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A COMPARISON OF THICKET CLUMPS ON THE ACCRA AND WINNEBA PLAINS OF GHANA

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Summary

Studies were conducted to compare the soil characteristics and plant communities in thicket clumps on the Accra and Winneba plains. Studies of some soil characteristics showed that soils in the clumps on the two plains are similar in pH but differ in field texture and per cent soil moisture content. The number of plants in the thickets on the Accra plains was higher than on the Winneba plains. However, the thicket clump on the Winneba plains showed a greater species richness and contained more species also associated with forest areas than those on the Accra plains. The number of species in the thickets on both plains tended to increase from the windward to the leeward side of the thicket. The observed differences in species composition and richness in the two plains were partly related to differences in soil characteristics particularly soil moisture content.

Introduction

Thicket clumps are a common sight on the Accra and Winneba plains in Ghana. They are patches of woodland vegetation on an otherwise wide stretch of grassland. These plains have been referred to as the southern savanna in Ghana (White, 1954). Troll (1950) described a similar zone in East Africa and called it "termite savanna" in view of the association of those woodland patches with termite mounds. Lawson & Jenik (1967) observed that this type of vegetation does not fit into any of the major savanna types in West Africa, because it departs from the ecological definition of a savanna as a vegetation showing a closed grass cover and scattered individual woody plants either shrubs or trees. Lawson & Jenik (1967) agreed with Boughey (1957) that the vegetation should be referred to as a kind of 'steppe' since the vegetation consists of short grasses rarely exceeding 80 cm in height.

Walter (1971) accepted that an area with patches of woodland vegetation which are associated with termite mounds did not fit into the ecological definition of savanna. He disagreed with the use of the term 'steppe' for this area, and suggested that the term should be reserved for grasslands of non-tropical zone. He then suggested that the area should be better referred to as macromosaics on rasied land (old termite mounds) that is not flooded during the rainy season.

Descriptions of this type of vegetation and its possible origin in West Africa have been given by Aubreville (1959) and Lawson (1985). Lawson & Jenik (1967) undertook microclimatic and vegetation studies on one thicket clump on the Accra plains and found that microclimate exerts considerable influence on the vegetation pattern on the Accra plains. They also listed some of the woody species on the single thicket clump which they considered. Obviously, then, there is a need for a more in-depth ecological study of the thicket clumps that occur on the plains.

The two plains fall within the two-peak rainfall zone in Ghana. The major rainfall season is from April to July and the minor season is from September to November. The dry season lasts from November to March. The soils on the Accra and Winneba plains belong to the Agawtaw and Simpa series respectively. The top soils of the Agawtaw

series contain grey to brown sandy loamy soil. Those of the Simpa series are composed of a grey brown to yellow brown sandy soil.

The aim of this study was to compare the soil characteristics and the species composition and distribution on several thicket clumps on the Accra and Winneba plains in order to observe the kind of relationships that exist between the soil characters, properties and the nature of the vegetation.

Experimental

Study areas

The Accra site was near kilometre post 37 on the Accra-Ada road and the Winneba site was about 5 kilometres west of the Winneba town on the Accra-Takoradi road (Fig.1).

Field methods

The study was carried out in 1974 during the wet season. Areas from the two sites with as little human interference as possible were selected so as to give a better picture of the natural state of the thicket clumps. Ten thicket clumps were selected at random from each of the two sites. These selected clumps were marked and mapped with the aid of a compass and wooden pegs so that one could return to the same thicket clump again.

The length and width of individual clumps were measured. The clumps were then divided arbitrarily into three parts (windward, central and leeward) as shown in Fig. 2. Since the clumps have a characteristic wedge shape due to the effect of wind, it was easy to determine the windward and leeward sides.

