

# Population size and habitat of the White-breasted Guineafowl *Agelastes meleagrides* in the Taï region, Côte d'Ivoire

MATTHIAS WALTERT, CHARLOTTE SEIFERT, GERHARD RADL and  
BERND HOPPE-DOMINIK

## Summary

The White-breasted Guineafowl *Agelastes meleagrides* is one of 15 bird species endemic to the Upper Guinea Forests of West Africa. The Taï region in southwestern Côte d'Ivoire probably holds one of the largest remaining populations of this species. We assessed population density in two different sectors in the southern part of Taï National Park and one sector in the N'Zo Faunal Reserve, north of the National Park. The sectors differ in rainfall patterns and hence vegetation type, as well as in previous and past levels of logging and hunting. Line transect surveys were undertaken between 2000 and 2001 with an overall survey effort of 2,883 km. Abundance was highest in the sector with the driest forest type, the N'Zo Faunal Reserve (encounter rate: 0.02 detections km<sup>-1</sup>, density: 32.9 ind. km<sup>-2</sup>), where we also observed the largest group recorded for the species so far (38 individuals). The species was almost absent in the southeast of Taï National Park (encounter rate: <0.002 detections km<sup>-1</sup>), where the impact of poaching on wildlife is strongest. The study confirms that the species reaches highest densities in drier forests and only occurs in smaller numbers in the wetter south of the Taï region. Our data also suggest that past disturbance from logging does not constitute an obstacle for its persistence. The population size in Taï National Park and N'Zo Faunal Reserve should be between 42,000 and 120,000 individuals.

## Introduction

The White-breasted Guineafowl *Agelastes meleagrides* Bonaparte, 1850 (Aves: Galliformes: Numididae) is one of 15 known bird species endemic to the Upper Guinea Forest (BirdLife International 2003, 2007), which once covered West Africa from southern Senegal to Togo (Sayer *et al.* 1992). Larger populations of the species are probably confined to remnants of continuous forest in Sierra Leone, Liberia and Côte d'Ivoire (BirdLife International 2007). Recent observations have been made in Ghana (L. H. Holbeck pers. comm.), but its occurrence in Guinea remains doubtful (Gartshore *et al.* 1995).

White-breasted Guineafowl probably occurred throughout the forest area from Sierra Leone to Ghana (Collar and Stuart 1985). After the reduction of the Upper Guinea Forest in the 1960s (Martin 1991) continuous primary forest now largely consists of fragments of less than 200 km<sup>2</sup> (Sayer *et al.* 1992; Holbeck 2005) and this loss of habitat as well as hunting pressure are thought to be the main threats to the existing populations of White-breasted Guineafowl (Francis *et al.* 1992). Little is known about its ecology (available information is compiled in Francis *et al.* 1992). Birds live in small flocks which move slowly through the forest, searching the leaf litter for invertebrates and possibly also seeds and fruits. Before dusk they settle to roost in thin

understorey trees at heights of 6–15 m. Interestingly, no nest has yet been scientifically described, either for the White-breasted Guineafowl or for its sister species the Black Guineafowl *Agelastes niger* Cassin, 1857 (Urban *et al.* 1986, Raethel 1991, Francis *et al.* 1992, Madge and McGowan 2002). Even today it is impossible to say with certainty whether the former nests on trees or on the ground, like most Galliformes (Bechinger 1964, Francis *et al.* 1992). Young birds have been observed from the end of November until the end of May. No relationship between the time of the year and the size of the young was found, suggesting aseasonal breeding (Francis *et al.* 1992).

Taï National Park (NP) in Côte d'Ivoire certainly holds an important part of the global population of the species and is therefore of importance to its conservation (Gartshore *et al.* 1995). It is classified as 'Vulnerable' on the IUCN Red List (IUCN 2007). Detailed surveys on White-breasted Guineafowl are rare (see Allport *et al.* 1989 for Gola Forest in Sierra Leone and Francis *et al.* 1992 for Taï NP, Côte d'Ivoire) and previous estimates of population density in Taï NP were based on data restricted to the western park region (Francis *et al.* 1992). The objective of this study was therefore to re-evaluate population density within the area of Taï NP and the adjacent N'Zo Faunal Reserve (N'Zo FR) in Côte d'Ivoire, to detect habitat preferences and to assess the influence of poaching on the population of White-breasted Guineafowl. We used data from line transects in three sectors of the protected area, differing in: 1) amounts of rainfall received - lower in the north of the Taï region vs. wetter in the south (van Rompaey 1993); 2) the degree of disturbance from logging, as logged forest in the north vs. primary forest in the south (Fishpool 2001); and 3) hunting pressure - high in the east vs. low in the west (Hoppe-Dominik 1997, Refisch and Koné 2005).

