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ORIGINAL ARTICLE

The Atmospheric Role on Francolin calls in Manfe Community, Southwest Region, Cameroon

Melle Ekane Maurice[1]*, Roy Lyonga Mbua[1], Ayuk Elizabeth Ebot[1], Asong Fred Zisuh[1], Nkongho Stanley Ayamba[2], Obassi-Anaman Okon[2]
[1]Department of Environmental Science, Faculty of Science, University of Buea, P.O. Box 63, Buea, Cameroon

ABSTRACT
The atmospheric conditions, especially at night enhance sound transmission because of strong temperature inversions and decreased air turbulence. Nocturnal communal roosting of birds is common across taxonomic groups, and it is believed to be a strategy to reduce predation risk, enhance courtship, and mark territories. This survey was based on assessing the role of some environmental factors such as the atmospheric condition on francolin vocalization in Manfe municipality. The data collection method was done randomly by spot-counting the francolin birds and recording their vocalizations in their nesting sites. The survey revealed that francolin number is significantly linked to the atmospheric condition, χ^2 = 25.900 df=12 P<0.05. Additionally, Vocalization frequency associated with the atmospheric conditions, χ^2 = 23.697 df=3 P=0.000. Nevertheless, vocalization time associated significantly with atmospheric conditions, χ^2 = 37.035 df=33 P<0.05. The study revealed a significant link between the call strength and atmospheric conditions, with darkness and moon-light having 39.44% and 33.80% respectively, the sunny 25.35% and rainy 1.41% conditions witnessed a relatively lower bird number and calls. The day-period recorded a proportionate call frequency of 52.11%, 35.21%, and 12.68% for morning, evening and afternoon periods respectively. Francolin birds can vocalize any time of the day, however, in this study the frequency of vocalization was consistently high during the early morning hours, specifically between 4:00-4:59am (28.17%), 5:00-5:59am (21.13%), and 7:00-7.59pm (19.72%) in the evening periods respectively, while the least call frequency occurred between 11:00-11:59am (1.41%), 2:00-2:59pm (1.41%), and 4:00-4:59pm (2.82%) respectively. Francolin birds vocalize during the day and night times, but this survey recorded the most frequent vocalizations during the early hours of the day, creating an impression that francolin birds such as Francolinus camerunensis, and Pternistis camerunensis, found in Cameroon might be nocturnal. However, feeding, movement, and other social related behaviors were not notice during this period.
Keywords: *Atmospheric conditions, Vocalizations, Nesting sites, Francolin birds, Spot counting*

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INTRODUCTION

Most research on avian vocalizations has traditionally focused on the daytime vocalizations of diurnal birds [10]. Although some iconic species such as francolins, owls, loons, and nightingales are well known to vocalize at night [2, 6], nocturnal vocalizations have received less attention [5, 63]. Nocturnal vocalizations by diurnal birds have been noted by several scientists since the late 1800s [55]. Most of these reports, however, are species-specific, largely anecdotal, and concentrate on sporadic or isolated events [28]. With the exception of migratory species' flight calls [17], nocturnal vocalizations by diurnal birds are generally considered to be rare [34, 2]. Nocturnal vocalizations have not been examined systematically for an assessment of how taxonomically widespread they are or what their function(s) might be. Nocturnal vocalizations are of interest because they contradict the idea common among ornithologists that diurnal birds almost exclusively sleep all night. Moreover, extended activities at night indicate that birds may partake in other behaviors associated with breeding [2], which may influence reproductive success and energy dynamics. If nocturnal vocalizations are prevalent across taxonomic groups, then it may open research opportunities previously thought to be limited because of the implication that diurnal birds are only active during daylight hours. Avian vocalizations have traditionally been divided into two categories: songs and calls [35-39, 10]. Catchpole and Slater [10] defined songs as structurally complex, learned, and given by oscine passerines, and calls as simple, innate produced by nonpasserines and suboscines. This traditional dichotomy continues to be debated in the ornithological literature [30, 10]. Because of the unclear and controversial boundaries between songs and calls, this

