Short communications

Using leopard cats (*Prionailurus bengalensis*) as biological pest control of rats in a palm oil plantation

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Introduction

Oil palm plantations constitute ideal habitat for several species of rats with a variety of shelter and constant food supply year around. In an ideal habitat rat populations can become so dense that they become one of the most serious pests in oil palm estates. Large rat populations can cause serious damage to fruit bunches resulting in significant economic loss. Studies have recorded losses in excess of US$ 32 million annually for the industry in Malaysia in the 1980s (Basri & Halim, 1985). The damage by rats is estimated at 5% to 30% of average yield if no pest eradication activities are undertaken (Hafidzi & Saayon, 2001; Wood & Chung, 2003).

The most common method of controlling rat populations is application of anticoagulating chemical rodenticides. These are traded under brand names such as Warfarin (*(RS)-4-Hydroxy-3-(3-oxo-1-phenylbutyl)-2H-chromen-2-one*), Bromadioline (*3-[3-[4-(4-bromophenyl)phenyl]-3-hydroxy-1-phenylpropyl]-2-hydroxychromen-4-one*) and chlorophacinone (*2-[2-(4-Chlorophenyl)-1-oxo-2-phenylethyl]indane-1,3-dione*) (Chong et al., 2011; Hafidzi & Saayon, 2001; Joshi et al., 2002). Extensive use of chemical rodenticide can greatly add to the average plantation's operational budget. In many cases it has also resulted in developing physiological resistance in the target pest species (Baker et al., 2007; Smith et al., 1993). In addition, there is a high risk of incurring serious residual effects on humans, particularly the workers applying the rodenticides (Joshi et al., 2002). For all of these reasons, biological rodent control was introduced in earnest in the early 1980s (Duckett, 1984). The barn owl, *Tyta alba javanica*, is the most widely used bio- rodenticide in palm oil plantations today (Chong et al., 2011). Some companies proclaim zero- use of chemical rodenticide, and they breed more than 10.000 barn owls annually for their plantations (Indofood Agri Resources Ltd. , 2012). Barn owls have proven excellent as bio-rodenticides. They are effective predators and they are able to establish local populations relatively well, as long as plantation owners deploy enough nest boxes (Naim et al., 2011). However, it is not certain whether barn owls are effective in reducing rodent populations that have grown to very high levels (Chong et al., 2011; Wood & Chung, 2003). Barn owls have proven effective in regulating rodents' damage to fruit bunches when rat populations are relatively low. However, studies suggest that without using aids such as rodenticides barn owls are unable to reduce rodent population effectively when rat populations are very high (Chia & Lim, 1995; Chong et al., 2011; Smal et al., 1990).

Very few estates have explored the opportunity of using other bio-rodenticides to substitute and/

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Figure 1. Leopard cat, *Prionailurus bengalensis*, stalking rats in an oil palm plantation in Central Kalimantan, Indonesia.

or compliment barn owls. A common predator in oil palm plantations is the leopard cat, *Prionailurus bengalensis* (Azlan et al., 2013; Grassman, 2000, 1998; Grassman et al., 2005a, 2005b; Rajaratnam, 2007) (Fig.1). With a body-weight ranging between 2.5-4kg it is considerably larger than a barn owl's 0.4-0.7kg. Therefore, it is expected to consume much more food and it may be a better bio-rodenticide than barn owls, provided the cats are are found in sufficiently large numbers.

This study aims to assess the effectiveness of the leopard cat at controlling rat populations in an oil palm plantation in Central Kalimantan, Indonesia.

Methodology

Study location

This study was conducted from 17th September to 17th October, 2012, in an oil palm plantation in Central Kalimantan province, Indonesia. Elevation range is 7-13m above sea level. The habitat consists of six year old oil palms.

Camera trapping

20 units of "Keep Guard Cam TM1" camera traps were deployed in a 1600m x 2000m trapping grid with the distance between cameras 400m. The cameras covered two different treatment areas in which rat population densities were estimated;

Site A: area with solid mill effluent and empty fruit bunch application.

Site B: control area (no treatment).

Camera traps were set to be active throughout 24 hours cycles. The motion detection was set to "medium" to avoid too many "ghost" pictures occurring from leaf and grass wind-movements. The cameras were set to take three photos at one seconds intervals (one independent event), and 10 seconds difference between events. Camera traps were fixed to wooden poles 0.6m above ground.

