

## The Urban termite fauna (Isoptera) of Jeddah City, Western Saudi Arabia

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**Abstract:** Recent field investigations on subterranean termites in Saudi Arabia showed the presence of a total of 19 species belonging to 10 genera categorized into 4 basic families (*Kalotermitidae*, *Hodotermitidae*, *Rhinotermitidae*, and *Termitidae*). Three families belong to the lower termites and the 4<sup>th</sup> belong to the higher advanced family *Termitidae*. Ten major species were reported from the metropolitan Jeddah city, which are considered endemic with one introduced species *Epicolotermes aethiopicus* that belongs to the dry wood termites which are believed to be inadvertently imported from country of origin with shipments of wood and timber. The main urban fauna within the city limits included 5 genera (*Epicolotermes*, *Psammotermes*, *Anacanthotermes*, *Microcerotermes*, and *Microtermes*). Among these four dominant species were considered permanent native (endemic) residents and represented (9 species or 90%) including *Microtermes najdensis* Harris which belongs to the higher termites (*Termitidae*), two harvester termites *Anacanthotermes ochraceus* and *A. vagans* and the sand termite *Psammotermes hybostoma* (Desneux). The rural (suburban) fauna on the marginal land is composed of 5 species including the former harvester termites, two sand termites *Psammotermes hybostoma* and *P. fuscofemoralis* and *Microtermes najdensis* which represent 50% of the rural fauna. All these species were predominantly subterranean feeding on a diverse variety of food sources of cellulosic origin on dead and living plants. The annual monetary losses in human properties have reached grave concern leading to initiate prophylactic and preventive measures.

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### 1.Introduction:

The subterranean termites have been indigenous organisms dominating huge areas in the tropics, subtropics and in both rich and poor savanna domains in the regions of Northern and Southern hemispheres. Many of these species prevail in a variety of landscape formations including *wadis* (valleys), plateaus; agricultural, horticultural orchards in addition to barren fallow uncultivated landscapes. **Badawi et al.** (1984a, b).

The soil in these domains varied greatly ranging from sandy, silty, loamy, clay and loose soil with varying degrees of organic matter (**Badawi et al.**, 1982, & **Sabine**, 2001). Practically all subterranean termites thrive best feeding on bizarre forms of food sources of cellulosic material arising from diverse different origins including dry dead plants, woods where lignin is predominant, cellulosic wastes including paper and cartons, dry herbaceous weeds, clothes of cellulosic origins. Other major structural damage on timber, wooden boxes, jute sacks, floor mats dry animal dung, litter feeding termites ie. dry camel dung and humus feeding termites (**Badawi et al.**, 1986 a, b; **Tracy et al.**, 1998.). Moreover, many living plants were also infested, including shrubs, bushes, ornamental trees,

orchard trees of date palms, citrus and mango trees (**Wood & Sands** 1978; **Faragalla**, 1983; **Faragalla**, 1988). Due to their ubiquitous, continued omnipresence and sustenance they have caused heavy infestations and huge monetary losses to human properties in warehouses, constructional timber wood, wood building materials, homes vintage woodworks of grave aesthetic values, book shelves, cupboards and even expensive commodities in private and government libraries and book stores. The annual remedial control and management procedures for losses valued to millions of dollars without including the actual cost of buildings and other construction facilities (**Nasr et al.**, 1978; **Nasr et al.**, 1980; **Su & Scheffrahn**, 1990; **Koehler**, 1998).

All termites are eusocial and composed of distinct casts including workers, soldiers, reproductive, queen, nymphs and larvae. *Isoptera* which are closely related to cockroaches thought to have evolved from cockroach-like ancestor 200 million years ago Krishna (1989). They are phylogenetically separated in two groups viz. the lower termites (*Mastotermitidae*, *Kalotermitidae*, *Hodotermitidae*, *Rhinotermitidae* and *Sternotermitidae*) and the most advanced higher termites (*Termitidae*). Moreover termites can be

grouped into 4 ecological types (**Nutting & Jones**, 1990) which is primarily based on where they live and the food they consume. Therefore the ecological groupings of termites include (dry wood, damp wood, harvester and subterranean termites).

