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The Termites aspects: A review

FAYHAA ABBOOD MAHDI AL-NADAWI

(Basic Education College, Sciences dept. Mustansiriyah University, Baghdad, Iraq)

Abstract:
Termites as asocial insects that classify the Order Dictyoptera, Order Blattodea, Superfamily Blattodea, infra order Isopteran, Epifamily Termitoidae and Family Termitoidae, Subfamily Termitoidae, Genera Amittermis. Recent genetic studies have shown that termites evolved from cockroaches. The Jurassic or Triassic period, termites arose during the Permian or even the Carboniferous period. About 3106 species of a few hundred others have not been described, although these insects are called termites (termites), they are not ants. Blattodea and mantises are now represented as part of the order Dictyoptera. Blattodea contains about 4,400 species of cockroaches in about 500 genera. and 3,000 species of termites in about 300 genera. It has about 17 families and over 4,100 described in the Blattodea species

Key words: Amittermis, Blattodea, cockroaches, Isoptera, Termites, Termitoidae.

Introduction

Termites in public culture is an enemy of man, as it is one of the most dangerous and harmful insects, as it builds difficult corridors and entrances to them, and it destroys many papers, books and wood in buildings and libraries, and perhaps because of them, housing has been damaged, and with the increasing damage that causes it, there is a group of The precautionary or preventive causes, including: painting wood and use sound methods when building housing and preventing water from reaching wood, cleaning the roofs of houses and so on. In the Islamic culture, it was mentioned in the Quran. This Quranic verse includes mentioning what happened to the Prophet of God Suleiman bin Dawood, peace be upon them upon his death. What indicates them to his death, that is: the jinn did not indicate the death of Solomon. Social organization. An insect life in societies called colonies with an estimated number of 30,000 to 2.5 million individuals [(1)]. Reproduction, Fertile sexual individuals: In the fall and spring, they appear dark and have eyes that see and wings, and they are fertile and turn into queens and kings to create new colonies. The queen: It is the result of fertile sexual individuals and there is a single queen in the colony and works to link all the colony members and the production of eggs, as it lay about 6 eggs per minute, and only one king lives in the colony [(2)]. Soldiers: It is responsible for guarding and protecting the colony, and it has a strong and cynical jaw, and the head is dark and represents a third of the length of the body and the rest of the body is light color, and its number reaches 1 - 3 of the colony census and the insect is sterile and blind. Laborers: It is responsible for all the damage caused by termite's injuries, as it feeds and feeds all the colonial sects, and represents about 97 of the colony censuses, its color is faded, sterile and blind. Diet: It feeds on cellulose available in many daily human uses (clothes - paper - carpet - carpet - mats - curtains - pillows and mattresses – furniture [(3)]. It attacks the houses built from raw bricks as well as cement. In the first, the white termites extract the ground extracting the clay parts from inside the

brick and work to spread them from the inside, which leads to the collapse of the building, as it can attack human property through wall [4]. In the case of concrete buildings, he attacks the woods, windows, wooden furniture and floors (parquet), by hacking the cement barriers [5]. It also attacks books, papers, records, railways, telegraph columns, phone, cardboard, clothes, simplicity, and others [6].Avoid ground problems [7].In the infected lands designated for construction, the land is cleaned of the waste of cellulose materials such as hay, peel, wood and dry plants, and the ground is sprayed with a penetration solution, a prolific spray, at a rate A trench around the building with a width of 30 cm and a depth of 30 cm surrounding the area and adjacent to the walls and wall of the building[8].

Infra order: Isoptera

Separate order: Hymenoptera love ants, some bees and wasps [1 and 2], termites divide tasks between male and female castes consisting of usually sterile &quote; workers &quote; and &quote; soldiers &quote [3 and 4]. All colonies contain fertile males called &quote; kings & quote; and one or more fertile females are called &quote; queens & quote; [5and6]. Termites feed mostly on cellulose and, more generally, in leaf litter, in the form of wood, soil, or animal dung [7]. Termites are major detritivores especially in subtropical and tropical regions, and recycled wood and plant materials are of great ecological importance. [8] Termites are one of the most successful groups of insects on Earth, and they are widespread in most regions of the Earth except Antarctica [9]. Termite colonies are organized from a few hundred individuals into large communities of several million individuals. Termite queens last longer than any insect in the world, as some queens live for 30-50 years, unlike ants that have undergone evolution processes begin with the formation in the ground of the incomplete type of nymph eggs, and the stages of puberty. Colonies are described as vital living organisms, because ants are part of a self-organizing colony [10], and ants are considered a delicious food in some peoples' cultures and used in traditional medicines [11], and hundreds of these species have economic importance from pests, especially because they cause severe damage to buildings and crops and forests and plantations, such as the invasive species known as the West Indian dry wood ant (Cryptotermes brevis) [12;13,14].

The origin of words (Etymology)

The infra order called Isoptera is derived from Latin words iso (equal)with Petra (winged), meaning the equal size of the front and hind wing [15]. Termites derived from the Latin terminology (woodworm, white ant) were changed from Latin terere ("to rub, wear, erode") from the earlier word terms. White ant's nests were known terminarium or termitaria [16]. In past English language times were known wood ants "or" white ants the first used of the modern name was in 1781[17].

Etymology (etymology)

Isoptera is derived from the Latin words iso (equal) with ptera (winged), meaning equal size of fore and hind wings [15]. ant) from the Latin terere to rub, wear, wear from the preceding word's terminology. Termite nests are known as terminarium or termitaria [16]. In past English times they were known as wood ants or 'termites', the first use of the modern name being in 1781 [17].

Scientific classification

Superorder: Dictyoptera

Blattodea and mantises are now part of Dictyoptera (Fig. 1). Blattodea contains about 4,400 species of cockroaches in about 500 genera. and 3,000 species of termites in about 300 genera. It has about 17 families and more than 4,100 are described in Blattodea species [18, 19].

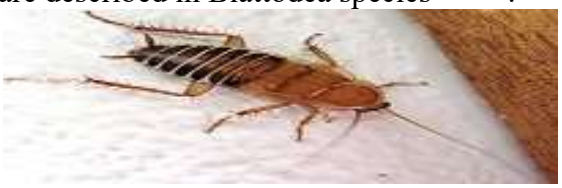

Figure 1: Twmnopteryx is a genus of cockroaches in South Africa (20).