review uses the term "vocalization" to encompass all calls and songs given by oscines, suboscines, and nonpasserines. At dawn and dusk, dim light can stimulate vocalizations by causing neurological changes in the brain [41, 54], thereby creating the dawn and dusk chorus [3]. The sequential timing of birds entering the dawn chorus is related to retinal sensitivity; birds with higher retinal sensitivity vocalize earlier because they have a better ability to detect dim crepuscular light[39, 58]. Because retinal sensitivity is difficult to quantify without sacrificing individual birds [35, 39], it has been suggested that eye size or timing of entry in the dawn chorus may serve as an appropriate proxy for a bird's ability to detect dim light [56]. If so, then birds with relatively large eyes or that vocalize early in the dawn chorus may, as a consequence of their ability to detect dim light, vocalize on nights with elevated light levels. Examples of light sources at night include moonlight and artificial light [41]. Nocturnal vocalizations may be a consequence of elevated light levels if the species has a large eye or vocalizes early in the dawn chorus and if nocturnal vocalizations increase on nights with bright moonlight or artificial light and decrease on dark nights. Nocturnal vocalizations caused by elevated light may be more frequent in birds that live in urban areas or in open habitats because of an increase in perception of artificial light and moonlight. Species that vocalize early in the dawn chorus and have been noted to vocalize particularly on nights with bright moonlight or in artificially lit areas include the American Robin (*Turdus migratorius)* [44, 30], gray kingbird (*Tyrannus dominicensis*) Smith and Jackson [52], northern Mockingbird (*Mimus polyglottos*; Miskell and Justice [42], Hill *et al.* [24], Pied-billed Grebe (*Podilymbus podiceps*; [44], swamp sparrow (*Melospiza Georgiana*) Mowbray [43], and Whitecrowned Sparrow (*Zonotrichia leucophrys*) Chilton *et al.* [12]. Although few studies have tested the effect of elevated light levels on nocturnal vocalizations directly [42, 56, 23], these species provide some preliminary support that light may play a mechanistic role in promoting nocturnal vocalizations. Night may be an ideal time for females to seek extra-pair copulations because dim light may allow them to remain undetected by their social mates [2]. Females may run, however, a high risk if caught by their social partner [60, 64]. Punishments by cuckolded males can include reduced nest defense [64], reduced parental care [13], and increased aggression and physical attacks [65, 60]. Because paternity may be at risk especially at night, males may vocalize nocturnally to guard their mates from extra-pair copulations. If nocturnal vocalizations function primarily to guard a mate, then they should be made during the time of year when females are fertile, be produced only by mated individuals, and should function to repel prospecting males. There have been no direct tests of this hypothesis, but it has been proposed as an explanation (alternative to the reproductive stimulation hypothesis) for why mated male common nightingales have a second peak in nocturnal vocalization just prior to egg laying [4]. Females may still be fertile during this time, which may prompt their social mate to vocalize at night to defend paternity. Males with high-quality vocalizations attract more females [25, 61], increasing their reproductive success and fitness [15, 49]. In oscine passerines, the quality of a male's song depends on at least some exposure to adult song of the bird's own species [10, 47]. In many species, there is a period of sensitivity in which nestlings and juveniles can effectively learn their song [30, 37, 38, 46]. As a result, males may indirectly benefit by singing as much as possible (including at night) to ensure successful song learning by their offspring so that they, in turn, will be able to reproduce as adults. Francolin birds in Cameroon are not known to be nocturnal, though; they seem to vocalize most at dusk than dawn. Vocalization is a language used by all animals to communicate inter-specifically or intra-specifically, enhancing their territorial defense positions, feeding site protection, and courtship attractions. However, this study was focused on determining the atmospheric influence on the vocalization behavior of francolin birds. Nocturnal vocalization of birds such as francolin is well known in some parts of Cameroon for local time indication, important to the illiterate class in the remote communities.

