HORNBILLS: ALLIES OF FARMERS

Abstract

The 62 species of hornbills around the world are extravagant birds with over-sized beaks that are found in tropical Asia, Africa, Indonesia, and Papua New Guinea. They are icons of their forest habitat. Because they spread the seeds of several tropical trees, they are frequently referred to as the "farmers of the forest" because of the way they spread forest tree seeds over the area they fly over. Hornbills regurgitate or vomit the seeds after eating as they typically occupy a home range of at least 10 km, they may disperse seeds across a far larger area with far greater efficiency than other smaller frugivores. They are a sign of a balanced and prosperous forest. For this reason, hornbills are regarded as an indicator species. The tale of how the bond between these birds and the long-standing custom of protecting forests in the name of a deity has helped to preserve both the unprotected forests and sacred groves throughout wide-ranging terrain. In recognition of the significance of these birds, and to ensure the continuity of this unique alliance, conservation initiatives have gained a greater spotlight. Conservation organizations, farmers, and local communities are working together to protect hornbill habitats and spread awareness among the local communities for safeguarding the agricultural landscapes inhabited by them by fostering a greater appreciation of the ecological and cultural worth of hornbills.

Keywords: Hornbills, ‘Farmers of the Forest’, Wide Ranging Terrain, Agricultural Landscapes, Conservation Organizations.

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With the opening quote of Datta "What may appear as a random assortment of trees may be an orchard created by generations of hornbills. In the lifespan of the long-lived hornbills, it is not improbable for a bird to feed on fruits of a tree, whose seed it would have dispersed".

I. INTRODUCTION

Around the world, hornbills have won over the hearts and minds of people living in their environments. These birds have a legendary character due to their unusual behaviour and appearance, which has inspired folklore. There are numerous stories about them being the harbingers of ample crop and rain.

The 62 species of hornbills around the world are extravagant birds with enormous, downward-curving beak, size, eyelashes, distinctive sounds, and close familial ties that are found in tropical Asia, Africa, Indonesia, and Papua New Guinea. They are important in preserving the equilibrium in the habitat they live in and are frequently regarded as an indication of good ecological health. They are frequently referred to as the "farmers of the forest" because they spread the seeds of several tropical trees over the area they fly over.

A crucial process that promotes the spread of fleshy-fruited tree species within forest fragments is long-distance seed dispersal. Large frugivorous bird species in particular have a great potential to offer long-distance and inter-patch seed transfer, which are both critical for preserving the basic genetic and demographic processes of plant populations in isolated forest fragments. Seed dispersal is an important ecosystem function. It facilitates gene flow, thereby influencing the genetic structure within and among plant populations, allows for range expansion, re-colonisation and dispersal to un-colonised habitats (Cody M.L. 1985). It is a crucial process for seedling recruitment, for maintaining the natural regeneration of forest ecosystems (Herrera 2002, Wang & Smith 2002, Sekercioglu 2006) and consequently for biodiversity conservation (Bascompte & Jordano 2007).

Seed Dispersal & Landscape Connectivity

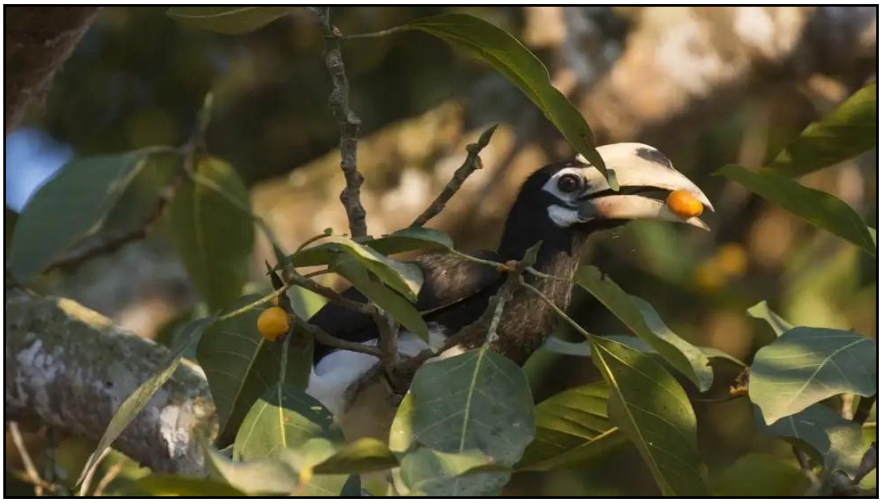

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Figure 1: Hornbills Play a Pivotal Role in Dispersing Plant Seeds across Forest Patches