Order: Blattodea

Blattodea represent most insects of cockroaches and termites (Fig. 2), under the order Isoptera [21; 22 and 23].

Figure 2: Blattodea Order [24]

superfamily: Blattodea

Blattodea is a superfamily of cockroaches and termites [25] (Fig. 3).

Figure 3: Superfamily Blattodea [26]

Formosan termites are an invasive species of termites. It has been transported worldwide from its native habitat in southern China to Formosa and Japan. In the twentieth century, they were established in South Africa, Sri Lanka, Hawaii, and the continental United States [27] (Fig. 4).

Figure 4: The Formosan termite [28]

Epifamily: Termitoidae

Nanotermes is an extinct genus of termites in the family Isoptera Termitoidae known from only one Eocene fossil found in the amber of the Cam Bay Basin. The genus contains one described species, Nanotermes is aacae is tentatively placed in the subfamily Termitoidae (Fig. 5).

Figure 5: Epifamily Termitoidae [29].

Termitoidae (higher termites) is a genus of termites. They are the most advanced evolutionary group of termites. The intestines of higher termite species have a high capacity to degrade lignocellulose. [30] Amittermis is a genus of termites in the family Termitoidae. It is the second largest genus after Microcerotermes in the family Amitermitinae, with about a hundred species. The species is found in a range of habitats including deserts and rain forests. Features of Amittermis soldiers include a bulbous head, sickle-shaped lower jaws with a single tooth on their inner edges and cephalic glands in the front of their heads [31]. Amittermis meridional, commonly known as the termite or magnetic compass, is a species of asocial insect, which refers to the family Termitoidae, settled in northern Australia, deriving its common names from the shape of a wedge-shaped mound along the major axis (Fig. 6)

Figure 6: Wedge-shaped mound profile along the major axis, running north to south [32; 33 and 34]

Distribution and diversity

Termite species are found on all continents except Antarctica, where termites are diverse in North America and Europe (10 species in Europe, 50 species in North America), where more than 400 [35] of the 3000 diagnosed termite species are known. There are currently 1,000 species in Africa, with many mounds in some areas, and there are about 1.1 million termite mounds in the Kruger National Park alone on the continent of Asia [36].

Termite Description

Termites play a vital role in nature, destroying wood and other cellulose materials, and are important in medicine and ecosystem balance [37].

Properties

The termite's body size ranges from 1/8 inch to 1 inch, and the color varies from white to brown and black, depending on the different species and age groups [38], and in most termites, its workers appear to be larval insects. When the exterior is smooth and tends to a white or light brown color for most termite species (Fig. 7), the dry termite does not have a specific working caste, as the nymphs were relied upon to perform the role of the typical worker [39]. It is responsible for all the damage caused by termite infestations, as it feeds and nourishes all colonies of the colony, and it represents about 97 of the colony's population and its color is pale (Fig. 8), sterile and blind [40]). Workers are female, females also represent the diploid queen and develop from fertilized eggs. The majority of workers in the colony are diploid and develop from fertilized eggs depending on the species. There may be different roles for females and males in the colony [41 and 42]. Workers are produced from the first nymph Molting, some workers become soldiers by feathering or become machinists. The smallest worker termite. Their body length does not exceed 1 cm (0.5–0.8 cm). Due to the permanent residence in shelters saturated with water vapor, it has a soft, bright body. Because of the underground lifestyle, the eyes are either very weak or not at all. Working individuals are easily recognized by the rounded head and posterior thoracic part. But this does not apply to all species, in the Hodotermes termites of South Africa, working individuals are often visible on the surface, and therefore painted in a dark brown color. Unlike ants, it is present in both males and females (in ants, only females). Their main goal: to take care of the offspring, to obtain and store food, to build and repair the termite mound. In addition, they feed the soldiers who have the special structure of the head capsule, and cannot feed themselves [43 and 44].

Figure 7: The worker [45]

Figure 8: The Soldiers and Workers [46]

The Soldiers

It is responsible for guarding and protecting the colony. It has strong, serrated jaws. The head is dark in color and represents a third of the body length. The rest of the body is light in color and pale. Its number is 1-3 of the population of the colony. The insect is sterile and blind. Soldiers have a large head capsule. There are reasons for this. Besides the fact that they have powerful jaws, they also play the role of a kind of traffic jam during sieges in narrow tunnels [47]. Limited soldiers have soft smooth bodies as in their soldiers, equipped. The lower jaw is well developed (jaws) (Fig. 9). In some tropical species, a small appendage on the head is added to the mandible, with which the soldier winds a special sticky termite in the enemy, which dries up on contact with air and restricts movement [48].

Figure 9: The Soldiers [49]

Alate stage:

It is a winged individual that appears in the breeding period. The stage of these insects can be identified by examining the wings and respiratory openings. The length is 5 mm except for the wing. The pairs of wings are transparent and twice the length of the body. The color is light yellow-brown [50]. The upper jaw is dark brown and ends with four teeth or ridges [51 and 52] (Fig. 10).

Figure 10: Alate stage [53]

The Queen:

It is the result of the sexual fertility of the individuals, and there is one queen in the colony who works to bind the members of the colony and produce all the eggs, as they lay about 6 eggs per minute, and they live with only one king in the colony [54]. The size of the queen compared to other termites is huge. The length can reach 10 cm. And the body in particular increases the abdomen of the female, after the start of reproduction, hundreds of times. Because of what they can no longer move and eat on their own. All of these concerns fall on the vulnerability of termites. If necessary, she will hold him and feed him. Besides the Queen throughout his life, there is a King who is slightly larger than the size of an ordinary termite soldier. Only he has the right to marry a female. Unlike ants, after fertilization, the male does not die. A flying termite matures a fertile amazing female. During the day, it can lay about 1,700-3,000 eggs (Fig. 11). All this time, she secretes special mucus with pheromones, which are contained in her stomach. She is happy to lick termite work. Mature and young individuals live for a certain period of time in the &quote; parental & quote; period. But with the onset of the gathering period (spring - early summer), they all leave the &quote; father's house and begin to marry. At this time, they become very vulnerable, because immediately after fertilization, both the female and the male flank their wings. Many of them become easy prey for insectivorous birds, spiders, centipedes, and other large insects [55]. The asocial termite Reticulitermes speratus Queens can obtain a long lifespan with its fertility, which has a higher level of oxidative damage, such as more oxidative DNA damage than nymph, soldier, and workers, increased catalase due to lower levels being damaged by an enzyme that protects against oxidative stress [56].

