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Review Article

Diversity of Termites Fauna in District Swabi

Tanveer Ahmad*

Department of Agriculture (Entomology), University of Swabi, Khyber Pakhtunkhwa, Pakistan

ABSTRACT

Termites belong to the order *Isoptera*, occurred throughout the world except the artic regions. Most of the reported species are from the tropical countries, followed by subtropical and humid climatic condition countries. In south east Asia the diversity of termites is enough well known. They are the source of causing economic damages to the human belongings but also play an important role in the forest by maintaining the nutrients. Termite's diversity of district Swabi is poorly known. Our study resulted 67% from the genus Heterotermes, 17% from the genus Microcerotermes and 16% from the genus Odentotermes. Further analysis of the collected samples is recommended.

Keywords: *Isoptera*; Termites; Heterotermes; Odontotermes

INTRODUCTION

Termites are social insects that are classified at the taxonomic rank of infra order *Isoptera* or as epifamily termitidae with in the cockroach order. About 3,106 species are currently described, with a few hundred more left to be described. Although these insects are often called white ants but they are not ants. They are small, white, tan or black insect that can cause severe destruction to wooden structure. Termites belong to an ancient insect group that dates back more than 100 billion years. The Latin name *Isoptera* means "equal wings" and refer to the fact that the front set of wings on a reproductive termite is similar in size and shape to the hind set. Termites are widely distributed throughout Pakistan, especially in Khyber Pakhtunkhwa region.

They are either soil or wood inhibiting termites. The climate of Khyber Pakhtunkhwa is most favorable for production of different fruits, food and sugar crops. Among fruits, peach, apricot, citrus, guava, plum, apple and persimmon are widely grown and are attacked by different insect pests, but termite is the most serious one, which inflicts substantial losses to farming community. Genus, Heterotermes, Coptotermes and Odontotermes have been observed to infest apricot, pear, plum, peach and lemon causing different ranges of infestations [1]. In Pakistan, 53 termite species have been described but only 11 species have been found to cause economic damage. Microtermes mycophagus D. is a fungus growing termite and is more common in arid/desert localities of Pakistan [2]. It has been reported from various districts of Pakistan like Multan, Bahawalpur, Bahawalnagar, Mianwali, Bhakkar, Lahore, Muzaffargarh, Khanpur, Chichawatni, Pirawala, Jhelum, Sibi, Karachi and Hyderabad [3]. This species has been found to cause serious damage to buildings, agricultural crops and trees [4,5].

In developing countries like Pakistan, severe termite infestation to structures is often tolerated because the cost of control may exceed the replacement of damaged lumber or renewal costs. But with the increase of earnings and living standards in big cities of Pakistan, the trend has changed, and people are now very conscious of termite damage to their valuable structures. Termites are a delicacy in the diet of some human cultures and are used in many traditional medicines. Several hundred specie are economically significant as pest that can cause serious damage to plantation forest, building, wide range of crops are affected by them such as sugarcane, rice, maize, wheat, sorghum, groundnuts, coffee, tea, cocoa, yam, cassava, cotton and orchards [6].Termites have been regarded as serious pests that attack a wide range of agricultural crops, forest trees and buildings in Western Ethiopia [7-9]. Most of the termite spp. is Macrotermssubhyalinus (Rambur) and Microtermesadschaggae (Sjosted) in this area [10]. They are subterranean in nature which is difficult to locate and destroy [11]. Termites attack caused up to 62% and 36% reduction in yields of hot pepper and maize, respectively. In addition, it causes severe soil degradation by reducing vegetation and leaving the soil surface barren and exposed to the elements of erosion [12].The consequences of

Correspondence to: Tanveer Ahmad, Department of Agriculture (Entomology), University of Swabi, Khyber Pakhtunkhwa, Pakistan, E-mail: ramzan.mnsua@gmail.com

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termite infestation reduce farm productivity, increased land degradation and vulnerability of resources of poor farmers. As a result, farmers were forced to abandon their farmlands and migrate to their surroundings [13]. The termites gut has inspired various research efforts aimed at replacing fossil fuels with cleaner, renewable energy sources. Termites are efficient bioreactors, capable of producing two hydrogen's from a single sheet of paper [14].