Picture analysis

All pictures were organized and analyzed following the method developed by Sanderson and Harris, 2013). Species photographed were identified according to Francis (2008) and Payne and Francis (1985).

Table 1. Six different animal species were recorded by camera traps in the two study sites, and two species of rats were captured in the area.

Species	#captures
Camera traps	
Prionailurus bengalensis	125
Felis domesticus	122
P. hermaphroditus	7
Centropus sinensis	3
Streptopelia chinensis	1
Homo. s. sapiens	97
Unidentified objects	162
Total	**517**
Cage traps	
Rattus argentiventer	208
Rattus jalorensis	45
Total	**253**

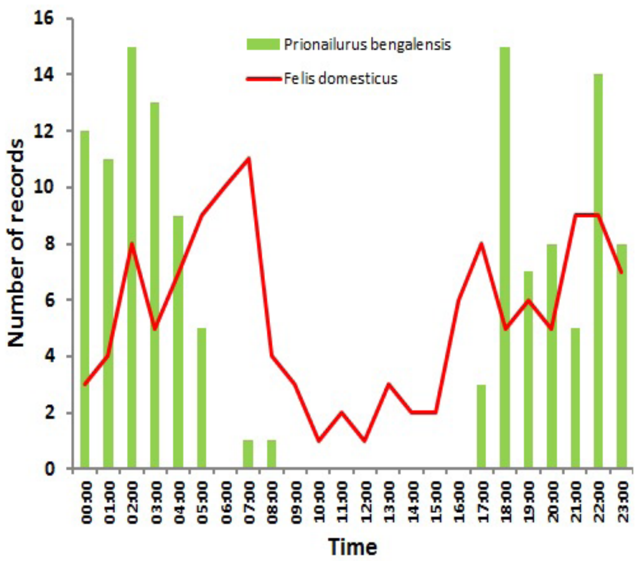

Figure 2. The diurnal rhythm of leopard cats (green columns) and feral cats (red line) in an oil palm plantation in Central Kalimantan, Indonesia.

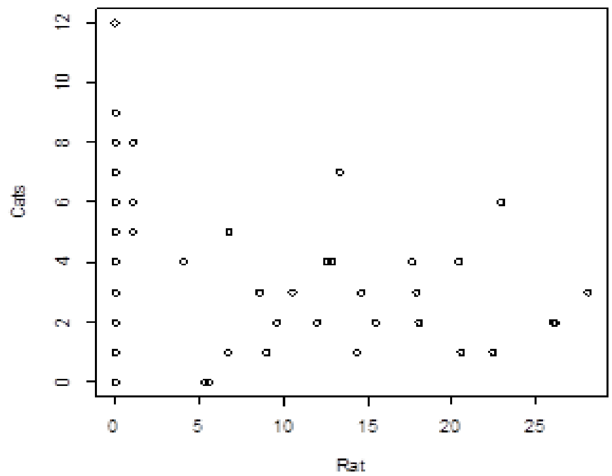

Figure 3. The relationship between cat and rat population in two study sites in an oil palm plantation. Spearman's rank correlation, $p < 0.0005527$, $\rho = -0.4328$.

Population estimates of rats

Concurrently with the camera traps we deployed 50 cage traps (15x20x40cm) in five trap lines with each 10 traps in each study site. The distances between the trap lines and the individual traps were 20m. The cage traps were positioned on the ground, baited with fresh coconut and checked twice daily in the early morning and in late afternoon. Each captured rat was marked by fur clipping and released. We used capture-mark-recapture method to estimate the rat population density (Jolly, 1965).

Results

A total of 517 images were recorded by camera traps during 608 trap nights. Leopard cats (*Prionailurus bengalensis*), feral cats (*Felis domesticus*) and humans were by far the most common captured with 125, 122 and 97 images respectively (Tab. 1). Palm civet (*Paradoxurus hermaphroditus*), Greater Coucal (*Centropus sinensis*) and Spotted dove (*Streptopelia chinensis*) were also recorded along with unidentified objects. Two species of rats *Rattus argentiventer* and *Rattus jalorensis* were captured during a total of 3000 trap nights (1500 traps nights in site A and 1500 traps nights in site B).

