

Specific composition, abundances and phenology of migratory landbirds of the Comoé National Park, north-east of Ivory Coast

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ABSTRACT

The migratory landbirds of the Comoé National Park (CNP), Ivory Coast, was inventoried from September 2017 to August 2019 in four habitat types (savannahs; forest islands; gallery forests and ponds) with two monthly visits per habitat. The listening point method was used on a total of 63 points located in all habitats. In the predefined habitats, the sampling of migratory landbirds was conducted from 06:30 to 12:30 in the morning and from 14:30 to 18:30 in the afternoon. On all listening points a species richness of 72 migratory landbirds was obtained. A total number of 17713 individuals with a monthly average number of 1476.77 ± 99.70 individuals of migratory landbirds were obtained. These birds visited the CNP most during the months of March and April with 3592 and 3911 individuals respectively. The phenology of intra-African and mixed migratory species shows that some species are present throughout the year in the CNP. In contrast to the previous ones, those originating from the Palearctic region frequent the park during nine months of the year (September to early May).

KEY WORDS

Abundance; Comoé National Park Migratory; Landbirds; Phenology; Specific Composition.

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INTRODUCTION

More than thirty years ago, estimates of Palearctic migratory birds to tropical regions south of the Sahara were over five billion individuals (Moreau, 1972). More recent studies have shown that these numbers have largely fallen, including those of African-Eurasian landbirds populations (Sanderson et al., 2006). Many factors contribute to the unfavorable conservation status of many African-Eurasian migratory landbirds species. These include the destruction of these birds' habitats as a result of human economic activities, now exacerbated by cli-

mate change (Belle et al., 2016). These changes are likely to have a negative impact on migratory landbirds populations. In addition, the lack of information and knowledge on the status and trends of many terrestrial migratory species in Africa is also of concern and makes conservation actions at local and international levels difficult (UNEP/CMS, 2014). In Ivory Coast, the loss of natural environments has accelerated (Lauginie, 2007) to such an extent that only the national parks are now excellent witnesses to each of the major environments that made up the natural landscape of this country (Thiollay, 1975). This is also the case of the Comoé Na-

tional Park (CNP), where migratory landbirds of various biogeographical origins stay every year (Salewski, 2000). For the conservation and protection of these birds, areas of bird conservation importance such as the CNP deserve special attention. Questions of temporal distribution and phenology of migratory landbirds have been little addressed in Côte d'Ivoire. Indeed, only the works of Thiollay (1973, 1978) and Salewski (2006) have addressed these issues. Nevertheless, the migratory phenology of many species remains to be elucidated, especially for intra-African migratory birds that winter or transit through the CNP.

In the framework of this study, the monthly abundances and phenology of migratory landbirds in the Comoé National Park will be studied.

MATERIAL AND METHODS

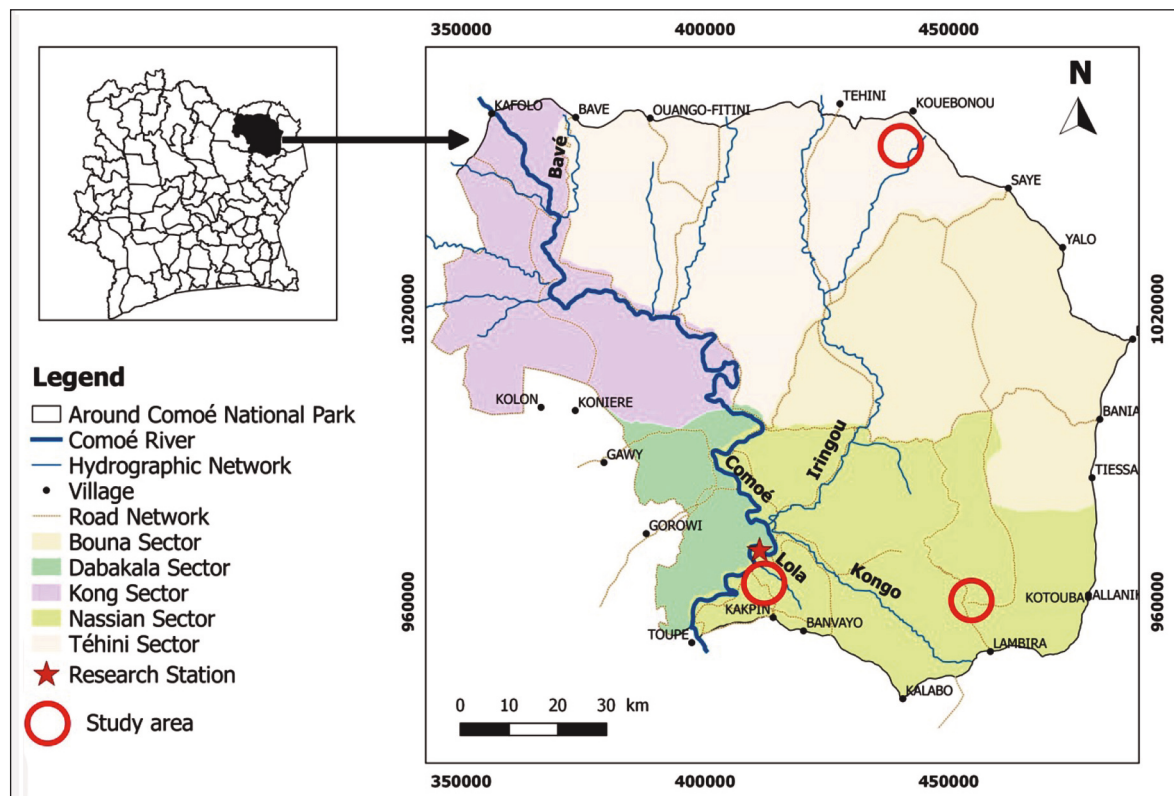
Study area

The Comoé National Park (CNP), with an area

of 1148756 ha, is located in the north-east of Ivory Coast (Fig. 1), between 3°07' and 4°25' west longitude and 8°30' and 9°37' north latitude (Lapiente et al., 2020). Its relief consists of plateaus with an average altitude of 300 m in the northwest. Its hydrographic network consists of the Comoé River and its main tributaries, the Kongo and Iringou Rivers (Girard et al., 1971). This park is subject to a sub-humid tropical climate influenced in the north-eastern part of the park by a sub-arid tropical climate. The average annual rainfall during our study period was around 1119.86 mm. The average annual temperature varies between 27 °C and 28 °C. The average relative atmospheric humidity is 64.46% and reaches 81.18% during the rainy season from May to October. The vegetation of the CNP is exclusively sub-Sudanese and Sudanese savannah (Porembeski, 1991).

Material

The technical equipment used consisted of a pair of binoculars (Bushnell Trophy 10X42 binoculars)



for bird watching, a digital camera (NIKON COOLPIX P900, 24-2000 mm) for taking photographs, and an OLYMPUS Linear PCM Recorder LS-P2 Dictaphone for recording the birds' vocalizations. A West African bird guide (Borrow & Demey, 2015) was used for bird identification. The discography of Chappuis (2000) was used for the vocal recognition (song and call) of the birds.

