Proceedings of
The 3rd National Meeting on Biodiversity Management in Thailand
การประชุมวิชาการการบริหารจัดการความหลากหลายทางชีวภาพแห่งชาติ ครั้งที่ 3 (2016) : 124–133

RP-02

Potential seed predators in an abandoned agricultural area in northern Thailand

Khuanphirom Naruangsri* and Pimonrat Tiansawat

Department of Biology, Faculty of Science, Chiang Mai University, Mueang Chiang Mai, Chiang Mai 50200
* Corresponding author: aom.khuan@gmail.com

One limitation of forest restoration by direct seeding in degraded areas is seed predation by animals foraging on the ground. Seeds sown on the ground can be removed or destroyed leading to loss of germination ability. Knowing small mammals and bird species and evaluating their roles relating to seed predation are beneficial for forest restoration plans. This study aims to examine small mammal and bird species that are active on the ground in an abandoned agricultural area, where seeds were sown on the ground for direct seeding. Camera traps were installed for seven months in a 500 m^2 abandoned agricultural land, which was 70 m away from the nearest natural forest. Seeds of five species were placed in the area to create seed availability in the direct seeding practice. The cameras were relocated randomly every week within the direct seeding plot. During seven months of camera trapping, 15 animal species were detected. Two of the species were categorized as seed predators (*Mus* sp. and *Turnix suscitator*), while the 13 remaining species were categorized as non—seed predators. The species with the highest frequency of visiting the area was *Mus* sp. Their visits peaked right after the time of seed sowing. The study emphasizes the need of quantifying seed loss due to animals and evaluating the risk of seed predation in a degraded area before using direct seeding for forest restoration.

Key words: Direct seeding, Camera trapping, *Mus* sp., Forest restoration, Chaing Mai

Introduction

Human activities, such as agricultures and shifting cultivations, are one of major causes of forest destruction (Pearce and Brown, 1994). The data from FAO (2016) showed the global forest area in 1990 – 2015 had been decreasing by 129 million hectares (3.1%) to under 4 billion hectares. In Thailand, located in tropical zone, forest areas were decreased more than 50% of original forest around the country at rates exceeding 3 percent per year (Hirsch, 1987). Deforestation and degradation have been linked to changes in climate pattern (Gorte and Sheikh, 2010) and loss of biodiversity (Moutinho and Schwartzman, 2005). To maintain high biodiversity and mitigate global climate crisis, forest restoration of degraded area has been widely recognized as a solution (Parrotta, 2000).

Methods for forest restoration conventionally include production of tree seedlings in nurseries and seedling plantation in target sites (Lamb and Gilmour, 2003; FORRU, 2006). The conventional methods are expensive, laborious, and time consuming (FORRU, 2006) because of constructing a tree nursery, intensive caring of young plants, and planting seedlings in target sites (Verdone, 2015). In practice, finding forest restoration methods that are cheap and easy to implement will help creating more restoring projects, leading to increase in forested areas. Direct seeding is an alternative method for accelerating forest recovery by sowing forest tree seeds directly into deforested areas (Doust *et al*., 2008). Many direct seeding research studies have been focused on selecting species with seed characteristics suitable such as thickness of seed coat and seed size for direct seeding in different restored sites (Tunjai and Elliott, 2012). However, one of the major limitations of direct seeding method is seed predation by vertebrate species (Holl, 1998; Doust *et al*., 2008). To protect seeds and better manage direct seeding programs, it is essential to get information on what animals play roles in seed predation of degraded areas, Natural enemies usually interact with plants at different life history stages and habitats (Fricke *et al*., 2014). At seed stage, vertebrate species such as rodents are the most commonly associated with post-dispersal seed predation (e.g. Crawley, 1992). The intensity of seed predation by vertebrates depends on size of seeds (Pizo *et al.,* 2006). Majority of work in seed predation study have been focused on seed predation in natural habitats (e.g. Fuentes and Schupp, 1998; Bricker *et al*., 2010; Fricke *et al*., 2014). Less works has been done in degraded areas (e.g. Cole, 2009; St-Denis *et al*., 2013). A previous study of seed predation in an open area of abandoned agriculture land shows that rodents preferably predated on large seeds than small-sized seeds (Wood and Elliott, 2003). In addition to rodents, other vertebrates such as birds play a role in post-dispersal seed predation (Hubbard and McPherson, 1997).

