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Nesting trees used by a pest bird (Village Weaver, *Ploceus cucullatus*): a large field survey suggests further human conflicts with local stakeholders in Southern Nigeria

Short communication

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Abstract

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The village weaver (*Ploceus cucullatus*) is a common colonial nesting bird widespread throughout Sub-Saharan Africa. It is known to weave its nests from leaf strips from a variety of tree species (mainly coconuts trees, oil palm trees) associated with human settlement areas, grasses, and other available plants. In this regard, this bird was considered a pest for its impact on different economic activities. Although extensive literature is already available on the parasitic role of village weavers, there is still a lack of analytical data that outlines which tree species are used for nesting and in what proportion, as well as the related implications in terms of economic impacts. Here, we carried out the first comprehensive arrangement of trees used by this species for nesting in Southern Nigeria (West Africa), checking for possible different impacts on stakeholders. In April 2021, we searched for village weaver nesting in 95 sites in 77 communities from 24 local government areas in Southern Nigeria, during 14 field surveys. Within each site, we collected GPS

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coordinates and counted the number of active nests, nesting birds and occupied trees. We recorded a total of 5,776 nests and 2,140 birds in 94 plants belonging to 23 tree species selected for nesting. Oil palm (*Elaeis guineensis*; n = 45) was the most used tree species, as 2,990 (51.77%) nests and 873 (40.79%) birds were recorded. Our results indicate the preference for nesting on trees used by stakeholders belonging to agricultural (palm farmers), touristic (operators) and energy (gas flare stations) sectors with economic implications about the conflict with this pest species.

Keywords
economic impact, *Elaeis guineensis*, pest species, tree check-list, stakeholders

Introduction

The village weaver (*Ploceus cucullatus*) is a small passerine bird recognized for its innate ability to craft nests using leaf strips from various tree types, including coconut trees, oil palms and plantain stands among the others (Akande, 1978; Efenakpo et al., 2017). These territorial, polygamous colonial breeders are predominantly found in Saharan Africa (Lahti, 2003; Efenakpo et al., 2017). Despite their fascinating behaviours, this species is often considered a pest in multiple countries, like other Ploceid species (Mengesha et al., 2011; Hiron et al., 2014; Aiyeloja and Adedeji, 2015).

In Southern Nigeria, weaver birds frequently choose oil palm trees (*Elaeis guineensis*) as nesting sites (e.g., Din, 1992), but the available data are quite anecdotal. However, the presence of these birds on oil palms poses concerns for palm fruits and frond harvesters. They fear that the nesting activities of weaver birds could lead to defoliation of the host trees and subsequently diminish palm fruit yields (Akande, 1978). Furthermore, weaver birds face the risk of losing roosting trees due to logging activities or land development, which can have cascading effects on their habitat.

In this note, we provided an arrangement of tree species used by weaver birds for nesting in Southern Nigeria. This investigation is crucial as it sheds light on the potential impacts of the birds' pest-like behaviour on various stakeholders, including those involved in the local agricultural, touristic and energy economy. This study aims to provide valuable insights into the interactions between these birds and their environment, which could have broader ecological and economic implications. To our knowledge, this is the first comprehensive review on this topic for the Nigeria (Western Africa).

Methods

Study sites

The study was carried out in 95 sites in 77 communities from 24 local government areas (Abua/Odua, Ahoada West, Alimosho, Andoni, Asaritoru, Calabar South, Dege-