MATERIAL AND METHODS

Description of the study area

Manfe municipality is found in the Southwest Region of Cameroon between latitude $5^0$46'0'' north and longitude $9^0$17'0'' east (fig.1). Climatically, Manfe falls within the equatorial zone, it has the equatorial rain forest climate, which is characterized by two distinct seasons; the rainy and the dry seasons. The dry season runs from October/November to March and is characterized by elevated temperatures (30^0C-32^0C) [57]. The rainy season begins from March/April and ends in September/October with an annual average rainfall ranging between 3500mm– 4000mm, and peak periods in the months of July and August. Generally, the equatorial rain forest occupies the area and also falls within the tropical evergreen forest type of Cameroon. It is also part of the Guineo-Congolian floristic region with altitude ranging from 90m-500m above sea level. The variation in the above-mentioned characteristics causes the existence of two unique types of vegetation in the municipality. The vegetation types are the lowland

rain forest and the mid-altitude forest. Mamfe municipality falls within the tropical evergreen rainforest zone of Cameroon. It is endowed with valuable forest resources including timber, non timber forest products (NTFPs) and wildlife [57].

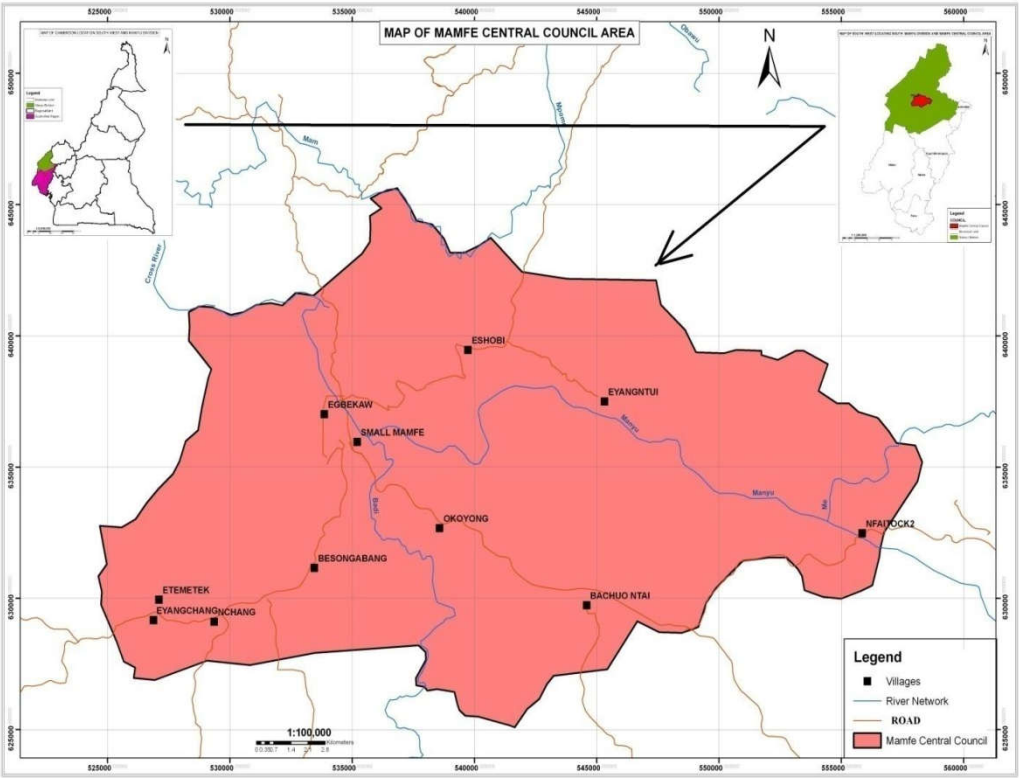

Figure 1: Map of Manfe municipality (Source: Manfe Council 2012)

