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Inventory of insects associated with shea trees (*Vitellaria paradoxa*) (Sapotaceae) in central and northern Benin

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Abstract. Shea parklands have a great socio-economic, cultural and ecological interest but suffer pest attack, which is among the major causes for their deterioration in Africa. To establish an inventory of insects associated with shea trees, the foliage, stems and fruits were regularly examined on 180 trees randomly chosen at six sites in the central and northern regions of Benin. From June to October 2010, a total of 196 samples containing 1415 specimens were collected. These insects belong to 8 orders, 36 families and 56 genera. Forty-seven insects were identified to the species level. The defoliator *Cirina forda* (Westwood) and the stemborer *Neoplocaedaerus* spp. were the two most damaging insect species occurring on shea trees. This study stresses the need to protect the shea parklands in Benin through the implementation of integrated insect pest management strategies against shea tree pests.

Key words: shea parklands, *Cirina forda*, *Neoplocaedaerus* spp., shea tree pests, Benin

Introduction

The shea tree (*Vitellaria paradoxa* C.F. Gaertner) (Sapotaceae), better known by its former name, *Butyrospermum parkii* (G. Don) Kotschy, is a wild species generally protected and preserved in West Sudanian Africa and in the Sahel. It has a great socio-economic, cultural and ecological significance due to its numerous local uses. Most importantly, shea trees produce fruits that can be transformed into a high-value export product, namely shea butter. It is used in cosmetology (raw material for many skin and hair treatment products), in pharmacology (excipient for ointments used to treat dermatosis, burns, cracks, etc.) and as a substitute for cocoa butter in recipes (Sallé *et al.*, 1991). The development of shea tree cultivation as an economic and nutritional resource began in West Africa in the 1950s and its importance has increased considerably during the last decade (Masters, 2004). In spite of the wide range of shea products, trees remained until very recently, naturally grown, principally because of their excessively long pre-fruiting period (usually 17–20 years, and in extreme cases up to 30 years), and their rather irregular year-to-year productivity (Agbahungba and Depommier, 1989; Sallé *et al.*, 1991). However, because of the growing socio-economic significance of shea products and the ageing of existing tree stands, commercial plantations are on the rise spurred by the development of vegetative propagation techniques, mainly by grafting (Masters, 2004; Sanou *et al.*, 2004).

Nowadays, shea tree use is one of the promising agricultural sub-sectors whose development has become a priority for several countries in West Africa, particularly for Benin. Biotic stress, however, consitutes one of the reasons for the presently observed decline of shea tree productivity (Sallé *et al.*, 1991). Records from Burkina Faso, Ghana, Mali, Nigeria and Togo indicate that trees can be affected by

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several insect species (Sallé *et al.*, 1991; Dwomoh, 2003, 2004; Odebiyi *et al.*, 2004; Lamien *et al.*, 2008). Related information for Benin is still scanty or limited to single pest species (Gnanglè, 2005; Douro Kpindou and Djègui, personal communication). As a prerequisite for the development of integrated management strategies against the most damaging species, the present study provides a detailed inventory of insects associated with shea trees in central and northern Benin.

Materials and methods

Study sites

The study was carried out from June to October 2010 at six sites – in the districts of Savè, Tchaourou and Bembèrèkè (Fig. 1) – all situated within the five shea parklands of Benin as identified by Gnanglè (2005). Additional site information is provided in Table 1.

Shea tree selection

In each of the six villages chosen, an area of 5–7 ha containing about 125–150 shea trees of 8–12 m height was delimited and all fruit-producing trees therein were individually numbered with paint. Of these trees, 30 were randomly selected using a random number table. Thus, over the six villages, a total of 180 trees were surveyed to collect data on fruits, foliage and stems.

Insect collection

Fruit insects

In June 2010, i.e. during the fructification period, 50 fruits, half of them mature, were collected from each of the 30 selected trees. All insects found on or within the subsequently dissected fruits were counted by species, preserved in small glass vials containing 55% ethanol and labelled with their concomitant data.