Based on previous studies (Francis *et al.* 1992, Demey and Rainey 2005, Dowsett-Lemaire and Dowsett 2007 in Klop *et al.* 2008), we expected that population density of White-breasted Guineafowl might be higher in drier forests north of Taï than in wetter forests in southern Taï NP. Furthermore, we expected White-breasted Guineafowl to be affected by poaching since groups are reported to be easily shot by imitating their grouping call which causes individuals to assemble rather than spread as in Crested Guineafowl *Guttera pucherani* (Bechinger 1964, and reports from hunters in Ghana and Eastern Côte d'Ivoire). The impact of poaching on the population density should be greatest in the eastern areas of Taï NP where hunting pressure is reportedly highest (Refisch and Koné 2005, Caspary *et al.* 2001, Hoppe-Dominik 1997). While Francis *et al.* (1992) conclude that population density in selectively logged forests is similar to unlogged primary forests, Bechinger (1964) and Allport *et al.* (1989) argue that population density is much lower in areas of past logging disturbance. The latter say that White-breasted Guineafowl is unable to adapt to the denser undergrowth of heavily disturbed forests. We expected our results to add useful information to this discussion by allowing us to compare data across three sectors, and to estimate effects of the factors of hunting and logging separately.

## Methods

### *Study area*

The study area comprises Taï NP (3,300 km<sup>2</sup>; 5°51' N, 7°23' W) and the adjacent N'Zo FR (930 km<sup>2</sup>; 6°15' N, 7°14' W) in southwestern Côte d'Ivoire, close to the border with Liberia (Fishpool 2001; Gartshore *et al.* 1995). Taï NP holds the largest continuous remnant of Upper Guinea Forest and is thus of extreme importance for the conservation of many bird species endemic to this biome (Gartshore *et al.* 1995). Twelve of the 15 bird species endemic to the Upper Guinea Forest are currently reported to live in Taï NP (BirdLife International 2003, 2007).

Until this research was carried out, the area has never been controlled by rebel or loyalist armed forces and the park staff was largely able to continue operating (IUCN/UNESCO 2006). Adverse impacts on Taï NP's fauna, flora or infrastructure due to the national crisis caused by the civil war in 2002 should therefore have been only temporary. In contrast, poaching has always

occurred and agricultural activities and, to a lesser extent, small surface gold-mining along rivers were other imminent threats to the park's unique fauna and flora (Avit *et al.* 1999, IUCN/UNESCO 2006). To prevent agricultural cultivation inside the park, 630 km<sup>2</sup> of buffer zones (Avit *et al.* 1999) almost completely surrounding the park were established in 1977 (IUCN/UNESCO 2006). In these zones, any hunting, settling or new plantation development and even harvesting of non-timber forest products were officially prohibited. It is expected that the pressure from the growing human population has already affected these zones (IUCN/UNESCO 2006).

Several forest reserves (Forêt Classées, FC), are found in the south (FC de la Haute Dodo 2,000 km<sup>2</sup>, 4°54' N, 7°18' W; FC Rapide Grah 2,042 km<sup>2</sup> 5°05' N, 7°08' W) and the west (FC du Cavally, 1,890 km<sup>2</sup> 6°10' N, 7°47' W; Grebo National Forest, 2,510 km<sup>2</sup> 5°36' N, 7°52' W, in Liberia) of Taï NP (van Rompaey 1993, Alonso *et al.* 2005). However, forest cover within these FCs might only be a fraction of their total surface area (Refisch and Koné 2005).

Data were collected in three different sectors of the protected areas, two in Taï NP and one within N'Zo FR, representing *ca.* 20% (Taï) and 50% (N'Zo) of the protected areas (Figure 1). These sectors vary considerably in the degree of hunting pressure and the impact of timber extraction. In N'Zo FR timber was extracted until 1992 (Fishpool 2001). The two Taï NP sectors are located in the south of the park, one at the southwestern and one close to the southeastern boundary. Both were covered with primary forest at the time of the study (Fishpool 2001), but the southeastern sector was strongly influenced by poaching, which should be of much less importance in the southwestern sector (Hoppe-Dominik 1997, Refisch and Koné 2005).