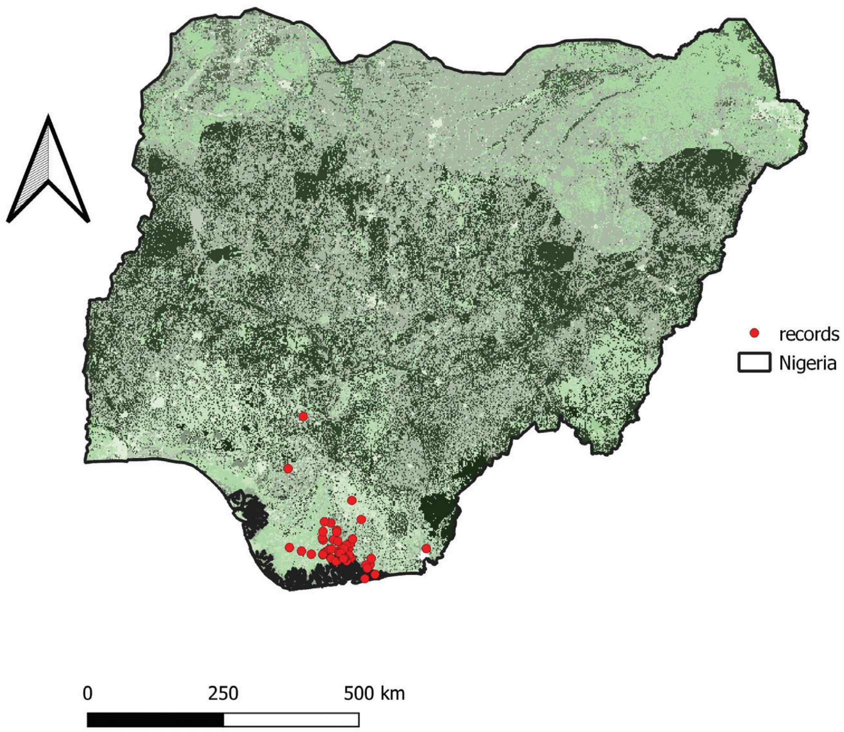

Fig. 1. Map of the study area. Location of records has been reported. See text for details.

ma, Eleme, Emohua, Etche, Etsako West, Gokana, Ideato North, Ikwerre, Khana, Mbaise, Obio/Akpor, Ogba/Egbema/Ndoni, Ohaji/Egbema, Okrika, Opobo/Nkoro, Owerri North, Port Harcourt and Yenagoa) in six states (Bayelsa, Cross Rivers, Edo, Imo, Lagos and Rivers) in Southern Nigeria (see Supplementary material for geographical coordinates and number of records for each site). The climate of the area is hot humid equatorial climate with an average temperature range of 25–28 °C, and a relative humidity of 80%; the zone has an annual rainfall average of over 3,500 mm (Niger Delta Environmental Survey - NDES, 1998; Akani et al., 2007; Amadi, 2017). The general environment is characterized by wet forest fragments interspersed within wide plantations and urban settlements (Fig. 1).

Data sampling and analysis

In April 2021, tree species that served as hosts for weaver birds and their active nests were surveyed over a span of 14 field days. Within each designated site, we gathered data on the location of each tree (hereafter, 'nesting tree'), using a GPS Garmin E trex-enabled device. Additionally, photographic documentation of each tree was undertaken, accompanied by a tally of nest counts wherever feasible. More particularly, during particularly sunny days, especially when assessing tall trees, a methodology involving tree photography was employed. Through this approach, the number of active nests and birds was directly counted from the captured images. To ensure an unbiased sampling process, it was ensured that each tree stand was evaluated only once and never subjected to repetition to avoid pseudo-replication (see Battisti et al., 2014). On average, a timeframe of 5 to 10 minutes was dedicated to evaluating each individual tree. Finally, both the number of active nests and birds have been normalized to the number of occupied trees, obtaining a ratio number of active nests/trees and number of sampled birds/trees.

To assess the pattern in frequency distribution of the active nests, we performed a diversity/dominance diagram (or Whittaker plots; Magurran, 2004). In this regard, relative frequencies of each tree species have been ranked. Shape and slope of point line, obtained by comparing ranks and relative frequencies, allows inferring general property of the assemblage, illustrating the evenness (i.e., the pattern in frequency distribution of the tree species; see Magurran, 2004). Considering S, the number of tree species, evenness index has been also quantified as: e = H'/H'max, where H' is the Shannon-Wiener diversity index (calculated on the assemblages of nests on different trees) and H'max = ln S (Pielou, 1966; Magurran and McGill, 2011). Finally, the frequency distribution of nests trees, sampled birds and occupied trees has been reported graphically using stacked charts (Hammer and Harper, 2001).