Termites are known to cause tremendous losses to finish and unfinished wooden structures in buildings, besides loss in agriculture and forestry crops [15]. For controlling termites, synthetic termiticides have been used for a long time. At the advent of termite control, persistency of the chemical was regarded to be a boon, as it provided protection for longer periods. But soon it was realized that, chlorinated, persistent type of insecticides posed a great hazard to environment, due to their residual effects. Therefore, some of the termiticides like DDT, aldrin, dieldrin, heptachlor and BHC were banned and a search for other less persistent insecticides was started. Now a day's chloropyriphos has been successfully employed as soil treatments against subterranean termite. Continuous use of synthetic termiticides for soil as well as crop treatment has been allowed for the present time because of the lack of any effective substitute. World over, research is going on for an effective formulation, which can reduce the damage by termites, at the same time being environmentally acceptable. The properties of Jatropha oil and its components against the termites using different additives have been evaluated against the test termite, Microcerotermesbeesoni [16].

LITERATURE REVIEW

Diversity and distribution

Termites are found on all continents except Antarctica. The diversity of termite's species is in North America and Europe (10 species known in Europe and 50 in North America), but is high in South America, where over 400 species are known. Of the 3000-termite species currently classified, 1000 are found in Africa, where mounds are extremely abundant in certain regions.

In Australia, all ecological groups of termites (Dampwood, Drywood, subterranean) are endemic to the country, with over 360 classified species. In Asia, there are 435 species of termites, which are mainly distributed in china. Within china, termite's species restricted to mild tropical and subtropical habitat south of the Yangtze River. Termite's fauna in Pakistan is fairly well known and 50 species of termites have been recorded so far [17].

Due to their soft cuticles, termites do not inhabit cool and cold habitat. There are three ecological groups of termites: Dampwood, Drywood and subterranean. Dampwood termites are found only in coniferous forests and Drywood termites are found in hardwood forests; subterranean termites live in widely diverse areas [18].One species in the Drywood group is the West Indian Drywood termite (Cryptotermis brevis), which is an invasive species in Australia in Table 1 [19].

S. No.	Country name	Estimated number of species
1	Europe	10
2	North America	50
3	South America	400
4	Australia	360
5	Africa	100
6	Asia	435

Table 1: Diversity of termites in various continents.

Biology and life cycle

Termites are often compared with the social Hymenoptera (ants and various species of bees and wasps), but their differing evolutionary origins result in major differences in life cycle. In the eusocial Hymenoptera, the workers are exclusively female (both worker and the queen) and diploid and developed from the fertilized eggs.

In contrast, worker termites, which constitute the majority in a colony, are diploid individual of both sexes and developed from fertilized eggs. Depending on species, males and females' worker may have different roles in a termite colony [20].

The life cycle of termites begins with eggs (Figure 1) but is different from that of a bee or ant in that it goes through a developmental process called incomplete metamorphosis, with egg, nymph and adult stages [21].

Nymphs resemble small adults and go through a series of molt as a growth. In some species, egg goes through four molting stages and nymph goes through three. Nymph first molt into worker, and then some worker go through further molting and become soldier or alates; workers become alates only by molting into alates nymph.

The development of nymph into adult can take months; the time depend on food availability, temperature, and the general population of the colony. Since nymph are unable to feed themselves, worker must feed them, but worker also take part in the social life of the colony and have certain other tasks to accomplish such a foraging, building or maintaining the nest or tending the queen. Pheromone regulate the caste system in termite's colonies, preventing all but a very few of the termites from becoming fertile queen [22].

Termite's alates only leaves the colony when a nuptial flight takes place. Alates males and females pair up together and then land in search of a suitable place for a colony. A termite king and queen do not mate until they find such a spot. When they do, they excavate a chamber big enough for both close the entrance and proceed to mate [23].

After mating, the pair never go outside and spend the rest of their lives in the nest. Nuptial flight time varies in each species. For example, alates in certain species emerge during the day in

summer while others emerge during the winter. The naptual flight may also begin at dust, when the alates swarm around areas with lot of lights.

The time when naptual flight begins depending on the environmental condition, the time of day, moisture, wind speed and precipitation [24]. The member of termites in a colony also varies, with the larger species typically having 100-1,000 individuals. However, some termite's colonies, including those with large individuals, can number in the millions [25].

The queen only lay 10-20 egg in the very early stages of the colony but lays as many as 1,000 a day when the colony is several years old. At maturity, a primary queen has a great capacity to lay eggs. In some species, the mature queen has a greatly distended abdomen and may produce 40,000 eggs a day.

The two mature ovaries may have some 2,000 ovaries each. The abdomen increases the queen's body length to several times more than before mating and reduces her ability to move freely; attendant workers help. The king grows only slightly larger after initial mating and continues to mate with the queen for life (a termite queen can live between 30 to 40 years); this is very different from ant colonies, in which a queen mates once with the male(s) and store the gametes for life, as the male ants die shortly after mating.