Figure 11: The Queen [57]

life cycle

Females lay eggs, which differ from the life cycle of a bee or ant, and incomplete metamorphosis [58]. Adult nymphs reproduce several times during the fledging period in some species. Eggs go through four clones while nymphs go through three, the nymphs are first cloned into workers and then some workers are cloned into soldiers or winged individuals [59]. In the mating flight, where mating occurs when flying and then landing in a place suitable for the colony where they dig a suitable place for them and close the entrance [60], and the time of the mating flight varies in each type during the day while others differ. During winter or at dusk in many illuminated locations, mating flight depends on environmental conditions, time, humidity, precipitation, and wind speed [61]. The number of ants per colony varies in large species up to 1000 and can be as many as millions [62].

Normal damage and life history: -

This type of land is considered one of the most important types of land in Iraq. It attacks different types of trees, buildings and wooden furniture. Palm trees spread in the southern region, especially in Basra. Earth attacks the roots, stem, pain and stems of palm trees used to roof some houses and warehouses. The earth works to make many tunnels inside the leg, especially the leg of the palm affected by the legs of excavators [63 and 64]. Digging the ground inside the stem leads to erosion of part of the stem, showing a hole that may reach 90 cm in length, 23 cm in width, and 19 cm in depth [65] (Fig. 12). On healthy palm trees, the earth builds mud tunnels on the surface of the stem up to the tip of the palm, where the bases of the fronds or grouse are attacked [66]. The earth digs into the green melancholy, many deep and deep gullies. The earth does not attack the taste; it nourishes on shrimp that fall to the ground in Basra. Ground hits plants and causes some to die, especially newly planted ones [67]. The earth affects the palm trunks after cutting them either while they are in the garden or after they are used to roof some simple buildings. However, the incidence of land between palms is low Zhang [68]. Workers and soldiers are present throughout the year moving between their colonies in the land and infected palms. Winged individuals appear at night in April, May and September [69].

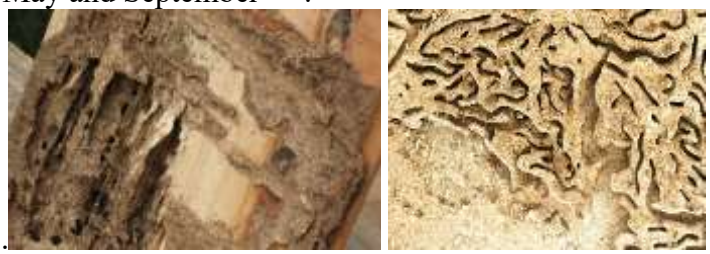

Figure 12: The Termites normal damage [70]

The behavior of the insect in its environment

White termites consume dead plants in all stages of decomposition and play an active role in the environmental system by recycling waste such as dead woods, stools and plants [71]. Many species deal with termite cells and is a major source of methane in the atmosphere [11], which is one of the main greenhouse gases [72]. It is produced when cellulose decomposes. White termites generally depend on the primary symbiotic organisms (Meta monads) and other microbes such as signs in their guts to digest cellulose, allowing the absorption of the final products for their own use [73]. Trichonympha intestinal protozoa depends on the symbiotic bacteria on its surfaces to produce some of the necessary digestive enzymes. Most termites, especially the termite family that can produce their cellulose enzymes, depends

completely on bacteria. Workers feed other individuals in the colony with materials taken from digestion of vegetables. It is closely related to the mouth or anal [74] depending on bacterial species are closely related to their descendants of multicellular ancestors [75]. Different types of wood in termite's attack depending on moisture, resin content, softness and hardness [76] have a role in growth and reproduction in stool kneeling [77]. This behavior of termites allowed the invasion of African savanna, new environments and expansion in Asia [78]. Depending on the nutrition habits, termites are placed in two groups of white termites and termites. For the first type, you prefer to eat wood with fungi for easy digestion and the fact that these fungi are rich in protein. Such as humus, leaves, roots and darkness [79], the termite intestine contains a few bacteria that contain some bacteria that do not contain Protozoa [80].

Natural enemies of termites

Predators

White termites are preyed by a wide range of predator termites that are prey to 65 birds and 19 mammals [81], while arthropods such as ants [82] (Fig 13), cockroaches, spiders [83], Circumcise, reptiles such as lizards [84], amphibians such as frogs, bats, bats and foxes are mice [85].

Figure 13: A Matabele ant (*Megaponera analis*) kills a *Macrotermes bellicosus* termite soldier during a raid [86].

Parasites, pathogens and viruses

Termites are attacked by bees, wasps, ants and parasites by fewer predators due to their lifestyle as they live in the form of colonies. However, insect pathogens such as Metarhizium anisopliae and Aspergillus nomius pose significant threats to the termite colony because they are not host-specific and may infect large parts of the colony [87]. Infection of termites with viruses such as Nuclear Poly morph virus (NPV) and Entomopoxvirinae [88].

Locomotion and foraging

Because of the lack of wings in the soldier and worker layers of termites, they miss relying on legs to move from one place to another [89]. The type of food is different for termites as they feed on wood, and others feed near their colonies [90]. Workers are rarely seen in open ground, where their campaign tunnels are built from predators [91]. Release of activating pheromone to attract female workers [92]. Pheromones are Para chemicals of communication between termite colony members [93]. The feeding journey is divided into three phases. First, the soldiers discover the source of the food as they come into contact with the soldiers. Second, small numbers of female workers begin to appear. Secondly, workers gather in droves at the food site. Third, the number of soldiers decreases and the number of workers increases [94].

Communication

Most termites are blind, so the method of communication between members of the colony occurs with chemical, mechanical, and pheromone signals [95]. These communication methods serve for mating, escaping from enemies, and defense. Communication is by means of an antenna [96], and shrews also communicate by means of mechanical signals, vibrations, and physical contact and are used for alertness and foraging [97].