II. IMPORTANCE OF LARGE-BODIED BIRDS

Bird species represent a large proportion of vertebrate frugivores in many terrestrial ecosystems (Sekercioglu 2006, Forget et al. 2011). Birds are particularly important seed dispersers in tropical forests because many tropical fruiting tree species are mainly dispersed by birds (Howe & Smallwood 1982, Herrera 2002, Levey et al. 2002). Depending on their physiological and behavioural traits, different bird species contribute differentially to the seed dispersal pattern (Dennis & Wescott 2007, Jordano 2007, Spiegel & Nathan 2007). In general, large bird species have higher potential to disperse a larger number and variety of seeds over greater distances than small birds (Herrera 1984, Holbrook & Smith 2000, Westcott & Graham 2000, Jordano et al. 2007, Spiegel & Nathan 2007).

Frugivorous birds provide important ecosystem services by transporting seeds of fleshy fruited plants. It is believed that the seed dispersal kernels produced by these species are typically leptokurtic, which leads to minimal distribution among habitat fragments. Still, not much is understood about the dispersion of seeds dispersed by large frugivorous birds in fragmented landscapes. Relationships between species frequently cross boundaries in the intricate tapestry of the natural world. Hornbills and farmers have one of the most intriguing and advantageous relationships. The unusual partnership these iconic birds have formed with farmers has resulted in a delicate balance that supports both biodiversity and agricultural livelihoods. These birds are widely recognized for their striking appearance and remarkable behaviours. We delve into the enchanting world of these endearing birds in this chapter, highlighting how important it is for them to serve as farmers' friends and how they may assist in maintaining the delicate balance of nature.

III. THE ACREAGE LANDSCAPE

1. **Short- Versus Long-Distance Dispersal:** The process of seed dispersal can be classified into two forms: short-distance dispersal and long-distance dispersal (Cain et al. 2000). The exact scale of each form is not always easy to determine and depends on the study system. Short distance dispersal is generally considered to be dispersal of several metres from the parental tree. Long-distance dispersal results in dispersal across larger distances (Nathan et al. 2003), e.g. more than 100 m (Cain et al. 2000). Long- and short-distance dispersal typically facilitates different ecological outcomes. The former plays an important role in determining the germination and survival probability of plants, which generally increases with distance to the parental tree (Janzen 1970, Connell 1971, Howe & Smallwood 1982). The latter is crucial for colonisation of new sites and for maintenance of genetic diversity through facilitating exchange of individuals among spatially separated populations (Cain et al. 2000, Clark 2005, Nathan 2006). Consequently, in regions where forests are increasingly fragmented, long-distance seed dispersal becomes increasingly important (Trakthenbrot et al. 2005). Nevertheless, in most plant species long-distance dispersal events are rather rare and most seeds are dispersed over short distances (Willson 1993a). In general, the dispersal distance depends largely on the seed dispersal mechanism; hence, different seed dispersal mechanisms lead to different seed dispersal outcomes.

2. **Temporal Variability (Between Seasons):** Temporal variations are a common phenomenon in plant-frugivore interactions (e.g. Loisell & Blake 1991, Levey 1988,

Jordano et al. 1995). Differences in the phenology of either the plant species, e.g. fruit ripening, abundance and distribution, or of the frugivore species, e.g. reproductive phase are assumed to lead to seasonal shifts in movement behaviour of frugivores (Herrera 1984, Leighton & Leighton 1983). Seasonal fluctuations in occurrence and density of individuals have been previously detected for several hornbill species (Kemp 1995, Kinnaird et al. 1996, Whitney & Smith 1998, Kinnaird & O'Brien 2007, Rainey & Zuberbühler 2007, Kitamura 2011). For instance, Holbrook and colleagues (2002) found large-scale movements of a hornbill species in Africa.