In this study, our objective was to obtain information on small mammal and bird species that are active on the ground in an agricultural area, where seeds were sown on the ground for direct seeding. We then categorized small mammal and birds to see if any of them may be potential seed predators.

Methodology

Study site

The field experiment was established at Mon-Cham degraded area (18° 56' 19" N 98° 49' 15" E at 1,343 m above sea level), in Doi Suthep-Pui National park, Chiang Mai (Figure 1). The average annual precipitation is 1200 mm per year with a dry season from December to April. The average annual temperature is 25°C and the average humidity is 78.24% (Meteorological Department of Thailand, 2015). The degraded area was an abandoned agricultural land, covered by grasses and herbaceous plants. The study site was 500 m^2 in area and 70 m away from the nearest natural forest.

To create conditions representing direct seeding for forest restoration, we used seeds of five species, which can be collected before the beginning of experiment. All species were suitable for forest restoration by the conventional tree planting method. The five species were *Hovenia dulcis* (5.57 mm × 5.37 mm, 200 ± 4 mg dry weight), *Alangium kurzii* (11.75 mm × 6.35 mm, 180 ± 30 mg dry weight), *Prunus cerasoides* (9.70 mm × 7.47 mm, 290 ± 30 mg dry weight), *Choerospondias axillaris* (19.40 mm × 14.55 mm, 2600 ± 320 mg dry weight) and *Horsfieldia amygdalina* (33.40 mm × 18.26 mm, 4250 ± 660 mg dry weight). The seeds were collected from the mother trees, cleaned, and air-dried before placing in the studied site. A seed of each species was placed on the soil surface and secured using a 10-cm long bamboo tube, installed vertically on the ground 15 cm apart. The tube allowed the seed to be exposed to animals, but prevented seeds from moving away by other means (e.g. rains) (Tunjai and Elliott, 2012). For each species, a group of 30 seeds were laid out in 6 columns and 5 rows, to form a seed station. For each species, 15 seed stations were random distributed across the site. In total, there were 75 seed stations laid out in a grid fashion for seven months (Figure 1). Seeds were placed in the 75 seed stations at the same time. The seed stations were 1 m apart from one another in the studied area.

Camera trapping

Photographs of small mammals and birds were collected using five camera traps for seven months from August 2015 to February 2016. The occurrence of animals was captured using RECONYX™ PC900 HyperFire™ cameras in burst mode (set for five snapshots per detection). Each camera trap was mounted in a plastic case and attached to an iron bar at 40 cm above the ground. The camera traps were randomly placed in the site at least five m apart from one another. The five cameras were deployed per month and the five cameras were randomly moved within the 18 locations (Figure 1). There were 28 sets of trapping locations in seven months (28 weeks) of the study.

The small mammal and bird species detected by the camera traps were identified to species or genus. We used "A Naturalist's Guide to the Mammals of Thailand and Southeast Asia" (Shepherd and Shepherd, 2012) and

“Guide to the Birds of Thailand by Doctor Boonsong Lekhakul” (Nabhitabhata *et al*., 2012) for species identification. In addition, time and date, the number of photos and the number of individuals were recorded. The number of independent photograph was counted from the photographs; whenever a single species appeared in photographs taken more than 30 minutes apart, the two subjects were treated as separate individuals (O’Brien *et al*., 2003). The photographs can be used as an index for species abundance, richness and distribution, based on the assumption that when the density of animals increases, the possibility of capturing by camera traps is increased (Rovero and Marshall, 2009; Abi-Said and Amr, 2011). To explore the small mammals and birds present at the site, we used the number of independent photographs to calculate number per total effort of 100 trap days.

Determine potential seed predator

Detected small mammal and bird species were divided into two groups, (1) seed predator and (2) non—seed predator. A seed predator is a vertebrate species that eats and damages seeds and potentially affects the survival of seeds. On the other hand, a non—seed predator visits the site and does not cause any damage to seeds. We used two sources of information to determine the potential seed predators present in the area, (1) from the captured photographs and (2) from the existing literature. If the animals’ photographs were captured when they searched and/or put their head in the bamboo tube with seeds, we listed them as a seed visitor. Then we looked into the previous literature to get information about their diets and/or their role in seed predation. If their diets include seeds and/or the species were reported elsewhere as seed predators, we categorized them as potential seeds predators of the studied area. The previous literature included Nabhitabhata *et al*., 2012; Shepherd and Shepherd, 2012; Arora, 2014; Crawley and Long, 1995; Woods and Elliott, 2003.

