) caught on camera and its implications

台灣水鹿啃食樹皮行為影像紀錄與其含意

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Abstract

Bark stripping behavior in two adult male Formosan sambar (*Rusa unicolor swinhoii*) was photographed in a Taiwan red cypress (*Chamaecyparis formosensis*) plantation in Yushan National Park for the first time in Taiwan on April 1, 2014. Both males expressed behaviors of sniffing, licking and bark-stripping on the same Taiwan red cypress. These behaviors imply that 1) exudates and secondary metabolites of the bark probably are one of the key reasons that attract the Formosan sambar to debark coniferous trees and 2) damage from bark-stripping may increase at an accelerated rate. Long-term monitoring of bark-stripping behavior using camera is suggested to test the above interpretations and reveal why the Formosan sambar strips barks.

摘 要

2014 年 4 月 1 日於玉山國家公園內的紅檜造林地首次以自動相機拍攝到兩隻雄性成體台灣水鹿啃食樹皮的行爲。兩隻個體皆有嗅聞、舔食及啃食同一棵紅檜樹皮的行爲。這些行爲顯示 1) 樹皮的分泌物及其中的次級代謝物可能是吸引台灣水鹿啃食針葉樹樹皮的關鍵之一，2) 啃食樹皮造成的損害速率可能以加速度方式提高。本研究建議以自動相機長期監測水鹿啃食樹皮的行爲以檢驗上述的推論，並釐清水鹿啃食樹皮的原因。

Key words: debark, exudate, secondary metabolites, Taiwan red cypress

關鍵詞：啃食樹皮、分泌物、次級代謝物、台灣紅檜

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Introduction

Ungulates' impact on forest ecosystems include browsing, bark stripping and fraying on plants. Among these behaviors, bark-stripping damages and kills trees more than the other two, causing an increase of forest gaps (Akashi and Nakashizuka 1999) and decline of overstory (Yokoyama *et al.* 2001). In recent years, the Formosan sambar (*Rusa unicolor swinhoii*) in Taiwan significantly increased in abundance (Lee and Lin 2007; Weng and Lin 2009). Signs of bark stripping are also widely distributed in Yuli Wildlife Refuge and Yushan National Park (Lee *et al.* 2007; Weng and Lin 2009, 2010). Preference for specific coniferous tree species by the Formosan sambar, which could potentially

alter the canopy species composition at high altitude, was also observed (Weng and Lin 2009, 2010, 2011). On the other hand, bark stripping can potentially cause economic loss in coniferous tree plantations. For example, along the Nanshi forest road in Yushan National Park, signs of bark-stripping began to appear in 2012-2013 in Taiwan red cypress (*Chamaecyparis formosensis*) plantations, raising concerns for management agencies (Chiayi Forest District Office, Forest Bureau, personal communication).

While previous research has tried to understand why deer strip barks from various aspects, such as chemical contents or nutrition (e.g. Ando *et al.* 2003, 2004), food availability (e.g. Ueda *et al.* 2002), and population abundance (Akashi and Tarazawa 2005), direct observation and description of bark-stripping

behavior is scarce. Direct observations of bark-stripping behavior are difficult but may reveal attributes of individuals performing such behavior and provide insight into how and why the deer uses barks. In this research we aimed to observe bark-stripping behavior in the Formosan sambar. We set up 14 cameras (Reconyx HC500 x 9, Reconyx PC800 x 1 and Bushnell Trophy Cam x 4) in December 2013 and tagged 1,000 Taiwan red cypresses in five Taiwan red cypress plantations along Nanshi forest road between 1,900m and 2,250m in altitude (Fig. 1). Each plantation had one camera and other cameras were distributed along the forest road. Cameras were set to take three consecutive photos with a three-second interval once an animal was detected. Photos were retrieved every month starting February 2014.

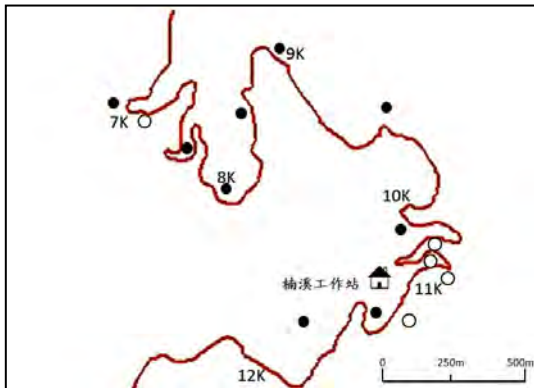


Fig. 1. Study sites within Taiwan red cypress plantations (open circles) and camera locations (solid circles) along Nanshi forest road in Yushan National Park. Each plantation has one camera.