Observed-versus-expected χ^2 tests were used to evaluate whether the various tree species were randomly selected by the weavers for nesting. Correlations (i) be-

Table 1. Preferred host tree species, number of active nests, nest percentage frequency (% fr), number of sampled birds, number of occupied trees, and normalized number both for the sampled birds and active nests

Tree species	Nests	% fr	Birds	Trees	Normalized birds	Normalized nests
Chrysophyllum albidum	244	4.22	59	5	11.80	48.80
Bambusa vulgaris	182	3.15	107	1	107	182
Terminalia mantaly	51	0.88	34	2	17	25.50
Pinus caribaea	72	1.25	41	1	41	72
Anacardium occidentale	38	0.66	12	1	12	38
Alchornea cordifolia	6	0.10	2	1	2	6
Cocos nucifera	171	2.96	45	4	11.25	42.75
Ficus sur	68	1.18	19	1	19	68
Terminalia catappa	15	0.26	7	2	3.50	7.50
Milicia excelsa	325	5.63	82	1	82	325
Jacaranda mimosifolia	3	0.05	6	1	6	3
Mangifera indica	721	12.48	420	7	60	103
Gmelina arborea	248	4.29	119	6	19.83	41.33
Moringa oleifera	167	2.89	50	4	12.50	41.75
Elaeis guineensis	2,990	51.77	873	45	19.40	66.44
Triplochiton scleroxylon	32	0.55	25	1	25	32
Citrus sinensis	64	1.11	36	3	12	21.33
Carica papaya	1	0.02	0	1	0	1
Pinus ponderosa	6	0.10	4	1	4	6
Roystonea regia	122	2.11	79	2	39.50	61
Ficus exasperata	47	0.81	32	1	32	47
Newbouldia laevis	114	1.97	37	2	18.50	57
Avicennia germinans	89	1.54	51	1	51	89
Total = 23 species	5,776	100.00	2,140	94	22.77	61.45

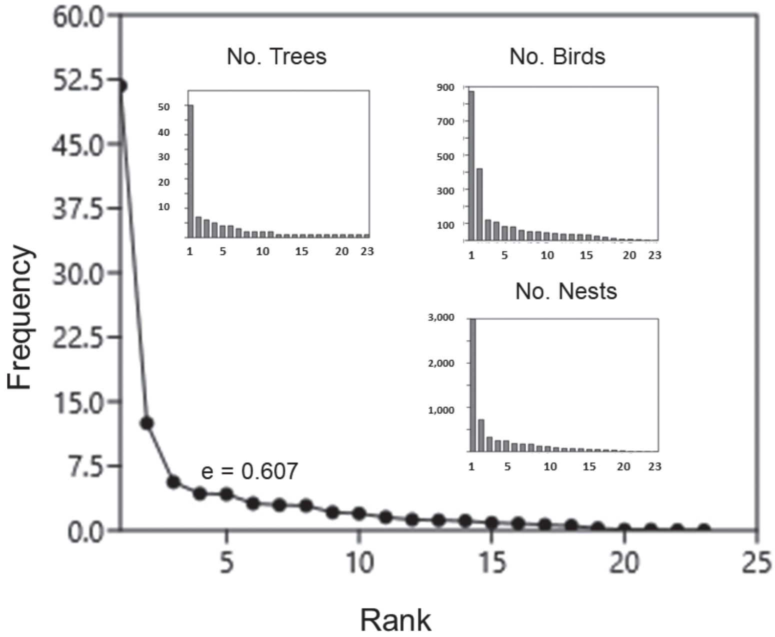

Fig. 2. Whittaker plot ranking the frequency of active nests (with stacked charts for number of trees, sampled birds and active nests). Evenness values has been reported. In any stacked chart, *Elaeis guineensis* and *Mangifera indica* were the first species dominant.

tween number of nests per tree and number of sampled birds, and (ii) between availability of trees (expressed as the number of trees per species) and number of nests per tree, were assessed by Spearman's rank correlation coefficient, after having verified that the variables were not normally distributed (Dytham, 2011). We performed an Ordinary Least Squares regression between both the number of birds and nests, once normalized to the number of trees. For statistical analyses, we used the PAST software (Hammer and Harper, 2001). Alpha was set at 0.05 level.

Results

A total of 5,776 nests and 2,140 individuals of the village weaver were recorded from 94 stands of 23 species of trees (Table 1 and Supplementary material). The distribution of nests was uneven across tree species (observed-versus-expected $\chi^2 = 74.7$, d.f. = 30, $p < 0.0001$; low evenness value: 0.607), as showed in Whittaker plot (Fig. 2). Among the various species, the oil palm tree (*Elaeis guineensis*; n = 45 stands) was the most preferred tree species, with 2,990 nests and 873 individuals recorded. A total of 51.77% of all observed nests and 40.79% of the recorded weaver birds were observed on this tree species. Similarly, 721 nests (12.48% of all recorded nests) and 420 individuals (19.63% of all observed individuals) were observed on 7 stands of the mango tree (*Mangifera indica*).