Data collection method

The data of this survey was collected on check-sheets in the study area, Manfe municipality. The brief pilot study witnessed the testing of research methods and familiarization of the research team with the community inhabitants and their norms. Most of the research team members were people from these communities, who volunteered to ensure the security of the principal investigator. Data collection was based on visiting farmlands, forest, and secondary forest during the dawn to records vocalizations, and visits were made to locations from where these calls were heard, this helped to estimate the number of francolin birds in the nesting sites and also the vegetation type [9, 56]. In the dusk, the research team members recorded vocalizations from their houses where they lodged for security reasons. Francolin calls were recorded randomly as were heard, but making sure the nearby call locations and vegetation types were noted. Surveys were conducted 5 days per week, from Monday to Friday, for a period of one month. In the dawn, call recording started 7:00am and ended 6:00pm, while in the dust it started 7:00 pm and ended 6:00am.

Data Analysis

The research data was analyzed by the use of SPSS version 20; chi-square and correlation statistical models considered most appropriate for the variables were used. The quantitative data such as the number of francolin birds and the vocalization time were tested on qualitative variables like atmospheric conditions. Additionally, both quantitative and qualitative variables such as francolin number, atmospheric conditions, day time, and the vocalization time were analyzed exploratory.

RESULTS

Francolin bird population showed a significant link on atmospheric condition, $\chi^2 = 25.900$ df=12 $P<0.05$ (fig.2). The study revealed a significant link between the call strength and meteorological condition, with darkness and moon-light having 39.44% and 33.80% respectively (fig. 3), the sunny 25.35% and rainy 1.41% conditions witnessed a relatively lower bird number and calls. Most bird species, like other wildlife lower activity during heavy rains, hence, budget more time on other behaviors such as rest and sleep. Francolin vocalization behavior seems to be strongly associated with the early morning darkest periods

than any other period as revealed by this study. Some wildlife species are nocturnal such as rodents, duikers and some cats, but for francolins, the nocturnal call behavior does not go alongside night-feeding like the former, meaning they are not nocturnal per se.