Sampling

Three study areas of four different ecosystem types (forest islands, gallery forests, ponds and savannahs) in the Comoé National Park were selected for the study. In total, 63-points counts were defined for all the above-mentioned habitats. Inventories were conducted monthly in these habitats from September 2017 to August 2019 with two monthly visits per habitat. The point count method was used (Blondel et al., 1970). This technique is based on the recording of bird contacts seen and/or heard during 20 minutes at fixed points. Thus, 420 visits to the habitats were necessary for this study. The surveys were carried out from 06:30 to 12:30 in the morning and from 14:30 to 18:30 in the afternoon (Bibby et al., 1998; Yaokokoré, 2001). All birds in flight or landing, or recognized by song or call, were recorded (Skinner et al., 1994). The list of species is established according to the phylogenetic order of Gill et al. (2022). The biogeographical status of the species is given according to Borrow & Demey (2015). They distinguish three (03) categories of bird species in Africa. Resident (R), migratory species among which are distinguished: intra-African migratory (M) and palearctic migratory (P). The last category concerns occasional species. Based on the relative frequency (Fr), Thiollay (1986) determines four categories of abundance. Thus, a species is considered dominant (D) if $Fr \geq 5\%$, regular (Re) if $1\% \leq Fr < 5\%$, rare (Ra) if $0.2\% \leq Fr < 1\%$ and accidental (Ac) if $Fr < 0.2\%$. The conservation status of the species is IUCN (2022).

RESULTS

Specific composition and characterization of migratory landbirds of Comoé National Park

The terrestrial migratory avifauna of the CNP has a species richness of 75 species of 50 genera belonging to 29 families (Table I). One migratory landbird species is mentioned for the first time in the park. This is the European Nightjar *Caprimulgus europaeus* Linnaeus, 1758. The non-Passeriformes, with 34 species, represent 45.33% of the species richness of the migratory landbirds. The order Passeriformes, with 41 species, represents 54.67% of the total species richness of these birds visiting the CNP. The analysis of the biogeographical status of the species shows that the strict migratory species with 39 species represent 52% of the terrestrial migratory species. Fourteen species (18.67%) of these are intra-African migrants (M) and 25 species (33.33%) are Palearctic migrants (P). The mixed-status migratory species (R/M; R/M/P) with also 36 species contribute to 48% of the species richness of migratory landbirds. One species of migratory landbirds visiting the CNP is close to threatened according to the IUCN (2022). This is Denham's Bustard *Neotis denhami* (Children & Vigors, 1826). Some of the migratory birds wintering at CNP are shown in Fig. 2.

Abundance of migratory landbirds in Comoé National Park

At the end of the count of the avifauna of the CNP, 72 species were observed at the count points with a total of 17713 individuals of migratory landbirds for a monthly average of 1476.77 ± 99.70 individuals.

On the basis of their abundance, the migratory landbirds of the CNP can be divided into four categories. Thus, 24 species are accidental with an abundance of 311 individuals (1.76%) and 25 species are rare with an abundance of 2571 individuals (14.51%). The regular species have a relative frequency of 32.80% for a population of 5,810 individuals and the dominant species, numbering five, represent 50.93% for a population of 9021 individuals (Table I). Abundance according to biogeographical status shows that species of mixed origin are the most abundant with a total of 7511 individuals (42.40%). Palearctic species are represented by 7160 individuals (40.43%) and intra-African migratory species with 3042 individuals contribute 17.17% of the total number. Three species stand out, considering the biogeographical origin of the

Orders/Families/Species	SB	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	CN	Fr	Avg±SD	AC
GALLIFORMES																	
Phasianidae																	
<i>Coturnix coturnix</i> (Linnaeus, 1758)*	P																
OTIDIFORMES																	
Otididae																	
<i>Neotis denhami</i> (Children & Vigors, 1826) NT	R/M	1	0	0	0	0	0	0	0	0	0	0	1	2	0.00	0.17	±0.28 Ac
<i>Lissotis melanogaster</i> (Rüppell, 1835)	R/M	1	2	2	0	0	0	2	2	2	3	3	2	19	0.03	1.58	±0.89 Ac
PTEROCLIFORMES																	
Pteroclididae																	
<i>Pterocles quadricinctus</i> Temminck, 1815	R/M	123	182	205	178	0	0	0	0	0	0	6	63	757	1.11	63.08	±72.61 Ra
COLUMBIFORMES																	
Columbidae																	
<i>Streptopelia vinacea</i> (Gmelin, 1789)	R/M	224	300	201	167	95	68	53	63	54	84	136	201	1646	2.41	137.17	±67.86 Re
CUCULIFORMES																	
Cuculidae																	
<i>Clamator levaillantii</i> (Swainson, 1829)	M	5	7	6	7	10	11	8	10	5	7	7	8	91	0.13	7.58	±1.51 Ac
<i>Cuculus solitarius</i> Stephens, 1815	M	3	1	8	7	13	14	19	9	7	12	6	3	102	0.15	8.50	±4.08 Ac
<i>Cuculus clamosus</i> Latham, 1802	R/M	1	0	2	4	2	0	0	0	1	0	0	2	12	0.02	1.00	±1 Ac
<i>Cuculus gularis</i> Stephens, 1815	M	9	14	17	18	8	6	0	0	0	0	0	2	74	0.11	6.17	±5.86 Ac
<i>Chrysococcyx klaas</i> (Stephens, 1815)	R/M	10	12	13	9	8	7	6	9	2	7	6	7	96	0.14	8.00	±2.17 Ac
<i>Chrysococcyx caprius</i> (Boddaert, 1783)	R/M	1	1	0	0	3	2	1	1	0	1	1	3	14	0.02	1.17	±0.75 Ac
<i>Chrysococcyx cupreus</i> (Shaw, 1792)	R/M	1	1	4	2	8	10	3	2	0	7	4	2	44	0.06	3.67	±2.44 Ac
CAPRIMULGIFORMES																	
Caprimulgidae																	
<i>Caprimulgus europaeus</i> Linnaeus, 1758	P	0	0	0	1	0	0	0	0	0	0	0	0	1	0.00	0.08	±0.15 Ac
<i>Caprimulgus inornatus</i> Heuglin, 1869	R/M	6	6	5	6	2	0	0	0	0	3	3	10	41	0.06	3.42	±2.65 Ac
<i>Caprimulgus climacurus</i> Vieillot, 1824	R/M	4	4	5	1	0	0	0	0	0	0	0	3	17	0.02	1.42	±1.72 Ac
Caprimulgidae (Suite)																	
<i>Caprimulgus ruficollis</i> Temminck, 1820*	P																
<i>Macrodipteryx longipennis</i> (Shaw, 1796)	M	2	4	3	2	0	0	0	0	0	0	0	4	15	0.02	1.25	±1.46 Ac
APODIFORMES																	
Apodidae																	
<i>Apus apus</i> (Linnaeus, 1758)	P	0	14	93	177	27	0	0	0	23	15	0	0	349	0.51	29.08	±35.31 Ra
<i>Apus caffer</i> (Lichtenstein, 1823)	R/M	0	0	32	36	15	0	0	0	12	0	0	0	95	0.14	7.92	±10.56 Ac
CORACIIFORMES																	
Alcedinidae																	
<i>Alcedo cristata</i> Pallas, 1764	R/M	14	20	18	16	10	7	14	9	2	6	10	13	139	0.20	11.58	±4.25 Ra
<i>Ceyx pictus</i> (Boddaert, 1783)	R/M	1	3	6	5	3	3	2	0	3	3	2	2	33	0.05	2.75	±1.13 Ac
<i>Halcyon leucocephala</i> (Statius Muller, 1776)	M	35	37	43	40	10	0	0	0	0	0	1	25	191	0.28	15.92	±16.74 Ra
<i>Halcyon senegalensis</i> (Linnaeus, 1766)	R/M	4	12	0	0	1	1	2	0	3	4	4	0	31	0.05	2.58	±2.35 Ac
Meropidae																	
<i>Merops hirundineus</i> Lichtenstein, 1793	R/M	26	39	28	14	8	13	15	21	10	34	62	22	292	0.43	24.33	±11.22 Ra
<i>Merops albicollis</i> Vieillot, 1817	M	0	0	0	117	118	0	0	0	25	61	10	0	331	0.49	27.58	±35.54 Ra
<i>Merops apiaster</i> Linnaeus, 1758	P	242	276	339	416	0	0	0	0	165	170	221	231	2060	3.02	171.67	±115.83 Re
<i>Merops nubicus</i> Gmelin, 1788	M	96	124	130	154	15	0	0	0	0	0	0	117	636	0.93	53.00	±59.33 Ra
Coraciidae																	
<i>Coracias abyssinicus</i> Hermann, 1783	M	22	24	15	20	7	8	1	0	0	0	6	38	141	0.21	11.75	±10.04 Ra
<i>Coracias naevius</i> Daudin, 1800	R/M	1	5	7	4	3	2	0	0	0	0	3	5	30	0.04	2.50	±2 Ac
<i>Coracias cyanogaster</i> Cuvier, 1816	R/M	0	4	3	1	6	5	4	0	1	12	1	2	39	0.06	3.25	±2.46 Ac