Bark stripping behavior of Formosan sambar

On April 1st, 2014, an adult male sambar was caught on camera stripping off bark from a Taiwan red cypress, the first time such behavior was photographed in Taiwan. This adult male with two-point antlers covered by velvet skin, showed up at 00:39:44 AM on April 1, 2014, sniffing at the base of a Taiwan red cypress next to the target tree (Fig. 2a). The male then walked to the target tree and sniffed at the base of the target tree until 00:41:04 AM when it started to rip off bark (Fig. 2b). The male kept alternately sniffing and stripping barks of the tree until 01:02:21 AM. The next photo was taken at 01:22:44 AM when the male was holding a strip of bark in its mouth and the tree showed clear signs of damage (Fig. 2c). We believe that time gaps longer than three seconds between any two consecutive photos are due to the individual's standing still and moving only its head since no other movements were photographed and the individual was in almost the exact same posture in each photo. The male left at 01:43:37 AM after staying roughly 70 minutes.

Another adult male, also with two-point although much shorter antlers covered by velvet skin, appeared at the same site at 01:50:50 PM on the same day, sniffing at the bare area of the trunk (Fig. 3a). At 01:53:22 PM and 02:03:57 PM the male was caught licking the exposed xylem (Fig. 3b). Between the two licks at 01:58:26 PM the male was caught holding a strip of bark in its mouth (Fig. 3c). The male was sniffing, licking exposed xylem, and stripping barks for 35 minutes before it left at 02:25:47 PM.



Fig. 2. Behavior of an adult male Formosan sambar in a Taiwan red cypress plantation on Nanshi forest road caught on camera during the early hours of April 1, 2014. a) Sniffing at the base of a Taiwan red cypress. b) Stripping off bark from a Taiwan red cypress. c) Holding a strip of bark in its mouth.

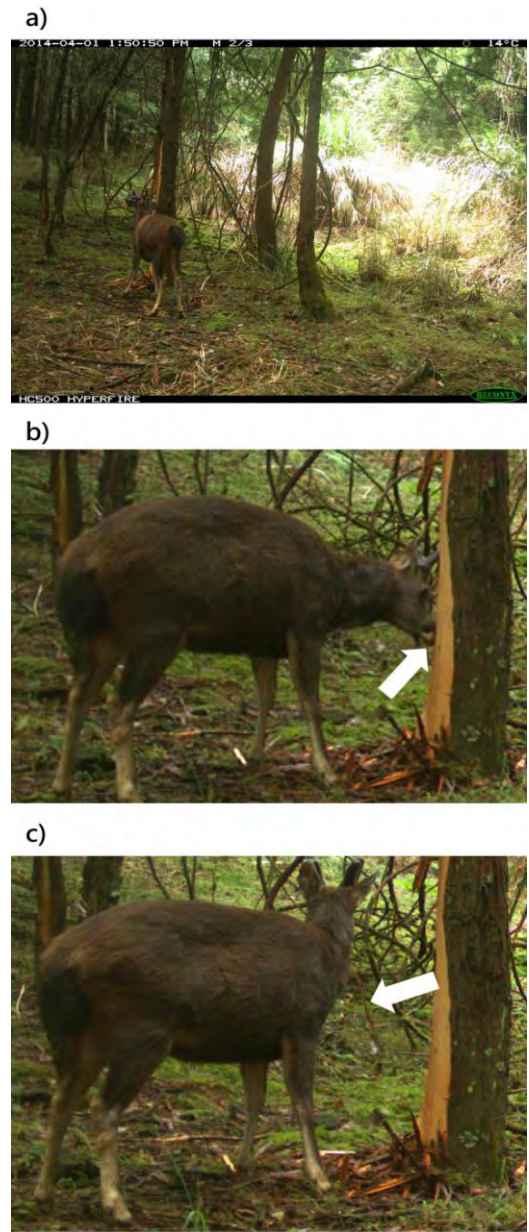


Fig. 3. Behavior of an adult male Formosan sambar in a Taiwan red cypress plantation on Nanshi forest road caught on camera in the afternoon of April 1, 2014. a) Sniffing at the exposed xylem of a Taiwan red cypress. b) Licking the exposed xylem (Arrow indicates the tongue). c) Holding a strip of bark in its mouth (Arrow indicates the bark strip).

Discussion

The behaviors shown by the Formosan sambar in the photos revealed some interesting points about possible explanations for bark-stripping behavior. First, both males sniffed at the Taiwan red cypress frequently even before the bark was stripped, indicating that some smells were attracting their attention to the bark. The smells may originate from the tree itself or have extrinsic sources such as urine or scent of animals. Considering the wide distribution and high density of debarking signs by sambar on Taiwan red cypress (266 out of the 1,000 tagged trees) and other tree species, it is less likely that the smells are from scent marking behavior of animals. Although the sambar also performs marking behavior on tree trunks, it usually urinates on its suborbital glands to wash pheromone-containing secretions into water or mud where it soaks its body before scrubbing against tree trunks. Such a marking behavior leaves mud and scrub signs on tree trunks, which is rare during this time of year when males are growing antlers. We did not find such scrub signs on the target tree and other Taiwan red cypress in our five plantations. We therefore suspect that the smells originate from the tree itself.