Biological control of termites

The availability of moisture and temperature in the areas of underground research is favorable for the growth of biological factors. Laboratory studies have been constantly confirmed by pathogens, such as Nomadic insects, Niophalevana, Carbioxai. Fungi are also used in the control of the Australian termites (Nasutitermes Exitiosus (Hill), such as Metarhizium anisopliae sorokin and Beauveria bassiana (Balsamo) Vullemin [98], whose efficiency has been proven in analgesics and anti -tip [99].

Insect growth regulators (IGRs)

Two types of insect growth organizations

On the termites (events (the peer of the joke hormone, the juvenile hormone simulation or the JHMS) and the disinfectants (CSIS), where they are mixed with grafts unlike some insects where the hormones of events (JH) [100] are immature forms, and the hormones (JH A unique in that it leads to the formation of soldiers in the colony. Many of the formation of soldiers will lead to the collapse of the food colony [101].

DISCUSSION:

Control methods Although termites are useful animals in nature because they scrape trees, branches, fallen wood, dead that accumulates from forests, etc., but because of this type of feeding and their dependence on this substance poses a serious threat to the environment. It is therefore necessary to carry out control operations against it to get rid of it as it is found in many studies when it appears in homes, furniture and orchards, in order to avoid the great damage, it causes. Countering this danger is the use of preventive and curative methods. Preventive measures include cleaning farmland and gardens of crop residues, and cutting and burning infected parts. You will need to clean the land on which the buildings will be built of straw, thatch, wood and wood residues because these materials contain cellulose as the insect's main food. Woody with the emergence of the edge of this interval width of 3 to 5 cm, leaving no piece buried in land during the construction process, and work to find suitable windows in the buildings to draw light and ventilation, as the insect prefers darkness, therefore, ventilation and natural lighting in buildings have an effect in limiting their activity. A concrete base for grain storage silos should be made at a height of not less than ten centimeters above the ground to cover the floor and connect it to the walls and extend a little to the outside. Also, as the catacombs and mud houses that termites built on the walls and the timber in the rural buildings is well cleaned, and a trench is made around the buildings in the affected areas with a depth of 20 cm and a width of 30 cm with the treatment of excavation products such as Dorspan, then filling the trench with treated soil, as this measure can be considered a preventive and curative measure. As for clothes and household items such as bread, sugar and papers, they must be placed on tables or in cupboards with a base and treated with recommended pesticides. In addition to keeping the legs of the tables clean so that dust does not accumulate on them, and does not touch the walls, the back surfaces of wheels, beds and other diluted safe insecticides must be painted and not placed next to the walls. Biological control of termites is applied when the availability of moisture and temperature in underground research areas are favorable factors for the growth of biological agents. Laboratory studies have consistently confirmed the presence of pathogens such as the insect nematode Neoaplectana carpocapsae Weise. Fungi are also used to control Australian termites (Nasutitermes Exitiosus (Hill), Metarhizium anisopliae Sorokin and Beauveria bassiana (Balsamo) Vullemin, which have been shown to be effective in eradicating and controlling termite colonies. Control methods are known as toxin traps. Where some of the members of the termites are coated with a layer of a toxin and then spread in the infested areas where these individuals act as a sex trap due to the presence of a toxin that kills every insect that is eaten by licking the body of the insect. . This method was used at the University of Toronto by entomologist TG Myles. This method is considered one of the most effective control methods because of its advantages such as a direct effect on the termite colony because it eliminates huge numbers, while chemical methods expel the insect from its places. few insects.

CONCLUSION:

Termites are considered one of the most dangerous insects in the world because of their great damage to home furniture, because they feed on cellulose, which is the main component of it, and it must be noted that this insect does its work secretly, while digging many of its passages and tunnels inside the furniture, termite colonies can vary The size ranges from only hundreds of termites to several million termites, which are about 0.4–1.2 cm long and come in red, black, brown, brown, and white colors. As with other insects. Termites use soil and mud to chew wood. Termite mounds are seen in tropical and subtropical regions. Termite mounds are often found up to 3 meters high, but most are usually smaller. and blindness.

The soldiers in the colony make up about 1 to 3 of the total number of soldiers. Soldiers are responsible for guarding; With their dark head, the rest of the body is light. Fertilized winged individuals: These individuals appear in spring and fall, are dark in color, have strong eyes and wings, and later become queens and kings to establish new colonies. The queen is the result of the sexual fertility of individuals; There is one queen in the colony, and she works to bind all members of the colony, and works to produce eggs; As she lays about six eggs per minute, it should be noted that only one lives with her. The life cycle of termite colonies is permanent. When the colony consists of a large number of individuals, colonies often consist of thousands, which is a small percentage. Most termites die while traveling, preying on birds, lizards, other ants, or other insects. Most termites have microscopic, one-celled organisms, called protests, that are found in their gut to help convert undigested fibers from wood into food for the colony. Both the king and queen feed the young with digested food, thus passing these gastropod protests up to the new brood so that they can feed themselves. Lifespan It is surprising that termites can live for so long. Queens and kings can have a lifespan of ten years or more, while individuals can live for several years. Insecticides, liquid herbicide applications for termite control are often used applied to the soil either in doses or by injection. Over-the-counter termite products are not available to the public in California. All effective products are for professional use only. Pest management professionals are given special training because of the risks involved in applying pesticides to the soil around and under buildings. There are many countries around the world that eat termites as part of their natural diet. Termites are a very nutritious insect with a good store of both fat and protein. Termites are also a source of food and nutrition for some animal species from birds, to reptiles and mammals.

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Conflicts of Interest

The authors declare that there is no conflict of interest.

Declaration of Generative AI and AI-assisted technologies in the writing process

“No generative AI or AI-assisted technologies were used during the preparation of this work.”.

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Disclose conflicts: conflicts of interest, which could include relevant financial interests or personal, political, or religious interests, there are not conflicts of interest.

Verify authorship: all co-authors meet authorship criteria and appropriate acknowledgments are made in the manuscript

Practice responsible animal research: Explain how animal research is conducted ethically* there is not animal research.