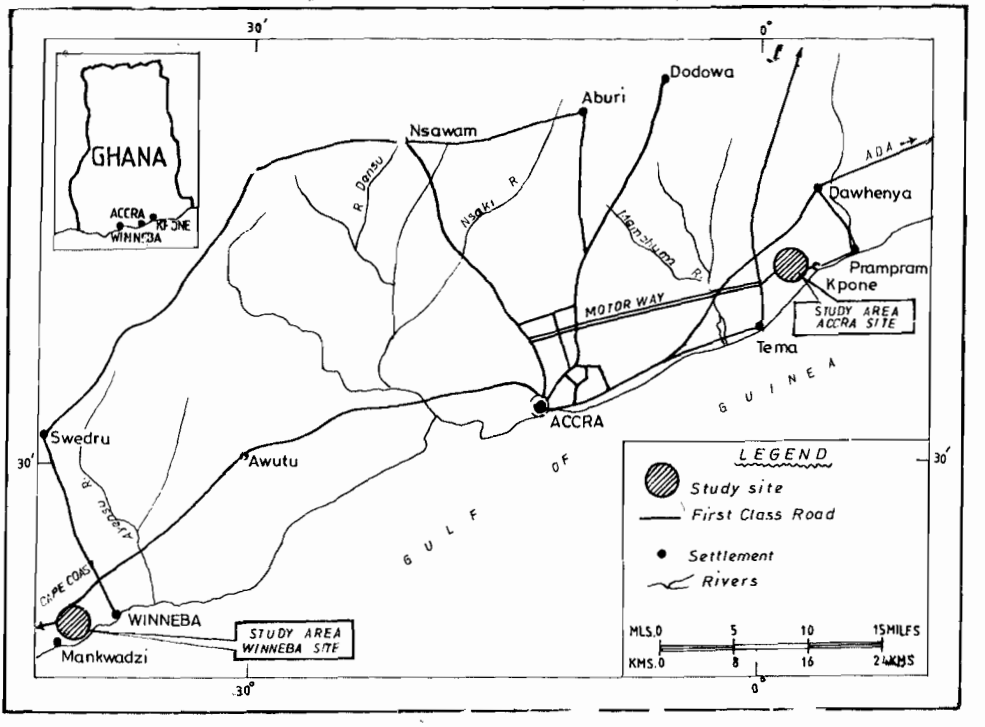

Fig. 1. Accra and Winneba plains showing study sites.

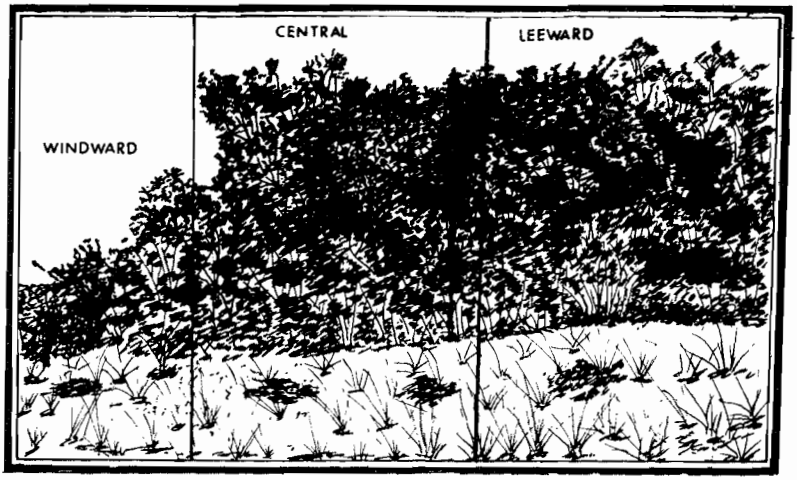

Fig. 2. A thicket clump arbitrarily divided into windward, central and leeward parts.

All plants measuring one meter and above within the clumps were identified and recorded. All identifications and nomenclature decisions followed Hutchinson & Dalziel (1954-1963) and Davies & Cullen (1965) respectively. The number of each species and its position on the clump (windward, central or leeward) were recorded.

Soil samples were taken from a depth of 25 cm with a soil auger. These samples were collected from the three positions of each clump and put into labelled polythene (polyethylene) bags for laboratory analysis. Soil samples from the grassland outside the clumps were also collected and similarly analysed.

Laboratory methods

The *p*H values for the soil samples were determined on stirred 1: 2 soil: water suspension, using a *p*H meter (Pye Model 292). The per cent soil moisture content was found by oven drying a specified weight of fresh soil sample at 105 °C to constant weight.

The soil texture was determined, using the manipulative texture test suggested by Ahn (1970). Although this might not be a very accurate test, it gives a practical indication of soil texture for comparison.