These sectors also represent a SW-NE oriented rainfall and vegetation gradient. Forest composition at N'Zo FR principally differs from the southern areas of Taï NP because N'Zo

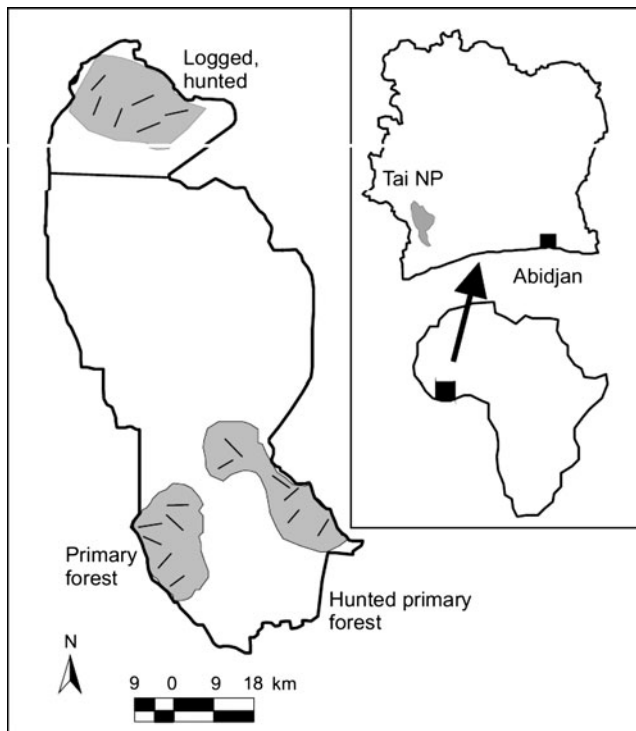


Figure 1. Map of the study area showing the three sectors and the location of the sampled transects (adapted from Radl 2000).

FR receives less annual precipitation (van Rompaey 1993). The rainfall gradient ranges from about 2,000 mm yr<sup>-1</sup> in the southwest of Taï NP to 1,600 mm yr<sup>-1</sup> in the northeast of N'Zo FR (van Rompaey 1994). The dry season becomes gradually longer from the coast of Côte d'Ivoire further inland (from a maximum of one arid month at the coast to three arid months at Taï (5°53' N 7°20' W) and precipitation during the driest month is significantly lower (van Rompaey 1993). Mean annual temperature is 26°C throughout the study area (Collar and Stuart 1988).

### Fieldwork

In each of the three sectors, six line transects were placed randomly, each with a length of 4 km. Experienced teams consisting of three observers walked each transect on average 43 times between January 2000 and December 2001. A transect was sampled twice during a day of observation, between 07h00 and 12h00 and 15h00–18h00. At N'Zo FR a total of 924.5 km of survey effort was completed during the two-year survey. At the southwestern site in Taï NP, the distance covered totalled 1,314.1 km and at the southeastern site a total of 644.0 km was walked. Group size and perpendicular distance from the transect midline to the nearest 50 cm were noted for all detections of White-breasted Guineafowl groups.

### Data analysis

We modelled the detection probability using *Distance 5.0* (see Buckland *et al.* 2001). Since the number of sightings of White-breasted Guineafowl was relatively low, we combined the data gathered in 2000 and 2001 for each transect to increase the precision of our estimates of detection probability.

A hazard-rate key provided the best fit to the detection function. The model was selected using Akaike's Information Criterion (AIC), chi-squared goodness-of-fit-test and visual examination of histograms to assure an adequate representation of close-to-the-line distance intervals. We truncated data to a width of  $w = 15.5$  m (1.25% of the data were excluded). Detection probability was modelled globally fitting a detection function to distance data from across strata (see Buckland *et al.* 2001), resulting in an AIC = 255.5, an effective strip width (ESW) = 8.4 m and a detection probability of  $P_a = 0.53$ . Resolution of estimates of encounter rate, group density, cluster size and individual density was at the sector level.