Foliage insects

Samples were collected on three occasions at 6-week intervals from July to October 2010 using PACHA 25 EC, a broad-spectrum pyrethrinoid insecticide (PACHA 25EC: acetamipride 10 g/l and lambda-cyhalothrin 15 g/l, Savana, France) at a concentration of 5 ml/l and at a dose of 2 litres/tree. At 20–30 min after application using the knock-down insecticide with a mechanized knapsack sprayer, trees or branches were shaken and all insects that fell on a material sheet of 10 × 10 m size previously spread under the trees were collected, and sorted under a binocular microscope. They were preserved by species in vials filled with 55% alcohol. Lepidopteran samples were conserved in paper envelopes.

Twig and stemborers

At each site, two trees showing severe stemborer infestation were felled. Attacked trunks and twigs were cut into pieces of 80 cm size and brought back to the laboratory and maintained at an ambient temperature of 28°C until the emergence of adult insects, which were subsequently sorted and handled as above.

Insect identification

All insect specimens were cross-checked and reference samples submitted for determination at the Biosystematics Unit of the International Institute of Tropical Agriculture (IITA), Cotonou, Benin, where voucher specimens were stage-mounted and retained in the arthropod reference collection.

Results

Relative importance of insect fauna collected on shea trees

From June to October 2010, regular collections on 180 randomly chosen shea nut trees at six sites in central and northern Benin led to the collection of a total of 196 samples and 1415 specimens representing at least 61 insect species distributed in 8 orders, 36 families and 56 genera. Figure 2 shows the relative importance of each insect order. It appeared that insect orders such as Coleoptera, Heteroptera, Homoptera, Lepidoptera and Orthoptera that contained pest species were the most important according to genera diversity. However, some orders such as Hymenoptera, Dictyoptera and Diptera (Syrphidae) that generally contain predators or parasitoids were also encountered.

Shea tree foliage-inhabiting insects

The 996 insect specimens collected from shea tree foliage belonged to 8 orders, 29 families, 45 genera and at least 47 species. Twenty-nine insects were identified to the species level. Table 2 shows the relative importance of foliage insects at each sampling period. This table also presents the list of the inventoried insects in shea tree foliage in Benin, the localities in which they were inventoried and the periods (month) of their census.

Shea fruit insects

The 376 insect specimens collected on or within shea fruits belonged to 3 orders, 6 families, 10 genera and at least 11 species. Seven insects were identified to