Roles Authors

Dr. FAYHAA ABBOOD MAHDI AL-NADAWI: Conceptualization, Methodology, Data curation, Investigation, Validation, Formal analysis, Supervision, Funding acquisition, Visualization, Project administration, Writing - original draft, Resources, Writing - review & editing, Software

References

[1] Tasaki, E. Kobayashi, K., Matsuura K, Iuchi Y (2017). "An Efficient Antioxidant System in a Long-Lived Termite Queen”. PLoSONE. 12 (1): e0167412. Bibcode: 2017PLoSO.1267412T. https://doi:10.1371/journal.pone.0167412.PMC5226355.PMID 28076409

[2] Poulsen, M., Hu, H., Li, C., Chen, Z., Xu, L., Otani, S., Nygaard, S., Nobre, T., Klaubauf, S.; Schindler, P. M., et al. (2014). "Complementary symbiont contributions to plant decomposition in a fungus-farming termite". Proceedings of the National Academy of Sciences. 111 (40): 1450014505.

Bibcode:2014PNAS. .11114500P. https://doi:10.1073/pnas.1319718111. PMC 4209977. PMID 25246537
[3] Dietrich, C., Kohler, T., Brune, A. (2014). "The Cockroach origin of the termite gut microbiota: patterns in bacterial community structure reflect major evolutionary events". Applied and Environmental Microbiology. 80 (7): 2261–2269. https://doi:10.1128/AEM.04206-13. PMC 3993134. PMID 24487532.
[4] Beccaloni, G.W. (2019). "Superfamily Blattodea Latreille, 1810". Cockroach species file online, Version 5.0. Retrieved 2019-04-13.
[5] Yashiro, T.& Matsuura, K. (2014). "Termite queens close the sperm gates of eggs to switch from sexual to asexual reproduction". Proceedings of the National Academy of Sciences. 111 (48): 17212–17217. Bibcode:2014PNAS.11117212Y.
[6] "Termite Biology and Ecology". Division of Technology, Industry and Economics Chemicals Branch. United Nations Environment Programme. Archived from the original on 10 November 2014. Retrieved 15 March2017.
[7] Abe, Y., Bignell, D. E.& Higashi, T. (2014). Termites: Evolution, Sociality, Symbioses, Ecology. Springer. pp. 61–63. ISBN 978-94-017-3223-9.
[8] Rose, T.C., Ediger, E.F., Lehman-Schletewitz, J., McClane, N.W., Schweigert, K.C., Alzweideh, S, Zeismann, J. (2015). "Life history and development-a framework for understanding developmental plasticity in lower termites". Development Genes and Evolution.
[9] Fougeyrollas R., Dolejšová K, Sillam-Dussès D, Roy V, Poteaux C, Hanus R, Roisin Y (June 2015). "Asexual queen succession in the higher termite Embiratermes neotenicus". Proc.Biol.Sci. 282 (1809):20150260. https://doi:10.1098/rspb.2015.0260. PMC 4590441. PMID 26019158.
[10] Werfel, J., Petersen, K.& Nagpal, R. (2014). "Designing Collective Behavior in a Termite-Inspired Robot Construction Team". Science. 343 (6172): 754–758.
[11] Figueirêdo, R.E.C.R., Vasconcellos, A., Policarpo, I.S., Alves, R.R.N. (2015). "Edible and medicinal termites: a global overview". Journal of Ethnobiology and Ethno medicine. 11 (1):29. https://doi:10.1186/s13002-015-00164.PMC4427943. PMI D 259 25503.
[12] Li, Z.-Q., Liu, B.-R., Zeng, W.-H., Xiao, W.-L., Li, Q.-J., Zhong, J.-H. (2013). "Character of Cellulase Activity in the Guts of Flagellate-Free Termites with Different Feeding Habits". Journal of Insect Science. 13 (37): 37. https://doi: 10.1673/031.013.3701.PMC 3738099. PMID 23895662.
[13] Glenday, C. (2014). Guinness World Records 2014. p. 33. ISBN 978-1-908843-15-9.
[14] Vane, C.H., Kim, A.W., Moss-Hayes, V., Snape, C.E., Diaz, M.C., Khan, N.S., Engelhart, S.E., Horton, B.P. (2013). "Degradation of mangrove tissues by arboreal termites (Nasutitermes acajutlae) and their role in the mangrove C cycle (Puerto Rico): Chemical characterization and organic matter provenance using bulk δ13C, C/N, alkaline CuO oxidation-GC/MS, and solid-state" (PDF). Geochemistry, Geophysics, Geosystems. 14
[15] Cranshaw, W. (2013). "11". Bugs Rule! An Introduction to the World of Insects. Princeton, New Jersey: Princeton University Press. p. 188. ISBN 978-0-691-12495-7.
[16] Lobeck, A. K. (1939). Geomorphology; an Introduction to the Study of Landscapes (1st ed.). University of California: McGraw Hill Book Company, Incorporated. pp. 431–432. ASIN B002P5O9SC.
[17] “Termite". Merriam-Webster Online Dictionary. Retrieved 5 January 2015.
[18] Inward, D., Beccaloni, G., Eggleton, P. (22 June 2007). "Death of an order: a comprehensive molecular phylogenetic study confirms that termites are asocial cockroaches". Biology Letters. 3 (3):331–335. https://doi:10.1098/rsbl.2007.0102. PMC 2464702. PMID 17412673.
[19] Legendre, F., Nel, A., Svenson, G.J., Robillard, T., Pellens, R., Grandcolas, P., Escriva, H. (2015). "Phylogeny of Dictyoptera: Dating the Origin of Cockroaches, Praying Mantises and Termites with Molecular Data and Controlled Fossil Evidence". PLoSONE. 10 (7):e0130127. Bibcode:2015PLoSO.1030127L. https://doi:10.1371/journal.pone.0130127. PMC 4511787. PMID 26200914.