The dry wood termites do not depend on the soil for moisture but acquire it from metabolically generated water from their food resources such as wood posts, tree stumps and wood houses. The other ecotype is the damp wood termites which do not require soil contact for the moisture needed for survival but thrive on the dead, damp, rotten logs (**Krishna**, 1989). The mound builders, the harvester termites store food (cellulosic materials) and/or harvest fungus that will be grown in epigeic or above ground stores after continued foraging (**Collins**, 1981; **Darlington**, 2000). Only the subterranean termites needed continued contact with soil to complement their watery and moisture needs.

Therefore the subterranean termites became the most destructive to human's property, carpentry, stored products, buildings and wooden infrastructure costing billions of dollars annually (**Su & Scheffrahn**, 1990).

The termite foraging or swarming behavior of dispersal for food or for establishing new nests and colonies has been documented thoroughly. Some of the procedural swarming behavior may either be indoors or outdoors and that is considered the early indication to homeowners that they already have subterranean termite infestation (**Grace**, 1991; **Eggleton & Bignell**, 1995; **Faragalla & Al-Ghamdi**, 1999; **Su & La Faye**, 1999; **Nash et al.**, 1999; **Whitford**, 1999; **Duryea**, 2011; **Stewart**, 2009; **Suiter et al.**, 2010; **Miller**, 2010). Due to their innate, cryptic fitness, insidious and secretive feeding behaviors, it is almost impossible to detect their presence unless clear symptoms were clearly evident including earth tubes and tunnels or galleries that indicate their heavy infestation incurred, hence the wood material would be hollowed inside filled with fine earth particles. (**Arshad**, 1981, **Al-Ghamdi & Faragalla**, 1998; **Chouvenc & Su**, 2012).

Quite a number of general and species have been endemic as permanent residents during decades of the past time with new inadvertently introduced species from other areas as immature or adult species inside timber and wood shipments. (**Gay**, 1967).

Many termite species live in rural areas however a great many species live in urban or suburban territories including both native (endemic) and some introduced cosmopolitan species (**Reginald & Dianese**, 2001). In addition to that their fauna is virtually unknown and never been authentically documented in most regions. The published data usually refer only to common termite species

depicted and described as notorious, noxious pests. In the Western region of Saudi Arabia, few systematic field investigations were available only for some metropolitan few cities where grave damage have been reported on wood used in construction or infrastructure or in heavy infestation on agricultural crops (field and vegetables) including maize, sorghum, sweet peppers, tomatoes, okra and millets. (**Badawi et al.**, 1986 c; **Faragalla et al.**, 1998).

Based on the unprecedented widespread rate of accelerated urbanization with the actual encroachment on marginal uninhabited land has led to current city sprawl during the last two decades (**Faragalla**, 1988). These outskirts on the periphery of the city limits have been subjected to heavy termite infestation and foraging becomes more rampant in newly constructed lavish villas and residential quarters. Due to these situation severe monetary losses strengthened by citizens complaints and public cry is becoming louder from concerned residents. In response to that many curative (prophylactic and preventive) measures have been enacted to curb the advancement of the ensuing menace but no clear indication of an appreciable success that satisfies and quenches the citizen's complaints is yet affected.

The aims of this study were to document the urban endemic subterranean termite fauna within the metropolitan Jeddah city as compared with the rural sub urban termite fauna that dwell on the marginal land of the out skirts of Jeddah city premises.

## 2. Material and Methods

Jeddah historically is an old metropolitan city established since more than 1000 years ago as the main port on the Red Sea Coast, Western Saudi Arabia. Its population is about 4-5 million people with a huge number of migration from the rural Bedouin regions. Its importance becomes as a cosmopolitan city since it represents the main entry port to the Holy Mosque in Makkah Al-Mukarramah and Al-Madeenah Al-Monawarah where annually more than 5 million people go through the city for Ummrah and Hajj rituals. Geographically, Jeddah lies at altitude 21° 31' 00" N and Longitude 39° 13' 09" E with its elevation above sea level at 34 meters (111 feet) validated against 14 meters (46 feet). The annual rainfall is about 5 inches, however many years passed dry without any rain precipitation. (Free Encyclopedia).

Originally Saudi Arabia is one of the driest countries of the World and the nationwide average temperature is 18°C (64°F). The climate under Kopper's climate classification, winter 15°C (59°F) midnight to 25°C (77°F) afternoon. Summers often breaking 43°C (109°F) mark the afternoon and

dropping to 30°C (86°F) in the evening. Rain is generally sparse about 3 inches (7.6cm.) A part from topographical factors, Saudi Arabian climate is also affected by tropical winds which cause monsoons in the West and Southwest regions which occur during summer months. In the South tropical continental winds blow particularly in winter often accompanied by sandstorms.