Predictably, the number of active nests per tree was positively correlated with the number of observed individuals ($r_s = 0.97$, $p < 0.0001$; Fig. 3). However, the number of available trees per species did not influence the number of observed nests per tree ($r_s = 0.03$, $p = 0.87$), thus confirming that it is not the relative availability of trees in the field but the tree species that influenced the nests selection by village weavers.

Number of birds and nests normalized with the number of trees were highly correlated among them (r =

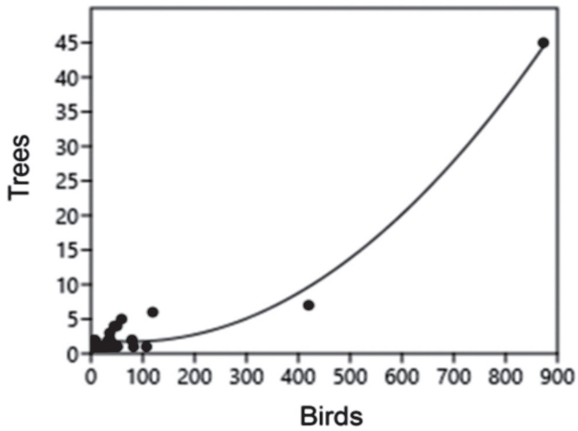

Fig. 3. Relationship between number of birds and number of trees.

0.85 p > 0.001; Ordinary Least Squares regression), with two trees (*Milicia excelsa* and *Bambusa vulgaris*) showed the highest values both for normalized number of birds and nests (Fig. 4): although these species were less common, they hosted a high number of birds and active nests.

Discussion

We obtained data on a large number of tree species (n = 23) used for nesting by village weaver in Sothern Nigeria. However, Whittaker plots and stacked charts showed as frequency distribution among tree species was largely uneven, with two dominant species (oil palm, *Elaeis guineensis,* and mango tree, *Mangifera indica*) representing about

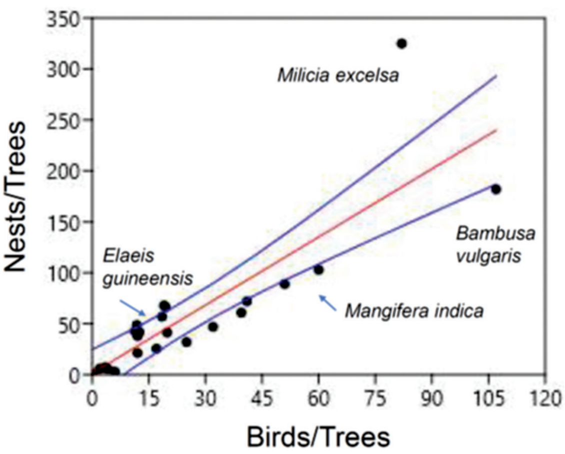

Fig. 4. Ordinary Least Squares regression between normalized birds and nests. Line represents the relationship between normalized number of nests and birds. The location of the first two dominant species (*Elaeis guineensis* and *Mangifera indica*) and the two species with the highest values in normalized sampled birds and active nests (*Bambusa vulgaris* and *Milicia excelsa*) have been reported.

the 64% of the whole nesting tree assemblage.

Oil palm tree (*Elaeis guineensis*), the most common tree species in the studied localities of Southern Nigeria (Reading et al., 1995), represents, locally, the most preferred tree used by the village weaver (*Ploceus cucullatus*) for nesting. The affinity for oil palm trees by weaver birds was likely due to the multilayered fronds of this species which do not only protect them from rain but also serves as a reserve for nest materials (e.g., Din, 1992). We observed, especially in intensive cultivation of oil palms and coconuts, that the nesting materials (leaf stripes) usually came from host trees, which were defoliated (see Adegoke, 1983).

Everywhere, the observed nest building materials included grasses, plantain, and palm fronds. This result is in line with the findings of Efenakpo et al. (2017) who stated that the families of Arecaceae and Poaceae always form part of the village weaver nests; because of their relatively high availability in the study area as well as the fibrous nature of the leaves to withstand weathering conditions. Interestingly, species of the Poaceae are grass-like plants that are also commonly used by humans for building thatch houses (Efenakpo et al., 2017). The result also indicates that the bulk of the nest weaving materials are sourced more from monocot (oil palm tree, coconut, royal palm, plantain, banana, grass, etc.) than dicot plants. The parallel vein leaves may be making the strip collection easier for the weaver birds (see Crook, 1960).