Results

Over the course of the seven months, the camera traps were installed for a total of 1,000 trap days (142.8 average trap days per month). During these 1,000 trap days, 15 animal species were detected in 116 photographs. Among all the photographs, 54% were of two seed predator species: shortridge's mouse (*Mus* sp.) and barred buttonquail (*Turnix suscitator*). In addition to seed predators, there were 13 species of non—seed predators, accounting for 46% of the total number of photographs.

Among the detected animals, shortridge's mouse (*Mus* sp.) was detected with the most frequency (Table 1). August was the month which *Mus* sp. visited most frequently. Two species, barred buttonquail (*Tupaia belangeri*) and northern treeshrew (*Turnix suscitator*) were found often but in lower frequency than the *Mus* sp. (Table 1). Species that detected with the lowest frequency were large Indian civet (*Viverra zibetha*), greenish warbler (P*hylloscopus trochiloides*), scaly-breasted munia (*Lonchura punctulata*), red-throated pipit (*Anthus cervinus*) and common jackal (*Canis aureus*) (Table 1).

According to timestamps recorded by the camera traps, most animals visited the plot during the daytime (12 out of 15 detected species; 80%), especially all of bird species. Only three species, shortridge's mouse (*Mus* sp.), hog badger (*Arctonyx collaris*), and large Indian civet (*Viverra zibetha*), visited at night.

Discussions

Species richness

The animal species found in the studied site were rodents, birds, and small carnivores. Among 15 animal species, a species of the genus *Mus* was the most frequent visitor detected by camera trapping. Many of species in the genus *Mus* are known to be seed predators of plant species (e.g. Hulme, 1998, Wood and Elliott, 2003, Doust *et al*., 2008) and barriers to successful direct seeding (Farlee, 2013). In this study, we found that one species in genus *Mus* frequently visited the site after seeds were sown in August.

We found one large Indian civet (*Viverra zibetha*), an omnivore species that is categorized as Near Threatened on The IUCN Red List of Threatened Species (Bista *et al*., 2012). The large Indian civet is an important secondary seed dispersal species (FORRU, 2006). We found small mammal and bird species that occur in a wide variety of habitats such as the leopard cat (*Prionailurus bengalensis*) (Ross *et al*., 2015), hog badger (*Arctonyx collaris*) (Duckworth *et al*, 2016) and scaly-breasted munia (*Lonchura punctulata*) (Gokula, 2001).

Activity of animals from camera trapping

Activities detected from the camera traps included searching in the bamboo tubes with seeds, walking through the site, and stopping at the site for a short time. The photographs revealed that the *Mus* sp. usually searched inside the bamboo tubes. The *Mus* sp. was detected in five out of seven months, with the most frequent visit in August. In addition, our study showed that *Mus* sp. was active and visited the site at night. This result agrees with Rowcliffe et al. (2014), which was also a camera trap study. The observations using camera traps, coupled with the findings of the previously mentioned studies, suggested that the *Mus* sp. was an important seed predator.

Another potential seed predator species was the barred buttonquail (*Turnix suscitator*). They visited the site only shortly after seeds were sown, in August and September. The usual diet of barred buttonquails (*Turnix suscitator*) consists of grains and seeds (Arora, 2014). In this study, we categorized the barred buttonquail (*Turnix suscitator*) as a potential seed predator based on their gape size and activities, captured in the photos. The barred buttonquails were photographed searching and picking inside the bamboo tubes. However, this species is known to be omnivorous: they also eat mealworms (Arora, 2014).

Carnivorous species and potential seed dispersal agents visited the site. We found one individual each of leopard cat (*Prionailurus bengalensis*) and common jackal (*Canis aureus*). For carnivorous species, photographs suggested that they walked through the site and/or made a short stopped at the site. The presence of carnivorous species is usually correlated with that of their prey (Carbone and Gittleman, 2002). Leopard cats (*Prionailurus bengalensis*) are commonly found in open habitats, secondary forests and plantation areas as long as they have food (Sunquist *et al.,* 2007). Leopard cats are usually active in both day and night (Rowcliffe *et al.*, 2014), but they seem to be more active during the daytime, when they look for their prey (Di Bitetti *et al*., 2008). Leopard cats' diets include small mammals such as *Mus sp*. (Grassman, 2000), birds (Sunquist *et al.,* 2007), amphibians and reptiles. The diet and typical habitat of the common jackal are similar to those of the leopard cat (Borkowski et al., 2011). In addition to the leopard cat and common jackal, we found various bird species perching on the ground. It is worth noting that the study site is located 70 m away from the forest. It is possible that the species found with low frequency, including the leopard cat, common jackal and some birds, may only have been at the site by chance.