<i>Eurystomus glaucurus</i> (Statius Muller, 1776)	M	33	52	58	47	45	40	2	0	2	10	17	45	351	0.51	29.25	±19.21	Ra
BUCEROTIFORMES																		
Upupidae																		
<i>Upupa epops</i> Linnaeus, 1758	R/M/P	7	7	1	1	2	0	0	0	0	0	8	9	35	0.05	2.92	±3.22	Ac
Bucerotidae																		
<i>Lophoceros nasutus</i> (Linnaeus, 1766)	R/M	100	111	107	98	66	55	31	33	41	53	88	119	902	1.32	75.17	±28.67	Re
PICIFORMES																		
Picidae																		
<i>Jynx torquilla</i> Linnaeus, 1758*																		
PASSERIFORMES																		
Alaudidae																		
<i>Pinarocorys erythropygia</i> (Strickland, 1852)	M	25	33	31	26	0	0	0	0	0	0	0	17	132	0.19	11.00	±12.83	Ac
<i>Eremopterix leucotis</i> (Stanley, 1814)	R/M	4	5	3	0	0	0	0	0	0	0	0	4	16	0.02	1.33	±1.78	Ac
Hirundinidae																		
<i>Psilidoprocne obscura</i> (Hartlaub, 1855)	R/M	0	13	1	16	9	22	27	43	24	39	5	0	199	0.29	16.58	±12.01	Ra
<i>Riparia paludicola</i> (Vieillot, 1817)	R/M	2	3	0	0	0	0	0	0	0	5	0	0	10	0.01	0.83	±1.25	Ac
<i>Pseudhirundo griseopyga</i> (Sundevall, 1850)	R/M	10	14	7	23	4	0	0	4	7	15	0	13	97	0.14	8.08	±5.76	Ac
<i>Hirundo smithii</i> Leach et K.D Koenig 1818	R/M	15	35	21	23	0	0	4	0	15	11	17	13	154	0.23	12.83	±8.19	Ra
<i>Hirundo aethiopica</i> Blanford, 1869	R/M	0	0	0	0	0	0	0	0	9	0	0	0	9	0.01	0.75	±1.375	Ac
<i>Hirundo rustica</i> Linné, 1758	P	17	35	90	124	0	0	0	0	49	35	0	13	363	0.53	30.25	±30.29	Ra
<i>Hirundo lucida</i> Hartlaub, 1858	R/M	4	13	35	50	14	17	7	30	34	0	0	0	204	0.30	17.00	±13.5	Ra
<i>Cecropis semirufa</i> (Sundevall, 1850)	R/M	15	52	26	29	13	8	0	0	0	0	0	17	160	0.23	13.33	±12.06	Ra
<i>Cecropis senegalensis</i> (Linnaeus, 1766)	R/M	14	60	32	52	0	0	9	0	5	0	5	13	190	0.28	15.83	±16.08	Ra
<i>Cecropis abyssinica</i> (Guerin-Meneville, 1843)	R/M	23	31	18	32	27	28	20	4	2	14	0	12	211	0.31	17.58	±9.32	Ra
<i>Cecropis daurica</i> (Laxmann, 1769)	R/M/P	2	0	0	0	0	0	0	0	0	0	0	0	2	0.00	0.17	±0.31	Ac
<i>Delichon urbicum</i> (Linnaeus, 1758)	P	69	73	1356	1411	0	0	0	0	7	18	60	64	3058	4.48	254.83	±376.22	Re
Motacillidae																		
<i>Motacilla flava</i> Linnaeus, 1758	P	6	4	5	6	0	0	0	0	2	2	1	8	34	0.05	2.83	±2.48	Ac
<i>Anthus trivialis</i> (Linnaeus, 1758)	P	22	29	29	33	0	0	0	0	4	8	6	33	164	0.24	13.67	±12.94	Ra
<i>Anthus cervinus</i> (Pallas, 1811)	P	8	8	3	1	0	0	0	0	0	0	0	5	25	0.04	2.08	±2.61	Ac
Campephagidae																		
<i>Campephaga phoenicea</i> (Latham, 1790)	R/M	2	5	13	4	3	0	4	5	2	8	3	4	53	0.08	4.42	±2.22	Ac
Acrocephalidae																		
<i>Acrocephalus scirpaceus</i> (Hermann, 1804)	P	0	0	1	0	0	0	0	0	0	2	2	0	5	0.01	0.42	0.63	Ac
<i>Hippolais polyglotta</i> (Vieillot, 1817)	P	13	10	23	14	0	0	0	0	0	2	3	15	80	0.12	6.67	±6.94	Ac
Phylloscopidae																		
<i>Phylloscopus trochilus</i> (Linnaeus, 1758)	P	30	38	35	41	0	0	0	0	0	7	24	32	207	0.30	17.25	±16.08	Ra
<i>Phylloscopus sibilatrix</i> (Bechstein, 1793)	P	14	19	18	22	0	0	0	0	2	4	11	17	107	0.16	8.92	±7.92	Ac
Sylviidae																		
<i>Sylvia borin</i> (Boddaert, 1783)	P	3	2	3	4	0	0	0	0	0	0	0	1	13	0.02	1.08	±1.28	Ac
Sylviidae (suite)																		
<i>Sylvia atricapilla</i> (Linnaeus, 1758)	P	1	0	0	0	0	0	0	0	0	0	0	0	1	0.00	0.08	±0.15	Ac
<i>Sylvia communis</i> Latham, 1787	P	0	4	2	0	0	0	0	0	0	0	0	2	8	0.01	0.67	±1	Ac
Muscicapidae																		
<i>Phoenicurus phoenicurus</i> (Linnaeus, 1758)	P	0	1	0	0	0	0	0	0	0	0	0	5	6	0.01	0.50	±0.83	Ac
<i>Saxicola rubetra</i> (Linnaeus, 1758)	P	13	13	22	17	0	0	0	0	7	10	12	24	118	0.17	9.83	±7.03	Ac
<i>Oenanthe oenanthe</i> (Linnaeus, 1758)	P	2	0	0	0	0	0	0	0	0	0	0	2	4	0.01	0.33	±0.56	Ac
<i>Ficedula hypoleuca</i> (Pallas, 1764)	P	44	48	59	55	0	0	0	0	28	43	52	51	380	0.56	31.67	±21.72	Ra
<i>Muscicapa striata</i> (Pallas, 1764)	P	15	18	14	14	2	0	0	0	7	16	19	20	125	0.18	10.42	±7.18	Ac
Monarchidae																		
<i>Terpsiphone viridis</i> (Statius Müller, 1776)	R/M	14	25	25	35	40	38	27	33	16	23	28	29	333	0.49	27.75	±6.08	Ra