[20] https://en.Wikipedia.org/wiki/Dictyoptera#/media/File:Temnopteryx_species_Zebra_Cockroach_Uniondale_South_Africa_1435.jpg.
[21] Djernæs, M., Klass, Klaus-Dieter; P., Mike D., Damgaard, Jakob (2011). "Phylogeny of cockroaches (Insects, Dictyoptera, Blattodea), with placement of aberrant taxa and exploration of out-group sampling". Systematic Entomology. 37 (1): 65–83. https://doi:10.1111/j.1365-3113.2011.00598.x.
[22] "ITIS Standard Report Page: Blattodea". www.itis.gov. Retrieved 10 May 2018.
[23] "Order Blattodea: Cockroaches and Termites". Bug Guide. Retrieved 27 August 2015.
[24] https://en.Wikipedia.org/wiki/Blattodea#/media/File:Domino_cockroach_Therea_petiveriana.jpg
[25] Atkinson, T. H., Koehler, Philip G., Patterson, R. S. (1991). "Catalog and Atlas of the Cockroaches of North America North of Mexico". Miscellaneous Publications of the Entomological Society of America. 78:1–85. ISBN 978-9991575872.ISS N 0071-0717.
[26] https://en.Wikipedia.org/wiki/Blattodea#/media/File:Archiblatta_beccarii_(36870587092) .jpg.
[27] Vrsanky, P.& Aristov, D. (2014). "Termites (Isoptera) from the Jurassic/Cretaceous boundary: Evidence for the longevity of their earliest genera". European Journal of Entomology. 111 (1):137–141. doi:10.14411/eje.2014.014.
[28] https://en.Wikipedia.org/wiki/Termite#/media/File:Coptotermes_formosanus_shiraki_USGov_k8204-7.jpg.
[29] https://en.Wikipedia.org/wiki/Termitoidae#/media/File:ZooKeys-148-105 g001Nano termes _ is aacae.jpg.
[30] Engel, M.S. (2011). "Family-group names for termites (Isoptera), redux". Zoo Keys. 148: 171-184.https://doi:10.3897/zoo keys.148.1682. PMC 3264418. PMID 22287896.
[31] Calaby, J. H. (1956). "The distribution and biology of the genus Ahamitermes (Isoptera)". Australian Journal of Zoology. 4 (2): 11–124. https://doi :10. 1071 / ZO9560111.
[32] https://en.Wikipedia.org/wiki/Amitermes#/media/File:Flickr__brew books__Magnetic _Termite_mound_-_Litchfield_National_Park.jpg.
[33] Flores, A. (17 February 2010). "New Assay Helps Track Termites, Other Insects". Agricultural Research Service. United States Department of Agriculture. Retrieved 15January 2015.
[34] "Termites". Victorian Building Authority. Government of Victoria. 2014. Retrieved 20 September 2015.
[35] ("Termite Biology and Ecology". Division of Technology, Industry and Economics Chemicals Branch. United Nations Environment Programme. Archived from original on 10 November 2014. Retrieved 12 January 2015.
[36] Meyer, V.W., Braack, L.E.O., Biggs, H.C.& Ebersohn, C. (1999). "Distribution and density of termite mounds in the northern Kruger National Park, with specific reference to those constructed by Macrotermes Holmgren (Isoptera: Termitoidae)". African Entomology. 7 (1): 123–130.
[37] Costa-Leonardo, A.M.& Haifig, I. (2013). Termite communication during different behavioral activities in Bio communication of Animals. Springer Netherlands. pp. 161–190.https://doi:10.1007/978-94-007-7414-810.ISBN978-94-007-7413-1
[38] Sun, Q., Haynes, K.F.& Zhou, X. (2013). "Differential undertaking response of a lower termite to congeneric and conspecific corpses". Scientific Reports. 3: 1650. Bibcode:2013 Nat SR...3E1650S. https://doi:10.1038/srep01650. PMC 3629736. PMID 23598990.
[39] Gouge, D.H., Smith, K.A., Olson, C.& Baker, P. (2001). "Dry wood Termites". Cooperative Extension, College of Agriculture & Life Sciences. University of Arizona. Retrieved 16 September2015
[40] Pennesi, Elizabeth (2015). "Africa's soil engineers: Termites". Science. 347 (6222): 596–597. https://doi:10.1126/science.347.6222.596.
[41] Miramontes, O., DeSouza, O., Paiva, L.R., Marins, A., Orozco, S., Aegerter, C.M. (2014). "Lévy flights and self-similar exploratory behavior of termite workers: beyond model fitting". PLoS ONE. 9 (10): e111183. arXiv:1410.0930.