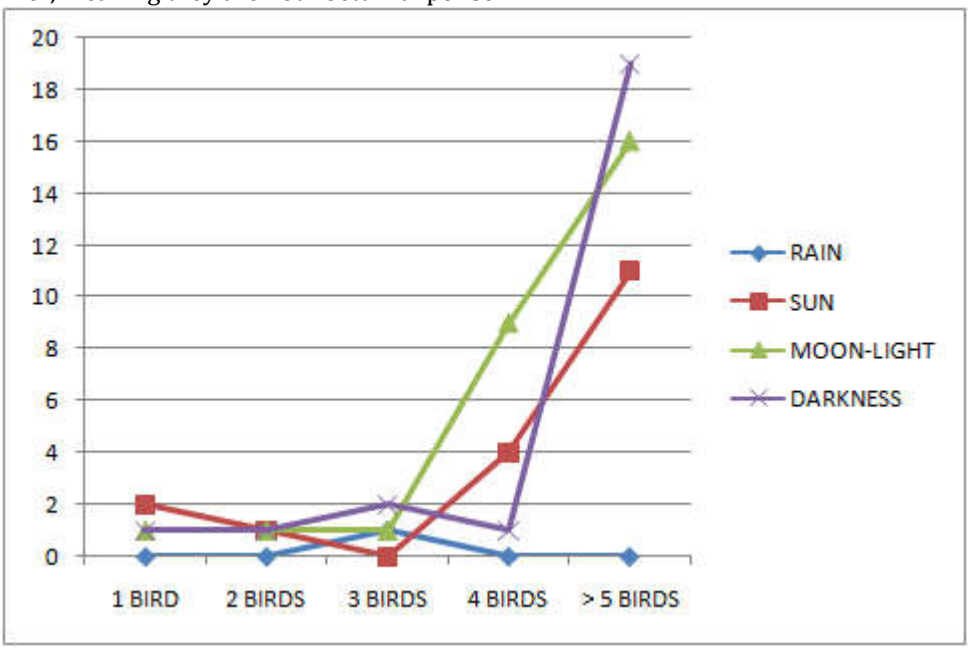

Figure 2: Bird population and atmospheric condition

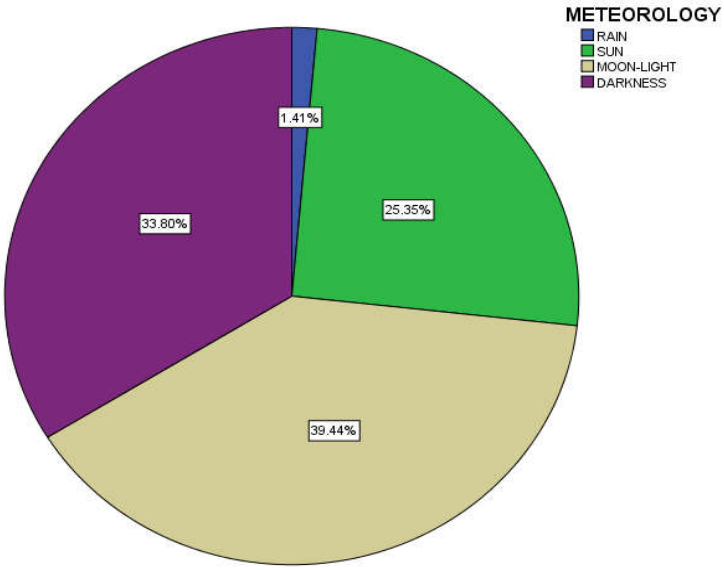

Figure 3: Atmospheric condition

Vocalization frequency has shown a strong link with meteorology, χ^2 = 23.697 df=3 P=0.000 (fig. 4). The innate behavior of these birds seems to associate them more on call-timing during the darkest and moon-light periods, from 4:00am - 6:00am than any other period of the dusk or dawn. From this study, one could assume that francolin call-behavior might be both innate and learnt. The chicks would learn the periodic time-calling from adults; a lineage behavior groomed into and would live to remain with till adult age. Nevertheless, vocalization time associated significantly with atmospheric conditions, χ^2 = 37.035 df=33 P<0.05 (fig. 5).