Nectariniidae																			
<i>Hedydipna platyura</i> (Vieillot, 1819)	R/M	6	18	9	8	5	2	2	0	0	4	24	20	98	0.14	8.17	±6.39	Ac	
<i>Chalcomitra senegalensis</i> (Linnaeus, 1766)	R/M	12	17	27	22	10	6	11	9	14	17	17	13	175	0.26	14.58	±4.51	Ra	
Laniidae																			
<i>Lanius senator</i> Linnaeus, 1758	P	9	10	9	13	0	0	0	0	0	0	0	8	49					
Oriolidae																			
<i>Oriolus oriolus</i> (Linnaeus, 1758)	P	0	0	0	0	0	0	0	0	1	2	0	0	3	0.00	0.25	±0.42	Ac	
<i>Oriolus auratus</i> Vieillot, 1817	M	26	49	42	39	26	7	0	1	8	16	26	36	276	0.40	23.00	±13.83	Ra	
Sturnidae																			
<i>Cinnyricinclus leucogaster</i> (Boddaert, 1783)	M	45	57	88	78	43	3	0	0	0	0	0	24	338	0.50	28.17	±28.36	Ra	
Passeridae																			
<i>Gymnoris dentata</i> (Sundevall, 1850)	R/M	208	230	184	171	0	0	0	0	0	121	228	213	1355	1.99	112.92	94.10	Re	
Ploceidae																			
<i>Quelea erythrops</i> (Hartlaub, 1848)	M	0	15	4	0	0	0	10	6	39	65	23	0	162	0.24	13.50	±14.67	Ra	
<i>Euplectes franciscanus</i> (Isert, 1789)	M	19	0	5	0	0	0	9	34	17	31	45	42	202	0.30	16.83	±14.5	Ra	
Emberizidae																			
<i>Emberiza tahapisi</i> A. Smith, 1836	R/M	0	0	1	0	0	0	0	0	0	0	0	0	1	0.00	0.08	±0.15	Ac	
		1684	2249	3592	3911	681	383	293	328	657	1010	1216	1709	17713	100	1472			

Table 1. List of migratory landbirds observed in the Comoé National Park. BS: Biogeographical Status, Jan: January, Feb: February, Mar: March, Apr: April, Jun: June, Jul: July, Aug: August, Sep: September, Oct: October, Nov: November, Dec: December, CE: Cumulative Number, Fr: Relative Frequency, Avg: Mean, Mon: Monthly, SD: Standard Deviation, AC: Abundance Category, * Species observed outside the Count points, NT: Near Threatened, R: Resident; M: Intra-African migratory species; P: Palearctic migratory species.

birds. Indeed, the Common House Martin *Delichon urbicum* is the most abundant species of the Palearctic species and of the whole population with 3058 individuals for a monthly average of 254.83 ± 376.22 individuals. The most abundant intra-African migrant species is the Northern Carmine Bee-eater *Merops nubicus* with 636 individuals and a monthly average of 53.00 ± 59.33 individuals. The Vinaceous Dove *Streptopelia vinacea* (Gmelin, 1789) is the most abundant mixed-status migrant species with 1646 individuals for a monthly average of 137.17 ± 67.86 individuals (Table 1).

Phenology of migratory landbirds in Comoé National Park according to their biogeographical status

The study of phenology shows that three main waves of arrivals can be distinguished among Palearctic migratory landbirds. In the first wave, there are 11 species that arrive in the CNP in September. These include *Motacilla flava*, *Anthus trivialis*, *Phylloscopus sibilatrix*, *Saxicola rubetra* and *Ficedula hypoleuca*. The month of October saw the arrival of the second wave of species. There are

three species involved. They are *Acrocephalus scirpaceus*, *Hippolais polyglotta* and *Phylloscopus trochilus*. The third wave concerns four species that arrive in the CNP in December. These are *Sylvia borin*, *Sylvia communis*, *Phoenicurus phoenicurus* and *Lanius senator*. Departures of all terrestrial migratory birds in the Palearctic generally take place in April. Amongst the intra-African migratory species, departures differ from one species to another, with two species occurring in all months of the year. In contrast, the other twelve species are absent from the park for a period varying from one to six months depending on the species.

The analysis of the phenology of the mixed-status migratory landbirds visiting the CNP reveals different patterns from those previously studied. Indeed, some species appear as strict migrants. This is the case of the Bush Petronia *Gymnoris dentata*, which arrives in the CNP during October and leaves in April. It is completely absent from May to September. As for the Four-Banded Sandgrouse *Pterocles quadricinctus*, it is observed from November to April and is absent from May to October in the park. Others are wandering (*Oriolus oriolus*, *Cecropis daurica*, *Caprimulgus europaeus*, *Emberiza*

tahapisi) or present all year round (*Clamator levailantii* and *Cuculus solitarius*) in the park (Table 2).

