NATURE IN SINGAPORE 2012 **5**: 285–289
Date of Publication: 29 October 2012

MASSIVE DEFORESTATION IN SOUTHERN PENINSULAR MALAYSIA DRIVING ECOLOGICAL CHANGE IN SINGAPORE?

D. L. Yong
South-east Asian Biodiversity Society
(Email: zoothera@yahoo.com)

ABSTRACT. — A number of bird and mammal species have become more abundant and widespread in Singapore in recent years, including at least three birds (*Gallus gallus*, *Vanellus indicus*, *Strix seloputo*) and one mammal (*Sus scrofa*), although all were either formerly rare or had highly localised distributions. Current ecological knowledge of these species show that all can exploit newly deforested or cultivated lands and in documented instances, can occur more abundantly in cultivated areas. While empirical evidence is limited, distributional records concentrated along Singapore's borderlands (e.g., Western Catchment Area and Pulau [=island] Ubin) suggest that source populations of these species are in southern Peninsular Malaysia (Johor state) and possibly the Riau Islands (Indonesia), where tropical forests have undergone massive conversion to cultivation, particularly for oil palm and rubber. All four species can easily disperse into Singapore from neighbouring source populations and colonise unoccupied habitats like scrublands and secondary forests. There are however few studies documenting these landscape-level ecological changes and how biodiversity can be affected in the long term, especially in Singapore's context. Based on a theoretical framework of island biogeography, metapopulations, and source-sink dynamics, I propose approaches to describe and quantify these ecological changes and their potential impacts.

KEY WORDS. — deforestation, Malaysia, Singapore, cultivation, colonisation, ecological change

INTRODUCTION

Deforestation and degradation of lowland tropical forests is a leading cause of vegetation cover changes at a landscape-level across much of Southeast Asia. This is especially the case in Peninsular Malaysia where much of the old-growth forest is in the process of being (Tan, 2009), or has now been, logged and converted into agriculture, especially for oil palm (Peh et al., 2006; Koh & Wilcove, 2008; FAO, 2010). Johor, Peninsular Malaysia's southernmost state which is adjacent to Singapore, is reported to be only 20.6% covered in forests (Forestry Department of Malaysia, 2010), while much of it is under oil palm (*Elaeis guineensis*) cultivation estimated at 717,398 ha in 2011 (Malaysian Palm Oil Board, 2012) or about 35% of the state's area. Such a large scale change in vegetation cover is drastically detrimental to forest biota, but favours faunal assemblages of low species diversity dominated by a few adaptable species. Although plantations abutting forest may support slightly richer fauna, low habitat structural complexity and absence of numerous keystone species mean that oil palm plantations are of limited value to biodiversity (Persey & Anhar, 2010), and are at best biological deserts. Some adaptable species like the yellow-vented bulbul (*Pycnonotus goiaver*), red junglefowl (*Gallus gallus*), red-wattled lapwing (*Vanellus indicus*), various owls (e.g., *Tyto alba*, *Strix seloputo*), snakes (e.g., *Python reticulatus*), wild pig (*Sus scrofa*), cats (e.g., *Prionailurus bengalensis*), and terrestrial rodents (e.g., *Rattus* spp.) are able to utilise oil palm plantations owing to easy availability of their food supply (e.g., palm fruits, other animals; Wells, 1999; Persey & Anhar, 2010) and may therefore exhibit higher abundances therein than in undisturbed forest.