If a queen is absent, a termite king produces pheromones which encourage the development of replacement termite queen. As the queen and king are monogamous, sperm competition does not occur [26]. Termites going through incomplete metamorphosis on the path to becoming alates form a sub caste in certain species of termites, functioning as potential supplementary reproductive.

These supplementary reproductive only mature into primary reproductive upon the death of a king or queen, or when primary reproductive, and there may also be more than a single supplementary with in a colony. Some queens have the ability to switch from sexual reproduction to asexual reproduction. Studies show that while termite queens mate with the king to produce colony workers, the queen reproduce their replacements (neotenic queens) parthenogenetically [27].

Two types of vails were used for storage in which 15 ml had 100% of ethyl alcohol that was used for preserving samples for DNA analysis and 50 ml vails having 70% ethyl alcohol was used for preserving samples of morphomatrics study. Small tags were put into that carried the information about its collection the field note book. All samples were taken to lab for their morphomatrics and DNA analysis Figure 1.

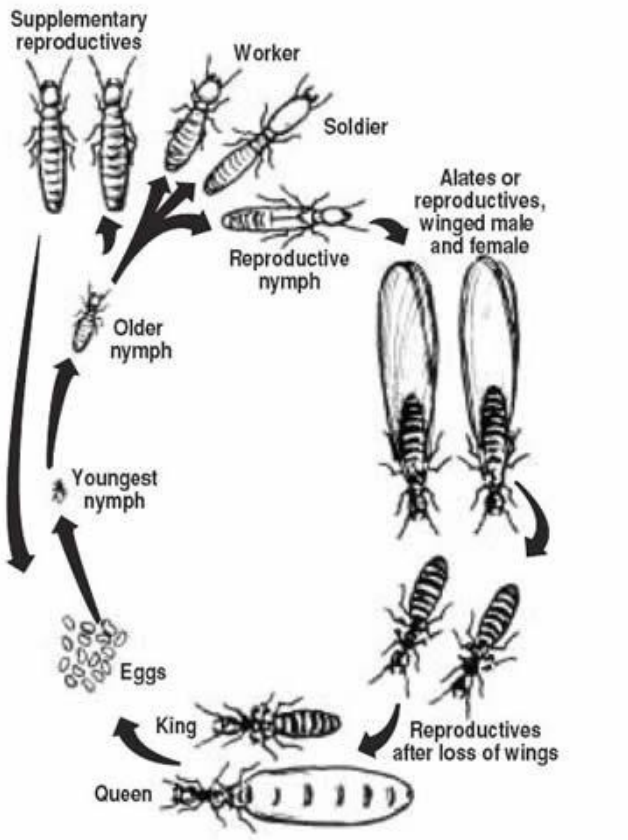

Figure 1: Life cycle of Termites.

Introduction to district swabi

Swabi district in the province of Khyber Pakhtunkhwa, Pakistan. It lies between the river Indus and Kabul and situated at latitude 34°06'60.00"N and longitude: 72°27'59.99"E. Geographically, Bunir district is in the north having mountainous area, Charsadda and Nowshera district in the West and South having plain area, and District Haripur and Abbotabad in the east having mountains. There are 56 union counsels and 4 Tehsil in Swabi. The coldest month of the area is December and January while the maximum temperature is recorded in the month of June and July. Downpour falls in the month of July, august, December and January. Major fruits are lokaath, guava and orange; and major crops are wheat, corn, kachalu, turmeric, garlic, onion, sugar cane, cucurbits, tobacco etc. It is also famous for nurseries of plants along with the all kind of fruit plants and ornamental plants. Total area of the district is 154062 hectares having 94707 hectares for agriculture while 1076 hectares forest in Figure 2.