Migratory phenology of the main terrestrial mi-

gratory species in Comoé National Park during this study

All Palearctic migratory landbirds in the CNP



Anthus trivialis



Ficedula hypoleuca



Coracias cyanogaster



Pinarocorys erythropygia



Eremopterix leucotis



Hedydipna platura

Figure 2. Photographs of some migratory landbirds species visiting the CNP.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<i>Neotis denhami</i>	+											+
<i>Lissotis melanogaster</i> *	+	+	+				+	+	+	+	+	+
<i>Pterocles quadricinctus</i>	+	+	+	+							+	+
<i>Streptopelia vinacea</i> *	+	+	+	+	+	+	+	+	+	+	+	+
<i>Clamator levaillantii</i> *	+	+	+	+	+	+	+	+	+	+	+	+
<i>Cuculus solitarius</i> *	+	+	+	+	+	+	+	+	+	+	+	+
<i>Cuculus clamosus</i> *	+		+	+	+				+			+
<i>Cuculus gularis</i>	+	+	+	+	+	+						+
<i>Chrysococcyx klaas</i> *	+	+	+	+	+	+	+	+	+	+	+	+
<i>Chrysococcyx caprius</i> *	+	+			+	+	+	+		+	+	+
<i>Chrysococcyx cupreus</i> *	+	+	+	+	+	+	+	+		+	+	+
<i>Caprimulgus europaeus</i> μ				+								
<i>Caprimulgus inornatus</i>	+	+	+	+	+					+	+	+
<i>Caprimulgus climacurus</i>	+	+	+	+								+
<i>Macrodipteryx longipennis</i>	+	+	+	+								+
<i>Apus apus</i>		+	+	+	+				+	+		
<i>Apus caffer</i> *			+	+	+				+			
<i>Alcedo cristata</i> *	+	+	+	+	+	+	+	+	+	+	+	+
<i>Ceyx pictus</i> *	+	+	+	+	+	+	+		+	+	+	+
<i>Halcyon leucocephala</i>	+	+	+	+	+						+	+
<i>Halcyon senegalensis</i> *	+	+			+	+	+		+	+	+	
<i>Merops hirundineus</i> *	+	+	+	+	+	+	+	+	+	+	+	+
<i>Merops albicollis</i>				+	+				+	+	+	
<i>Merops apiaster</i>	+	+	+	+					+	+	+	+
<i>Merops nubicus</i>	+	+	+	+	+							+
<i>Coracias abyssinicus</i>	+	+	+	+	+	+	+				+	+
<i>Coracias naevius</i>	+	+	+	+	+	+					+	+
<i>Coracias cyanogaster</i>		+	+	+	+	+	+		+	+	+	+
<i>Eurystomus glaucurus</i>	+	+	+	+	+	+	+		+	+	+	+
<i>Upupa epops</i>	+	+	+	+	+						+	+
<i>Lophoceros nasutus</i>	+	+	+	+	+	+	+	+	+	+	+	+
<i>Pinarocorys erythropygia</i> *	+	+	+	+								+
<i>Eremopterix leucotis</i> *	+	+	+									+
<i>Psalidoprocne obscura</i>		+	+	+	+		+		+	+	+	
<i>Riparia paludicola</i> *	+	+								+		
<i>Pseudhirundo griseopyga</i> *	+	+	+	+	+			+	+	+		+
<i>Hirundo smithii</i> *	+	+	+	+			+		+	+	+	+
<i>Hirundo aethiopica</i>									+			
<i>Hirundo rustica</i>	+	+	+	+					+	+		+
<i>Hirundo lucida</i>	+	+	+	+	+	+	+	+	+			
<i>Cecropis semirufa</i> *	+	+	+	+	+	+						+
<i>Cecropis senegalensis</i> *	+	+	+	+			+		+		+	+
<i>Cecropis abyssinica</i>	+	+	+	+	+	+	+	+	+	+		+
<i>Cecropis daurica</i>	+											
<i>Delichon urbicum</i>	+	+	+	+					+	+	+	+

<i>Motacilla flava</i>	+	+	+	+					+	+	+	+
<i>Anthus trivialis</i>	+	+	+	+					+	+	+	+
<i>Anthus cervinus</i>	+	+	+	+								+
<i>Campephaga phoenicea</i> *	+	+	+	+	+		+	+	+	+	+	+
<i>Acrocephalus scirpaceus</i>			+							+	+	
<i>Hippolais polyglotta</i>	+	+	+	+						+	+	+
<i>Phylloscopus trochilus</i>	+	+	+	+						+	+	+
<i>Phylloscopus sibilatrix</i>	+	+	+	+					+	+	+	+
<i>Sylvia borin</i>	+	+	+	+								+
<i>Sylvia atricapilla</i>	+											
<i>Sylvia communis</i>			+	+								+
<i>Phoenicurus phoenicurus</i>			+									+
<i>Saxicola rubetra</i>	+	+	+	+					+	+	+	+
<i>Oenanthe oenanthe</i>	+											+
<i>Ficedula hypoleuca</i>	+	+	+	+					+	+	+	+
<i>Muscicapa striata</i>	+	+	+	+	+				+	+	+	+
<i>Terpsiphone viridis</i> *	+	+	+	+	+	+	+	+	+	+	+	+
<i>Hedydipna platyura</i>	+	+	+	+	+	+	+			+	+	+
<i>Chalcomitra senegalensis</i> *	+	+	+	+	+	+	+	+	+	+	+	+
<i>Lanius senator</i> *	+	+	+	+								+
<i>Oriolus oriolus</i>									+	+		
<i>Oriolus auratus</i> *	+	+	+	+	+	+		+	+	+	+	+
<i>Cinnyricinclus leucogaster</i> *	+	+	+	+	+	+						+
<i>Gymnoris dentata</i> *	+	+	+	+						+	+	+
<i>Quelea erythrops</i> *			+	+			+	+	+	+	+	
<i>Euplectes franciscanus</i> *	+		+				+	+	+	+	+	+
<i>Emberiza tahapisi</i>			+									

Table 2. Phenology of migratory landbirds species in the CNP by month. Jan: January, Feb: February, Mar: March, Apr: April, May: May, Jun: June, Jul: July, Aug: August, Sep: September, Oct: October, Nov: November, Dec: December, * Migratory landbirds species whose phenology is determined for the first time in the CNP from our study, μ migratory landbird species newly reported in the CNP. +Presence of the species in the CNP.