Long-term conservation planning must take into account the importance of agro ecosystems as habitat for wildlife because different crop strata and landscape features can have an impact on bird communities, which are also influenced by seasonality (Cody M.L. 1985). Aesthetic, cultural, and other societal values are all present in agricultural landscapes, which are the visible results of the interaction between agriculture, the environment, and natural resources. A key element of human civilization is agriculture. A major alteration in the terrain resulted from the expansion of agricultural activity alongside civilizations. Unluckily, these developments frequently encroach on natural ecosystems, resulting in confrontations between people and animals. Hornbills have managed to close this gap, nevertheless.

3. **The Unveiled Mutualism:** A specific type of ecological interaction between two species is known as mutualism, in which both species benefit from the other's presence. The mutualistic relationship between hornbills and farmers is illustrated by the fact that the hornbills disperse seeds, which helps the farmers by promoting forest regeneration and delivering ecosystem services (Bascompte, J. & Jordano, P. 2007). Hornbills swallow the fruit and then regurgitate or urinate the seeds in various places as they migrate through the forest (Anggraini, K., Kinnaird, M. & O'Brien, T. 2000). Hornbills unintentionally spread seeds over vast areas when they consume a variety of foods. Some of these seeds wind up in fields of crops, where they can sprout and develop into fresh fruit-bearing plants indirectly regenerating forests and enhancing plant genetic variety.

4. **Hornbills: Crop Defenders:** With their striking appearance and loud calls, hornbills are not only recognizable creatures in the forests of Asia and Africa, but they are also valuable assets for farmers. Pest management is one of the most important contributions rendered by hornbills. They specialize in capturing pests that may damage crops, as their food consists of insects, small animals, and fruits. Hornbills consume insects that would otherwise destroy crops in agricultural areas, minimizing the need for synthetic pesticides and supporting organic farming methods. In addition to saving farmers money, this organic pest management method also contributes to the preservation of a healthy environment.

5. Diversity of Trees and Nesting Ecology

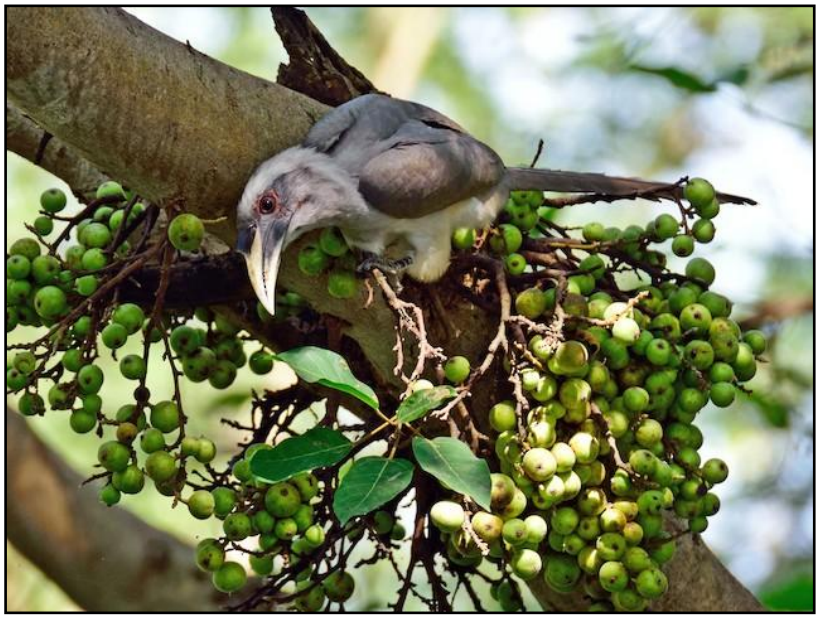

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Figure 2: Indian Grey Hornbill Feeding on *Ficus* Trees

Hornbill nesting habits are essential to preserving the health of the forest ecosystem. Hornbills require large tree hollows for nesting for which they frequently choose older trees that naturally harbor decay and disease (Janzen, D. H. 1970). Removing potential disease sources, this behaviour enhances the health of the forest. Additionally, farmers' long-term interests are aligned with the preservation of such mature trees like *Ficus* species, because they gain from healthy forests in terms of soil fertility and water retention.