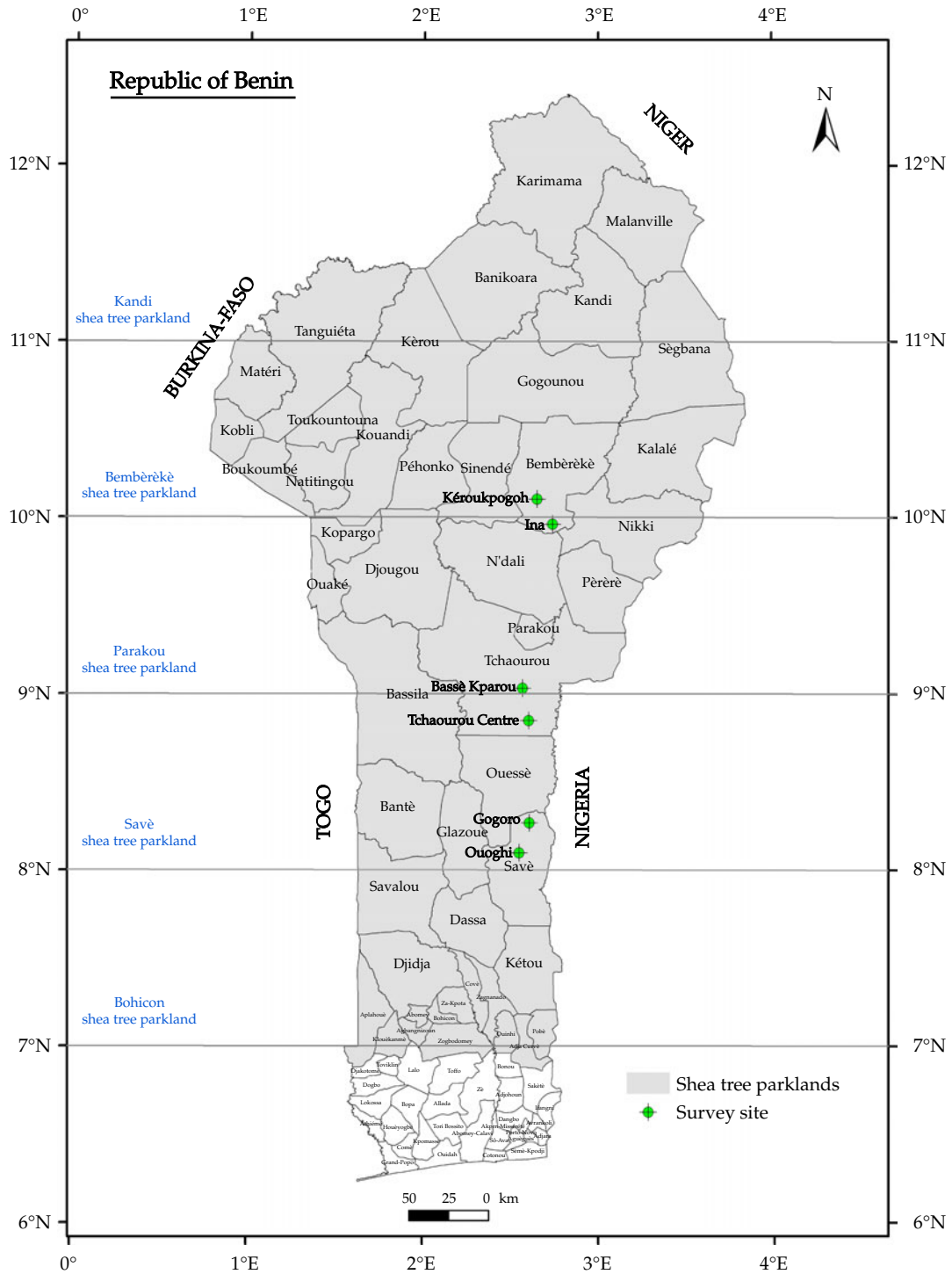

Fig. 1. Survey sites in Benin (a colour version of this figure can be found online at http://www.journals.cambridge.org/jti).

the species level. The Coleoptera order was the most important, with four families and seven genera. The majority of fruit insects (nine species) were collected in the pulps of fallen decomposing fruits. Two species feed on mature almonds that fall to the floor. Only one species of cochineal was recovered on the epidermis of immature shea fruits on the tree. Table 3 provides information related to all the species.

Shea twig and stemborers

The 41 insect specimens collected on shea twigs and stems belonged to only one order, two families, two

Table 1. Study area characteristics*

Characteristics	Bembèrèkè district		Savè district		Tchaourou district	
Villages	Ina	Kéroukpogoh	Ouoghi	Gogoro	Tchaourou Centre	Bassè Kparou
Geographic co-ordinates	09°58′08N 02°44′42E	10°06′55N 02°39′01E	08°06′16N 02°33′00E	08°16′36N 02°36′44E	08°51′29N 02°36′19E	09°02′26N 02°34′12E
Rainfall	An average annual rainfall of 1000 mm distributed over a rainy season from May to October		An average annual rainfall of 1150 mm distributed over two rainy seasons from mid-March to mid-June and August to November		An average annual rainfall of 1150 mm distributed over two rainy seasons from mid-March to mid-June and August to November	
Main soils	Tropical ferruginous		Tropical ferruginous		Tropical ferruginous	
Main crops	Cotton, maize, sorghum, yam, livestock products		Cotton, maize, cassava, yam		Cotton, maize, peanuts, yam	
Plantations	Cashew, teak		Cashew, teak		Cashew, teak	
Natural agroforestry trees	Shea, locust bean		Shea, locust bean		Shea, locust bean	
Fallow periods	5–10 years or more		5–10 years		5–10 years	
Dominant ethnic groups	Bariba, Bô and Gando		Nago, Mahi and migrants (Fon, Wama)		Nago, Bariba and migrants (Fon, Wama)	

*Sources: Gnanglè (2005) and authors' own data (2010).

genera and three species: *Sphenoptera laplumei* Kerremans (Coleoptera: Buprestidae), a shea branch insect and the stemborers *Neoplocaedaerus denticornis* (Fabricius) and *N. iridescens* (Atkinson) (both Coleoptera: Cerambycidae).