Analyses of data

Data for the *p*H and soil moisture content from similar sections on the Accra and Winneba plains were compared using the t-test; the formula used is as follows:

$$t\text{-} = \frac{\bar{X}a - \bar{X}w}{\sqrt{s.e.}}; \quad s.e. = \sqrt{(s.e.)^2_a + (s.e.)^2_w}$$

where $\bar{X}a$ = mean of Accra locality

$\bar{X}w$ = mean of Winneba locality

$(s.e.)_a$ = s.e. of Accra mean

$(s.e.)_w$ = s.e. of Winneba mean

5 per cent t- for 18 d.f. is 2.101

Also, using the formula below, a coefficient of similarity, S (community coefficient), (Barbour, Burk & Pitts, 1980) between the clumps on the two plains was calculated.

$$S = \frac{Ns \times 100}{Ns - Nd}$$

where Ns = number of species common to the two plains but absent in the other,
Nd = number of species present in one plain but absent in the other.
An S of 100 represents identify, while S of 0 represents complete difference.

Results

Soils

Table 1 shows the results of the *p*H values of the soils from various sections of the thicket clumps on both Accra and Winneba plains. It may be noted from the results that the differences in the *p*H were not statistically significant. However, when the soils on the grassland outside the clump were compared, the soil from the Accra plains was found to be significantly more acidic than the soils from the Winneba plains.

Table 2 shows that soil moisture content at Winneba was significantly higher on all sections of the clumps than at Accra. There was no significant difference, however, between various sections of the clumps of the same area. The per cent moisture of the soils from the grassland (outside the clumps) was significantly higher on the Winneba plains than on the Accra plains. At both plains, the soils outside the clumps had much lower moisture content than those from inside the clumps.

Soil texture in the thicket clumps on the two plains differed to some extent (Table 3). On the Accra plains, the soils on the windward side were clay but this became lighter towards the leeward side, where the texture was heavy loam. Heavy loam soil was also observed on the windward side of thicket

TABLE 1
pH of soil from various sections of clumps in the Accra and Winneba plains
(Data are means of 20 samples ± SE)

Site	*Windward*	*Central*	*Leeward*	*Grassland out side the clump*
Accra	6.89 ± 0.22	7.13 ± 0.24	6.94 ± 0.13	6.40 ± 0.13
Winneba	6.65 ± 0.07	6.85 ± 0.13	6.83 ± 0.07	6.90 ± 0.07
Significance of difference (P)	> 0.10	> 0.10	> 0.10	> 0.10

TABLE 2
Soil moisture content (per cent) in the Accra and Winneba plains
(Data are means of 20 samples ± SE)

Site	*Windward*	*Central*	*Leeward*	*Grassland out side the clump*
Accra	19.19 ± 0.85	18.54 ± 0.92	18.49 ± 1.20	17.82 ± 0.73
Winneba	24.46 ± 1.01	23.28 ± 1.11	23.69 ± 1.14	21.11 ± 0.98
Significance of difference (P)	< 0.01	< 0.01	< 0.01	< 0.01

TABLE 3
Soil texture from from various sections of clumps in the Accra and Winneba plains

Site	*Accra*	*Winneba*
Grassland outside the clumps	Sandy loam	Sandy loam
Windward	Clay	Heavy loam
Central	Light clay	Loam
Leeward	Heavy loam	Loam

of thicket clumps on the Winneba plains but the central and leeward portions of the clumps had soils which were loamy in texture. The results also show that the soils outside the thicket clumps on both Accra and Winneba plains were sandy loam in texture.

Vegetation

The length and width of the experimental clumps ranged from 8.0 - 19.0 m and 5.2 - 13.0 m.

As shown in Table 4, 877 plants belonging to 38 species were recorded on the 10 clumps studied on the Accra plains. Seven out of the 38 species were found to be exclusive to the Accra plains and 27 of the total species found in the area also occurred in the forest zones.

On the Winneba plains, 740 plants belonging to 62 species were recorded (Table 4). Out of the 62 species, 31 were found only on the Winneba plains and not on the Accra plains. Forty-six (46) species here were also noted to occur in the forest zones. A species composition list for the Accra and Winneba plains is provided in Appendix 1. A measure of the coefficient of similarity between the Accra and Winneba plains showed an S of 44.9 meaning that they are not similar.

Table 5 shows the distribution of species in the various sections of the clumps. The species seemed to be fairly well distributed in the clumps although there was tendency for the leeward side to have a greater number of species than the other two sides. It is of interest to note that a relatively higher number of *Elaeophorbia drupifera* plants were found in the centre of the clumps.