are true migrants. The six species with significant numbers will be analyzed in terms of their migratory phenology. The House Martin *Delichon urbicum* is the most abundant species of all the migratory landbirds observed in the CNP with a total of 3058 individuals. This wintering species at the CNP is present only during eight months of the year (September to April). Peak numbers are reached in March and April with 1356 and 1411 individuals respectively (Fig. 3). The second most abundant species of migratory landbirds in the Palearctic is the European Bee-eater *Merops apiaster* with 2060 individuals. *Merops apiaster* was observed in the CNP in mid-September with a total of 165 individuals. From this month onwards, the

numbers of this species gradually increase to reach a maximum value of 416 individuals in April. The month of April saw individuals of this species leave the CNP. Their total absence from the park will last until August (Fig. 3). The Pied Flycatcher, *Ficedula hypoleuca*, occupies the CNP for eight months, except for the months of May to August. The numbers of this species fluctuate between 0 and 59 individuals. Two main peaks were reported in November and March with values of 52 and 59 individuals respectively. The last individuals left in April (Fig. 3). The Barn Swallow *Hirundo rustica* with 363 individuals was regularly observed during seven months. Two peaks were reached in April and March with 124 and 90 individuals re-

spectively. The species was absent from the park from May to August and again in November. It arrives in the CNP in September and disappears in November. Population numbers fluctuate between 13 and 35 individuals from December to February and then peak in March (Fig. 3). The Common Swift *Apus apus* has a migratory phenology where

it is observed during six months in the CNP and the other six months it is absent. In fact, the species frequents the park during the months of February to May and September to October. However, absences are noted between December and January, and from June to August. Two peaks are reached in March and September with a very high

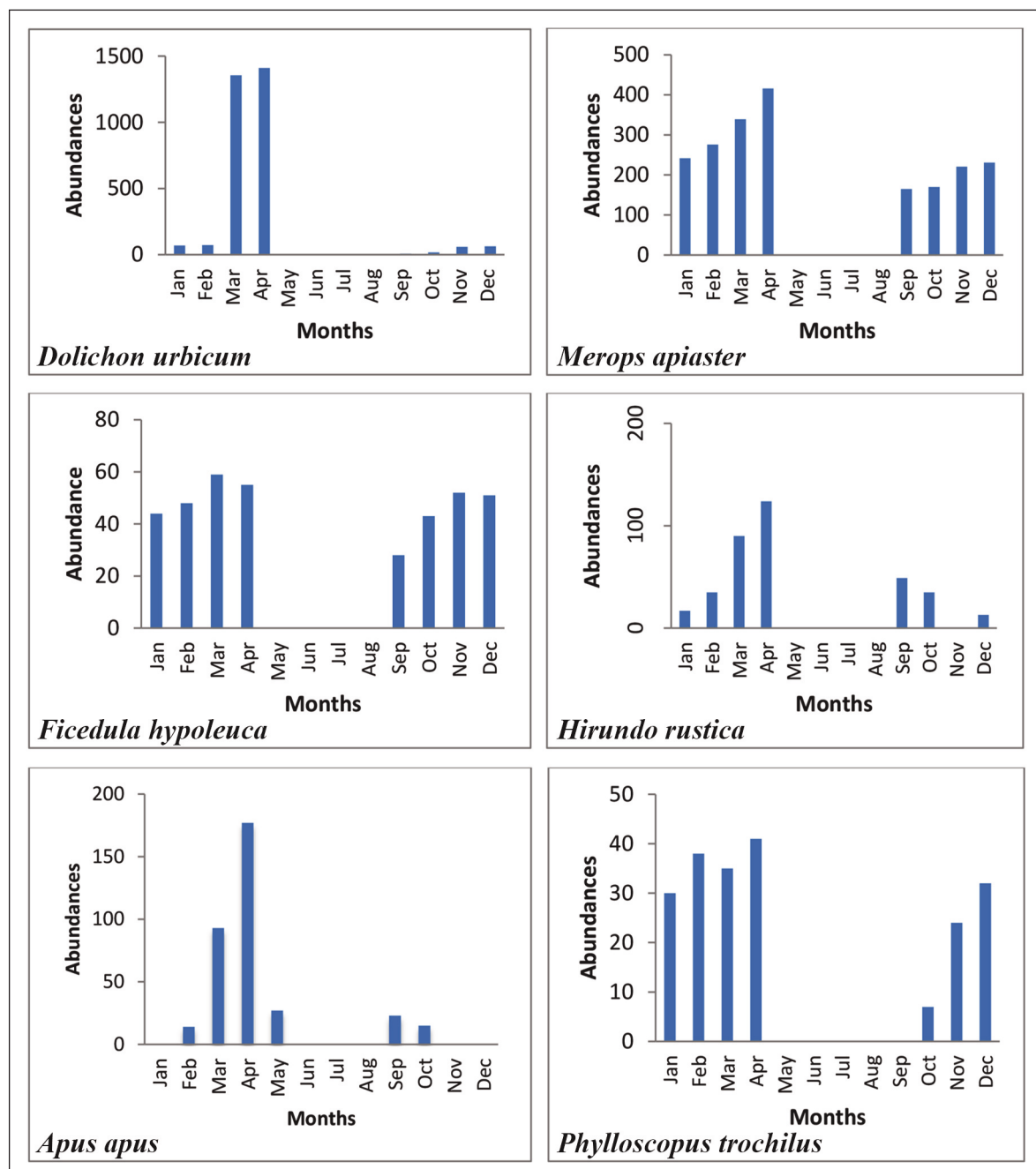


Figure 3. Migratory phenology of the six main Palearctic migratory landbirds species in Comoé National Park.

peak in the first month mentioned with 177 individuals. The second peak was only 23 individuals. A total of 349 individuals were counted during this study (Fig. 3). The last species of numerical importance among the migratory landbirds of the Palearctic is the Willow Warbler *Phylloscopus trochilus* with 207 individuals. Its abundance is

high in February (38 individuals) and April (41 individuals). A total absence of the latter is observed from May to September like most of its Palearctic congeners (Fig. 3).