Discussion

A good knowledge of shea insects is the first step in the development of integrated management strategies against the most damaging insect pests. The results of the present survey show that in Benin, 56 genera of shea insects were identified while 53 and 33 genera were identified by Dwomoh (2003) and Odebiyi *et al.* (2004), respectively, in Ghana and Nigeria. Insects of the mantid family in this survey were classified in the Dictyoptera order, whereas Dwomoh (2003) and Odebiyi *et al.* (2004) classified them in the Hymenoptera and Orthoptera orders, respectively. The results of this survey also show the existence of a second genus of shea stemborers in Benin (*Neoplocaedaerus*) in addition to the *Pachydissus* genus discovered by Douro Kpindou and Djègui (personal communication) during their study. The discovery of a second shea stemborer genus explains the extent of stemborer-related damage in the parkland.

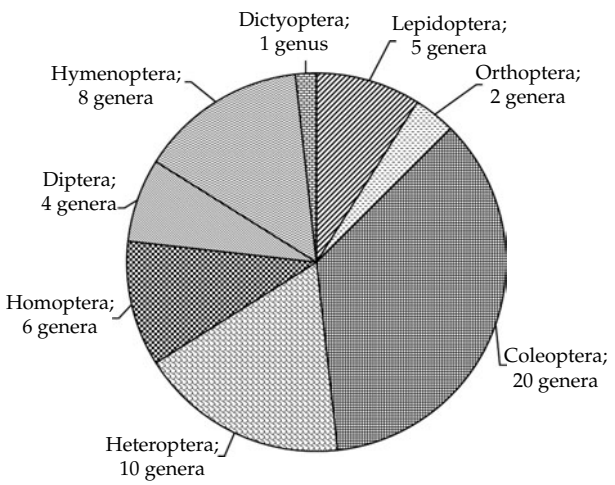

Fig. 2. Relative importance of insect orders associated with shea trees in Benin

Among foliage insects, some were present throughout the survey period (mid-July to mid-October 2010). These are *Oecophylla longinoda*, *Tanymecus* sp., *Rhinia* sp., *Sphodromantis* sp. and *Mantis* sp. Others were present in all the three districts (Savè, Tchaourou and Bembèrèkè). These are *Himatismus senegalensis* Haag-Rutenberg (Coleoptera: Tenebrionidae), *Xerophyllum platycorys* (Westwood) (Orthoptera: Tetrigidae), *Tanymecus* sp. (Coleoptera: Curculionidae), *Rhinia* sp. (Diptera: Calliphoridae), *O. longinoda* (Latreille), *Camponotus* sp. (both Hymenoptera: Formicidae), *Sphodromantis* sp., *Mantis* sp. (both Dictyoptera: Mantidae) and *Cirina forda* Westwood (Lepidoptera: Saturniidae). As for the shea stemborers, they were present in all the three districts and their larvae and damage were visible throughout the survey period.

The defoliator *C. forda* and the stemborer *Neoplocaedaerus* spp. are pest species that have