Tables 6a and 6b show the most common species on the Accra and Winneba plains respectively. The most common species on the Accra plains was *Sanseviera liberica* with a relative density of 37 per cent (Table 6a); that on the Winneba plains was *Dichapetalum guineense* with a relative density of 15.6 per cent (Table 6b). Two species *Securinega virosa* and *Sanseviera liberica* had equally high relative densities on both plains. Species like *Dichapetalum guineense* and *Azadirachta indica* were abundant on one plain and relatively low on the other.

A. indica and *E. drupifera* showed 100 per cent frequencies on the clumps of the Accra plains. The species which were found exclusively on one plain

TABLE 4
Total number of plants and number of species recorded on the experimental clumps in the two sites

Site	*Total No. of plants on clumps*	*No. of species*	*No. of species exclusive to site*	*No. of forest species present*
Accra	877	38	7	27
Winneba	740	62	31	46

TABLE 5

Distribution of plant species on the various species of clumps

Site	Windward		Central		Leeward	
	No. of plants	*No. of species*	*No. of plants*	*No. of species*	*No. of plants*	*No. of species*
Accra	290	26	323	26	264	30
Winneba	308	41	247	45	185	49

and not the other are recorded in (Appendix I). *Milletia thonningii* and *Mallotus oppositifolius* showed a higher density on the Winneba plains, while *Grewia villosa* was quite abundant on the Accra plains.

Discussion

In this study, an attempt has been made to study and compare the soil and the plant communities on thicket clumps on the Accra and the Winneba plains.

It was found that, although the *p*H of the soil on the grassland outside the clumps at Winneba was significantly different from that of Accra, yet there was no significant difference in soils from inside the thicket clumps of the two plains. This similarity in the *p*H values of the soils on the thicket clumps may be due to limited human activities on the thicket clumps because of the impenetrable nature of the vegetation. Other factors being equal, such a restriction of human activities may result in the maintenance of similar soil exchangeable cation capacity in the two areas, a factor which is known to influence soil *p*H (Donahu, Millerard & Stickluna, 1983). Similarly, the observed differences in *p*H of soils on the grassland outside the clumps at Accra and Winneba may reflect differences in human activities. With a rapid population growth in Accra, the grassland is subjected to much land exploitation such as intensive farming, grazing and burning. Perhaps such greater land use in Accra has resulted in greater acidity on the plains generally than has happened on the Winneba plains with its lower population and lower land use pressure.

It is well known that with the same amount of moisture supply, water content in the various textural classes follow the following pattern in order of greater moisture retention: clay, clay loam, loam, sandy loam, loamy sand and sand. Contrary to this pattern, however, it was observed that the loamy soil in the thicket clumps at Winneba contained more moisture than the clay soil in the clumps on the Accra plains (Tables 2 and 3). Factors which could contribute to this observation include differences in the amount of rainfall received at the two sites and differences in the rates of evapotranspiration (Ahn, 1970). The Winneba plains receives a slightly higher mean annual rainfall than the Accra plains (Carson, 1985).

Comparative data on evapotranspiration of the two plains are unavailable. However, in their study, Lawson & Jenik (1967) noted that the Accra plains experience very high wind speeds which may contribute to high rates of evapotranspiration leading to low moisture levels in the soil. They further noted that the wind affects transpiration rates of the plants. There is the need for a similar evapotranspiration data for the Winneba plains to provide a better understanding of the water relations of soils on the two plains.

A higher number of plants was found in the clumps on the Accra plains but the clumps on the Winneba plains showed a greater species richness.

TABLE 6

Per cent relative density and frequency of the common species on the Accra (A) and Winneba (B) plains