Camera trapping revealed leopard cats and feral cats as active predators of rats in both study areas, with several cameras recording both leopard cats and feral cats feeding on rats. The presence of both species did not seem to negatively affect the other cat species, since leopard cats are strictly nocturnal and feral cats exhibit crepuscular and diurnal activity pattern (Fig.2).

The rat population was estimated at 0.07 individuals/ha in Site A with a cat abundance of 0.89/ha in contrast to 7.29 individuals/ha (rats)in Site B with a cat abundance of 0.58 individuals/ha. There was reverse correlation between cat and rat populations ($p<0.01$, $\rho= -0.4328$, Spearman's rank correlation) with high abundance of cats resulting in low population of rats and vice versa (Fig. 3).

Discussion

Murids constitute the majority of the prey base for leopard cats in general (Grassman et al., 2005; Sakaguchi & Ono, 1994; Yasuma, 1981). The dominating percentage of murids in the diet of leopard cats is expected, in consideration that murids dominate terrestrial small-mammal communities in tropical rain forests (Wells et al., 2004). In an oil palm plantation rats are also the dominant small mammal, to the extent that it is considered a pest animal. An earlier study in Sabah, Malaysia, revealed that murids comprised 92.8% of the mammalian prey consumed by leopard cats (Rajaratnam et al., 2007), suggesting that leopard cats are indeed significant predators of rats in a plantation landscape. The presence of feral cats does not seem to affect the distribution of leopard cat in the plantation landscape as both species generally recorded from the same areas. In general, however, feral cats are more abundant close to human habitations (housing area, mill, offices), whereas leopard cats seem to prefer less disturbed areas. From a rat controlling perspective, it seems that the presence of both cat species may be an advantage, because when both are present their combined hunting pressure is extended from 18:00-05:00 to a 24hour cycle (Fig.2).

In comparison to barn owls, leopard cats are expected to consume more rats per individual, simply because the larger cats require more energy to sustain their bigger body mass. However, this does not necessarily mean that leopard cats are more effective rat-controllers in oil palm plantations. Considering that total off-take of rats depends on predator population size, a large barn owl population may be more effective rat controllers than a small leopard cat population. A study by Chong et al. (2011) recorded a rat population of 0.09 rats/ha using barn owls as rat controllers, which appears less effective than that recorded in this study with leopard cats. Unfortunately, Chong et al. (2011) does not report the numberrs of the population of barn owls in their study; therefore, it is not possible to make direct comparisons between these two studies.

This study suggests that leopard cats, *Prionailurus bengalensis*, can be very effective rodent controllers in oil palm plantations. Although it is not possible to compare the rat controlling effect of leopard cat with that of barn owls, *Tyta alba javanica*, there is enough evidence for plantation operators to consider improving the habitat conditions for a native larger predator rather than spending significant additional funds to purchase and erect thousands of nest boxes for barn owls in areas where it is not native. From a conservation perspective, the introduction and promotion of barn owls is an unnecessary expenditure. In Central Kalimantan, barn owls are exotic species that may compete with a native mammal species such as leopard cats which are already present and effectively maintain rat populations at levels that are economically insignificant to palm oil production. However, more studies are needed to determine to what degree leopard cats and barn owls may increase rodent predation pressure or reduce it due to intraspecific competition.

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References

Azlan, M., Sollmann, R., Bernard, H., Ambu, L.M., Lagan, P., Mannan, S., Hofer, H and A. Wilting (2013). Density and habitat use of the leopard cat (*Prionailurus bengalensis*) in three commercial forest reserves in Sabah, Malaysian Borneo. *Journal of Mammalogy*, 94(1): (in press).

Basri, M.W. and A.H. Halim (1985). The Effects of *Elaeidobius Kamerunicus Faust* on rat control program on oil palm estate in Malaysia. *PORIM Occasional Paper* 14: 1-50.

Chia, T.H. and Lim, J.L. (1995). Barn Owl for Rats Control in Oil Palm Plantation – Do they work? *The Planters* **71**: 109-117.

Chong, L.P., Goldizen A.W., Zakaria, M., Hafidzi, M.N. and G.X. Baxter (2011). Absence of differential predation on rats by Malaysian barn owl in oil palm plantations . *J. Raptor Res.* **45(1)**: 71-78.

Duckett, J.E. (1984). Barn owls (*Tyto alba*) and the 'second generation' rat baits utilised in oil palm plantations in Peninsular Malaysia. *Planter* **60**: 3-11.