## Results

Our results show that White-breasted Guineafowl was not distributed uniformly throughout the study area (see Table 1). In the hunted primary forest sector in the southeast of Taï NP only one

Table 1. Survey effort, Number of detections per sector ( $n$ ), encounter rate (ER, [ $n$  km<sup>-1</sup>]), group density (GD, [flocks km<sup>-2</sup>]), expected cluster size (ECS, [ind./flock]) and individual density (D, [ind. km<sup>-2</sup>]) of White-breasted Guineafowl in the Taï region, Côte d'Ivoire. Limits of the 95% confidence interval are given in brackets.

	Survey effort [km]	$n$	ER (95% CI)	GD (95% CI)	ECS (95% CI)	D (95% CI)
N'Zo FR (Logged)	924.5	23	0.02 (0.02–0.04)	1.5 (1.0–2.2)	22.3 (13.9–36.0)	32.9 (18.4–58.9)
Taï NP - west (Primary)	1,314.1	55	0.04 (0.03–0.06)	2.5 (1.7–3.5)	9.1 (7.5–11.0)	22.6 (15.3–33.1)
Taï NP - east (Hunted primary)	644.0	1	0.00 (0.00–0.02)	0.1 (0.0–1.3)	5 (5–5)	0.5 (0.03–6.3)

group of five individuals was recorded on one occasion, while it was regularly recorded in the other two sectors (23 observations at N'Zo FR and 55 observations in the southwestern sector of Tai NP).

Group density varied notably between sectors. In N'Zo FR, an average of 1.5 group(s) km<sup>-2</sup> was estimated compared to 2.5 groups km<sup>-2</sup> in the unhunted primary sector of Tai NP. However, there was a much higher cluster size in N'Zo FR, ranging from 1 to 38 individuals per group with an average of 22.3 ind. per group (95% CI: 19.3–29.4). This more than doubled the values from the undisturbed, but wetter southwest of Tai NP (range: 1–23 ind./group; average: 9.1 ind./group, 95% CI: 7.2–9.7).

Individual density was with 32.9 ind. km<sup>-2</sup> at N'Zo FR, *ca.* one-third higher than in the unhunted primary forest (22.6 ind. km<sup>-2</sup>, Z test  $Z = 1.88$ , two-tailed  $P = 0.030$ ).

## Discussion

### *Distribution and density*

The high individual density in N'Zo FR (32.9 birds km<sup>-2</sup>) strongly suggests that the White-breasted Guinea fowl is not confined to undisturbed primary forest areas and that former sightings in logged forest (Allport *et al.* 1989) potentially were not isolated cases. Our findings confirm the assumption by Francis *et al.* (1992) that White-breasted Guinea fowl occurs at high densities in areas of past disturbance. It would, however, be far too speculative to attribute the high population density exclusively to the fact that forest in N'Zo FR has formerly been logged. The species is apparently absent from forest plantations in Côte d'Ivoire (Gartshore *et al.* 1995). Several studies from the Sundaic region in Southeast Asia and from French Guiana in South America showed that terrestrial litter-gleaners are particularly vulnerable to the effects of logging (Thiollay 1992, 1997, Grieser Johns 1996, Lambert and Collar 2002). Studies of bird communities and different feeding guilds in several forest types in East Africa and Madagascar also showed that they are negatively affected by timber extraction (Plumptre *et al.* 2001). Thus in our case, other factors, maybe related to vegetation composition or rainfall patterns, might be of higher importance in explaining why the logged sector had a higher bird density than both unlogged sites.

Demey and Rainey (2005) who conducted a rapid assessment programme in the FC de la Haute Dodo (south of Tai NP) and in the FC du Cavally (west of the park) discovered White-breasted Guinea fowl at both sites, also proving the existence of populations in logged forest areas outside the national park. White-breasted Guinea fowl was found to be more abundant at the FC du Cavally, which is situated about 100 km north of the FC de la Haute Dodo, receiving less annual precipitation (van Rompaey 1993).

Forests in N'Zo FR are even drier than those at Cavally and certainly than those in the south of the national park. The southern sectors of the park are likewise influenced much by floods of the river Hana and its tributaries. Apparently, White-breasted Guinea fowl avoids wet valley bottoms (Francis *et al.* 1992).