In the midst of these landscape-level and corresponding biotic changes across much of Johor, Singapore recently witnessed a resurgence of species formerly rare or thought to be locally extirpated. It is not unusual that many of these species (e.g., the red junglefowl and wild pig) are also associated with open-country, secondary growth and cultivated areas (Diong, 1973; Wells, 1999), particularly oil palm cultivation in Peninsular Malaysia. Four species that have documented increases in abundance include at least two birds (i.e., the red jungle fowl *Gallus gallus*, and the red-wattled lapwing *Vanellus indicus*) and one mammal (i.e., the Eurasian wild pig *Sus scrofa*; Yong, 2008, 2010; Yong et al., 2010), while there is evidence to show that the spotted wood owl (*Strix seloputo*), a species common in oil palm estates in Peninsular Malaysia, has become more common and widespread in recent years in Singapore (pers. obs.; Wells, 1999). Yet another bird of open scrub, the black-winged kite (*Elanus caeruleus*) was considered a 'winter visitor' in Gibson-Hill (1950), but has bred recently on multiple occasions (Lim, 2007), indicating not just a change of status, but an increase in abundance within the last five decades that is likely explained by the large increase in availability of suitable open country habitat. Unsurprisingly, accumulated distributional records of the red junglefowl, red-wattled lapwing, and the wild pig all tend to be concentrated along Singapore's borderlands (e.g., Pulau [= island] Ubin, Western Catchment, and Changi; see Fig. 1) and is along the line of evidence that current Singapore populations of these species originated from individuals dispersing from source habitats in Johor (e.g., Lim, 2007).