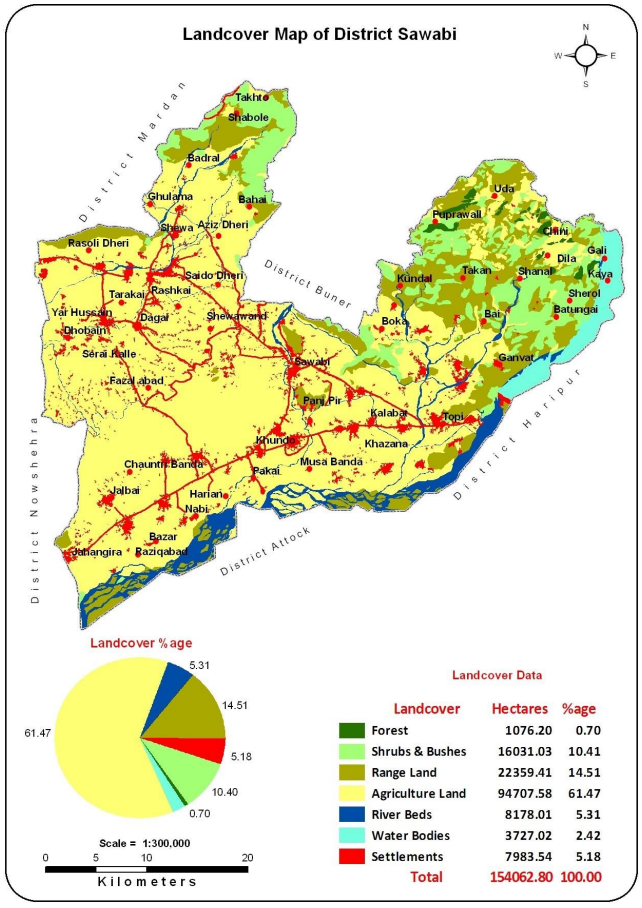

Figure 2: Land distribution of district swab.

[28] Collected 289 termite samples from counties in Indiana from 2002-2004. Almost 82%of the samples are from artificial structures, and half of them from inside the structures. While all others from the forested areas. Collected samples are identified based on their molecular, morphological or from both. They identified five species from genus Reticulitermes. To overcome the identification a 389-bp area of the mitochondrial DNA (mtDNA) 16srRNAgene was amplified and sequenced from all the five species. Based on species-specific polymorphism exhibited in mtDNA sequences, a polymerase chain reaction-restriction portion length polymorphism-based indicative tool was developed to identify samples deficient of indicative morphological characters.

[29] conducted survey in district Gujranwala, Pakistan for the evaluation of the population diversity of termites fauna of in garden trees of that particular region from January to June, 2012.From this survey six species of termites were recorded by them i.e., Coptotermesheimi, Microcerotermschampioni, Odontotermesobesus, Microtermsobesi, Microtermesmycophagus and Odontotermesguptifrom structures and garden trees. Maximum diversity of termites was 78% on Simpson's index and 70% on Shannon scale from garden trees.

[30] Conducted survey in district Bahawalpur for capturing-identifying to appraise the population diversity of subterranean termites fauna of the area. Six species were recorded of termites, Psammotermes rajasthanicus, Coptotermes heimi, Odontotermes obesus, Microtermes unicolor, Microtermes mycophagus and Eramotermes paradoxalis. Alphadiversity, Simpson and Shannon indices used to clarify different patterns of diversity. Overall values of diversity on Simpson scale were 68% and on Shannon scale was 66%. Utmost diversity was found in August as 64%on Simpson scale and 95% on Shannon scale in September In the study of beta diversity, maximum overlapping of species found in Bahawalpur and AddaMukdi, and minimum in Bahawalpur and MukdiAdda.

[31] Conducted survey termite's cause's momentous damage to wooden structures in Pakistan, thus makes termites of public curiosity.53 termites species are described in Pakistan from these 11 are of significant threat to timber–in-service. Termite control measure is important to take essential and timely actions to save excessive damage and increase service life of the property. Increased termites trouble is also related to construction techniques and materials. Before treatment there is a required to understand building materials and construction well enough. Structures fabric once treated must be examined annually to test the efficacy of insecticides and the inspector must be familiar with the biology of termites.

[32] A field study was conducted in district Swabi during fall, 2017. Different infested areas were visited by using Google map. A preliminary site visiting plan was prepared for samples collection across the district. Proposed samples site included infested areas of structures, agriculture fields and forests. Sample tags were prepared with the exact data book entry number and were used in samples for record.

Two types of vails were used for storage in which 15 ml had 100% of ethyl alcohol that was used for preserving samples for DNA analysis and 50 ml vails having 70% ethyl alcohol was used for preserving samples of morphomatrics study. Small tags were put into that carried the information about its collection points. GPS device and Google map were used to get exact location of the sampling sites along with the entry of the data in the field note book. All samples were taken to lab for their morphomatrics and DNA analysis.

DISCUSSION

Data has been collected from various locations in Tehsil Razar Table 2 considering all the major land distribution as shown in Figure 2 and Out of 12 samples 02 belong to the genus of Odantotermes, 02 from Macrocerotermes while 8 from the Genus Heterotermes, expressed in the Figure 3 As per data mentioned in Table 1 some of the collection was made from dung and some from the soil, its diversity is expressed in Figure 4 Keeping sunlight as a potential agent in the termite's detection some of the collection is made from direct Sun light and some indirect expressed in Figure 5.