Drier forests usually support a considerably thicker litter layer and potentially a richer arthropod fauna than wet evergreen forests (L. H. Holbech pers. comm.).

The differences in cluster size detected between N'Zo FR and the south-western sector of Tai NP are also of interest. Before this study, the largest White-breasted Guinea fowl group ever recorded was a flock of 29 birds (Francis *et al.* 1992). The largest flock we observed consisted of 38 birds and was found at N'Zo FR. Other Galliformes showed altered flock behaviour due to changed habitat conditions which might also influence flock size (Shin-Jae and Woo-Shin 2003), but reproductive and social behaviour of the species is largely unknown.

### *Poaching*

Although not addressed in our study, there is much evidence of increasing poaching levels in the Tai region. One reason is the dramatically growing human population in areas surrounding the

park. Many immigrants, primarily resettled Baoulé from the centre and the north of Côte d'Ivoire and refugees from Liberia, have settled since 1970, causing an increase in population of more than 10% annually (Koch 1994). Secondly, the growing large-scale commercial market for bushmeat in Côte d'Ivoire has turned poaching into an important source of income in the region (Caspary *et al.* 2001). Lastly, increased pressure on game is triggered by advances in hunting technology which result in more efficient hunting (Refisch and Koné 2005).

The extremely low number of detections of the species in the hunted sector at the southeastern border of the park is an alarming signal and in line with Refisch and Koné (2005) who conclude that also other wildlife has disappeared over much of the eastern part of Taï NP.

Initially, we assumed that hunting pressure might also be high at N'Zo FR due to the infrastructure created to extract timber (Robinson *et al.* 1999). Our results could imply, however, that at least for White-breasted Guineafowl, the impact of poaching is much smaller in this area than in the southeastern sector of Taï NP. Whether accessibility is really a problem for hunters remains unclear but at least roads are apparently underdeveloped given the usual infrastructure created by logging companies.

Nevertheless, the near-absence of the species in the southeastern sector of the NP suggests that illegal hunting is likely to pose a major threat to the White-breasted Guineafowl population in Taï NP. The birds might not be the main target of poachers (Francis *et al.* 1992) since prices for guineafowl are usually low compared to other game (Allport *et al.* 1989) but the cost-benefit relationship could be influenced by the species' gregarious habits which allow groups rather than individuals to be targeted. In addition to commercial hunting with guns, subsistence hunting and the use of snares are also likely to affect the population (Allport 1991).

### Population size

Any estimate of population size based on our data is necessarily neither exact nor statistically tenable, because we can only assume that our line transects covered representative proportions of favourable and less favourable habitats. An educated guesswork approach might use the following assumptions: (i) population data from the southwestern sector of Taï NP (22.6 ind. km<sup>-2</sup>) might be representative for about 50% of the NP (1,650 km<sup>2</sup>); (ii) data from the southeastern sector of Taï NP (0.5 ind. km<sup>-2</sup>) might be representative for the other half of the park area (1,650 km<sup>2</sup>); and (iii) data from the N'Zo FR (32.9 ind. km<sup>-2</sup>) might be characteristic for the whole faunal reserve (930 km<sup>2</sup>). Based on these assumptions, we obtained an overall individual density of 16.2 ind. km<sup>-2</sup> for the whole study area and a total population size of roughly 68,700 individuals (range based on 95% CI of density estimates: 42,400 to 119,800) for Taï NP and N'Zo FR combined (4,230 km<sup>2</sup>).

This value is higher than the population size estimate of Francis *et al.* (1992), who calculated a maximum potential population of 30,000–40,000 individuals for Taï NP and the surrounding buffer zone. Their estimate included 3,400 km<sup>2</sup> of national park area and 660 km<sup>2</sup> of peripheral zone. Differences between the estimates arise partly from the area included (4,060 km<sup>2</sup> Francis *et al.* 1992; 4,230 km<sup>2</sup> this study), but mainly from the fact that our calculations include observations from different sectors inside the protected area. Values used for the estimate in Francis *et al.* (1992) were based only on observations next to the IET (Institut d'Ecologie Tropicale) scientific station in the west of the park and some sightings at Hana and Meno River in the wetter southwestern region. Our study showed, however, that the population in N'Zo FR is particularly large, underlining the conservation importance of the N'Zo FR.