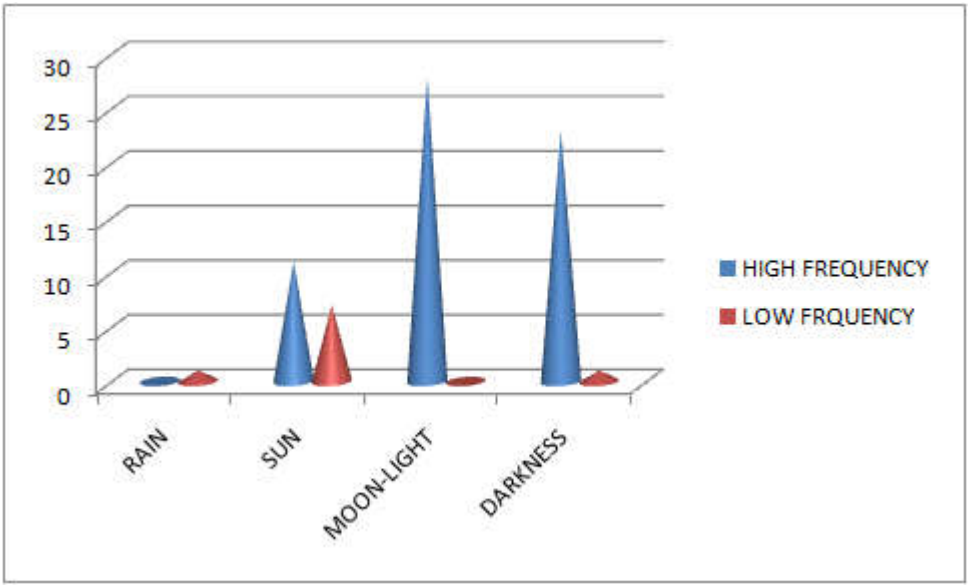

Figure 4: Atmospheric condition and call frequency

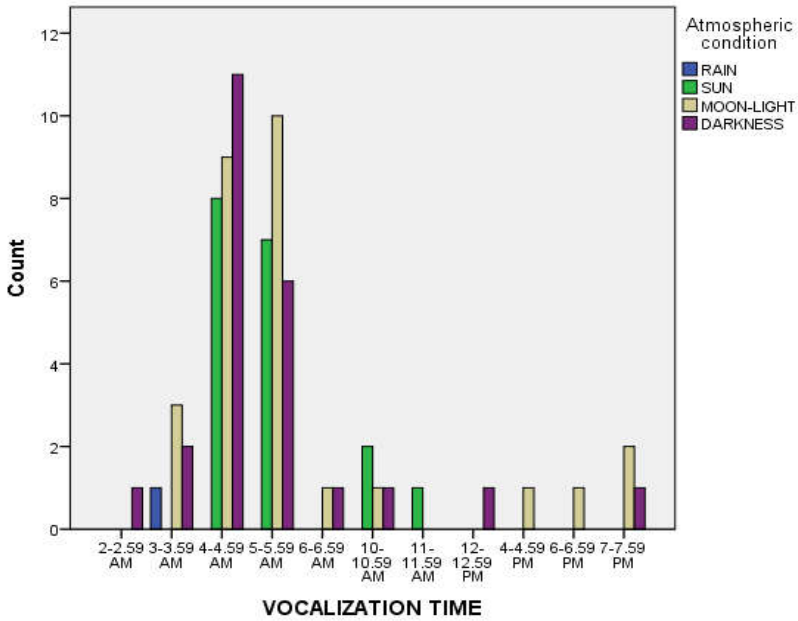

Figure 5: Vocalization time and atmospheric condition

The day-period recorded a proportionate call frequency of 52.11%, 35.21%, and 12.68% for morning, evening and afternoon periods respectively (fig.6). The call frequency intensity was highest between 4:00am-6:00am during the morning period. The study also discovered that calls were intensively stronger as the bird population increased. During this period, moon-light and darkness played a significant role on the vocalization frequent intensity.

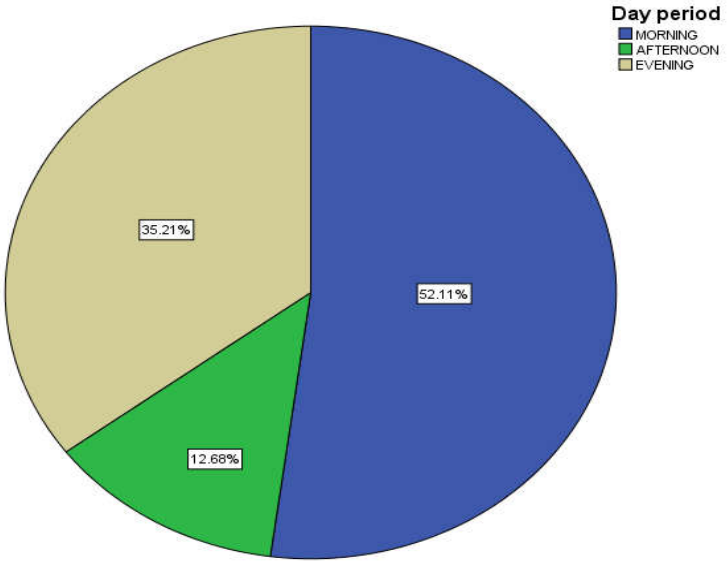

***Figure** 6: The day-period*

Francolin birds can vocalize any time of the day, however, in this study the frequency of vocalization was consistently high during the early morning hours, specifically between 4:00-4:59am (28.17%), 5:00-5:59am (21.13%), and 7:00-7.59pm (19.72%) in the evening periods respectively, while the least call frequency occurred between 11:00-11:59am (1.41%), 2:00-2:59pm (1.41%), and 4:00-4:59am (2.82%) respectively (fig. 7).