	Species	Relative density (per cent)	Frequency (per cent)	No of plants per species	No of plants Windward	Central	Leeward
(A)	*Sansevieria liberica*	37.31	90	327	113	137	77
	Azadirachta indica	13.6	100	119	36	34	49
	Grewia villosa	8.7	90	76	26	25	25
	Securinega virosa	6.8	90	55	20	15	20
	Elaeophorbia drupifera	5.3	100	46	8	26	12
	Capparis erythrocarpos	3.9	80	34	12	15	7
	Clausena anisata	3.5	80	31	5	12	14
	Lantana camara	2.9	70	26	14	5	7
	Zanthoxylum zanthoxyloides	2.7	90	24	7	9	8
	Grewia carpinifolia	1.6	80	14	3	6	5
(B)	*Dichapetalum guineense*	15.6	80	117	58	45	14
	Securinega virosa	9.6	80	72	51	8	13
	Sansevieria liberica	7.5	70	56	4	39	13
	Milletia thonningii	6.7	90	50	27	12	11
	Mallotus oppositifolius	4.9	50	37	17	13	7
	Ehretia cymosa	4.8	80	36	24	3	9
	Melanthera scandens	4.8	30	36	20	14	2
	Allophylus africanus	4.0	90	30	19	6	5
	Chassalia kolly	3.7	70	28	5	14	9
	Grewia carpinifolia	3.6	90	27	7	11	9
	Tacca leontopetaloides	2.9	80	22	6	5	11
	Hoslundia opposita	2.8	60	21	5	3	13
	Clausena anisata	2.3	60	17	11	4	2
	Dialium guineense	2.3	70	17	5	8	4
	Azadirachta indica	2.0	70	15	6	4	5
	Zanthoxylum zanthoxyloides	1.9	60	14	2	8	4
	Elaeophorbia drupifera	1.6	50	12	3	6	3

APPENDIX 1

A list of all the plant species recorded in the Accra and Winneba clumps. Presence of a species is symbolized as +, absence as -. Species with asteriks are also found in forest areas

Species	*Family*	*Site*	
		Accra	*Winneba*
* *Abrus precatorius* Linn	Papilionaceae	+	+
* *Acridocarpus alternifolius* Schum &Thonn	Malpighiaceae	-	+
* *Adenia lobata* (Jacq.) Eng.	Passifloraceae	-	+
* *Albizia zygia* Machride	Mimosaceae	-	+
* *Allophylus africanus* (P. Beauv)	Sapindaceae	+	+
* *Anchomanes difformis* Rendle	Araceae	+	+
* *Antiaris africana* Engl.	Moraceae	-	+
* Asparagus warneckei (Engl.) Hutch.	Liliaceae	-	+
* *Azadirachta indica* Juss.	Meliaceae	+	+
* *Baphia nitida* Lodd.	Papilionaceae	-	+
* *Byrsocarpus coccineus* Schum & Thonn	Connaraceae	+	+
* *Canthium hispidum* Benth.	Rubiaceae	-	+
* *Capparis erythrocarpos* Isert	Capparidaceae	+	+
* *Carissa edulis* Vahl	Apocynaceae	+	+
* *Chaetacme aristata* Planch	Ulmaceae	-	+
Chassalia kolly Schum.	Rubiaceae	+	+
* *Cissus* sp.	Ampelidaceae	+	+
* *Clausena anisota* (Willd) Hook. f. ex Benth	Rutaceae	+	+
* *Cordia guineensis* Thonning (Syn C. *Johnsonii* Bak)	Boraginaceae	+	+
* *Cremaspora triflora* (Thonn) K. Schum	Rubiaceae	-	+
* *Crinum ornatum* (Ait) Bury	Amaryllidaceae	+	-
* *Deinbollia pinnata* Schum & Thonn.	Sapindaceae	-	+
* *Dialium guineense* Willd.	Caesalpiniaceae	-	+
* *Dichapetulum guineense* (DC) Keay	Chailletiaceae	-	+
* *Diospyros mespiliformis* Hochst	Ebenaceae	+	+
* *Drypetes floribundus* (Muell Arg) Hutch.	Euphorbiaceae	-	+
* *Ehretia cymosa* Thonn.	Boraginaceae	+	+
* *Elaeophorbia drupifera* Stapf	Euphorbiaceae	+	+
* *Eugenia coronata* Schum & Thonn.	Myrtaceae	+	+
* *Zanthoxylum zanthoxyloides* Lam.	Rutaceae	+	+
* *Flacourtia flaverscens* Willd.	Flacourtaceae	+	+
* *Grewia carpinifolia* Juss.	Tiliaceae	+	+
* *Grewia villosa* Willd.	Tiliaceae	+	-
Haemanthus miltiflorus Martyn.	Amaryllidaceae	+	+
Hibiscus surattensis Linn.	Malvaceae	+	+