### Management

Certainly, the first priority to save the unique fauna of Taï NP is to control poaching more effectively. A much better conservation awareness by the park staff is needed to reach this goal.

Access points to the park, routes and preferred game species should be recorded every time a group of poachers is detected in order to obtain a clearer picture of their methods and to quantify their influence on the fauna (see also IUCN/UNESCO 2006). Animal husbandry and/or alternative wildlife friendly farming of resilient and prolific rodents and duikers has to be promoted through community-based programmes (Refisch and Koné 2005). Efforts to control the large-scale commercial market are also of great importance in reducing poaching in the Taï region, but it is managerially more complicated as it entails prosecution of bushmeat operators.

The 'forêts classées' surrounding the National Park suffer even more than N'Zo FR from agricultural encroachment, uncontrolled logging and poaching (Alonso *et al.* 2005). To ensure that enough appropriate habitat for White-breasted Guinea fowl is protected, drier forest areas such as the 'forêts classées' and N'Zo FR should be awarded a higher conservation status. N'Zo FR should be seen as a part of Taï NP as proposed in the joint IUCN/UNESCO mission report (IUCN/UNESCO 2006). Stronger legal protection status is an advantage in the fight against poaching and agricultural encroachment, especially if the human population in the surroundings of this area continues to grow.

Increased protection and restoration of the 'forêts classées' would contribute to the construction of a protected area network connecting the Taï NP population of White-breasted Guinea fowl to populations in Liberia (in Grebo National Forest and Sapo NP). A bilateral project to create this 'green sickle' (van Rompaey 1993) is a challenge for future conservation of Upper Guinea Forest bird endemics.

To prevent the 'forêts classées' from being a 'sink' for the local fauna, timber extraction needs to be reduced to a level of minimum impact and hunting activities need to be controlled more effectively, by involving neighbouring communities as well as strengthening law enforcement. The conservation of endangered species should be more effectively included in integrated conservation programmes (IUCN/UNESCO 2006) by incorporating biodiversity goals not only into park management but also in buffer zone management through increased awareness creation at the level of project staff.

### Conclusions

As for the conservation of wildlife in general, the first priority for the conservation of White-breasted Guinea fowl is the reduction of poaching in Taï NP and adjacent areas, to ensure the survival of a viable core population. Not only the poachers themselves but also traders, markets and restaurants profiting from the illegally hunted meat need to be addressed. Community-based programmes might provide appropriate alternatives to bushmeat and might help in the process of forming legal wildlife management but it is also essential that existing conservation regulations are enforced.

The incorporation of N'Zo FR into the national park, as proposed in the IUCN/UNESCO mission report (2006) would provide a more adequate protection status to a considerable part of the population of White-breasted Guinea fowl.

A network of forests connecting Taï NP in Côte d'Ivoire and Sapo NP in Liberia is another important step in enhancing long-term survival of White-breasted Guinea fowl. Remaining forest areas next to the Liberian border, such as the FC du Cavally and the FC de la Haute Dodo, should be protected more strictly. Further agricultural encroachment into these areas has to be stopped and wildlife-friendly, agroforestry-based production systems should be encouraged to create a 'green bridge' between Liberia and Côte d'Ivoire.

Also further research is needed to determine the main mortality factors of White-breasted Guinea fowl and factors influencing social structure and behaviour. Indeed any ecological information gathered on this species would facilitate an optimal conservation strategy.

## Acknowledgements

We thank Taï National Park and the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) for supporting wildlife monitoring as part of their management activities. Matthias Waltert is currently supported by a grant from the Volkswagen Foundation. We also thank Benjamin G. Krause, Nicolai G. Brock, Jasmine Braidwood and Juliane Geyer, as well as the reviewers Lars H. Holbeck and Hugo Rainey for useful information and improvements to our manuscript.