Conclusion and future direction

The study showed the presence of potential seed predators, shortridge's mouse (*Mus* sp.) and barred buttonquail (*Turnix suscitator*), in an old agricultural area at Mon Cham. The presence of seed predators confirmed that the seeds used in direct seeding are subject to predation, and highlights the need for quantifying number of seed loss due to seed predators and for finding some means to protect the seeds used in direct seeding. The studies of seed predator density, and activity patterns (especially for rodent seed predators) will also help in understanding how to protect seeds in direct seeding. For future improvement, increasing camera trap days will help better estimating the diversity of animals in the area. Using varieties of methods at once such as Sherman traps plus camera traps will give better estimates of animal abundance and density. In addition, expanding research studies to quantify predation of seed predators (by carnivorous mammals) may be useful to evaluate the intensity of seed predation and to plan long term forest restoration.

Acknowledgements

The research study was supported by the Thailand Research Fund (MRG5980177) and the Development and Promotion of Science and Technology Talents Project (DPST) scholarship. We thank Dr Stephen Elliott for his advice and equipment, Mr Jatupoom Meesena for his help with animal identification and Dr David Lipsky for his help editing. We thank two anonymous reviewers for the comments to help improving the manuscript. We would like to thank Nong Hoi Royal Project Foundation for permission to conduct the field experiment.

References

Abi-Said, M. and Amr, Z.S. 2011. Camera trapping in assessing diversity of mammals in Jabal Moussa Biosphere Reserve, Lebanon. Vertebrate Zoology 62(1): 145–152.

Arora, D. 2014. Case Study: Hand-rearing a barred buttonquail (*Turnix suscitator*) fledgling. Rehabber's Den

Bista, A., Chanchani, P., Warrier, R., Mann, R., Gupta, M. and Vattakavan, J. 2012. Detection of large indian civet *Viverra zibetha* in camera-trap surveys in and around Dudhwa National Park in the Terai Region of North India. Small Carnivore Conservation 47: 54–57.

Bricker, M. Pearson, D. and Maron, J. 2010. Small-mammal seed predation limits the recruitment and abundance of two perennial grassland forbs. Ecology 91(1) 85–92.

Carbone, C. and Gittleman, J.L. 2002. A common rule for the scaling of carnivore density. Science 295: 2273–2276.

Cole, R.J. 2009. Post dispersal seed fate of tropical montane trees in an agricultural landscape, Southern Costa Rica. Biotropica 41(3) 319-327.

Crawley, M.J. and Long, C.R. 1995 Alternate bearing, predator satiation and seedling recruitment in Quercus robur L. Journal of Ecology 83: 683–696

Doust, S. J., Erskine, P. D. and Lamb, D. 2008. Restoring rainforest species by direct seeding: Tree seedling establishment and growth performance on degraded land in the wet tropics of Australia. Forest Ecology and Management 256(5) 1178-1188.

Di Bitetti, M.S., Paviolo, A., Ferrari, C.A., De Angelo, C. and Di Blanco, Y. 2008. Differential responses to hunting in two sympatric species of brocket deer (*Mazama americana* and *M-Nana*). Biotropica 40: 636-645.

Duckworth, J.W., Timmins, R., Chutipong, W., Gray, T.N.E., Long, B., Helgen, K., Rahman, H., Choudhury, A. and Willcox, D.H.A. 2016. *Arctonyx collaris*. The IUCN red list of threatened species 2016. Available from: http://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T70205537A45209459.en. Downloaded on 05 October 2016.

Farlee, L.D. 2013. Direct seeding of fine hardwood tree species. Proceedings of the Seventh Walnut Council Research Symposium.

Food and Agriculture Organization; FAO. 2016. State of the world's forests 2016. Forests and agriculture: land-use challenges and opportunities. Rome.