The study reveals that the selection of a potential nesting tree by weaver birds is possibly dependent on the availability of tree species that could support many birds, provide easy access to nest making materials, protect nest and juveniles from intruders, and finally, be in proximity to foraging sites (e.g., maize farm), from which the fledglings will be fed (our unpublished observations).

Mango tree (*Mangifera indica*) represented the second dominant species, occupied by active nests, confirming the pattern for West Africa (e.g., Yisau et al., 2014). However, two tree species (*Bambusa vulgaris* and *Milicia excelsa*) showed high values in normalized number of active nests and birds (Fig. 3), with possible impact on plants and conflicts with stakeholders carrying out local economic activities: the African teak (*Milicia excelsa*) and common bamboo (*Bambusa vulgaris*), the first being a species of high conservation concern (near threatened, sensu IUCN, 2004) of high commercial interest (Keogh, 2009), the second a non-native grass of large ornamental, construction, food, medicine use, both worldwide (Lobovikov et al., 2007), and locally (Ogunjinmi et al., 2009; Nwaihu et al., 2015). Differently, the two dominant tree (*Elaeis guineensis* and *Mangifera indica*), having the highest number of occupied plants, showed lower values in normalized number of nests and birds.

The nesting activities of these birds are often injurious to certain urban ornamental trees, for instance in Yenagoa (Bayelsa State, Nigeria). The activities of these birds were predominantly responsible for the massive defoliation of the royal palm (*Roystonea regia*) which was serially planted along the entrance of the city with implication for touristic economy and local people wellness, corroborating previous records (Aiyeloja and Adedeji, 2015).

The practice of using leaf strips from oil palm trees as well as plantain and banana leaves was largely responsible for the defoliation of the economic plants and negative effects in photosynthetic activity (Aiyeloja and Adedeji, 2015). Such defoliating activities and the suspicion that they may be instrumental in the transmission of plant parasites between trees they interact with, as well as the constant noise emanating from the colonies of these birds were responsible for their eviction and outright felling of their host trees in some localities (personal observations).

The nesting activities of these birds in certain parts of Southern Nigeria were unpleasant to oil palm farmers and even touristic operators (Akande, 1978). For instance, we observed as in Egbema community of Imo State, a flock of weaver birds were responsible for defoliating over 500 trees prepared for supply; similarly, in a Port Harcourt, the weaver birds were responsible for defoliating two stands of coconut planted in touristic resorts (pers. obs.). The nesting activities of these birds would have an economic impact on touristic operators and commercial palm growers. In other words, these birds can negatively affect the local economy of the human settlements in southern Nigeria. In addition, the selection of trees in the vicinity of gas flare stations as nesting sites by village weavers in Nigeria was reported for the first time by Akani (2008). In his opinion the Village weavers were attracted by the elevated temperature of the environment due to gas flaring, which possibly enhanced hatchability of their eggs by shortening the incubation period, because 80% of all the weaver nests he examined in all the stations contained some hatchlings. He also reported that the bulk of the nests were 100–200 m away from the flare stack (”gasophilic” birds, Akani , 2008). Village weaver response to gas flare site to nest is a case of niche expansion, as they are adjusting their weaving pattern selection to the internodes of *Rhizophora* and *Avicennia* mangrove trees, for instance around Alakiri and Nembe flow stations in the Niger Delta (Akani, 2008).

Our data suggests that the human-wildlife conflict between stakeholders and village weaver could increase in the next years: in fact, this species can be considered a pest not only for oil palm farmers but also by other categories of stakeholders (e.g., linked to tourist and energy activities). Wildlife practitioners should develop measures to mitigate this conflict, such as: (1) driving away breeding colonies with acoustic calls; (2) economic compensation for stakeholders; (3) planting of unsuitable trees for these birds in sensitive areas of conflict. Chemical repellent and other approaches to control populations, yet used for these and other pests (e.g., Martin, 1976), should be avoided. Finally, human dimension approaches involving stakeholders are further suggested (for Africa, see, e.g., Newby and Grettenberger, 1986).