Tag no	Area	15 ml	50 ml	Source	Sunlight	Genus
1	Shewa	35-40	40-45	Dung	Indirect	Odantotermes

2	Parmoli	40-45	35-40	Soil	Indirect	microceroteremes
3	Sher Dara	25-30	20-25	Soil	Indirect	Heterotermes
4	Naranji	25-30	35-35	Soil	Direct	Heterotermes
5	Dagai	30-35	35-40	Soil	Indirect	Heterotermes
6	Yaqubi	30-35	20-25	Dung	Indirect	Heterotermes
7	Yarhusain	30-35	35-40	Soil	Indirect	Heterotermes
8	Nazar Kalli	30-35	20-25	Dung	Indirect	Heterotermes
9	Ismaila	40-50	35-40	Soil	Direct	Odantotermes
10	Adina	25-30	30-35	Dung	Indirect	microceroteremes
11	Kalu Khan	30-35	40-45	Soil	Indirect	Heterotermes
12	Asota Sharif	40-45	35-40	Soil	Indirect	Heterotermes

Table 2: Termites' collection points from the various locations of district Swabi, during, 2018.

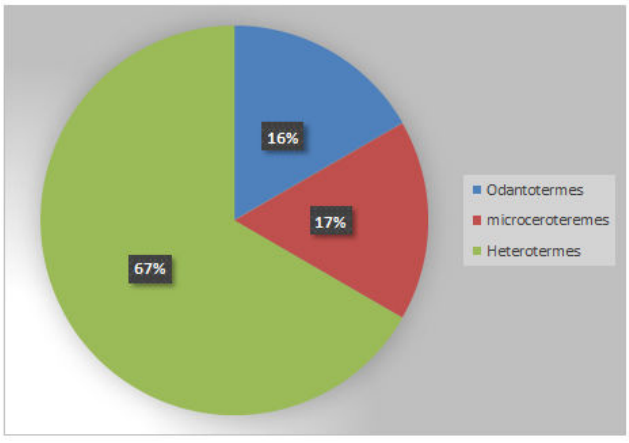

Figure 3: Diversity of termites in district Swabi, fall, 2018.

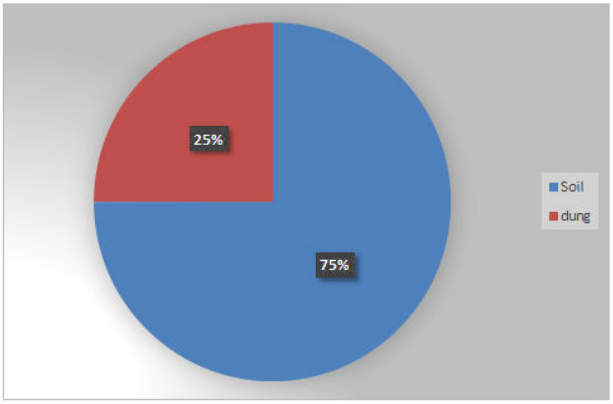

Figure 4: Diversity of termites in Swabi expressing source of collection during fall, 2018.

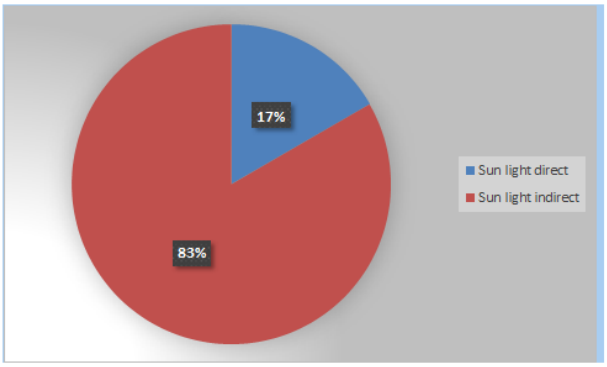

Figure 5: Diversity of termites based on sun light during fall 2018.

CONCLUSION AND RECOMMENDATIONS

Considering the land distribution, topography, crops and plants diversity, the diversity of termites is not fully known in the district. Further study shall be carried out for complete knowledge of the termite's diversity which could be used in the future management and control plans. Molecular analysis of the collected specimen is recommended.

ACKNOWLEDGEMENT

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CONFLICT OF INTEREST

The author declares that there is no conflict of interest.

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