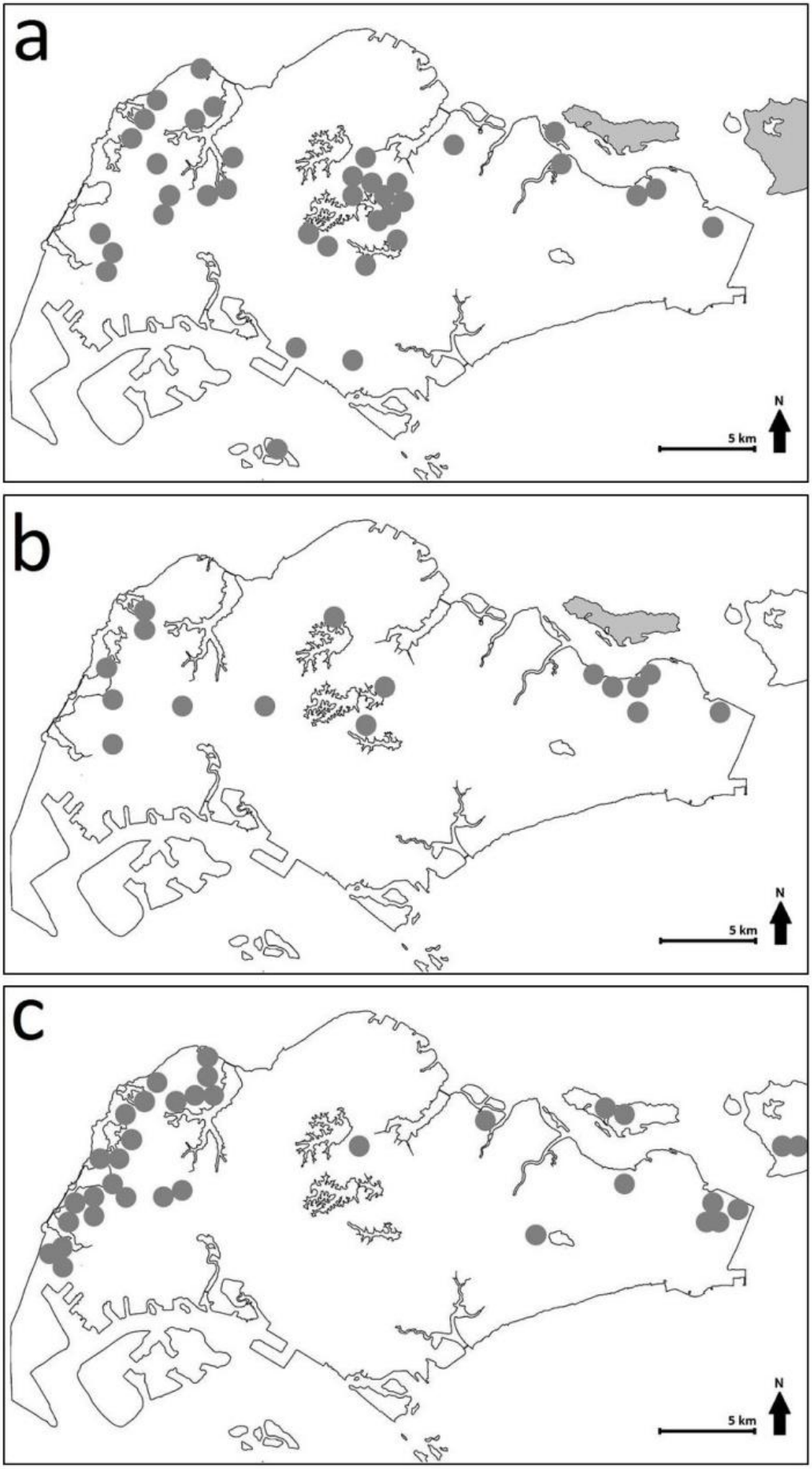

Fig. 1. Approximate distributions, based on published (e.g., Lim, 2007; Lok & Subaraj, 2009) and compiled recent records, of: a, Eurasian wild pig (*Sus scrofa*); b, red junglefowl (*Gallus gallus*); c, red-wattled lapwing (*Vanellus indicus*). Note that areas shaded in grey (e.g., Pulau Ubin in a and b) show distributions prior to 2000.

The ecological repercussions of these re-invasions remain poorly understood and deserve careful study in the light of current conservation priorities in Singapore to maintain forest biodiversity (Yong et al., 2010). On the other hand, these apparent recolonisations suggest that Singapore's present faunal communities are susceptible to future change as a result of biotic changes driven by forest clearance in southern Peninsular Malaysia and surrounding Indonesian islands (e.g., Bintan Island), through provision of dispersing colonisers. In theory, deforestation in the region would benefit adaptable open-country species which in turn constitute source populations for colonisers invading Singapore, and there are already known examples (e.g., the savanna nightjar; Lim, 2007). In this letter, I summarise recent observations of these biotic changes, particularly changes in status, increases in abundance (if documented), and recolonisation pathways of four species (*Gallus gallus*, *Vanellus indicus*, *Strix seloputo*, *Sus scrofa*) known to be associated with cultivated land in Malaysia. Secondly, I suggest possible approaches in studying the consequences of these natural 'invaders' for Singapore's biodiversity.

DISCUSSION

Most of Singapore's old-growth lowland forests were lost by the end of the 19th century (Corlett, 1992), leaving less than 0.5% of its original extent, while the total acreage of open parkland, scrub, and secondary growth has increased substantially in the past few decades (see National Parks Board, 2008). Biotic extinctions from these changes have been well-documented, with as much as 68% (61 out of 91) of known forest birds and a large percentage of many other taxonomic groups extirpated (Brook et al., 2003). Compared to Singapore, deforestation in nearby southern Peninsular Malaysia, Indonesia's Riau Islands and eastern Sumatra lagged by many decades and only became more rapid recently owing to an increase in cultivation of economically important monoculture crops (Miettenen et al., 2011) like oil palm and rubber. Therefore, it is likely that large areas of lowland old-growth forest in Johor and surrounding regions may have historically formed the source of dispersing colonists to Singapore's landscape, particularly highly vagile birds and mammals. This has all but changed in the last few decades. While logging and land clearance for urban expansion have decimated large areas of forests on islands like Bintan (Sodhi et al., 2010), the rapid expansion in oil palm cultivation regionally has deforested much of lowland Peninsular Malaysia and Sumatra, with severe implications for their biodiversity (Lambert & Collar, 2002; Koh & Wilcove, 2008). Adaptable species that prefer secondary growth or cultivated areas, like the wild pig, rats, and red junglefowl, were able to use these cultivated areas and have demonstrated increases in abundances (Persey & Anhar, 2010), becoming more common than in old-growth forest. Theory predicts that 'source' populations of these adaptable species can colonise surrounding 'sink' habitat patches where they do not occupy or where they occur at low densities (e.g., Boughton, 1999), and indeed this has apparently occurred in Singapore.