6. **Mythological Significance and Conservation:** Beyond their ecological benefits, hornbills have important cultural roles in a variety of communities. They have been included in mythology and customs because of their remarkable appearance, distinctive behaviours, and vocalizations. Although hornbills are well-recognized, problems still exist. Their habitats are still being encroached upon by habitat destruction, habitat fragmentation, logging, hunting and rising agricultural activity. Furthermore, hornbills and the ecosystems they rely on are both impacted by new dangers brought on by climate change. Integrative strategies that incorporate habitat conservation, sustainable land-use methods, and community involvement are crucial for addressing these issues.

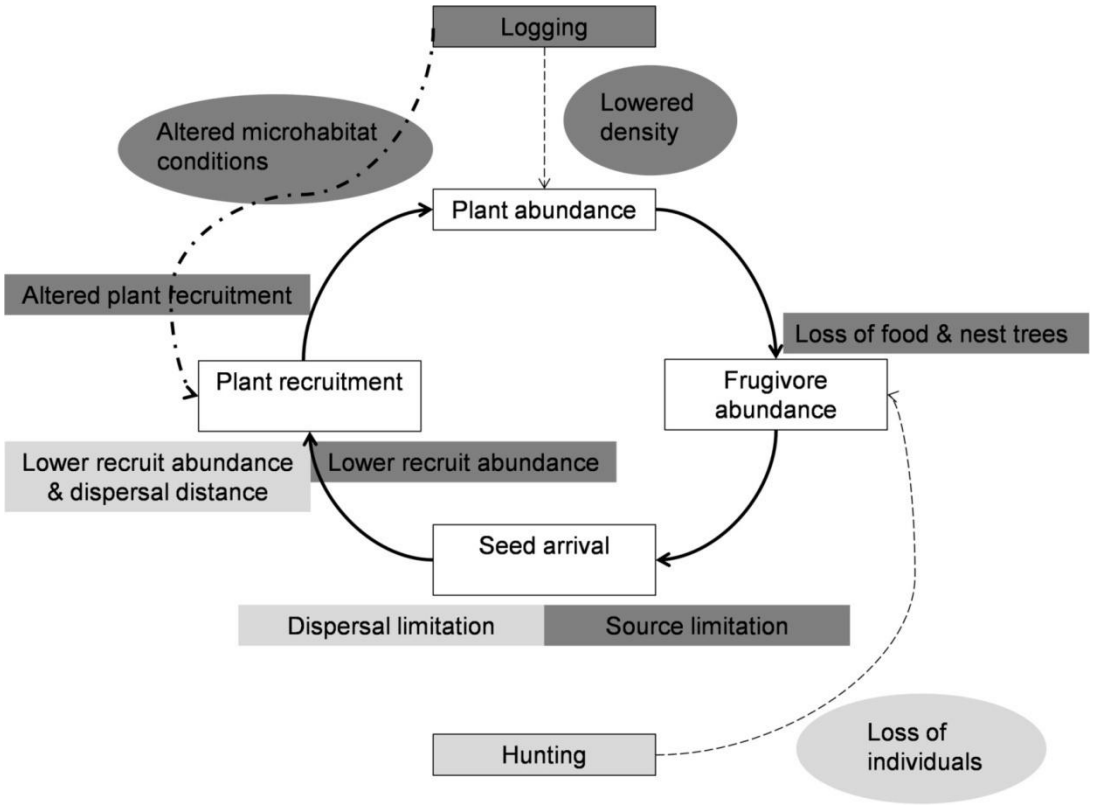

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Figure 3: Conceptual Model of Direct and Indirect Impacts of Logging and Hunting on Seed Dispersal Cycle

In recognition of the significance of these birds, and to ensure the continuity of this unique alliance, conservation initiatives have gained a greater spotlight. Conservational organizations, farmers, forest officials and local communities are working together to protect hornbill habitats and educate society about the vital roles that these birds play in ecosystems and agriculture. These initiatives aid in safeguarding the long-term survival of hornbills and the agricultural landscapes they live in by fostering a greater appreciation of the ecological and cultural worth of hornbills.

IV. CAUSES OF DEPLETION OF HORNBILL SPECIES

1. Hornbills have been subject to hunting over most of their range, adding to their vulnerability.
2. Habitat modification and fragmentation due to shifting cultivation and logging are serious threats faced by them.
3. Hornbills are vulnerable in North-east India due to the traditional value for their feathers, beaks, casques, flesh and medicinal value of their fat, among many tribal groups.
4. Lack of fruiting trees like Banyan & Peepal on which Hornbill feeds are some of the causes for population decrease.

