U. of K. J. Agric. Sci. 19(3), 399-415, 2011

Biomass and Habitat Use of Guinea Fowl (*Numidia meleagris*) in Dinder Biosphere Reserve, Sudan, during the Dry Season*

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Abstract: This study was conducted in the Dinder Biosphere Reserve during the dry seasons of 2007 and 2008. The objective of the study was to determine biomass and habitat use of Guinea fowl (*Numidia meleagris*) in the various ecosystems of the reserve. Loop and nearest neighbour methods were used for measuring the vegetation attributes. The density of Guinea fowl was calculated in strip transects that were 500 m long and 200 m wide by the double sampling procedure. First, the number of Guinea fowl was estimated and then counted directly. Second, a predictive model was developed from the relationship between the counted and the estimated variables. Subsequently, the number of the birds was only estimated and the actual count was predicted from the model. Guinea fowl was captured by mist nets and locally made traps, weighed and morphometric measurements were taken. Biomass was calculated as the product of density and the live weight. The density of Guinea fowl was high around the *mayas* (meadows) and riverine ecosystems. The total biomass in the reserve was 93.76 kg/km². The vegetation attributes around the *mayas* varied considerably. The percentage of litter was high in some *mayas* and low in others; bare land was relatively high in most of the reserve area but burnt areas were very low. Trees of high densities included *Acacia seyal*, *Combretum* sp., *Balanites aegyptiaca*, *Ziziphus-spina-christi* and *Acacia polycantha*. Of these, Guinea fowl roosted only on *A. seyal* and *Combretum* sp.

Key words: Guinea fowl; habitat; biomass; Dinder biosphere reserve

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*Part of M.Sc. (Wildlife) thesis by the first author, Sudan Academy of Science, Khartoum, Sudan

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INTRODUCTION

Guinea fowl (*Numidia meleagris*) is an important game bird in Africa. The three races that inhabit Sudan (Cave and Macdonald (1955) are the following:

1. Tufted Guinea fowl *(N. m. meleagris*) which is found north of latitude 10; its range extends as far as 80 miles north of Kassala. It is a resident game bird in the southern Blue Nile, southern Kordofan, southern Darfur, Bahr el Ghazal, Upper Nile and Equatoria. The Dinder Biosphere Reserve is a primary habitat for this bird (Plate 1), where large flocks are encountered, (Mohammed 1994).
2. *N. m. major*, which occurs in Wakkla Bari Country and Gondokorro.
3. Crested Guinea fowl (*Guttera edouardi*), which is similar to the tufted Guinea fowl except for the conspicuous bunch of curly black feathers on the crown with bluish instead of white spots. It is uncommon and locally distributed in forests of Equatoria States, on the Nile Congo and in the foothill forest of Imatong mountains.

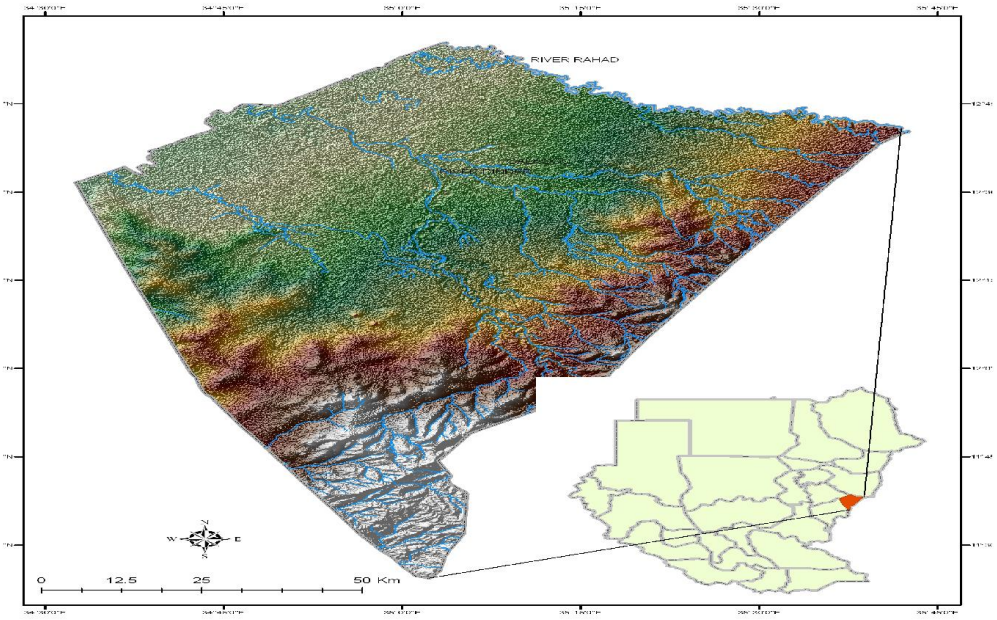
Plate 1. A flock of guinea fowl (*Numidia melleagris*) among *Acacia seyal* in Dinder Biosphere Reserve