Francis, C.M. (2008). A Field Guide to the mammals of Southeast Asia. New Holan Publisher. London,UK.

Grassman, L.I (2000). Movement and diet of the leopard cat *Prionailurus bengalensis* in a seasonal evergreen forest in southcentral Thailand. *Acta Theriologica Scientific Report* **45**: 421–426.

Grassman, L.I. (1998). Movements and prey selection of the leopard cat (*Prionailurus bengalensis*) in a subtropical evergreen forest in southern Thailand. *Societa Zoologica "La Torbiera"* **4**: 9–21.

Grassman, L.I., Tewes, M.E., Silvy, N.J. and K. Kreetiyutanont (2005a). Ecology of three sympatric felids in a mixed evergreen forest in north-central Thailand. *Journal of Mammalogy* **86**:29–38.

Grassman, L.I., Tewes, M.E., Silvy, N.J. and K. Kreetiyutanont (2005b). Spatial organization and diet of the leopard cat (*Prionailurus bengalensis*) in north-central Thailand. *Journal of Zoology* **266**: 45–54.

Hafidzi, M.N. and M.K. Saayon (2001). Status of rat infestation and recent control strategies in oil palm plantations in Peninsular Malaysia. Pertanika *J. Trap. Agric. Sci.* **24(2)**: 109- 114.

Indofood Agri Resources Ltd. (2012). Annual Report. Singapore.

Jolly, G.M. (1965). Explicit estimates from capture-recapture data with both death and immigration Stochastic model. *Biometrika* **52**: 225-247.

Joshi, A., Fernandez, I., Mourin, J. and S.V. Rengam (2002). Poisoned and silenced: a study on women spraying pesticides on plantations. Teneganita and Pesticide Action Network Asia and the Pacific. Kuala Lumpur, Malaysia. 68pp.

Naim, M., Hafidzi, M.N., Kassim, A. and A. Jalila (2011). Comparison of breeding performance of the barn owl (*Tyto alba javanica*) under chemical and bio-based rodenticide baiting in immature oil palms in Malaysia. *Dynamic Biochemistry, Process Biotechnology & molecular Biology* **5(2)**: 5-11.

Payne, J. and C.M. Francis (1985). A field guide to the mammals of Borneo. The Sabah Society, Kota Kinabalu, Sabah, Malaysia. 332pp.

Rajaratnam, R., Sunquist, M., Rajaratnam, L. and L. Ambu (2007). Diet and habitat selection of the leopard cat (*Prionailurus bengalensis borneoensis*) in an agricultural landscape in Sabah, Malaysian Borneo. *Journal of Tropical Ecology* **23**: 209–217.

Sakaguchi, N. and Y. Ono (1994). Seasonal change in the food habits of the Iriomote cat *Felis iriomotensis*. *Ecological Research* **9**:167–174.

Sanderson, J. and G. Harris (2013). Automatic data organization, storage, and analysis of camera trap pictures. *Journal of Indonesian Natural History* **1(1)**: 6-14.

Smal, C.M. (1990). Research on the use of Barn Owls *Tyto alba* for biological control of rats in oil palm plantations: 1986–89. Proceedings International Palm Oil Development. PORIM, Kuala Lumpur, Malaysia. Pages 342–356.

Smith, P., Berdoy, M., Smith, R.H. and D.W. MacDonald (1993). A new aspect of Warfarin resistance in wild rats: Benefits in the absence of poison. *Functional Ecology* **7**: 190–194.

Smith, P., Berdoy, M. and R.H. Smith (1994). Body-weightand Social-Dominance in Anticoagulant-Resistant Rats. *Crop Protection* **13**:311–315.

Wells, K., Pfeiffer, M., Lakim, M.B. and K.E. Lisenmair (2004). Use of arboreal and terrestrial space by a small mammal community in a tropical rain forest in Borneo, Malaysia. *Journal of Biogeography* **31**: 641–652.

Wood, B.J. and Chung, G.F. (2003). A critical review of the development of rat control in Malaysian agriculture the 1960s. *Crop Protection* **22**: 445-461.

Yasuma, S. (1981). Feeding behaviour of the Iriomote cat (*Prionailurus iriomotensis imaizumi*, 1967). *Bull. Tokyo Univ. Forests* **70**: 81–140.