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Supplementary material

Localities, tree habitats, number of active nests and the coordinates of the sampled sites of Village weaver habitats in Southern Nigeria

Locality	Habitats	No. of nests	Latitude	Longitude
Iwofe	Oil palm	24	4°49’15.0168”N	6°57’34.9632”E
Beeri/Khana	Oil palm	29	4°41’09.2”N	7° 25’32.0”E
Degema	Iroko	325	4°47’24.5”N	6°46’40.9”E
Egbelu	Palm oil	82	4°50’8.10924’’N	6°56’55.59972’’E
Okogbe/Ahoada	Oil palm	214	5°05’30.6”N	6°38’49.0”E
Choba	Mango	204	4°53’55.79464”N	6°55’43.55366”E
Eliparanwo	Orange	1	4°50’15.828”N	6°58’10.416”E
Abua	Oil palm	301	4°53’10.98”N	6°40’13.818”E
Abua	Oil palm	208	4°47’50.214”N	6°58’46.638”E
Rumoparaeli	Drumstick tree	7	4°52’3.251”N	6°54’34.631”E
Okuruama	Mango	68	4.7927789°	7.0690127°
Rumuodomaya	Caribbean pine	72	4°52’22.50372”N	6°59’55.93812”E
Choba	Mango	320	4°53’55.476”N	6°55’44.508”E
Umuapu/Imo	Oil palm	152	5°15’31.482”N	6°52’22.686”E
Ozuoba	Indian almond	3	4.870390°	6.9103360°
RSU campus	Orange	25	4°47’43.02”N	6°58’56.04”E
Ogbo Ahoada	Oil palm	6	5°07’49.8”N	6°38’01.3”E
Rainbow Town	Shrine tree	110	4°47’47.76936”N	7°1’54.71796”E
Ogan/Lagos	Drumstick tree	32	6°16’33.755”N	6°3’56.501”E
Egboloma/Abua	Oil palm	52	4°51’2.136”N	6°38’30.978”E
Yeghe/Bori	Obeche	32	4°40’47.4”N	7°21’18.1”E
Rumuobiakani	Oil palm	23	4°50’10.41837”N	7°2’8. 11126”
Rukpokwu	Oil palm	89	4°54’58.24728”N	E 6°59’ 51.05616”
Obrikom/omoku	Melina	36	5.2340529°	6.6456059°
Buguma	Oil palm	41	4°44’25.05948”N	6°51’42. 8562”E
Ozuoba	Oil palm	10	4°50’50.7534”N	6°55’44.05908”E
Kalaibiama Opobo	Jacaranda	3	4.524613°N	7.506954°
Ogbida/Edo	Mango	63	7°08’19.5’’N	6°19’00.5”E
Igwuruta	Oil palm	48	4°56’4.28068”	7°0’17.56871”
Bo-ue Ogoni	Sand paper tree	47	4°37’36’’N	7°22’43’’E
Omuwei	Orange	38	4°58’49.8”N	7°01’20.1”E
Alakahia	Mango	62	4°52’51.75”N	6°55’16.71”E
Ogan/ Lagos	Drumstick tree	32	6°16’33.755”N	6°3’ 56. 501” E
Umuoko Aluu	Melina	31	4°54’39.462”	6°54’25. 848”E
Amasoma/ BY	Royal palm	68	4°58’10.1”N	6°05’22.2”E
Rumuolumeni	African cherry tree	32	4°48’53.1“N	6°57’28.5”E
Rundele	Cashew	38	4°47.8259”N	6°59.0100”E
Okrika Road	Oil palm	49	4°46’8.69565”N	7°0’52.13702”E
Chokocho	Shrine tree	4	4.9885”N	7. 0570”E
Oginigba	Oil palm	36	4°49’43.36356”N	7°2’21.74185”E
Oroworukwo	Ponderosa pine	6	4°52’22.50372”N	6°59’55.93812”E
Mgbuakara	Oil palm	21	4°51’13.968”N	6°38’49. 608”E

Localities, tree habitats, number of active nests and the coordinates of the sampled sites of Village weaver habitats in Southern. Nigeria. Continued