FORRU. 2006. Planting trees. In: Elliott, S., Blakesley, D., Maxwell, J.F., Doust and Suwannaratana. S. How to plant a forest: the principles and practices of restoring tropical forests. Biology Department, Science Faculty, Chiang Mai University, Chiang Mai p. 103–132.

Fricke, E. C., Tewksbury, J. J. and Rogers, H. S. 2014. Multiple natural enemies cause distance-dependent mortality at the seed-to-seedling transition. Ecology Letters 17(5) 593-598.

Fuentes, M. and Schupp, E.W. 1998. Empty seeds reduce seed predation by birds in *Juniperus osteosperma*. Evolutionary ecology 12: 823-827

Geiser, F. 1987. Reduction of metabolism during hibernation and daily torpor in mammals and birds: temperature effect or physiological inhibition? Journal of Comparative Physiology B 158: 25-37

Gokula V. 2001. Nesting ecology of the spotted munia *Lonchura punctulata* in Mudumalai wildlife sanctuary (South India). Acta Ornithol 36: 1–5.

Gorte, R.W. and Sheikh, P.A. 2010. Deforestation and climate change. Congressional Research Service. 45 pages.

Grassman, L.I. 2000. Movements and diet of the leopard cat *Prionailurus bengalensis* in a seasonal evergreen forest in south-central Thailand. Acta Theriologica 45(3) 421-426.

Hirsch, P. 1987. Deforestation and development in Thailand. Singapore Journal of Tropical Geography 8(2) 129-138.

Holl, K. D. 1998. Effects of above-and below-ground competition of shrubs and grass on *Calophyllum brasiliense* (Camb.) seedling growth in abandoned tropical pasture. Forest Ecology and Management 109: 187-195.

Hubbard, J.A. and McPherson, G.R. 1997. Acorn selection by Mexican jays: A test of a tri-trophic symbiotic relationship hypothesis. Oecologia 110: 143–146

Hulme, P.E. 1998. Post-dispersal seed predation: consequences for plant demography and evolution. Perspectives in Plant Ecology, Evolution and Systematics 1(1) 32–46

Lamb, D. and Gilmour, D. 2003. Rehabilitation and restoration of degraded forests. IUCN, Gland, Switzerland and Cambridge, UK and WWF, Gland, Switzerland. 110 pp.

Liua, X., Wuc, P., Songerd, M., Caie, Q. Hef, X., Zhue, Y. and Shaoc, X. 2013. Monitoring wildlife abundance and diversity with infra-red camera traps in Guanyin Shan Nature Reserve of Shaanxi Province, China. Ecological Indicators 33: 121–128.

Moutinho, P. and Schwartzman, S. 2005. Tropical deforestation and climate change. Amazon Institute for Environmental Research. 132 pp.

Nabhitabhata, J., Lekhakul, K. and Sa-nguansombat, W. 2012. Guide to the Birds of Thailand by Doctor Boonsong Lekhakul (Thai version). Bangkok, Thailand 488 pp.

O'Brein, T., G'Kinnarid, M.F. and Wibisono, H.T. 2003: Crouching tigers, hidden prey: Sumatran tiger and prey populations in a tropical forest landscape. – Animal Conservation 6: 131–139.

Parrotta, J. A. 2000. Catalysing natural forest restoration on degraded tropical landscapes. In Elliot, S., Kerby, J., Blakesley, D., Hardwick, K., Woods, K. and Anusarnsunthorn, V. Forest restoration for wildlife conservation. International Tropical Timber Organization and the Forest Restoration Research Unit, Chiang Mai University, Chiang Mai, Thailand p. 45-54.

Pearce, D. and Brown, K. 1994. Saving the world's tropical forests. In: Brown, K. and Pearce, D. The causes of tropical deforestation. The economic and statistical analysis of factors giving rise to the loss of the tropical forest, UCL Press, p. 2-26.

Pizo, M.A. Allmen, C.V., Morellato, L.P.C., 2006. Seed size variation in the palm Euterpe edulis and the effects of seed predators on germination and seedling survival. Actaoecologiga 29: 311-315.

Ross, J., Brodie, J., Cheyne, S., Hearn, A., Izawa, M., Loken, B., Lynam, A., McCarthy, J., Mukherjee, S., Phan, C., Rasphone, A. & Wilting, A. 2015. *Prionailurus bengalensis*. The IUCN Red List of Threatened Species 2015. Available from: http://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS. Downloaded on 05 October 2016.