Migration phenology of the six main intra-African migratory landbirds species

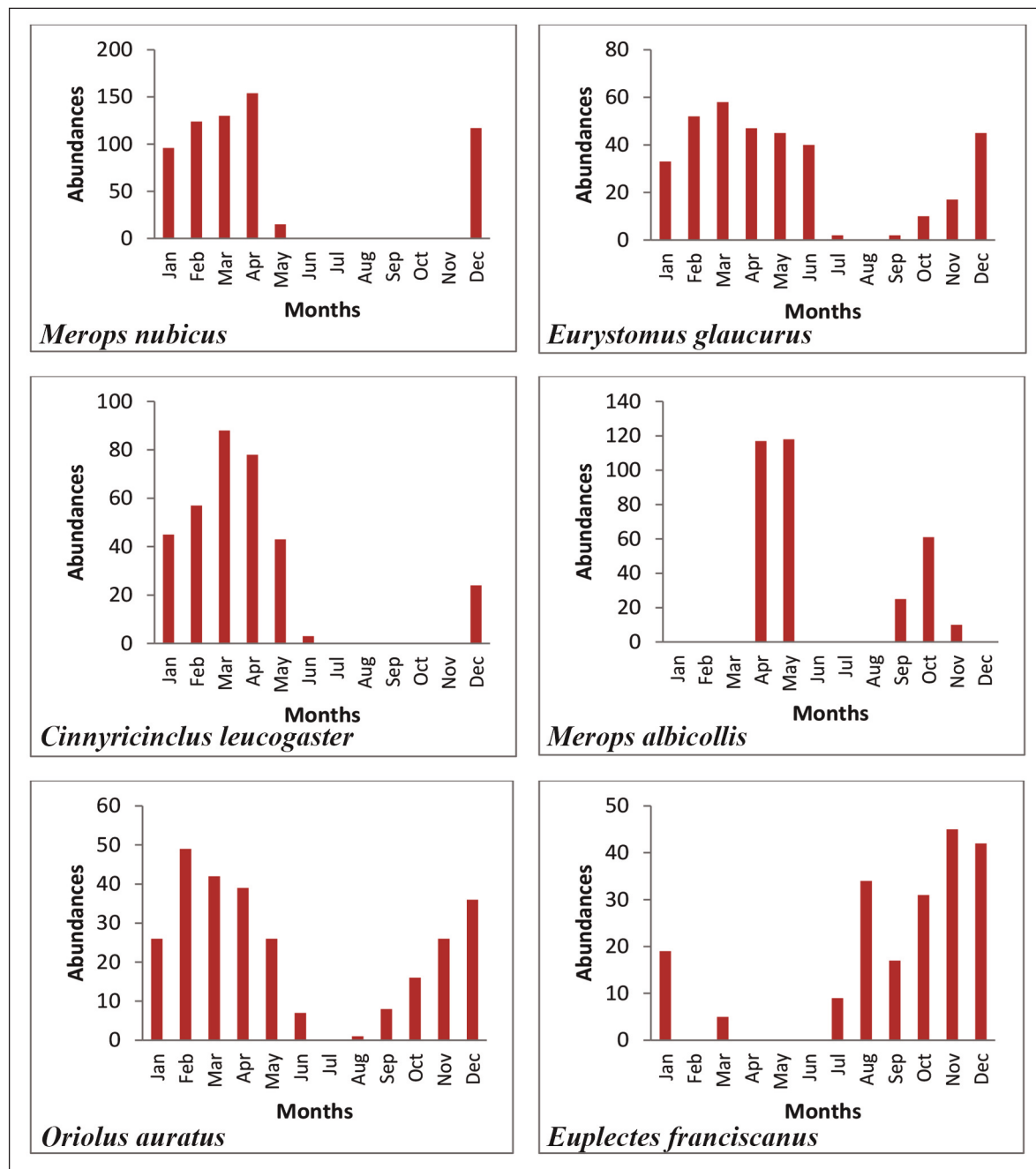


Figure 4. Migratory phenology of the six main intra-African migratory landbirds species in Comoé National Park.

The phenology of the six main species of these birds will be analyzed in detail. The Northern Carmine Bee-eater *Merops nubicus* is the most abundant intra-African migrant species with 636 individuals. It frequents the CNP during one semester. The highest numbers of this species are found between February and April, when more than 120 in-

dividuals are observed during these months. The peak in the number of individuals was reached in April with 154 individuals, followed by the lowest value in May with 15 individuals (Fig. 4). The Broad-billed Roller *Eurystomus glaucurus* is the second most important species in terms of numbers, with 351 individuals visiting the CNP. This species

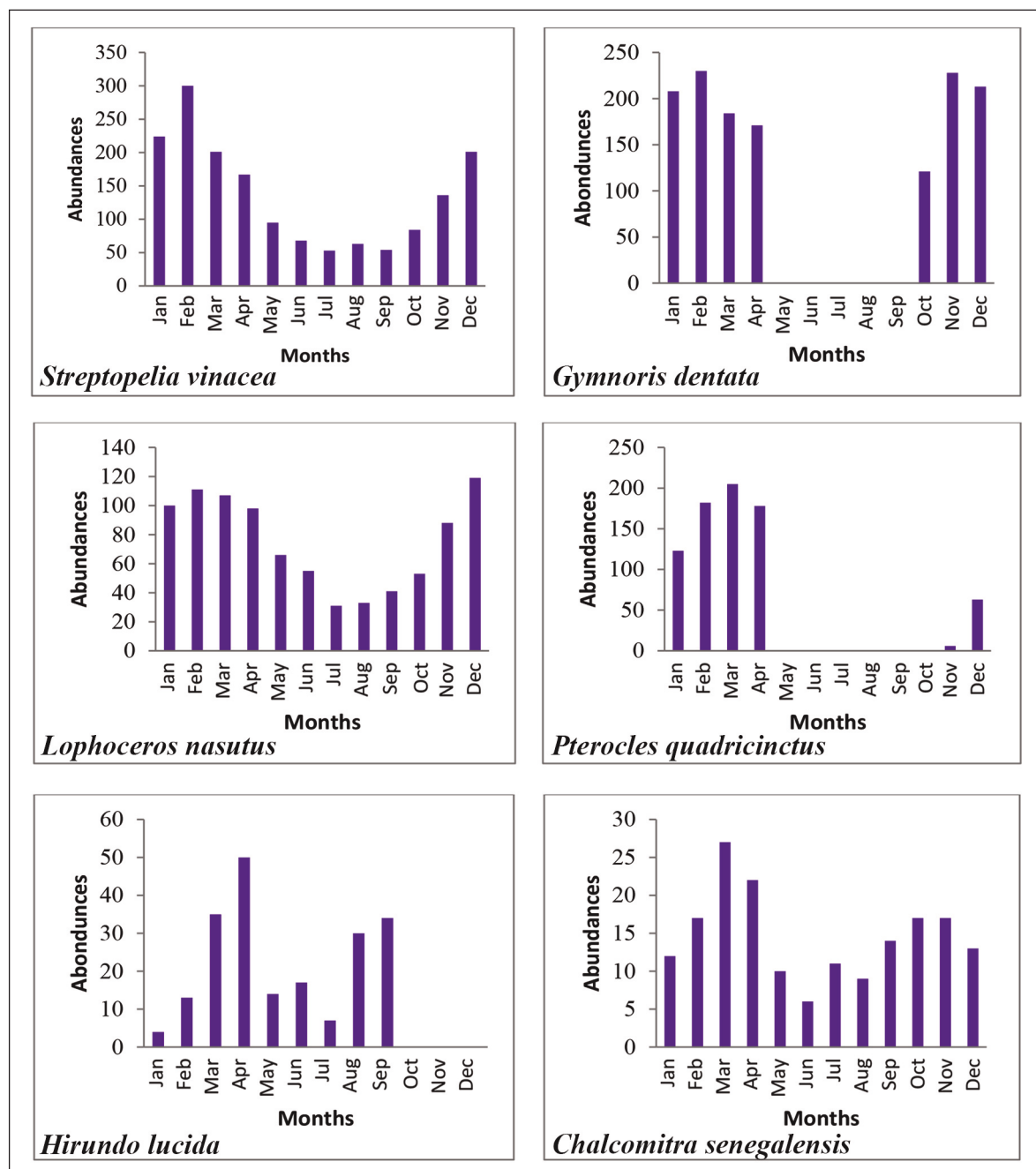


Figure 5. Migratory phenology of the six main migratory species with mixed status.