Locality	Habitats	No. of nests	Latitude	Longitude
Rumuji	Oil palm	193	4°56’43”N	6°47’7”E
Isiokpo	Oil palm	26	4°47’40. 55”N	6°58’51.51”E
Rumuokwuta	Oil palm	28	4°52’41.712”N	6°54’43.068”E
Angon/Abua	Fruit	12	4°51’34.542”N	6°27’4.986”E
Umueze/Mbaise	Oil palm	27	5°25’59.3508”N	7°16’45.33528”E
Elele	Oil palm	32	5°06’06.4”N	6°49’09.5”E
Ohuaha	Oil palm	62	4°58’45.99934”N	6°57’49.99489”E
Rumuwokerebe	Coconut	78	4°47’41.573”N	6°59’01.708”E
Omerelu	Indian bamboo	182	5°13’33.4”N	6°52’16.8”E
Omute /Ikwerre	Oil palm	63	5°4’27.27756”N	6°53’12. 96834”E
Choba	Oil palm	66	4°52’38.6”N	6°54’56.9”E
Egbema/Imo	Oil palm	46	5°22’32.6”N	6°46’18. 6”E
Yenagoa	Canopy tree	48	4°54’38.1”N	6°17’18.6”E
Rumuorosi	Pawpaw	1	4°50’49.38828”N	7°0’18.43236”E
Nkpolu	Oil palm	63	4°51’59.53594”N	6°58’45. 57546”E
Ogbogoro	Oil palm	50	4°51’20.43576”N	6°55’55.59024”E
Rumualogu	Oil palm	45	4°52’41.6892”N	6°54’43.6788”E
Nyande/Eleme	Oil palm	286	4°47’45.31812”N	7°6’30.88152”E
Nkpolu	Oil palm	3	4°52’12.38417”N	6°58’26.10891E
Rumualogu	Oil palm	45	4°52’41.6892”N	6°54’43. 6788”E
Nyande	Oil palm	107	4°47’45.30012”N	7°6’30.89988”E
Igbo Etche	Oil palm	50	4°57’8.3088”N	7°4.14.8548”E
Okrika	Oil palm	62	4°51’20. 81988’’N	6°55’56.10108E
Agwut-Obolo/ Andoni	White mangrove	89	4.4551683°N	7.3377°
Ulakwo 1	Drumstick tree	68	5°2’21.18624”N	7°5’54.38184”E
Eagle Island	Christmas bush	6	4°48’24.19056”N	6°59’10.27212”E
Mgbuoshimini	African cherry	105	4°48’48”N	6° 57’27”E
Akwukabie/Etche	Moringa	96	5°6’37.03038”N	7°8’4.69782”E
Umuechem	Oil palm	78	5°00’22.140”N	7°01’53.550”E
Rumuoparaeli	African cherry	78	4°50’53.076”N	6°57’45. 642”E
Esuk Atu Calabar	Melina	98	4°57’8.58204”N	8°21’19.42236”E
Woji	Melina	56	4°47’49.36848”N	6°59’35.26105”E
Elikporkwordu	Mango	3	4°54’17.813”N	6°59’22.883”E
Ada George Road	Melina	3	4°47’51”N	6°58’57”E
Okana/Abua	Coconut	70	4°51’18’’N	6°38’39’’E
Rukpokwu	Orange	1	4°46’74”N	6°42’30”E
Diobu	Oil palm	15	4°47’51”N	6°58’49”E
Rumuokwuta	Oil palm	76	4°52’41.712”N	6°54’43.068”E
Total village	African cherry	15	4°47’56”N	6°58’54”E
Elelenwo	Mango	1	4°47’51”N	6°58’50”E
Rumuosi	Oil palm	34	4°48’12”N	6°58’36”E
Ozuoba	Coconut	22	4°52’18.559”N	6°57’18. 897”E
Borokiri	Melina	24	4°44’36.190”N	7°02’41.965”E
Ogbumnabali	Madagascar almond	3	4°47’51”N	7°0’33” E
Diobu	Coconut	1	4°47’47.298”	6° 8’50.202”E
Rumuepirikom	African cherry	14	4°47’53”N	6°58’52”E
Mgbuoshimini	Oil palm	32	4°47’20”N	6°58’44”E
Igwuruta	Oil palm	30	4°47’38.45”N	6°59’22.79”E
Obrikom	Royal palm	54	5°23’16.278”N	6°40’32. 651”E
Igwuruta	Oil palm	25	4°54’41”N	6°59’37”E
Ofeorie/Imo	Oil palm	52	5°44’55.3632”N	7°07’21.198”E
Rumuosi	Oil palm	2	4°52’48”N	6°56’16”E
Eagle Island	Oil palm	7	4°47’6.73152”N	6°58’59.39364”E