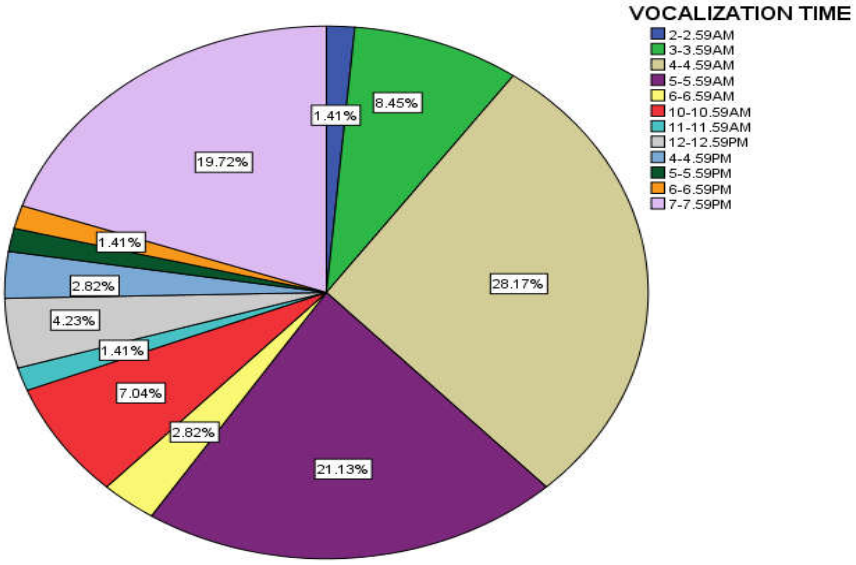

Figure 7: Vocalization time

DISCUSSION

Weather conditions at night often enhance sound transmission because of strong temperature inversions and decreased air turbulence [32]. Signalers may take advantage of these conditions and vocalize at night, which may allow their signals to reach more receivers without the sender expending extra energy on amplitude [62]. Furthermore, at night, signalers may produce more complex vocalizations that cannot be heard easily during the day. More complex vocalizations may help make the signaler more locatable [26], or a complex signal may be more attractive [53]. If francolin birds vocalize nocturnally to take advantage of calm conditions at night, then it can be expected that these birds' vocalizations will travel farther at night than during the day or that their nocturnal vocalizations are more complex than daytime vocalizations. It can also be expected that they will vocalize less, if at all, on nights with high winds or stormy weather, which impede signal transmission [31, 33]. Moreover, enhanced sound transmission may apply more to francolin birds that live in open habitats than to those in closed habitats, where there

is less risk for signal degradation due to air turbulence [51]. More complex vocalizations at night may apply more to oscine passerines, whose vocalizations are thought to be more malleable than those of suboscines or nonpasserines [10]. Nocturnal communal roosting is common across taxonomic groups, and it is believed to be a strategy to reduce predation risk and thermoregulation costs [6]. Participating birds may choose to communicate at these nocturnal roosts because night may be the only time that they come into close contact with one another. Furthermore, night may be an ideal time for social interactions of diurnal birds, when they are not engaged in other activities such as foraging [57]. This may apply particularly to seabirds, because they often forage solitarily at sea during the day and return to roosts on land at night [7].