is present in eleven months throughout the year. It is only absent in August. The months from February to May and December are the peak periods for this species in the park. Its numbers during these months exceed 40 individuals. However, April has the highest number of individuals with 58 (Fig. 4). The Violet-backed Starling *Cinnyricinclus leucogaster* spends seven months of the year in the CNP. The first individuals of the species arrive at the CNP in mid-December and the last individuals are observed in June. The species is absent from July to November. The peak in the number of individuals is reached in March with 88 individuals (Fig. 4). The White-throated Bee-eater *Merops albicollis*, with 331 individuals, is the fourth most abundant species in the total number of intra-African migratory land birds surveyed. Its phenology can be divided into four main phases: two periods of presence and two periods of absence. The species is observed in the CNP at the end of September and leaves in November. An absence is observed from December to March. At the end of April the species returned to the Comoé National Park and left the following month, in May (Fig. 4). The African Golden Oriole *Oriolus auratus* with 276 individuals is the second most common migratory oriole species visiting the CNP together with the European Oriole *Oriolus oriolus*. Individuals of this species are practically present all year round in the CNP, although there are no individuals in July. The peak number of individuals is in February with 49 individuals (Fig. 4). The Northern Red Bishop *Euplectes franciscanus* is the last of the intra-African migratory species to show a high abundance. Individuals of this species are observed during eight months of the year, with more individuals present during the months of July to December. Two other observations are also made in January and March. The peak of the number of individuals of this species is in November, when it is 45 individuals. Absences of individuals of this species are observed in February and during the period from April to June (Fig. 4).

Migratory phenology of the six main mixed-status migratory landbirds species

The analysis of the phenology of the mixed-status migratory birds visiting the CNP reveals different trends from those previously studied. Indeed, some species are strictly migratory while others are

present all year round in the park. The following observations will focus on the six most important species of this biogeographic status. The Vinaceous Dove *Streptopelia vinacea* is present throughout the year in CNP. Its numbers are highest from January to April and November to December with over 130 individuals. The lowest numbers are between May and October with less than 85 individuals (Fig. 5). The Bush Petronia *Gymnoris dentata* regularly visits the park over seven months, especially during the months of October to April. However, the species is absent between May and September. Numbers peak in February and November with 230 and 228 individuals respectively. The lowest number of individuals was observed in October with 121 (Fig. 5). The African Grey Hornbill *Lophoceros nasutus* is a partial migrant present all year round in the CNP with high numbers throughout the year. The park is frequented by low numbers of individuals during the months of June to September with values ranging from 68 to 53 individuals (Fig. 5). The fourth most abundant species of mixed-status migratory landbirds is the Four-banded Sandgrouse *Pterocles quadricinctus* with 757 individuals. The evolution of the numbers of *Pterocles quadricinctus* shows that this species has a phenology typical of strictly migratory birds. Its peak is reached in March with 205 individuals. The smallest number of birds is reached in November with six individuals. The months from May to October constitute the period of the year when this species is absent from the park (Fig. 5). The migratory phenology of the Red-chested Swallow *Hirundo lucida* is such that the species is absent during the last quarter of the year. However, during the first nine months of the year it is present in irregular numbers. April is the month when more individuals visit the park (Fig. 5). The Scarlet-chested Sunbird *Chalcomitra senegalensis* is present throughout the year in the park. The lowest numbers occur between May and August. At this time of year numbers vary from six to a maximum of 10 individuals (Fig. 5).

DISCUSSION

The Comoé National Park has a richness of 75 species of 50 genera belonging to 29 families of migratory landbirds. This high species richness could be explained by our sampling plan which consid-

ered all the main ecosystems present in the CNP as well as the 420 field visits made during these 24 months. Previous studies in the CNP, FGU (1980) and Salewski (1997 & 2000), show similar results to ours. Only 19 species could not be seen during these studies. Most of them are partial migrants or subject to seasonal erratic movements or visitors, most of which are rare in our study area (Thiollay, 1971; Borrow & Demey, 2015). The majority of the migratory landbirds species inventoried at the CNP are typical of species visiting the Sudano-Guinean and Sudan-Sahelian savannahs of West and Central Africa (Dowsett-Lemaire & Dowsett., 2008 & 2018).

This study shed light on the phenology of 29 terrestrial migratory species (28 Afro-tropical and one Palearctic migratory species) whose migratory chronology was previously unknown in the CNP. In addition, it provides information on the value of using the site for all terrestrial migratory avifauna visiting the park in view of the phenology.

Most migratory Palearctic species that transit through the CNP spend the entire winter there. However, the Common Swift *Apus apus* and two intra-African migrant species, the White-throated Bee-eater *Merops albicollis* and the Red-headed Quelea *Quelea erythrops*, are thought to stop over in the CNP. These observations contrast with those made by Salewski (2002), who instead noted the Willow Warbler *Phylloscopus trochilus* as the only species staging in the CNP. This difference in observations could be explained by the methodology used during this study, which differs from the mist-netting methodology used by this author. The phenology of some so-called mixed-status migratory species such as the Hoopoe *Upupa epops*, the Bush Petronia *Gymnoris dentata* and the Four-Banded Sandgrouse *Pterocles quadricinctus* indicates that they would rather be true migrants in our study area contrary to the observations of Borrow & Demey (2015). On the other hand, species such as the Broad-Billed Roller, *Eurystomus glaucurus*, and the Golden Oriole *Oriolus auratus*, recognised by the same authors as true migrants in Côte d'Ivoire, are present throughout the year in the CNP. The migratory chronology of Palearctic migratory landbirds is generally the same in Côte d'Ivoire, both in the north and in the south, i.e. from September to April (Thiollay, 1985; Salewski, 2006). However, some intra-African migratory species may show some

differences depending on the latitude. These differences in migratory phenology would be mainly due to the movements of the inter-tropical front responsible for the rains on which their phenology is largely dependent (Skinner et al., 1994; Dingle, 2008).

CONCLUSIONS

This study has enabled us to inventory 72 species of migratory landbirds in all our investigated habitats. Denham's Bustard *Neotis denhami* is close to being threatened. The population of these birds is largely dominated by migratory species of mixed status. Migratory species from the Palearctic regions are present in CNP for nine months of the year between September and early May. They also have the highest abundances with 7160 individuals. Some Mixed-status migratory species and intra-African migrants landbirds are present throughout the year. But it is noted that in the last category, very few species and individuals are observed within the park.

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