A Guinea fowl rarely weighs over 1.6 kg (Frank 1997). The full adult weight can be reached in 210 days (Emil *et al*. 1986), the maximum weight being 2.5 kg. According to Shams Eldeen (2006), the mean live weight in Dinder Biosphere Reserve is 0.9 kg.

Guinea fowl roosts high in acacias or similar trees. They rise from the ground with a great noise of wings, scatters and perches high in trees. When it is going to roost, the bird becomes very suspicious and hard to please in choosing the perch (Pries 1933). There is a considerable clamor as the bird settles down for the night in flocks in tall trees; a flock generally roosts together on the same tree (Bannerma 1930). Towards the evening, the roosting flocks make harsh, abrasive cackles through the trees until silenced by night fall (Bramwell 1974).

This study was conducted in Dinder Biosphere Reserve, which lies between latitudes 11°55'-12°48'N and longitudes 35°44'-35°42'E. Established in 1935, the reserve is bordered by three states: Sennar, Gedarif and Blue Nile (Map 1), embracing 10291 km^2 (Anonymous 2001). The Reserve comprises three ecosystems; namely, the riverine, the *maya* (meadow) and *dehara* (hinterland) which were described in detail by Mahgoub (2004). Its climate, drainage network, soil, vegetation, fauna and flora also have been described (Smith 1949; Harrison and Jackson 1958**;** Holsworth 1968; Dasmann 1972; Hashim 1984; Hashim and Mahgoub 2007**).**

The objective of this study was to determine habitat use and biomass of the tufted Guinea fowl in ecosystems of Dinder Biosphere Reserve during the dry season.



Map 1. Dinder Biosphere Reserve (Source: Lubna M. Abd Alla Hassan, personal communication)

METHODS

Biomass

The density of Guinea fowl in Dinder Biosphere Reserve was estimated in strip transects, following Hashim and Mahgoub (2007) method. Thirty-four strip transects of 500 m long and 200 m wide were selected randomly surrounding *mayas* along the north, south, east and west directions from which two directions were selected randomly and sampled.

The selection of the strip transects along the roads was done by measuring the length of each road and calculating the number of transects needed. Since the transects were to be selected at 500-m intervals, the length of the road was measured by GPS and divided by 500 m, which gave the total number of transects to be sampled. There were two options for selecting the direction of the line transects: north-south or east-west. Because many of the roads are very long, only 30% of the calculated transects were selected randomly for sampling.

Each strip transect was traversed by at least two observers, and the number of Guinea fowl was estimated by the double-sampling procedure which was originally developed by a plant ecologist for estimating herbage biomass (Whim *et al.* 1944; Hilmon 1958).This was done in two steps. First, the numbers were estimated and then counted. The double-sampling was repeated by the observer until the estimated number was equal to or very close to the counted number. A linear regression model was then developed between the estimated and counted numbers, from which numbers of Guinea fowl were predicted by the following equation:

$$\hat{y} = a + bx,$$

where $\hat{y}$ is the predicted number of birds, a is constant, b is the slope and x is the counted number of birds.

Second, when a predictive model was attained, the observer then only estimated the number of the birds in each transect, which permitted the sampling to be very fast.

The density was calculated as the predicted numbers of Guinea fowl divided by the areas of the strip transects and was averaged across all the strips in the favourable habitats. The area of the favourable habitat in the reserve was estimated as 200 km².

Eighty-four Guinea fowl were captured by mist nets and the indigenous *digi-digi* trap, weighed and measured. The live weights and measurements were averaged across ecosystems of the reserve. Total biomass was estimated by multiplying the total predicted number of birds by its mean live weight.