## References

- Allport, G. (1991) The status and conservation of threatened birds in the Upper Guinea forest. *Bird Conserv. Internatn.* 1: 53–74.
- Allport, G., Ausden, M., Hayman, P. V., Robertson, P. and Wood, P. (1989) *The conservation of birds of Gola Forest, Sierra Leone*. Cambridge, UK: International Council for Bird Preservation. ICBP Study Report No. 38.
- Alonso, L. E., Lauginie, F. and Rondeau, G., eds. (2005) *A rapid biological assessment of two classified forests in south-western Côte d'Ivoire*. Washington, DC: Conservation International. RAP Bulletin of Biological Assessment 34.
- Avit, J.-B. L. F., Pedia, P. L. and Sankaré, Y. (1999) *Diversité biologique de la Côte d'Ivoire - Rapport de synthèse*. Abidjan, Côte d'Ivoire: Ministère de l'Environnement et de la Forêt.
- Bechinger, F. (1964) Beobachtungen am Weißbrust-Waldhuhn (*Agelastes meleagrides*) im Freileben und in der Gefangenschaft. *Gefied. Welt* 88: 61–62.
- BirdLife International (2003) *BirdLife's online world bird database: the site for bird conservation*. Version 2.0. Cambridge, UK: BirdLife International [http://www.birdlife.org, accessed 2 May 2008].
- BirdLife International (2007) *BirdLife's online world bird database: the site for bird conservation*. Version 2.1. Cambridge, UK: BirdLife International [http://www.birdlife.org, accessed 2 May 2008].
- Buckland, S. T., Anderson, D. R., Burnham, K. P., Laake, J. L., Borchers, D. L. and Thomas, L. (2001) *Introduction to distance sampling: estimating abundance of biological populations*. Oxford, UK: Oxford University Press.
- Caspary, H.-U., Koné, I., Prouot, C. and de Pauw, M. (2001) *La chasse et la filière viande de brousse dans l'espace Taï, Côte d'Ivoire*. Wageningen, The Netherlands: Tropenbos - Côte d'Ivoire Série 2.
- Collar, N. J. and Stuart, S. N. (1985) *Threatened birds of Africa and related islands*. ICBP/IUCN Red Data Book, part 1. Third edition. Cambridge, UK: International Council for Bird Preservation.
- Collar, N. J. and Stuart, S. N. (1988) *Key forests for threatened birds in Africa*. Cambridge, UK: International Council for Bird Preservation (ICBP Monograph 3).
- Demey, R. and Rainey, H. J. (2005) A rapid survey of the birds of the Haute Dodo and Cavally Classified Forests. Pp. 84–90 in L. E. Alonso, F. Lauginie and G. Rondeau, eds. *A rapid biological assessment of two classified forests in south-western Côte d'Ivoire*. Washington, DC: Conservation International. RAP Bulletin of Biological Assessment 34.
- Fishpool, L. C. D. (2001) Côte d'Ivoire. Pp. 219–232 in L. D. C. Fishpool and M. I. Evans, eds. *Important bird areas in Africa and associated islands - priority sites for conservation*. Cambridge, UK: BirdLife International. BirdLife Conservation Series 11.
- Francis, I. S., Penford, N., Gartshore, M. E. and Jaramillo, A. (1992) The White-breasted Guineafowl *Agelastes meleagrides* in Taï National Park, Côte d'Ivoire. *Bird Conserv. Internatn.* 2: 25–60.
- Gartshore, M. E., Taylor, P. D. and Francis, I. S. (1995) *Forest birds in Côte d'Ivoire - a survey of Taï National Park and other forests and forestry plantations, 1989–1991*. Cambridge, UK: BirdLife International. BirdLife International Study Report 58.