Table 2. Shea foliage insects inventoried in Benin

Order	Family	Species	Number of collected specimens in Mid-July	End-August	Mid-October	Localities	Periods
Coleoptera	Alleculidae	*Alogista serricorne* Kolbe	18	12	0	Ouoghi, Bassè Kparou and Kéroukpogoh	July and August
	Bruchidae	*Caryedon* sp.	6	0	0	Bassè Kparou	July
	Cantharidae	*Ichthyurus* sp.	68	0	0	Ouoghi, Gogoro, Bassè Kparou, Ina and Tchaourou Centre	July
	Chrysomelidae	*Monolepta* sp.	12	0	0	Bassè Kparou	July
		Syagrus sp.	38	10	0	Ouoghi, Gogoro, Bassè Kparou, Ina and Tchaourou Centre	July and August
	Curculionidae	*Proictes curvipes* Hustache	8	0	0	Tchaourou Centre and Kéroukpogoh	July
		Tanymecus sp.	66	56	8	Ouoghi, Bassè Kparou, Ina, Tchaourou Centre and Kéroukpogoh	July to October
	Elateridae	*Aeoloderma* sp.	18	0	0	Bassè Kparou and Tchaourou Centre	July
	Staphylinidae	*Paederus sabaeus* Erichson	0	0	16	Ouoghi	October
	Tenebrionidae	*Himatismus senegalensis* Haag-Rutenberg	50	0	0	Ouoghi, Bassè Kparou and Ina	July
		Paramarygmus femoralis Imhoff	4	0	0	Bassè Kparou	July
Dictyoptera	Mantidae	*Mantis* sp.	8	8	6	Ouoghi, Gogoro, Bassè Kparou, Tchaourou Centre, Ina and Kéroukpogoh	July to October
		Sphodromantis sp.	6	10	10	Ouoghi, Gogoro, Bassè Kparou, Tchaourou Centre, Ina and Kéroukpogoh	July to October
Diptera	Calliphoridae	*Rhinia* sp.	52	24	8	Ouoghi, Bassè Kparou, Ina, Tchaourou Centre and Kéroukpogoh	July to October
	Syrphidae	*Ischiodon aegyptius* Wiedemann	0	6	0	Ina and Kéroukpogoh	August
	Tephritidae	*Ceratitis cosyra* (Walker)	0	4	0	Gogoro and Kéroukpogoh	August
		Leucotaeniella guttipennis Bezzi	0	2	0	Kéroukpogoh	August
Heteroptera	Coreidae	*Cletus* sp.	4	0	0	Tchaourou Centre	July
		Pseudotheraptus devastans Distant	2	0	0	Bassè Kparou and Tchaourou Centre	July
	Lygaeidae	*Dieuches* sp.	32	0	0	Bassè Kparou, Ina and Tchaourou Centre	July
	Pentatomidae	*Acrosternum miliaris* (Klug)	0	4	0	Kéroukpogoh	August
		Amaxosana punctata Distant	4	2	0	Tchaourou Centre	July and August
		Macrina juvenca Burmeister	0	2	0	Kéroukpogoh	August

Table 2. *Continued*

Order	Family	Species	Number of collected specimens in Mid-July	End-August	Mid-October	Localities	Periods
		Myrochea aculeata (Westwood)	6	0	0	Gogoro	July
	Pyrrhocoridae	*Dysdercus voelkeri* Schmidt	6	0	0	Bassè Kparou and Ina	July
	Reduviidae	*Lisarda vandenplasi* Schouteden	4	0	0	Ouoghi	July
		Pephricus pellucida (Westwood)	4	2	0	Bassè Kparou	July and August
Homoptera	Cicadellidae	*Batracomorphus* sp.	10	8	0	Bassè Kparou and Tchaourou Centre	July and August
		Cicadella nigrifrons Distant	2	0	0	Bassè Kparou	July
		Coelidia sp.	12	0	0	Tchaourou Centre and Ina	July
	Fulgoridae	*Zanna tenebrosus* Fabricius	4	0	0	Tchaourou Centre	July
	Ricaniidae	*Ricania quinquifasciata* Stål	0	0	6	Kéroukpogoh	October
Hymenoptera	Anthophoridae	*Amegilla acraensis* (Fabricius)	2	4	0	Tchaourou Centre and Ina	July and August
	Braconidae	*Bracon* sp.	8	0	0	Bassè Kparou and Tchaourou Centre	July
	Formicidae	*Camponotus sericeus* (Fabricius)	6	4	0	Ouoghi, Gogoro and Tchaourou Centre	July and August
		Camponotus sp.	34	6	0	Ouoghi, Bassè Kparou and Tchaourou Centre	July and August
		Crematogaster sp.	6	0	0	Gogoro	July
		Oecophylla longinoda (Latreille)	50	34	14	Ouoghi, Gogoro, Bassè Kparou, Tchaourou Centre, Ina and Kéroukpogoh	July to October
		Pheidole sp.	114	22	0	Ouoghi and Kéroukpogoh	July and August
	Sphecidae	*Sphex* sp.	4	0	0	Ouoghi and Gogoro	July
Lepidoptera	Ctenuchidae	*Thyretes negus* Oberthür	0	2	0	Tchaourou Centre	August (adults)
	Noctuidae	*Achaea catocaloides* Guenée	0	2	0	Tchaourou Centre	August (adults)
	Pieridae	*Eurema desjardinsii regularis* Butler	0	2	0	Bassè Kparou	August (adults)
	Saturniidae	*Cirina forda* Westwood	0	10	0	Gogoro, Kéroukpogoh and Tchaourou Centre	June (larvae) and August (adults)
		Gonimbrasia hecate Rougeot	0	2	0	Kéroukpogoh	August (adults)
Orthoptera	Tetrigidae	*Xerophyllum platycorys* (Westwood)	14	0	0	Ouoghi, Bassè Kparou, Ina, Tchaourou Centre and Kéroukpogoh	July
	Tettigoniidae	*Habrocomes* sp.	0	8	0	Gogoro, Bassè Kparou and Tchaourou Centre	August