While Singapore's biota has suffered numerous past extinctions which are well documented (see Brook et al., 2003), historical and recent non-human assisted colonisations by indigenous species have hardly received research attention. In the absence of human assistance, natural colonisations can be inferred by re-appearances of species that were either previously extinct or did not occur locally but are now clearly conspicuous and highly detectable, suggesting genuine population increases. Certain species may also have occurred at low densities until populations become augmented by colonists from elsewhere. For instance, the red-wattled lapwing was described as a 'occasional visitor' (Gibson-Hill, 1950) and until two decades ago was considered by Lim & Gardner (1997) as 'rare', but is now known from many sightings and multiple breeding records, including observations of large groups of 6–15 birds (Yong, 2008). In Johor, the red-wattled lapwing is common in young oil palm plantations, open scrubland, and flooded open areas (Wells, 1999), especially deforested areas (pers. obs.). Similarly, the red junglefowl, locally listed as 'endangered' and was until recently only recorded from Pulau Ubin (Lim & Gardner, 1997), has undergone a steady increase in the number of records in recent years, especially in the Western Catchment and northern Singapore (Yong, 2010), suggesting the birds are likely to have colonised Singapore island fairly recently. Parallels can also be made in accounting for recent increases in abundance of the spotted wood owl and black-winged kite, both known to be able to utilise oil palm cultivation in Peninsular Malaysia (Wells, 1999).

The most well-known instance of an animal's dramatic resurgence however is that of the Eurasian wild pig, a species unrecorded in the late 1990s (Yang et al., 1990) but have since undergone population increases to the point that large groups now occur in many sites (e.g., Lower Peirce, Western Catchment; Yong et al., 2010). For such an adaptable and formerly abundant species, it remains intriguing how it became subsequently extirpated when in fact early sources like Ridley (1895) described wild pigs to be common and destructive to crops. In Peninsular Malaysia, pigs remain common in oil palm plantations where they take advantage of the locally abundant food sources (Persey & Anhar, 2010) and is thought to be responsible for ecological disturbances in adjacent forests (Fujinuma & Harrison, 2012). However, the absence of records led authors in the 1990s to consider the wild pig as locally extirpated from Singapore Island although viable populations continued to persist on Pulau Ubin and Pulau Tekong (Yang et al., 1990; Corlett, 1992; Baker & Lim, 2008). It is unclear when wild pigs recolonised Singapore Island, but they were increasingly frequently encountered in the mid-2000s, suggesting that significant propagule pressure afforded by movement of individuals into Singapore Island could have gradually established the populations (Yong et al., 2010). Given that oil palm cultivation is now extensive across Johor and extends even into the districts bordering Singapore (e.g., Gelang Petah, Skudai, Pekan

Nenas), it appears most likely that populations in these oil plantations, as well as those on Pulau Ubin and Pulau Tekong, constitute the source populations, and the mainland Singapore populations arose from individuals swimming across the straits.

Increases in abundance of the three birds (the red junglefowl, spotted wood owl, and red-wattled lapwing; all current red-list species [Davidson et al., 2008]) are fairly well-documented, given the availability of citizen science data from regular bird censuses and birdwatchers' records. The resurgence of the red-wattled lapwing and red junglefowl is stark, given that both used to be only infrequently encountered (Lim, 2007; Yong, 2010). Described as 'rare visitor' and based on only very few sight records in the 1990s (Lim & Gardner, 1997), the red-wattled lapwing has undergone a large increase in population number within slightly more than a decade. By 2008, there were already a number of breeding records (Lok & Subaraj, 2009), and apparently breeding pairs were present at a number of sites across Singapore, notably on Pulau Ubin, Changi, Tuas, and the marshy fringes of Kranji Reservoir (Yong, 2008; Lok & Subaraj, 2009). Similarly, the red junglefowl was previously highly localised, occurring only on Pulau Ubin where possibly the largest population then occurs (Lim & Gardner, 1997), but was not known before the 1980s (Lim, 2007). Earlier authors like Chasen (1923) also did not find the species in Singapore. Within a span of a decade, the birds are now widespread across Singapore Island and is common in the Western Catchment Area, a large area of scrub, secondary forests, and marshes along Singapore's western border with Johor (Yong, 2010), as are a number of other rural sites. It appears that the expansion of oil palm cultivation in Johor and corresponding deforestation has created considerable suitable habitat, allowing species to invade and spread into areas (Singapore) where they were formerly rare or did not occur.