- Grieser Johns, A. (1996) Bird population persistence in Sabahan logging concessions. *Biol. Conserv.* 75: 3–10.
- Holbech, L. H. (2005) The implications of selective logging and forest fragmentation for the conservation of avian diversity in evergreen forests of south-west Ghana. *Bird Conserv. Internatn.* 15: 27–52.
- Hoppe-Dominik, B. (1997) Suivi et analyse des résultats du travail de la cellule suivi faune sur l'état actuel des effectifs des grands mammifères dans l'ensemble du parc national de Taï et des propositions et mise en oeuvre d'un système plus efficace de surveillance. Unpublished report to GTZ. Eschborn, Germany: Gesellschaft für Zusammenarbeit.
- IUCN (2007) 2007 IUCN Red List of threatened species [http://www.iucnlist.org, accessed 2 May 2008].
- IUCN and UNESCO (2006) *Rapport de mission - suivi de l'état de la conservation du Parc National de Taï en Côte d'Ivoire, site de patrimoine mondial, 10–23 Juin 2006*. Paris: UNESCO - Centre du Patrimoine Mondial.
- Klop, E., Lindsell, E. and Siaka, A. (2008) *Biodiversity of Gola Forest, Sierra Leone*. Sandy, UK, and Freetown, Sierra Leone: Royal Society for the Protection of Birds, Conservation Society of Sierra Leone, and Government of Sierra Leone.
- Koch, V. (1994) Le milieu ethnique et socio-culturel. Pp. 94–111 in E. P. Riezebos, A. P. Vooren and J. L. Guillaumet, eds. *Le Parc National de Taï, Côte d'Ivoire*. Wageningen, the Netherlands: La Fondation Tropenbos.
- Lambert, F. R. and Collar, N. J. (2002) The future for Sundaic lowland forest birds: long-term effects of commercial logging and fragmentation. *Forktail* 18: 127–146.
- Madge, S. and McGowan, P. J. K. (2002) *Pheasants, partridges, and grouse: a guide to the pheasants, partridges, quails, grouse, guineafowl, buttonquails, and sandgrouse of the world*. London: Christopher Helm.
- Martin, C. (1991) *The rainforests of West Africa: threats – ecology – conservation*. Basel, Switzerland: Birkhäuser.
- Plumptre, A., Dranzoa, C. and Owionji, I. (2001) Bird communities in logged and unlogged African forests: Lessons from Uganda and beyond. Pp. 213–238 in R. A. Fimbel, A. Grajal and J. G. Robinson, eds. *The cutting edge: conserving wildlife in logged tropical forests*. New York: Columbia University Press.
- Radl, G. (2000) Le biomonitoring dans le Parc National de Taï. Pp. 122–131 in O. Girardin, I. Koné and T. Yao, eds. *Etat des recherches en cours dans le Parc National de Taï (PNT)*. Abidjan, Côte d'Ivoire: Centre Suisse de Recherches Scientifiques.
- Raethel, H. S. (1991) *Hühnervögel der Welt*. Augsburg, Germany: Natur-Verlag.
- Refisch, J. and Koné, I. (2005) Impact of commercial hunting on monkey populations in the Taï region, Côte d'Ivoire. *Biotropica* 37: 136–144.
- Robinson, J. G., Redford, K. H. and Bennett, E. L. (1999) Wildlife harvest in logged tropical forests. *Science* 284: 595–596.
- van Rompaey, R. S. A. R. (1993) Forest gradients in West Africa - a spatial analysis. Doctoral thesis. Wageningen, The Netherlands: Wageningen Agricultural University.
- van Rompaey, R. S. A. R. (1994) Climat. Pp. 42–50 in E. P. Riezebos, A. P. Vooren and J. L. Guillaumet, eds. *Le Parc National de Taï, Côte d'Ivoire*. Wageningen, The Netherlands: La Fondation Tropenbos.
- Sayer, J. A., Harcourt, C. S. and Collins, N. M. (1992) *The conservation atlas of tropical forests. Africa*. London: IUCN, Macmillan.
- Shin-Jae, R. and Woo-Shin, L. (2003) Winter sociality of hazel grouse *Bonasa bonasia* in relation to habitat in a temperate forest of South Korea. *Wildl. Biol.* 9: 365–370.
- Thiollay, J.-M. (1992) Influence of selective logging on bird species diversity in a Guianan rain forest. *Conserv. Biol.* 6: 47–61.
- Thiollay, J.-M. (1997) Disturbance, selective logging and bird diversity: a neotropical forest study. *Conserv. Biol.* 6: 47–63.
- Urban, E. K., Fry, C. H. and Keith, S. (1986) *The birds of Africa*. Volume II, Gamebirds to pigeons. London: Academic Press.

MATTHIAS WALTERT\*

*Department of Conservation Biology, Centre for Nature Conservation, Georg-August-Universität, Von-Siebold-Straße 2, 37075 Göttingen, Germany.*

CHARLOTTE SEIFERT

*Josefstr. 50, 33106 Paderborn, Germany.*

GERHARD RADL

*Werbachstr. 6, 63739 Aschaffenburg, Germany.*

BERND HOPPE-DOMINIK

*Wilhelmshöhe 14, 38108 Braunschweig, Germany.*

*\*Author for correspondence; e-mail: mwalter@gwdg.de*

Received 9 October 2008; revision accepted 27 February 2009;

Published online 16 October 2009