Roosting sites were located by observing the time when the birds stopped the diurnal activity in the evening and perched on trees, and when they came down from the trees in the morning. Vegetation attributes, surrounding the roosting sites, were quantified. Tree density and ground cover were determined by the nearest neighbour method (Clark and Evans 1954) and the loop method (Hutchings and Holmgren 1959), respectively, along 76 line transects each was 500 m long. The lines started from the bark of the roosting tree and ran north, south, east and west. Ground cover was recorded at 50-m intervals along the lines.

Tree density (D)/ha was calculated as follows:

$$D = 1000 \div (x^2 \times 1.67)$$

where x is the mean distance and 1.67 is a constant.

Ground cover was determined as

Cover = (No. of loops that hit the ground ÷ Total no. of loops) x 100.

Crown area was determined by projecting three extremes of crown diameters from the top of the tree onto the ground. These diameters were measured and averaged. The crown area was calculated as πr^2, where r is the radius of the crown.

Guinea fowl in all roosting sites was counted; the distance from the roosting site to the diurnal activity areas was measured. Regression analyses were conducted in which biomass was the dependent variable and the vegetation attributes (litter, bare soil and burnt areas) as well as crown areas of trees were the independent variables. SPSS statistical package was used in all regression analyses.

RESULTS AND DISCUSSION

The model

The relationship between the estimated and the counted numbers of Guinea fowl (Fig. 1) was highly predictive ($r^2 = 0.985$, $P < 0.001$). This model is applicable for birds occurring in flocks and possibly animals in groups that make them difficult and cumbersome to count every now and then.

The double-sampling procedure (Hilmon 1958) is adopted for estimating the numbers of Guinea fowl. To the best of our knowledge, it has never been used before by animal ecologists to estimate animal numbers or their biomass. Apparently, the double-sampling procedure is very promising for estimating population numbers of wild animals. It is important that the observer is trained to make good estimates of the birds in the flocks or animals in groups, and a model should be developed for each animal species.

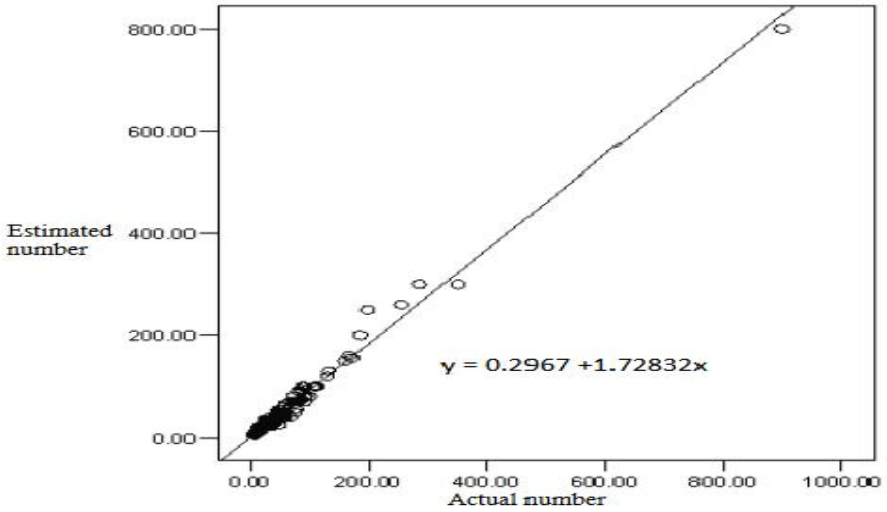


Fig. 1. Relationship between actual count and estimated number of Guinea fowl (*Numedia melleagris*) in Dinder Biosphere Reserve

Biomass

Because they drink water every day, Guinea fowl were found around the *mayas*, rivers and waterholes. Thus, from sun rise at 7:00 am until sun set at 6:00 pm, its density was high in the vicinity of the water sources (Table 1). The density, however, varied considerably among water sources, along roads and between seasons. In 2007, the density ranged from 1800 to 5080 birds /km² in two *mayas*. In 2008, the bird was widely distributed; its density ranged between 650 and 3250 birds/km². The wider distribution in 2008 is probably attributed to the flooding in the biosphere reserve that filled most of the *mayas* and thus provided a favourable habitat for Guinea fowl.