To date, there has been no attempt to quantify these recent biotic changes although authors have acknowledged that some of these recolonisers, particularly 'keystone' species like the wild pigs, are capable of causing significant ecological impact (Yong et al., 2010), at least based on studies elsewhere in the region (e.g., Ickes et al., 2001), and are in fact beginning to be felt in multiple locations across Singapore. It is therefore timely to document these increases and quantify the dynamics of these novel ecological interactions that were absent until a few years ago. A number of research challenges and opportunities for ecologists and conservationists are clear from these observed biotic changes. First, they can provide valuable ecological insights in species colonisation processes from the larger landscape matrix in a non-island context. It should be noted that on top of existing literature on edge-effects in fragmentation ecology, less is known on how increases in abundance and populations of adaptable species in the landscape matrix, in this case plantation (non-forest) cover, can impact ecological processes in tropical forest fragments despite the fact that many studies have investigated the reverse: how species populations in habitat fragments can interact with that in other fragments under well-established, theoretical frameworks (e.g., island biogeography, metapopulation theory, source-sink dynamics) and how less hostile landscape matrices can support spill-over species from habitat fragments. Researchers in Malaysia and Singapore could therefore carry out collaborative studies on populations of species typical of deforested landscapes and elucidate their colonisation dynamics at a regional level, which will certainly have future conservation implications as these species colonise the deforested landscape matrix.

Second, the biotic changes described here are likely to result in novel or resurgence of disappeared ecological interactions that may benefit some species and threaten others. For instance, populations of wild pigs in the Lower Peirce Reservoir forest, a species that did not occur there until a few years ago has now been documented to threaten tree sapling and shrubs by their destructive foraging behaviour (Tan et al., in press), but on the other hand may prove beneficial to dung beetle communities (Lee et al., 2009). Given these caveats, conservationists in Singapore ought to work closely with ecologists to investigate the dynamics of these ecological interactions and how they are likely to impact existing floral and faunal communities in the long term, so as to inform future conservation interventions.

ACKNOWLEDGEMENTS

I am grateful to Chong Kwek Yan and Ng Wen Qing for their ideas in the discussions that led to this short commentary. I thank one anonymous referee for reviewing an earlier draft of the article.

LITERATURE CITED

Baker, N. & K. K. P. Lim, 2008. *Wild Mammals of Singapore*. Draco Publishing and Nature Society (Singapore), Singapore. 180 pp.

Boughton, D. A., 1999. Empirical evidence for complex source-sink dynamics with alternative states in a butterfly metapopulation. *Ecology*, **80**: 2727–2739.

Brook, B. W., N. S. Sodhi & P. K. L. Ng, 2003. Catastrophic extinctions follow deforestation in Singapore. *Nature*, **424**: 420–423.

Chasen, F. N., 1923. An introduction to the birds of Singapore Island. *Singapore Naturalist*, **1**: 87–112.

Corlett, R. C., 1992. The ecological transformation of Singapore, 1819–1990. *Journal of Biogeography*, **19**: 411–420.

Davison, G. W. H., P. K. L. Ng & H. C. Ho (eds.), 2008. *The Singapore Red Data Book. Threatened Plants and Animals of Singapore. 2nd Edition.* Nature Society (Singapore), Singapore. 400 pp.

Diong, C. H., 1973. Studies of the Malayan wild pig in Perak and Johore. *Malayan Nature Journal*, **26**: 120–151.

FAO, 2010. *Global Forest Resources Assessment 2010: Main Report*. Food and Agricultural Organisation of the United Nations, Rome. 378 pp.

Forestry Department of Malaysia, 2010. *Summary of the State of Johor's Forest Management Plan for the Period Between 2006–2015*. Forestry Department of Malaysia, Malaysia. 71 pp.

Fujinuma, J. & R. D. Harrison, 2012. Wild pigs (*Sus scrofa*) mediate large-scale effects in a lowland tropical rainforest in Peninsular Malaysia. *PLoS ONE*, **7**(5): e37321.