The Formosan sambar debarks more than 150 tree species, including coniferous and broad-leaved trees (Lin, personal communication), and it prefers certain specific coniferous trees (Weng *et al.* 2009, 2010, 2011). Ando *et al.* (2004) also observed preference for

coniferous trees by the sika deer in Japan. Preference on tree species could relate to how easy the bark can be stripped, but Ando *et al.* (2004) found that bark physical properties barely explained preference for three coniferous trees by the sika deer (*Cervus nippon*). We found that bark thickness marginally correlate with the preference by the Formosan sambar (Weng, unpublished data). We thus suspect that the sambar debarks for something in the bark. Although previous research investigated contents of the bark such as nutrition and minerals in relation to the bark-stripping preference by deer (e.g. Ando *et al.* 2003, 2004), exudates of the bark and secondary metabolites therein were largely unexplored. Trees, especially conifers, contain oleoresins that has aromas and occur in resin ducts or blisters in the bark (Hillis 1987). The oleoresin or other exudates with secondary metabolites could be ones the Formosan sambar is looking for, or the smells may link to other materials that the Formosan sambar really needs.

Besides bark stripping, the behavior of licking exposed xylem of the trunk was apparent, especially with the second male. This behavior has not been described for any deer species in the literature, possibly due to the difficulty of direct observations of bark stripping behavior. The Formosan sambar will definitely ingest the exudates of coniferous trees by licking the xylem. Therefore, the Formosan sambar ingests both barks and exudates by performing the behavior. While several hypotheses regarding bark-stripping behavior of deer are to be tested with the Formosan sambar, our observations

provide another possibility for future research that secondary metabolites in exudates of the bark are a potential explanation for why the Formosan sambar, and possibly other deer species also, strip and consume barks.

Second, as pertains to the smells from exudates of coniferous trees, debarked coniferous trees would be more attractive to the Formosan sambar than untouched trees, making an already damaged tree prone to further debarking. In other words, the level of damage by the Formosan sambar may increase at an accelerated instead of steady rate. The significance of such a pattern to wildlife management agencies is that the control of bark-stripping at a local scale would be more efficient in the initial rather than a later stage.

Further researches are necessary to test the interpretations above. Images of bark-stripping behavior by the Formosan sambar provided new insight into the mechanism and consequence of this behavior. This research thus suggests long-term monitoring on bark-stripping behavior by the Formosan sambar and other deer species, as well as using cameras to investigate this behavior and provide suggestions for management policies.

Literature cited

- Akashi, N. and T. Nakashizuka. 1999. Effects of bark-stripping by sika deer (*Cervus nippon*) on population dynamics of a mixed forest in Japan. *Forest Ecology and Management* 113: 75-82.
- Akashi, N. and K. Tarazawa. 2005. Bark stripping damage to conifer plantations in relation to the abundance of sika deer in Hokkaido, Japan. *Forest Ecology and Management* 208:77-83.
- Ando, M., H. O. Yokota and E. I. Shibata. 2003. Bark stripping preference of sika deer, *Cervus nippon*, in terms of bark chemical contents. *Forest Ecology and Management* 177:323-331.
- . 2004. Why do sika deer, *Cervus nippon*, debark trees in summer on Mt. Ohdaigahara, central Japan? *Mammal Study* 29: 73-83.
- Hillis, W. E. 1987. Heartwood and tree exudates. Springer-Verlag, New York.
- Lee, L.-L. and C.-Y. Lin. 2007. Monitoring of large mammals and populations of Formosan sambar deer along the 2nd section of southern central ridge trail in Yushan National Park. Yushan National Park Headquarters, Construction and Planning Agency, Ministry of the Interior, Executive Yuen, Taiwan. (in Chinese)
- Ueda, H., S. Takatsuki and Y. Takahashi. 2002. Bark stripping of hinoki cypress by sika deer in relation to snow cover and food availability on Mt Takahara, central Japan. *Ecological Research* 17: 545-551.
- Weng, G.-J. and C.-Y. Lin. 2009. Monitoring of large mammals in Singkang mountain and the 2nd section of southern central ridge trail in Yushan National Park. Yushan National Park Headquarters, Construction and Planning Agency, Ministry of the Interior, Executive Yuen, Taiwan. (in Chinese)
- . 2010. Monitoring of large mammals and

- study of population ecology of sambar deer in the area of Sinkang Mountain in the Yushan National Park. Yushan National Park Headquarters, Construction and Planning Agency, Ministry of the Interior, Executive Yuen, Taiwan. (in Chinese)
- . 2011. Surveying of the effect of sambar on the recruitment and structure of forests in the areas of Jyunda and Guangao in the Yushan National Park. Yushan National Park Headquarters, Construction and Planning Agency, Ministry of the Interior, Executive Yuen, Taiwan. (in Chinese)
- Yokoyama, S., I. Maeji, T. Ueda, M. Ando and E. Shibata. 2001. Impact of bark stripping by sika deer, *Cervus nippon*, on subalpine coniferous forests in central Japan. *Forest Ecology and Management* 140:93-99.