[42] Korb, J. (2008). "Termites, hemimetabolous diploid white ants?". Frontiers in Zoology. 5(1):15. https://doi:10.1186/17429994515. PMC 2564920. PMID 18822181.
[43] "Native subterranean termites". University of Florida. Retrieved 8 January 2015.
[44] Su N-Y. (2019). Development of baits for management of subterranean termites. Annual Review of Entomology 64: 115-130. https://doi.org/10.1146/annurev-ento-011118112429.
[45] https://en.Wikipedia.org/wiki/Termite#/media/File: Termite-by-RalfR.jpg.
[46] https://amikamoda.ru/ar/kak-vyglyadyat-i-chem-zhivut-termity-termity-oni-zhe-belyemuravi -na-vsei-territorii.html
[47] Engel, M.S. & K. Krishna (2004). "Family-group names for termites (Isoptera) ". American Museum Novitiates. 3432: 1–9. https://doi:10.1206/0003-0082 (2004) 432 < 0001: FNFTI>2.0.CO;2.
[48] Weesner, F.M. (1960). "Evolution and Biology of the Termites". Annual Review of Entomology. 5 (1): 153–170. https://doi:10.1146/annurev.en.05.010160.001101.
[49] https://amikamoda.ru/ar/kak-vyglyadyat-i-chem-zhivut-termity-termity-oni-zhe-belye-mura vi-na-vsei-territorii.html
[50] Djernæs, M. (2012). "Phylogeny of cockroaches (Insects, Dictyoptera, Blattodea), with placement of aberrant taxa and exploration of out-group sampling". Systematic Entomology. 37 (1): 65–83. https://doi:10.1111/j.1365-3113.2011.00598.x.
[51] Roberts, E.M., Todd, C.N., Aanen, D.K., Nobre, T., Hilbert-Wolf, H.L., O'Connor, P.M., Tapanila, L., Mtelela, C., Stevens, N.J. (2016). "Oligocene termite nests with in situ fungus gardens from the Rukwa Rift Basin, Tanzania, support a paleogene African origin for insect agriculture ". PLoSONE.11(6): e0156847. Bibcode :2016PLoSO.1156847R. https://doi:10.1371/journal.pone.0156847. PMC 4917219. PMID 27333288.
[52] Coty, D.; Aria, C.; Garrouste, R.; Wils, P.; Legendre, F.; Nel, A.; Korb, J. (2014). "The First Ant-Termite Syninclusion in Amber with CT-Scan Analysis of Taphonomy". PLoSONE. 9(8):e104410. Bibcode:2014PLoSO...9j4410C. https://doi:10.1371/journal.pone.0104410. PMC 4139309. PMID 25140873.
[53] https://amikamoda.ru/ar/kak-vyglyadyat-i-chem-zhivut-termity-termity-oni-zhe-belye-mura vi-na-vsei-territorii.html
[54] Korb, J. (2008). "Termites, hemimetabolous diploid white ants?". Frontiers in Zoology. 5(1):15. doi:10.1186/1742-9994-5-15. PMC 2564920. PMID 18822181.
[55] Tasaki E, Kobayashi K, Matsuura K, Iuchi Y (2017). "An Efficient Antioxidant System in a Long-Lived Termite Queen". PLoS ONE. 12 (1): e0167412. Bibcode: 2017PLoSO.1267412T. https://doi:10.1371/journal.pone.0167412. PMC 5226355. PMID 28076409
[56] Davis, P. "Termite Identification". Entomology at Western Australian Department of Agriculture. Archived from the original on 2009-06-12 .
[57] https://amikamoda.ru/ar/kak-vyglyadyat-i-chem-zhivut-termity-termity-oni-zhe-belye-muravi-na-vsei-territorii.html.
[58] "Native subterranean termites". University of Florida. Retrieved 8 January 2015.
[59] Miller, D.M. (5 March 2010). "Subterranean Termite Biology and Behavior". Virginia Tech (Virginia State University). Retrieved 8 January 2015.
[60] Gouge, D.H., Smith, K.A., Olson, C.& Baker, P. (2001). "Dry wood Termites". Cooperative Extension, College of Agriculture & Life Sciences. University of Arizona. Retrieved 16 September 2015.
[61] Engel, M.S.& Gross, M. (2008). "A giant termite from the Late Miocene of Styria, Austria (Isoptera)". Naturwissenschaften. 96 (2): 289 295. Bibcode :2009 NW..... 96..289 E. https://doi: 10. 1007 / s 00114-008-0480-y. PMID 19052720.
[62] Cosme, L., Haro, M.M., Guedes N.M.P., Della, L. T.M.C., Guedes, R.N.C. (2018) Tropical wood resistance to the West Indian dry wood termite Cryptotermes brevis: if termites can't chew. Pest Management Science 74, 914– 924.

[63] Abd-Elkareem E& Fouad H (2016) Termites, their role in the damaged mud buildings, and prevention methods: application on the ruins of the White Monastery, Sohag, Egypt. Egyptian Journal of Archaeological and Restoration Studies 6, 85– 96.
[64] Almeida-Warren, K., Sommer, V., Piel, A. K., Pascual-Garrido, A. (2017) Raw material procurement for termite fishing tools by wild chimpanzees in the Issa valley, Western Tanzania. American Journal of Physical Anthropology 164, 292– 304.
[65] Bonachela, J.A., Pringle, R.M., Sheffer, E et al. (2015) Termite mounds can increase the robustness of dry land ecosystems to climatic change. Science 347, 651– 655.
[66] Buczkowski G.& Bertelsmeier C. (2017) Invasive termites in a changing climate: a global perspective. Ecology and Evolution 7, 974– 985.
[67] JC, H. G., Lin, R.K., Kuo, Y.H., Ju, Y.M., Lee, T.H. (2017) Bio active constituents from the termite nest-derived medicinal fungus Xylaria nigripes. Journal of Natural Products 80, 38– 44.
[68] Chouvenc, T., Helmick, E.E.& Su, N.Y. (2015) Hybridization of two major termite invaders as a consequence of human activity. PLoS ONE 10, e 120745.
[69] de Souza, O.F.& Brown, V.K. (2009). "Effects of habitat fragmentation on Amazonian termite communities". Journal of Tropical Ecology. 10 (2): 197–206. https://doi: 10.1017/ S 02 66467400007847
[70] https://amikamoda.ru/ar/kak-vyglyadyat-i-chem-zhivut-termity-termity-oni-zhe-belye-muravi-na-vsei-territorii.html.
[71] Tokuda, G., Watanabe, H., Matsumoto, T.& Noda, H. (1997). "Cellulose digestion in the wood-eating higher termite, Nasutitermes takasagoensis (Shiraki): distribution of cellulose and properties of endo-beta-1,4-glucanase". Zoological Science. 14 (1): 83–93. https://doi:10.2108/zsj.14.83.PMID 9200983.
[72] Ikeda-Ohtsubo, W.& Brune, A. (2009). "Co speciation of termite gut flagellates and their bacterial endosymbionts: Trichonympha species and Candidatus Endomicrobium trichonymphae". Molecular Ecology. 18 (2):332–342.https:// doi:10.1111 /j.13652 94 X. 2008. 04029.x. PMID 19192183.
[73] (Machida, M., Kitade, O., Miura, T.& Matsumoto, T. (2001). "Nitrogen recycling through proctodeal trophallaxis in the Japanese damp-wood termite Hodotermopsis japonica (Isoptera, Termitoidae)". Insects Sociaux. 48 (1): 52–56. https://doi:10.1007/PL00001745. ISSN 1420-9098.)
[74] (Dietrich, C., Kohler, T.& Brune, A. (2014). "The Cockroach origin of the termite gut microbiota: patterns in bacterial community structure reflect major evolutionary events". Applied and Environmental Microbiology. 80 (7): 2261–2269. https://doi:10.1128/AEM.04206-13. PMC 3993134. PMID 24487532.)
[75] McMahan, E.A. (1966). "Studies of Termite Wood-feeding Preferences" (PDF). Hawaiian Entomological Society. 19 (2): 239–250. ISSN 0073-134 X.
[76] Aanen, D.K., Eggleton, P., Rouland-Lefevre, C., Guldberg-Froslev, T., Rosendahl, S., Boomsma, J.J. (2002). "The evolution of fungus-growing termites and their mutualistic fungal symbionts". Proceedings of the National Academy of Sciences. 99(23): 1488714892.Bibcode:2002PNAS. 9914887A.https://doi:10.1073/pnas.222313099. JSTOR 3073687. PMC 137514. PMID 12386341.
[77] Roberts, E.M., Todd, C.N., Aanen, D.K.; Nobre, T.; Hilbert-Wolf, H.L.; O'Connor, P.M.; Tapanila, L.; Mtelela, C.; Stevens, N.J. (2016). "Oligocene termite nests with in situ fungus gardens from the Rukwa Rift Basin, Tanzania, support a paleogene African origin for insect agriculture". PLoS ONE. 11 (6): e0156847. Bibcode:2016PLoSO. 1156847R.https://doi:10.1371/journal.pone.0156847. PMC 4917219. PMID 27333288.
[78] Radek, R. (1999). "Flagellates, bacteria, and fungi associated with termites: diversity and function in nutrition – a review" (PDF). Ecotropica. 5: 183–196.
[79] Breznak, J.A.& Brune, A. (1993). "Role of microorganisms in the digestion of lignocellulose by termites". Annual Review of Entomology. 39 (1):453–487. https://doi: 10. 1146 / annurev.en.39.010194.002321