The mean density of Guinea fowl in 2007 was 78.8 birds / km² and 54.9 birds / km² in 2008, averaging 66 birds/ km² in the biosphere reserve. This was higher than that recorded by Mohammed *et al*. (1999). Elsewhere, studies conducted on the density of helmet Guinea fowl in Africa revealed a range of 11.8 to 49.0 birds / km² (Ayeni and Ajayi 1983).

Table 1. Density of Guinea fowl *Numidia melleagris* in Dinder Biosphere Reserve in two dry seasons

*Maya**	Density (birds/m^2)	
	Season 2007	Season 2008
Ras Amir	5090	3250
Ein Es Shams	3450	1705
Musa	2000	345
Gererrisa	1800	2505
Abdel Ghani	1945	------
Al Abyad	------	650
Al Sama'aya	------	2050

**Maya* = Meadow

The mean live weight of the females was 1.0 kg, and the wing length was 35.2 cm (N = 52). The respective measurements for the males were 1.1 kg and 36.625 cm (N = 32). Biomass of Guinea fowl in various *mayas* is presented in Table 2. The total biomass varied among *mayas* and the mean was 93.8 kg / km².

The live weight reported in this study agrees with that of Mareko and Molelekwa (2006). Hindu group (2002) found that the adult bird weighed about 2.5 kg, which is higher than what was recorded in this study. At maturity, live weight of both males and females ranged from 1.35 to 1.58 kg (Ayeni 1978). Live weight reported by Ayeni and Ajayi (1983) in Nigeria and Mohammed (1994) in Dinder Biosphere Reserve is close to the present findings.

Habitat use

Herbaceous vegetation attributes are shown in Table 3. The litter range was 30.5% to 49.8%, and the bare land was about 50 %. Percentages of burnt area varied considerably; it was high in some *mayas* (18.33% - 18.77 %) and very low (2.56% - 3.93%) in others.

Table 2. Numbers and biomass of Guinea fowl (*Numidia melleagris*) in *mayas** and roads of Dinder Biosphere Reserve (2007

Maya/Road	Estimated number	Predicted number	Calculated biomass (kg)
Ras Amir	3780	4050.8	4250.97
Ein Es shams	3867	4154.7	4359.98
Abdel Ghani	810	867.2	910.05
Musa	650	695.9	730.23
Gererrisa	1370	1467.1	1539.59
El Abyad	460	491.4	515.70
El Sama'aya	4490	4809.3	5046.88
Gazrat El Abyad	650	694.1	728.36
El Abyad to Galagu	260	276.0	289.60

**Maya* = Meadow

Table 3**.** Proportions of herbaceous vegetation attributes at roosting sites surrounding *mayas** in Dinder Biosphere Reserve (2007 and 2008)

Maya	Ground cover		
	Litter	Bare land	Burnt areas
Ras Amir	34.0	56.8	18.3
Abdel Ghani	49.7	45.3	10.0
Geterrisa	45.6	51.5	4.0
Ein Es Shams	30.5	57.0	18.8
Musa	40.6	56.9	2.6
El Abyad	43.6	53.9	2.6
El Sama'aya	42.1	47.5	10.5

**Maya*= Meadow

Bare land is mainly due to overgrazing and the trampling of vegetation by wild herbivorous ungulates and livestock trespassing into Dinder Biosphere Reserve. Burning is done illegally by honey collectors and by the livestock herders (Sulaiman, 2006) in their attempt to improve the grazing for their animals and sometimes eliminate ticks from the *mayas*

Regression analysis revealed that there is no relationship between the biomass of Guinea fowl and proportions of litter and bare land. However, available evidence suggests that Guinea fowl preferred using burnt areas, as reflected in the significant linear relationship between the bird's biomass and the proportion of burnt areas ($r^2 = 0.63$, $P < 0.03$). It is likely that the burnt areas permit better visibility for the bird to escape the predators.

There were high densities of trees at roosting site (Table 4) including, *Acacia seyal*, *Combretum* sp., *Balanites aegyptiaca*, *Ziziphus spina-christi* and *Acacia polycantha*.