Figure 4: Hornbills Hunted for their Beaks
Source: The Star

V. CONSERVATION STRATEGIES

1. **Habitat Protection:** To ensure hornbills have sufficient nourishment supplies and nesting locations, conservation efforts must focus on preserving and restoring their ecosystems.

2. **Community Engagement:** Informing nearby populations about the value hornbills possess for the environment assists in fostering a sense of responsibility and the long-term survival of these birds.

   For Instance: The Hornbill Festival, called the 'Festivals of Festivals', is a 10-day annual cultural fest of Nagaland that showcases the rich and diverse Naga ethnicity through folk dances, traditional music, local cuisine, handicraft, art workshops, etc. Hornbill Festival was instituted primarily as a cultural event by the Government of Nagaland to give audiences a pan-Naga experience. The main purpose to celebrate this festival is to protect and promote the rich culture of Nagaland, reviving the traditions of Nagaland, promoting inter-tribal interaction and to promote tourism in Nagaland, by helping the tourists experience the customs, food, songs and, dance of Nagaland.

Figure 5: Hornbill Festival in Nagaland
Source: Festivals from India.

3. **Anti-Poaching Initiatives:** Hornbills' existence depends on collaboration with law enforcement organizations in the fight against hunting and poaching.

VI. NARROWING THE GAP IN LONG-DISTANCE SEED DISPERSAL RESEARCH

The chapter focused on the seed dispersal potential of Hornbill species. In general, hornbill species are suggested to play a major role in ecosystem functioning as seed dispersers (Whitney et al. 1998, Whitney & Smith 1998, Holbrook & Smith 2000, Bleher & Böhning-Gaese 2001, Kemp 2001, Poulsen et al. 2002, Kinnaird & O'Brien 2007, Sethi & Howe 2009), but so far this chapter has investigated seed dispersal function and the factors influencing seed dispersal distribution in such detail for any large frugivorous bird species.

VII. CONCLUSION

Dispersal ability is one key process determining the migration capacity of plant species, plant species distribution and distribution of plant species communities (Cain et al. 2000, Nathan & Muller-Landau 2000). The complex interactions between agriculture and nature are best exemplified by hornbills. They support farmers as allies by offering essential pest control services, maintain resilient landscapes and promoting biodiversity through the dissemination of seeds. Hornbills are important to cultural narratives and have the ability to spur conservation efforts in addition to their ecological significance. The value of protecting hornbill habitats and the delicate equilibrium they help preserve between agriculture and the natural world are highlighted by understanding the relevance of hornbills in these many functions (Trakhtenbrot, A., Nathan, R., Perry, G. & Richardson, D. M. 2005).