The climate is principally determined by the southerly shift in wind pattern during winter months which brings rain and cool weather.

Study sites: Two distinct natural habitats were chosen for carrying the field monitoring of the subterranean termites surveillance for inventory documentation.

**The first site:** is a fallow natural habitat within the city limits in the old international airport space which was deserted with huge empty land where annual weeds and grasses grow covering the experimental site. The soil type included clay to sandy fine loam soil.

**The 2<sup>nd</sup> site:** Abra q Al Ragammah is an enclave of a marginal land east of the city separated by low mountain range. The area is basically a fallow natural habitat covered with perennial shrubs and bushes with low annual grasses and weeds where huge numbers of Bedouins find a refuge for their camel herds making widely separated mushrooming tent city. The soil texture and structure varies between sandy, clay, loamy and calcareous soil.

The field surveys and termite recovery took place during morning hours and the recovered species collected from infested cellulosic material (wood, cartons, paper, dry weeds, etc) and also from small mounds made by the harvester termites. The recovered specimens were registered then kept in vials preserved in 70% alcohol and taken to the lab for further investigations. Some samples of the recovered species were kept at the biology and the entomological collection of the college of science and the college of medicine of King Abdul-Aziz University.

### 3.Results

Recent surveys conducted by the authors and other collectors including some pest control firms and government specialists have reported the presence of about 19 subterranean termite species. Although the documentation and authenticity of the endemic termite fauna is not yet complete in most regions of Saudi Arabia, however it is categorized into 4 basic families, 10 genera and 19 species (Table 1).

At least 10 species live within the metropolitan Jeddah city premises (Table 2). Only

one species has been introduced which is *Epiculotermes aethiopicus*, a dry wood termite believed to be imported with wood or timber from country of origin. The main fauna of urban subterranean termites genera within the city limits included 5 genera *Epiculotermes*, *Psammotermes*, *Anacanthotermes*, *Microcerotermes*, and *Microtermes*. In the first site, nine species were most present among which four species were considered permanent endemic (native local) residents which represent (9 species or 90%) including the ubiquitous *Microtermes najdensis* that belongs to the advanced family (*Termitidae*), two harvester termites *Anacanthotermes ochraceous* & *A. vagans* (family: *Hodotermitidae*) ( Burmeister) and the sand termite (family: *Rhinotermitidae*) *Psammotermes hybostoma* Desneux *P. fuscofemoralis* and *Microcerotermes gabrielis*.

The main permanent residents of the rural fauna (in the outskirts of the city limits recovered from the 2<sup>nd</sup> site on the marginal land) in the newly erected suburbs is composed of 5 species including both species of the harvester termite *Anacanthotermes ochraceous* and *A. vagans*, two sand termite species *Psammotermes hybostoma* and *P. fuscofemoralis* and *Microtermes najdensis* which they represent 50% of the total fauna. The natural habitat of some species is not yet documented but most probably they spread wherever they get the opportunity to live and thrive.

Generally, only 3 species *Psammotermes hybostoma* and *Microcerotermes gabrielis* and *Microtermes najdensis* were considered major wood pests, damaging especially all wood and timber, highly valued aesthetic furniture and structural damage. Both species of the harvester termite *Anacanthotermes ochraceous* and *Anacanthotermes vagans* used to build low mounds about 2-4 inches (5.08-10.16 cm) above soil level in fallow land in gardens and lawns covering the landscape. However, workers from both species were observed foraging after sunset on irrigated lawns damaging living plants or hiding pieces if dry herbaceous weeds and small plants within their low level mounds. The advanced family *Termitidae* included the main 3 species *Microtermes najdensis* (infesting living green plants), *Microtermes yemenensis* and possibly *Trinervitermes saudiensis*. They have established themselves as leaf-litter, grass-feeders and most probably humus feeders. Some species including *Microcerotermes gabrielis* and *Microcerotermes parvulus* seemed to be generalized feeders thriving on humus and decaying wood, grasses and other litters (Table 2).