* *Hoslundia apposita* Vahl.	Labiatae	-	+
Indigofera hirsuta Linn.	Papilionaeceae	+	-
* *Jasminum dichotomum* Vahl	Oleaceae	+	+
* *Lantana camara* Linn.	Verbenaceae	+	+
* *Lecaniodiscus cupaniodes* Planch ex Benth.	Sapindaceae	+	+
* *Lonchocarpus sericeus* (Peir) H.B. & K.	Papilionaceae	-	+
* *Malacantha alnifolia* (Bak) Pierre	Sapotaceae	-	+
* *Mallotus oppositifolius* (Geisel) Muell.	Euphorbiaceae	-	+
Milletia thonningii (Schum. & Thonn.) Bak.	Papilionaceae	-	+
Solemonostemon monostachyus (Beauv.) Briq.	Labiatae	+	+
Strychnos splendens Gilg	Loganiaceae	-	+
Tacca leontopetaloides (Linn.) O. Ktze.	Taccaceae	-	+
Tiliacora sp.	Menispermaceae	+	+
* *Triaspis odorata* (Willd) A. Juss.	Malpighiaceae	-	+
* *Triumfetta rhomboidea* Jacq.	Tiliaceae	-	+
* *Turraea heterophylla* Smith	Miliaceae	-	+
* *Uvaria chamae* P. Beauv	Annonaceae	-	+
Uvaria doeringii diels	Annonaceae	+	+
* *Vangueriopsis vanguerioides* (Hiern) Robyns	Rubiaceae	-	+
Wissadula amplissima (L) R.E. Fries.	Malvaceae	-	+

(Plant nomenclature after Hutchison & Dalziel (1954-1963) and Davies & Cullen (1965)

Thirty-one (31) out of 62 species found on the Winneba plains were absent on the Accra plains but only seven (7) out of a total of 38 species on the Accra plains were absent on the Winneba plains.

The number of species in the various sections of the clumps at both Accra and Winneba plains tended to increase in the direction of the leeward side. The observation has also been made by Lawson & Jenik (1967) and confirmed by Jenik & Hall (1976), and may be explained by the fact that the leeward side is protected against the prevailing winds.

On the Accra plains, two plants *S. liberica* and *A. indica* form over 50 per cent (446 plants) of the total plant community. This was not the case on the Winneba plains where the most abundant species *Dichapetalum guineense* and *S. virosa* formed only 25 per cent (189 plants) of the plant community on the clumps. So, despite the fact that a greater number of plants were recorded in the clumps at the Accra plains this number was greatly influenced by only two species, *Sanseviera* and *Azadirachta*, whereas at Winneba, six species contributed about 50 per cent of the total plant community. This implies a greater species diversity of the thicket clumps on the Winneba plains.

The vegetation on the thicket clumps at Winneba had a greater number of forest species compared to the Accra plains. Forty six of the species found on the Winneba plains do occur in the forest zone but only 27 forest species were recorded on the Accra plains. The soils on the clumps at Winneba, as mentioned earlier, have higher water content compared with the Accra plains. The difference in the amount of water available could have considerable controlling effect on the species composition on the two plains. Thus, certain species on the Winneba clumps particularly some forest species may fail to survive in the drier soils in the clumps

on the Accra plains. On the other hand, many of the species on the Accra plains are drought resistant. For example, *Sanseviera liberica*, one of the most common species on the Accra plains, possesses sclerophyllous leaves which one can withstand drought and excessive loss of water without collapsing. *Azadirachta indica* has also been found to have roots that are able to penetrate deep into the soil, thus, it is able to survive in areas where the water table may be quite low (Lawson & Jenik,1967). Delivaulle (1977) recommended that because *A. indica* is drought resistant, it could be used for reforestation in the arid and semi arid savanna. A study on the water relations the various species on the two plains may throw more light on differences in the species composition of these two plains.

A. indica and *E. drupifera* are well distributed on the Accra plains in that they occurred on every thicket clump studied (Table 6a). *E. drupifera* was found to be associated with the centre of the clumps quite often. In addition to being drought resistant, the abundance of *A. indica* on the Accra plains may be explained to have been caused through the dispersal by birds and bats and planted by human beings for shade and firewood (Lawson, 1985).

Although the vegetations on the Accra and Winneba plains are similar in structure and general appearance, the work reported here shows that floristically, they are quite different with a coefficient of similarity of only 44.9 per cent. It may be interesting to study the natural distribution of species found in the Winneba plains but not found on the Accra plains, and also the changes in species composition with time on the two plains. Such a study may help to explain the possible origin of this vegetation in West Africa.

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