Flight calls are used to maintain contact in flocks particularly during migration [23]. Many diurnal birds migrate at night [16, 17, 21], and it has been suggested that they do so because of calmer winds and to avoid diurnal bird predators [1]. Nocturnal calling in migration has been well studied for over a century [20, 23], and it is widely accepted that these calls are used to maintain contact and flocks during nocturnal migration [23]. Recent study suggests that nocturnal vocalizations also play an important role in selecting stopover habitats during migration [2, 45]. A potential cost of producing vocalizations is to inadvertently give away one's location to an eavesdropping predator [66, 22]. As a result, to avoid being conspicuous, there may be a strong selection pressure for birds to vocalize when potential predators are not active. If so, then birds that are under considerable diurnal predation pressure and less nocturnal predation pressure may choose to vocalize at night, when diurnal predators are not active. If nocturnal vocalizations are a strategy to avoid predation, then these nocturnally vocalizing birds should live in areas with high diurnal predation pressure and be under weak, if any, nocturnal predation pressure. Thomas *et al*. [58], however, found that european robins responded to playback calls at night more frequently in Wales than in Ireland. The authors suspected that this difference may have been due to nocturnal predation pressure, nocturnal predators in Ireland, mainly the long-eared owl, *Asio otus*, being more specialized in taking robins than the more generalist predators [(Tawny Owl, *Strix aluco*) in Wales. This study provides preliminary support that predation pressure may influence the occurrence of nocturnal vocalizations.

In many francolin species, a territory is a crucial prerequisite for the attraction of a female and successful breeding [10]. Often, territories are defended throughout the day [54]. It may be beneficial, however, to continue territorial defense into night-time hours, especially if there are prospecting individuals such as nocturnal birds that are active at night. Experiments have demonstrated that vocalizations alone are sufficient in deterring prospecting individuals from entering a territory [29, 19,48]. Territorial vocalizations may be especially useful at night, when other territorial signals such as visual ornaments are more difficult to evaluate. Nocturnal vocalizations may also serve as a continuation of diurnal efforts at mate attraction (Barclay et al. 1985), possibly to attract nocturnally females.

If a bird species vocalizes nocturnally to attract mates, then it can be expected that unpaired individuals vocalize at night more than do paired individuals and that the vocalizations produced at night are mate-attraction signals. If nocturnal vocalizations are used to attract nocturnally migrating females, then nocturnally vocalizing species should be nocturnal migrants and their nocturnal vocalizations should be made shortly after the male's arrival during the time in which females are arriving on breeding grounds. Examples of birds of which unpaired males vocalize at night more than do paired males include the common nightingale [4, 50], corn crake (*Crex crex*) [59], limpkin (*Aramus guarauna*) [8], and northern mockingbird [14, 40]. For the nightingale, further support of this hypothesis is that unmated males vocalize nocturnally until they have found a mate and resume vocalizing at night if their mate deserts [4]. Preliminary observations suggest that at least 85 species of nocturnal migrants vocalize at night after they are settled from migration. Consequently, it cannot be concluded that the nocturnal vocalizations of these 85 nocturnal migrants function primarily to attract nocturnally migrating females. Regardless, the support provided by the few studies that have investigated mated status and nocturnal vocalization output make mate attraction one of the most substantiated hypotheses for nocturnal vocalizations. In many bird species, mates increase their reproductive success by vocalizing with one another to maintain a pair bond [11]. Night is likely an ideal time for diurnal birds to maintain pair bonds because few activities other than sleep, such as foraging, occur at night [57, 58]. If a bird vocalizes nocturnally to strengthen a pair bond, then it can be expected that vocalizations produced at night are pair-bond vocalizations and that the output of these vocalizations is independent of nesting stage, provided that pair bonds are important throughout the breeding season.

CONCLUSION

The environmental indication role played by many wildlife species such as birds is neglected in countries like Cameroon where wildlife research is not considered important. Very little research attention is given

to the survival of wildlife species in the country, even the species that are highly vulnerable and their population is threatened to extirpation are neglected. Wild birds such as francolins have ecological importance, and have had a longstanding history in indicating local time, especially to the local people in remote parts of the country. Vocalization behavior was revealed by this study to be influenced by the atmospheric ecological conditions like darkness, moonlight, rain, sunlight and the day-period. However, darkness and moonlight during the early hours of the day were observed to influence the francolin vocalizations most. Nonetheless, the study has open research doors to more ecological work to be carried out in the domain of population management of this species of bird, though, known to play a crop-pest devastative role in many cropland areas in the remote parts of Cameroon.

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