**Table 1: Subterranean termites recovered in Jeddah, Saudi Arabia (1990-2012)**

Category Super family and family	Subterranean termites species
I. Family	<i>Kalotermitidae</i> (Dry wood termite) <i>Epicalotermes aethiopicus</i>
II. Family	<i>Hodotermitidae</i> (harvester termite) <i>Anacanthotermes ochraceus</i> <i>A. vagans</i> <i>A. ubachi</i> ??
III. Family	<i>Rhinotermitidae</i> Super family: <i>Psammotermitinae</i> <i>Psammotermes hybostoma</i> ? ( Sand termite) <i>P. Fuslofemoralis</i> ? <i>Heterotermes aethiopicus</i>
IV. Family	<i>Termitidae</i> (Advanced termite) Super family: <i>Microcerotermes diversus</i> <i>M. gabrielis</i> <i>M. parvulus</i> <i>M. buttikeyi</i> <i>Amitermitinae</i> <i>Amitermes messinae</i> <i>A. vilis</i> <i>A. stephensoni</i> <i>Eremotermes sabaenus</i> <i>Angulitermes arabiae</i> <i>Macrotermitinae</i> <i>Microtermes najdensis</i> <i>M. yemenensis</i> <i>Trineritermes saudiensis</i>

**Table 2: The subterranean termite species permanent residents in the urban localities in Jeddah City. Pest status refers to the local damage, mounds are restricted to only one family (*Hodotermitidae*)**

Species	Origin	Feeding habits	Pest Status
<i>KALOTERMITIDAE</i> <i>Epicalotermes aethiopicus</i>	introduced	Dry wood	Major wood and timber (++)
<i>RHINOTERMITIDAE</i> <i>Psammotermes hybostoma</i> <i>P. fuscofemoralis</i>	endemic locally	Wood, carton, construction material	(+++) (+++)
<i>HODOTERMITIDAE</i> <i>Anacanthotermes ochraceus</i> <i>A. vagans</i> <i>A. ubachi</i> ??	endemic endemic endemic?	Small mound builders Dry wood Small mound builders, dry grass?	(++) (++)
<i>TERMITIDAE</i> Super family": <i>Macrotermitinae</i> <i>Microtermes najdensis</i> <i>M. yemenensis</i> <i>Microcerotermes</i> <i>Microcerotermes gabrielis</i> <i>Microcerotermes parvulus</i>	endemic endemic local local	Leaf litter, dry wood Grass, litter, and dry wood Humus feeder General feeders*	(+++) (+) (++) (+)
Pest status (+) Low infestation (++) mild infestation (+++) heavy infestation			
(*) Feeding on decaying wood, dry grasses humus and litter, being generalized feeders on wood or litter – feeding and humus –feeding			

The major collection of the subterranean termite species belongs to 5 genera including *Microtermes*, *Amitermes*, *Microcerotermes*, *Anacanthotermes* and *Psammotermes* feeding on a variegated number of hosts of dry cellulosic origin and damaging living plants (Table 3). As shown in

(Table 3) there is a wide range of material infested with these termites to the extent of causing great monetary losses in human's property. Quite a number of living plants of agricultural, horticultural, gardens, lawns and field crops usually infested with subterranean termites especially by *Microtermes* spp.

and mostly by *Microtermes najdensis*. This infestation is characterized by either presence of earth tunnels and galleries observed on stems and branches of trees or clearly apparent as wilting and drying up

of seedlings of growing horticultural plants including green peppers, okra, tomatoes and agricultural crops such as sorghum, millets and maize.

**Table 3: Major subterranean species as resident in the rural (suburban) locality in the outskirts of Jeddah City Western Saudi Arabia 2012**

Species	Origin	Feeding habits	Pest Status
<i>RHINOTERMITIDAE</i>			
<i>Psammotermes hybostoma</i>	endemic	Wood, carton, constructional material	(+++)
<i>P. fuscofemoralis</i>	endemic	Wood, timber, carton, etc	(+++)
<i>HODOTERMITIDAE</i>			
<i>Anacanthotermes ochraceus</i>	endemic	Dry herbaceous grasses weeds, date palm stems	(++)
<i>A. vagans</i>	endemic	Dry herbaceous grasses weeds, date palm stems	(++)
<i>TERMITIDAE</i>			
<i>Microtermes najdensis</i>	endemic	Dry weeds and grasses wooden sticks, green plants	(+++)
Pest status (+) Low infestation (++) mild infestation (+++) heavy infestation			

**Table 4: Subterranean termite species recovered from host plants (dry-cellulosic material) and (green living plants) in Jeddah, Western Region Saudi Arabia.**