The use of roosting sites in 2007 and 2008 indicated that more roosting occurred in *A. seyal* and *Combretum* sp. surrounding the *mayas* (Table 5). Guinea fowl, however, roosted in *A. seyal* slightly more (53 %) than in *Combretum* sp. (47 %), possibly due to its prevalence and close proximity to the *mayas*. *Combretum* sp. always grew at further distances (370 - 780 m) from the *mayas* than *A. seyal* (240 - 373 m), and the latter had slightly larger and more variable crown area (397.0 – 221.5 m^2) than the former (370.0–362.1 m^2)

At *mayas* where there was no *A. seyal* (see Table 5), Guinea fowl roosted in *Combretum* sp. but had to fly slightly longer distances to reach it. Because they had less dense crowns than *B. aegyptiaca*, *Z. spina-christi*, *A. sieberiana* and *A. polycantha*, *A. seyal* and *Combretum* sp. permitted Guinea fowl to detect predators during the night and avoid them by flying to another roosting tree. There were many other small tree species in the roosting sites, but only seven birds were seen roosting in them.

Table 4. Density of trees/ha at roosting sites surrounding *mayas** of Dinder Biosphere Reserve

Taxon	*Maya**						
	Ras Amir	Abdel Ghani	Gererrisa	Ein Es Shams	Musa	El Abyad	El Sama'aya
Acacia seyal	110.0	192.1	166.0	195.2	161.6	129.6	
Balanites aegytiaca	45.5	142.6	166.0	155.3	69.6	67.6	289.9
Combretum sp.	138.7	112.6	119.6	184.7	101.6	515.5	72.2
Acacia sieberiana	223.4	318.5	82.5	128.9	72.5	-	205.6
Acacia polyacantha	-	256.2	769.2	267.2	128.8	128.9	-
Acacia nilotica	-	299.0	-	-	-	-	-
Crateva adansonii	-	-	515.4	-	-	-	-
Piliostigma reticulatum	-	-	179.0	-	-	72.5	185.6
Lonchocarpus laxiflora	-	-	229.1	-	-	378.7	-
Ziziphus spina-christi	223.4	1159.7	3388.4	137.3	286.6	1241.1	-
Acacia senegal	185.5	-	-	-	-	-	-
Hyphaene thebiaca	-	-	378.68	-	-	-	515.4

**Maya* = Meadow

Table 5. Mean crown areas and distances of roosting trees from *mayas** in Dinder Biosphere Reserve (2007 and 2008)

Maya	Roosting tree	Crown area (m²)	Distance (m)
Ras Amir	*Combretum* sp.	362.1	780.0
Abdel Ghani	*Acacia seyal*	397.0	373.3
Gererrisa	*Acacia seyal*	298.5	363.3
Ein Es shams	*Acacia seyal*	288.6	358.3
Musa	*Acacia seyal*	221.5	240.0
El Abyad	*Acacia seyal*	353.1	350.0
El Sama'aya	*Combretum* sp.	370.0	370.0

**Maya* = Meadow.

The relationship between the biomass of Guinea fowl and density and crown area of *A. seyal* and *Combretum* sp. revealed that the former tree variables had no predictive relationship with the biomass. *Combretum* sp. density and crown area, however, had significant linear ($r^2 = 84$, $P < 0.065$) and quadratic ($r^2 = 0.998$, $P < 0.049$; Fig. 2) relationships with biomass, respectively. Based on these relationships, it is argued that when the two tree species were available, *Combretum* sp. would be preferred. It is worth mentioning that densities of *B. aegyptiaca*, *A. sieberiana* and to some extent *A. polycantha* were high around some *mayas*, but they were not selected for roosting by the bird. The reason for this is that the first two trees had large and dense crowns, the latter with inhibitory thorns.

Tall trees in open areas, in open forest with little bushes and shrubs around them were usually preferred for roosting. Emil *et al*. (1986) reported that Guinea fowl roosted in the tallest *Acacia*, often in depressions or water courses surrounded by dense shrubs. The same general area may be used nightly. Roosting is normally in flocks that fly up together into the same tree, but use a different tree each night. The flock descends to ground early in the morning for foraging.