Gibson-Hill, C., 1950. A checklist of the birds of Singapore Island. *Bulletin of the Raffles Museum*, **21**: 132–183.

Ickes, K., S. J. Dewalt & S. Appanah, 2001. Effect of native pigs (*Sus scrofa*) on woody understorey vegetation in a Malaysian lowland rainforest. *Journal of Tropical Ecology*, **17**: 191–206.

Koh, L. P. & D. S. Wilcove, 2008. Is oil palm agriculture destroying tropical biodiversity? *Conservation Letters*, **1**: 60–64.

Lambert, F. R. & N. J. Collar, 2002. The future for Sundaic lowland forest birds: Long term effects of commercial logging and fragmentation. *Forktail*, **18**: 127–146.

Lee, J. S. H., I. Q. W. Lee, S. L-H. Lim, J. Huijbregts & N. S. Sodhi, 2009. Changes in dung beetle communities along a gradient of tropical forest disturbance in South-east Asia. *Journal of Tropical Ecology*, **25**: 677–680.

Lim, K. S., 2007. *The Avifauna of Singapore*. Nature Society (Singapore), Singapore. 600 pp.

Lim, K. S. & D. Gardner, 1997. *An Illustrated Field Guide to the Birds of Singapore*. Suntree Press, Singapore. 226 pp.

Lok, A. F. S. L. & R. Subaraj, 2009. Lapwings (Charadriidae: Vanellinae) of Singapore. *Nature in Singapore*, **2**: 125–134.

Malaysian Palm Oil Board, 2012. *Economics and Industry Development Division*. http://bepi.mpob.gov.my/. (Accessed 20 Aug.2012).

Miettenen, J., C. Shi & C. L. Soo, 2011. Deforestation rates in insular Southeast Asia between 2000 and 2010. *Global Change Biology*, **17**: 2261–2270.

National Parks Board, 2008. *Annual Report 07–08: My Green City*. Singapore.

Peh, K. S-H., N. S. Sodhi, J. de Jong, C. H. Sekercioglu, C. A-M. Yap & S. L-H. Lim, 2006. Conservation value of degraded habitats for forest birds in southern Peninsular Malaysia. *Diversity and Distributions*, **12**: 572–581.

Persey, S. & S. Anhar, 2008. *Biodiversity Information for Oil Palm*. International Conference on Oil Palm and Environment 2010, Bali, Indonesia. 7 pp.

Ridley, H. N., 1895. The mammals of the Malay Peninsula (Part III). *Natural Science*, **6**: 161–166.

Sodhi, N. S., D. S. Wilcove, T. M. Lee, C. H. Sekercioglu, R. Subaraj, H. Bernard, D. L. Yong, S. L-H. Lim, D. M. Prawiradilaga & B. W. Brook, 2010. Deforestation and avian extinction on tropical landbridge islands. *Conservation Biology*, **24**: 1290–1298.

Tan, C. L., 2009. Whither our wilds. *The Malaysian Star*, 7 Jul.2009. (Accessed 10 Aug.2012).

Tan, Y. X., X. H. Lam, S. H. Tok & D. L. Yong, in press. Ecological impacts of foraging wild pigs (*Sus scrofa*) in a tropical forest setting. *SPIRE Proceedings 2012*.

Wells, D. R., 1999. *The Birds of the Thai-Malay Peninsula. Volume 1*. Academic Press, UK. 600 pp.

Yang, C. M., K. Yong & K. K. P. Lim, 1990. Wild mammals of Singapore. In: Chou, L. M. & P. K. L. Ng (eds.), *Essays In Zoology*. Department of Zoology, National University of Singapore, Singapore. Pp. 1–23.

Yong, D. L., 2008. The status of the red-wattled lapwing *Vanellus indicus* in Singapore. *Singapore Avifauna*, **22**: 15–20.

Yong, D. L., 2010. Red junglefowl making a comeback in Singapore? *Singapore Avifauna*, **24**: 31–32.

Yong, D. L., B. P-H. Lee, A. Ang & K. H. Tan, 2010. The status of the Eurasian wild pig (*Sus scrofa*) in Singapore. *Nature in Singapore*, **2**: 365–371.