REFERENCES

[1] Ali S., Ripley S.D. 1987. Compact Handbook of the Birds of India and Pakistan together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (2nd Edition, Vol. 1–10). Delhi: Oxford University Press. 890 p.
[2] Anggraini, K., Kinnaird, M. & O'Brien, T. 2000. The effects of fruit availability and habitat disturbance on an assemblage of Sumatran hornbills. Bird Conserv. Int. 10: 189–202.
[3] Bachan A.K.H. 2006. The Hornbill haven. Sanctuary Asia 25(6): 46–49.
[4] Balasubramanian P., Prasad S.N., Kandavel K. 1998. Role of birds in seed dispersal and natural regeneration of forest plants in Tamil Nadu. Technical Report No. 7. Coimbatore, India: Salim Ali Centre for Ornithology and Natural History. 33 p.
[5] Bascompte, J. & Jordano, P. 2007. Plant-Animal Mutualistic Networks: The Architecture of Biodiversity. Annual Review of Ecology and Systematics, 38, 567-93.
[6] Bleher, B. & Böhning-Gaese, K. 2001. Consequences of frugivore diversity for seed dispersal, seedling establishment and the spatial pattern of seedlings and trees. Oecologia,129, 385-394.
[7] Cain, M. L., Milligan, B. G. & Strand, A. E. 2000. Long-distance seed dispersal in plant populations. American Journal of Botany, 87, 1217-1227.
[8] Clark, C. J., Poulsen, J. R., Bolker, B. M. Connor, E. F. and Parker, V. T. 2005. Comparative seed shadows of bird-, monkey-, and wind-dispersed trees. Ecology 86, 2684-2694.
[9] Cody M.L. 1985. An introduction to habitat selection in birds. In: M.L. Cody (Ed.): Habitat Selection in Birds. Orlando, Florida: Academic Press. P. 3–56.
[10] Connell, J. H. 1971. On the role of natural enemies in preventing competitive exclusion in some marine animals and in rain forest trees. In: Den Boer, P. J., Gradwell, G., (eds.) Dynamics of populations. Wageningen, the Netherlands: PUDOC. 298-312.
[11] Datta A. 1998. Hornbill abundance in unlogged forest, selectively logged forest and a forest plantation in Arunachal Pradesh, India. Oryx 32(4): 285–294. DOI: 10.1046/ j.1365-3008.1998.d01-58.
[12] Dennis, A. J. & Westcott, D. A. 2007. Estimating Dispersal Kernels Produced by a Diverse Community of Vertebrates. In: Dennis, A. J., Schupp, E. W., Green, R. J. & Westcott, D. A. (eds.) (2007) Seed Dispersal: theory and its application in a changing world. Wallingford, UK: CABI Publishing 201-228.