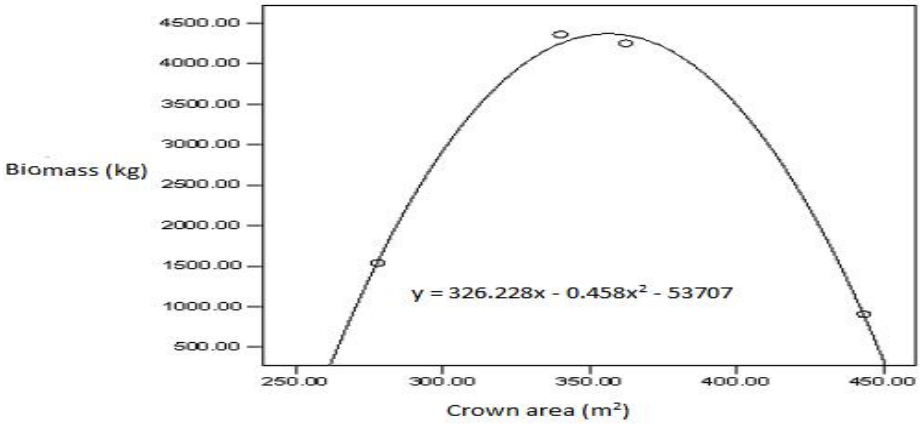


Fig. 2. Relationship between biomass of Guinea fowl (*Numidia melleagris*) and Combretum sp. crown area in Dinder Biosphere Reserve

In conclusion, high numbers of Guinea fowl occupy burnt areas in Dinder Biosphere Reserve. *Acacia seyal* and *Combretum* sp. surrounding the *maya* and Riverine ecosystems, where water is readily available, are preferred for roosting. Less distance is required to access *A. seyal*, but the density and crown area of *Combretum* sp. are more attractive for roosting, possibly because they are sparse and facilitate the detection and easy escape from predators.

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مجلة جامعة الخرطوم للعلوم الزراعية : المجلد التاسع عشر – العدد الثالث ، 2011م

الوزن الحى لدجاج الوادى(*Numidia mellegris*) وإستغلاله للموئل فى محمية المحيط الإحيائى بالدندر – السودان

مبارك على ابراهيم و ابراهيم محمد هاشم

مركز بحوث الحياة البرية ، شمبات – السودان

المستخلص: اجريت هذه الدراسة فى محمية المحيط الاحيائى بالدندر اثناء فترتي الجفاف لموسمي 2007 و2008 وذلك بهدف تحديد الكتلة الحيوية لدجاج الوادى وإستغلاله للموائل فى النظم البيئيه المختلفه. درست خصائص الغطاء النباتى باستعمال طريقتى اللوب (دائرة صغيرة أقرب لحجم النقطة) وأقرب جار. وقدرت كثافة الدجاج فى قطاعات شريحية منتظمة طولها 500 مترا وعرضها 200 مترا عن طريق أخذ العينات المزدوج. أولا، قدر أعداد الدجاج فى السرب ومن ثم عده عدا مباشرا. ثانيا، طور نموذج إحصائى للتنبؤ من العلاقة بين نتائج العد والتقديرات. بعد ذلك قدر عدد الدجاج فقط والتنبؤ بالعدد الفعلى من النموذج الإحصائى. قبضت اعداد من الدجاج بالشباك الضبابية والشراك محلية الصنع ووزن هذا الدجاج واخذت له القياسات المظهرية، وحسبت كتلته الحيوية بحاصل ضرب كثافته فى المحمية والوزن الحي. كانت كثافة الدجاج عالية حول نظام الميعات والنظام النهرى وبلغت كتلته الحيوية الكلية فى المحمية 93.76 كلجم|كلم². تباينت خصائص الغطاء النباتى حول الميعات لحد كبير وكانت النسبة المئوية للسقط النباتى عالية فى بعض الميعات ومنخفضة فى أخرى. والنسبة المئوية للارض الجرداء كانت نسبيا عاليه أما نسبة المساحة المحروقة فكانت ضئيلة جدا. شملت الاشجار ذات الكثافة العالية فى محمية الدندر الطلح والهبيل والهجليج والسدر والطلح الابيض، ومن بين هذه الاشجار فان دجاج الوادى يبيت جاثما فى شجرتى الطلح والهبيل فقط.