Rovero, F. & Marshall, A.R. 2009: Camera trapping photographic rate as an index of density in forest ungulates. Journal of applied Ecology 46: 1011–1017.

Rowcliffe, M.J., Kays, R., Kranstauber, B., Carbone, C. and Jansen, P.A. 2014. Quantifying levels of animal activity using camera trap data. Methods in ecology and evolution 5: 1170–1179.

Shepherd, C.R. and Shepherd, L.A. 2012. A naturalist's guide to the mammals of Thailand and Southeast Asia. Asia Books Co.,Ltd 176 pp.

Si, X., Kays, R. and Ding, P. 2014. How long is enough to detect terrestrial animals? Estimating the minimum trapping effort on camera traps. PeerJ 2: 374.

St-Denis, A. Messier, C. and Kneeshaw, D. 2013. Seed Size, the Only Factor Positively Affecting Direct Seeding Success in an Abandoned Field in Quebec, Canada. Forests 4: 500–516

Sunquist, M., Rajaratnam, L. and Ambu, L. 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(02) 209–217.

Tunjai, P. and Elliott, S. 2012. Effects of seed traits on the success of direct seeding for restoring southern Thailand's lowland evergreen forest ecosystem. New Forests 43(3) 319–333.

Verdone, M. 2015. A Cost-Benefit Framework for Analyzing Forest Landscape Restoration Decisions. Gland, Switzerland: IUCN. 46 pp.

Western, D. and Grimsdell, J.J.R. 1979. Measuring the distribution of animals in relation to the environment. Second edition. New York Zoological Society 72 pp.

Woods, K. and Elliott, S. 2003. Direct seeding for forest restoration on abandoned agricultural land in northern Thailand. Journal of Tropical Forest Science 16(2) 248-259.

Zhang, Z.B., Hinds, L., Singleton, G. and Wang, Z.W. 1998. Rodent biology and management. The International Conference on Rodent Biology and Management, held at Beijing, China, 5-9 October 1998.

Table 1. Relative species occurrence in each month shown by the number of photographs per total effort 100 trap days (R). The number in parenthesis under the month name shows total trap days in each month of five cameras.

Scientific name	Common name	August (140)	September (175)	October (140)	November (140)	December (175)	January (140)	February (90)	Total
Seed predators		**30**	**2**	**2**	**4**	**0**	**0**	**7**	**45**
Mus sp.	Shortridge's mouse	21	1	2	4			7	35
Turnix suscitator	Barred buttonquail	9	1						10
Non—seed predators		**16**	**3**	**4**	**5**	**0**	**4**	**10**	**42**
Viverra zibetha	Large Indian civet	1							1
Tupaia belangeri	Northern treeshrew	4	1	1	3		1		10
Phylloscopus trochiloides	Greenish warbler							1	1
Lonchura punctulata	Scaly-breasted munia							1	1
Centropus sinensis	Greater coucal	4		1			1	1	7
Anthus cervinus	Red-throated pipit			1					1
Pycnonotus aurigaster	Sooty-headed bulbul				1		1		2
Saxicola caprata	Pied bushchat	2					1	1	4
Lanius schach	Long-tailed shrike			1	1			1	3
Herpestes javanicus	Small Asian mongoose	1	1	1	1			3	7
Prionailurus bengalensis	Leopard cat	1	2					1	4
Canis aureus	Common jackal			1					1
Arctonyx collaris	Hog badger	2							2
Total photographs		**46**	**5**	**6**	**9**	**0**	**6**	**15**	**87**

Figure 1. The location of study site (Black circle) in Mon-Cham degraded area, Ban Nong Hoi, Chiang Mai, Thailand. A diagram on the right of the map shows seed stations (Grey Square) and the locations of camera traps (X) in the study site.

Figure 2. Some of species detected from camera trapping in field experimental plot. There are two seed predator species; (a) Shortridge's mouse (*Mus* sp.) and (b) barred buttonquail (*Turnix suscitator*), Examples of non—seed predator species are (c) large Indian civet (*Viverra zibetha*), (d) leopard cat (*Prionailurus bengalensis*), (e) Northern treeshrew (*Tupaia belangeri*), (f) small Asian mongoose (*Herpestes javanicus*), (g) common jackal (*Canis aureus*), (h) Long-tailed shrike (*Lanius schach*) and (i) Greater coucal (*Centropus sinensis*)