Table 3. Inventoried insects on shea fruits

Order	Family	Species	Fruit part attacked	Number of collected specimens per site					
				Savè		Tchaourou		Bembèrèkè	
				Ouoghi	Gogoro	Tchaourou Centre	Bassè Kparou	Ina	Kéroukpogoh
Coleoptera	Carabidae	*Neosiopelus* sp.	Pulp	0	13	0	0	0	0
	Histeridae	*Hister tropicalis* Marseul	Pulp	0	4	5	0	0	0
		Epitoxus circulifrons (Marseul)	Pulp	0	15	8	7	0	11
	Nitidulidae	*Epuraea* sp.	Mature almond	0	0	0	9	0	0
		Phenolia (*Lasiodites*) sp.	Pulp	7	18	24	13	6	12
			Mature almond	0	8	0	17	0	0
		Urophorus niditus Murray	Pulp	6	48	0	68	0	0
	Scarabaeidae	*Onthophagus* sp.	Pulp	0	0	0	6	0	0
Homoptera	Coccidae	*Udinia catori* (Green)	Immature fruit epidermis	0	0	20	0	0	0
Hymenoptera	Formicidae	*Crematogaster censor* Forel	Pulp	0	0	0	0	0	28
		Crematogaster kneri Mayr	Pulp	0	0	0	0	0	8
		Myrmicaria fumata Santschi	Pulp	0	0	0	0	0	15

already been identified on shea trees. Odebiyi *et al.* (2004) and Dwomoh *et al.* (2004) have started research on control methods against *C. forda*. In contrast, no published data are available on the control of shea stemborers. Future research on the main insect pests will need to establish integrated management methods to safeguard shea parklands. Control methods developed for cerambycid stemborers on some tree species in northern Africa, Asia and Europe can possibly be applied to control shea stemborers. These are:

(a) biological control with natural enemies, entomopathogen agents such as *Beauveria bassiana* and nematodes (Taketsune, 1983; El-Sebay, 1984; Luo, 1997; Sone *et al.*, 2007);
(b) chemical control with ovicide and larvicide insecticides such as Endosulfan and Diazinon spray against adults (Hashemi Rad *et al.*, 2005; López Pantoja *et al.*, 2008). The adults of beetles are very sensitive to insecticides and can be controlled at the field level if insecticide spray is managed correctly and at the right time (peak time when adults appear) (Hashemi Rad *et al.*, 2005).

However, the use of systemic insecticides to kill the stemborer larvae in shea trees should be considered only when all the other control options fail. This would avoid the problems of pesticide residues in the almonds and shea butter.

The method used for collection of foliage insects presents the following limitations:

(a) the insects that are found on the lower leaf surface (aphids and cochineals) cannot be detected;
(b) temporary insects that are not associated with the shea tree can be trapped.

In spite of these few limitations, our results were comparable to those obtained by Odebiyi *et al.* (2004) who used circular nets and vacuum cleaners. The fewer number of genera recorded by these authors can be explained by the fact that they were concerned only with the insect pest species.

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