DRIED CELLULOSIC ORIGIN	<i>Microtermes</i>	<i>Amitermes</i>	<i>Microceroterme</i> <sub>s</sub>	<i>Anacanthoterme</i> <sub>s</sub>	<i>Psammotermes</i>	
Date palm stems <i>Phoenix dactylifera</i> L.		X	X	X	X	Presence of live workers or earth tunnels
Date Palm leaves		X	X	X	X	"
Athl: <i>Tamarax aphylla</i> L.	X	X	X	X	X	"
Arar: <i>Juniperus procera</i> L.					X	"
Talh ( <i>Acacia</i> ) <i>Acacia arabica</i> (Lam) Wild			X			"
<i>Eucalyptus Eucalyptus</i> spp.					X	"
Citrus <i>Citrus medical</i> L.	X				X	"
Almond <i>Prunus amygdalis</i> Batch	X	X	X	X	X	"
Dry grasses			X		X	"
Wood posts	X	X	X	X	X	"
Wood works (Door, windows,etc)		X	X	X	X	"
Wooden doors, windows etc.		X	X	X	X	"
Cartons		X	X	X		"
Books and papers	X	X	X	X	X	"
Carpets and rugs				X		"
Jute sacks		X	X	X	X	"
Textiles			X	X		"
Animal dung					X	"
Miscellaneous (non-cellulosic) materials					X	"
<b>Green Living Plants</b>						Presence of live workers or tunnels
Red Pepper <i>capsicum annum</i>	X					
Mango <i>Mangifera indica</i> L.	X					
Guava <i>Psidium Juajava</i> L						
Citruses <i>Citrus sinensis</i> Obseck	X					
Grapevine <i>vitis vinifera</i> L.	X					Earthen tubes cover all plant
Sorghum <i>Sorghum vulgare</i> Pers.	X					tunnels in stem and roots
Maize <i>Zea mays</i> L.	X					"
Ground nuts, <i>Arachis hypogaea</i> L.	X					destruction of plant roots
Okra <i>Hibiscus esculentus</i> L.	X					"
Tomatoes <i>Lycopersicum esculentus</i> Mill.	X					"
Eggplant <i>solanum esculentus</i> Nees	X					"
Green peppers <i>Capsicum frutescens</i> L.	X					"
Abutilon <i>Abutilon figaratum</i>	X					"
Millets <i>Pennisetum glaucum</i> L.	X					"
Bermuda grass <i>Cynodon</i> (*) <i>dactylon</i> L.				X		Live workers observed foraging in the dark
Linie <i>Citrus lima</i> Lun.	X				X	earth tunnels cover plant stem
Banana <i>Musa</i> sp.	X					"
Christ-throne <i>Zizyphus spina christi</i> (L.) Wild.	X					"

#### 4. Discussion

Although there is a heavy infestation by subterranean termites within the city limits of Jeddah and its neighboring suburbs but the main infestation is restricted to wood and timber used in buildings and construction. However, some of them play a vital role in returning metals from the decomposition and decaying of organic matter from cellulosic waste hence completing the natural nutrient cycle. The permanent urban fauna seems to be formed from termites of 3 origins: (1); species that are already present in the natural habitat but able to survive all soil manipulation including digging, plowing, movement and constructional maneuvering practices. (2); some species that live on nearby close natural fallow barren areas close to the city limits and due to the encroachment on the marginal land with increased establishment of housing and settlements quarters together with more irrigation facilities they were able to invade these new favored habitats. (3); species that were inadvertently introduced by man and was not detected by the vigilant eyes of the quarantine and agricultural technical staff and customs. In this context, the termite dry wood *Epicalotermes aethiopicus* which has been reported from both Jeddah and Makkah Al-Mukkaramah cities have devastated completely many high storey buildings destroying all doors, windows, highly valued woodworks and expensive furniture without having any contact with the underground soil, as a result of (pers. comm.).

It is becoming evident that as a result of the expansion of city sprawl and the establishment of new settlements in the marginal land due to the migration of Bedouins from rural areas, have led to the huge infestation by subterranean termites which might lead to the urbanization of the already rural termites living on sparse vegetation and barren fallow domains with few food sources to live on. However with more expansion of settlements in the city outskirts more infestation and urbanization of termites will occur which will evidently lead to a new structure of a diverse fauna of subterranean termites that will affect the diversity and structure of the urban fauna.

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