[13] Forget, P.-M., Jordano, P., Lambert, J. E., Böhning-Gaese, K., Traveset, A. & Joseph Wright, S. 2011. Frugivores and seed dispersal (1985-2010); the 'seeds' dispersed, established and matured. Acta Oecologica, 37, 517-520.
[14] Gadikar, A. 2017. Adaptations of the Indian Grey Hornbill Ocyceros birostris in an urban environment. Indian Birds 13: 167–168.
[15] Herrera, C. M. 2002. Seed dispersal by vertebrates. In: Plant-Animal Interactions: An Evolutionary Approach (ed. C. M. Herrera & O. Pellmyr), Oxford: Blackwell Science pp. 185-208.
[16] Holbrook, K.M. & Smith, T.B. 2000. Seed dispersal and movement patterns in two species of Ceratogymna hornbills in a West African tropical lowland forest. Oecologia 125: 249–257.
[17] Howe, H. F. & Smallwood, J. 1982. Ecology of seed dispersal. Annual Review of Ecology and Systematics, 13, 201-228.
[18] Ismail, S.A., Ghazoul, J., Ravikanth, G., Kushalappa, C.G., Uma Shaanker, R. & Kettle, C.J. 2017. Evaluating realized seed dispersal across fragmented tropical landscapes: a two-fold approach using parentage analysis and the neighbourhood model. New Phytol. 214: 1307–1316.
[19] Janzen, D. H. 1970. Herbivores and number of tree species in tropical forests. American Naturalist, 104, 501-528.
[20] Jordano, P. 1995. Spatial and temporal variation in the avianfrugivore assemblage of Prunus mahaleb: patterns and consequences. Oikos, 71, 479-491.
[21] Jordano, P. 2007. Frugivore, Seeds and Genes: Analysing the Key Elements of Seed Shadows. In: Dennis, A. J., Schupp, E. W., Green, R. J. & Westcott, D. A. (eds.) 2007. Seed Dispersal: theory and its application in a changing world. Wallingford, UK: CABI Publishing 229-251.
[22] Kalina J. 1988. Nest intruders, nest defense and foraging behavior in the Black-and-white Casqued Hornbill (Bycanistes subcylindricus). Ibis 131(4): 567–571. DOI: 10.1111/j.1474-919X.1989.tb04791.
[23] Karanth, K.K., Sankararaman, V., Dalvi, S., Srivathsa, A., Parameshwaran, R., Sharma, S., Robbins, P. & Chhatre, A. 2016. Producing diversity: agroforests sustain avian richness and abundance in India's Western Ghats. Front. Ecol. Evol. 4: 111.
[24] Kinnaird M.F. 1998. Evidence for effective seed dispersal by the Sulawesi Red-knobbed Hornbill *Aceros cassidix*. Biotropica 30(1): 50–55. DOI: 10.1111/j.1744-7429.1998.tb00368.
[25] Kitamura, S. 2011. Frugivory and seed dispersal by hornbills (Bucerotidae) in tropical forests. Acta Oecologica, 37, 531-541.
[26] Leighton M., Leighton D.R. 1983. Vertebrate responses to fruiting seasonality within a Bornean rainforest. In: S.L. Sutton, T.C. Whitmore, A.C. Chadwick (Eds.): Tropical Rainforests: Ecology and Management. Oxford: Blackwell Scientific. P. 181–209.
[27] Levey, D. J. 1988. Spatial and temporal variation in Costa Rican fruit and fruit-eating bird abundance. Ecological Monographs, 58, 251-269.
[28] Levey, D. J., Silva, W. R. & Galetti, M. 2002. Seed Dispersal and Frugivory: Ecology, Evolution and Conservation. Wallingford, UK: CABI Publishing.
[29] Loiselle B. A., Blake J. G., 1991. Temporal variation in birds and fruits along an elevational gradient in Costa Rica. Ecology,72, 180- 193.
[30] Nathan, R. & Muller-Landau, H. C. 2000. Spatial patterns of seed dispersal, their determinants and consequences for recruitment. TRENDS in Ecology & Evolution, 15, 278-285.
[31] Nathan, R., Perry, G., Cronin, J. T., Strand, A. E. & Cain, M. L. 2003. Methods for estimating longdistance dispersal. Oikos, 103, 261-273.
[32] Nathan, R. 2006. Long-distance dispersal of plants. Science, 313, 786-788.
[33] O'Brien T. G., Kinnaird M.F., Jepson P., Setiwan I. 1998. Effect of the forest size and structure on the distribution of Sumba Wreathed Hornbills *Aceros everetti*. In: P. Poonswad (Ed.): The Asian Hornbills: Ecology and Conservation (Thai studies in Biodiversity No.2). P. 209–218.
[34] Poulsen, J. R., Clark, C. J., Connor, E. F. & Smith, T. B. 2002. Differential resource use by primates and hornbills: Implications for seed dispersal. Ecology, 83, 228-240.
[35] Rainey, H. J. & Zuberbühler, K. 2007. Seasonal variation in hornbill abundance in a West African national park detected using analysis of acoustic recordings. Bird Conservation International, 17, 235-244.
[36] Raman T.R.S. 2001. Effect of Slash-and-Burn shifting cultivation on rainforest birds in Mizoram, Northeast India. Conservation Biology 15(3): 685–698. DOI: 10.1046/j.1523-1739.2001.015003685.
[37] Raman T.R.S., Mudappa D. 2003. Correlates of hornbill distribution and abundance in rainforest fragments in the Southern Western Ghats, India. Bird Conservation International 13(3): 199–212. DOI: 10.1017/S0959270903003162.
[38] Schupp, E. W., Jordano, P, & Gómez, J. M. 2010. Seed dispersal effectiveness revisited: a conceptual review. New Phytologist, 188, 333-353.

[39] Sekercioglu, C. H. 2006. Increasing awareness of avian ecological function. TRENDS in Ecology & Evolution, 21, 464-471.
[40] Spiegel, O. & Nathan, R. 2007. Incorporating dispersal distance into the disperser effectiveness framework: frugivorous birds provide complementary dispersal to plants in a patchy environment. Ecology Letters, 10, 718-728.
[41] Wang, B. C. & Smith, T. B. 2002. Closing the seed dispersal loop. TRENDS in Ecology & Evolution, 17, 379-385.
[42] Willson M. F. 1993a. Dispersal mode, seed shadows, and colonization patterns. Vegetatio, 108, 261 -280.
[43] Taylor, P. D., Fahrig, L., Henein, K. & Merriam, G. 1993. Connectivity is a vital element of landscape structure. Oikos, 68, 571-573.
[44] Trakhtenbrot, A., Nathan, R., Perry, G. & Richardson, D. M. 2005. The importance of long-distance dispersal in biodiversity conservation. Diversity and Distributions,11, 173-181.
[45] Whitney, K. D. & Smith, T. B. 1998. Habitat use and resource tracking by African Ceratogymna hornbills: implications for seed dispersal and forest conservation. Anim Animal Conservation, 1, 107-117.