[80] Kok, O.B.& Hewitt, P.H. (1990). "Bird and mammal predators of the harvester termite Hodometers mossambicus (Hagen) in semi-arid regions of South Africa". South African Journal of Science. 86 (1): 34–37. ISSN 0038-2353.
[81] Culliney, T.W.; Grace, J.K. (2000). "Prospects for the biological control of subterranean termites (Isoptera: Rhinotermitidae), with special reference to Comptometer formosanus " . Bulletin of Entomological Research. 90 (1): 9–21. https://doi :10.1017 /S 00074853 0000 066 3 . PMID 10948359.
[82] Dean, W.R.J.& Milton, S.J. (1995). "Plant and invertebrate assemblages on old fields in the arid southern Karoo, South Africa". African Journal of Ecology. 33 (1):1–13. https://doi:10.11 11 /j. 1365-2028. 1995.tb 00777.x.
[83] Wade, W.W. (2002). Ecology of Desert Systems. Burlington: Else vier. p. 216. ISBN 978-0-08-050499-5.
[84] Abe, Y., Bignell, D.E.& Higashi, T. (2014). Termites: Evolution, Sociality, Symbioses, Ecology.Springer.pp. 124–149.https:// doi:10.1007/978-94-017-3223-9 . ISBN 978-94-017-3223-9.
[85] Chouvenc, T., Efstathion, C.A., Elliott, M.L.& Su, N.Y. (2012). "Resource competition between two fungal parasites in subterranean termites". Die Naturwissenschaften. 99 (11):94958. Bibcode:2012 NW..... 99..949 C. https://doi:10.1007/s 00114-012-0977-2. PMID 23086391.
[86] https://en.Wikipedia.org/wiki/Termite#/media/File:Megaponera_analysis_major_killing_ Macrotermes_soldier.jpg.
[87] Chouvenc, T., Mullins, A.J., Efstathion, C.A.& Su, N.-Y. (2013). "Virus-like symptoms in a termite (Isoptera: Kalotermitidae) field colony". Florida Entomologist. 96 (4): 1612–1614. https://doi:10.1653/024.096.0450
[88] Bignell, Roisin & Lo, 2010, p. 11.
[89] Traniello, J.F.A.& Leuthold, R.H. (2000). Behavior and Ecology of Foraging in Termites. Springer Netherlands. pp. 141–168. https://doi:10.1007/978-94-017-3223-9_7. ISBN 978-94-017-3223-9.
[90] Bignell, Roisin & Lo 2010, p. 13.
[91] Reinhard, J., Kaib, M. (2001). "Trail communication during foraging and recruitment in the subterranean termite Reticulitermes santonensis De Feytaud (Isoptera, Rhinotermitidae)". Journal of Insect Behavior .14(2): 157171.https://doi:10.1023/A:1007881510237
[92] Costa-Leonardo, A.M.& Haifig, I. (2013). Termite communication during different behavioral activities in Bio communication of Animals. Springer Netherlands. pp. 161–190. https://doi:10.1007/978-94-007-7414-8_10. ISBN 978-94-007-7413-1.
[93] Traniello, J.F.& Busher, C. (1985). "Chemical regulation of polytheism during foraging in the Neotropical termite Nasutitermes costalis". Journal of Chemical Ecology. 11 (3): 319–32. https://doi:10.1007/BF 01411418. PMID 24309963.
[94] Costa-Leonardo, A.M.& Haifig, I. (2013). Termite communication during different behavioral activities in Bio communication of Animals. Springer Netherlands. pp. 161–190. https://doi:10.1007/978-94-007-7414-8_10. ISBN 978-94-007-7413-1.
[95] Costa-Leonardo, A.M.& Haifig, I. (2010). "Pheromones and exocrine glands in Isoptera". Vitamins and Hormones. 83: 521–549. https://doi:10.1016/S0083-6729(10)83021-3. ISBN 9780123815163. PMID 20831960.
[96] Evans, T.A., Inta, R., Lai, J.C.S.& Lenz, M. (2007). "Foraging vibration signals attract foragers and identify food size in the dry wood termite, Cryptotermes secund us". Insects Sociaux. 54 (4): 374–382. https://doi:10.1007/s 00040-007-0958-1.
[97] Lai, P.Y., Tamashiro, M. & Fujii, J.K. (1982) Pathogenicity of six strains of entomophagous fungi to Cryptotermes formosanus. J. Invert. Pathol.39,1-5
[98] Mauldin, J.K. and Beal, R.H. (1989) Entomophagous nematodes for control of subterranean termites, Reticulitermes spp. (Isoptera: Rhinotermitidae). J. Econ. Entomol. 82, 1638 ± 42
[99] NAN-YAO, S.U. & Scheffrahn, R. H. . (1989). A review of subterranean termite control practices and prospects for integrated pest management programs. Available from: https://www.research gate .net/

publication
/225192539_A_review_of_subterranean_termite_control_practices_and_prospects_for_integrated_pest_management_programs [accessed Nov 22 2019].
[100] scher, M. (1969) Die Bedeutung des Juvenal hormones fur die Differenzierung der Soldaten dei der Termite Kalotermes Øavicollis. In Proceedings of the Sixth Congress of the IUSSI, pp. 165 ± 70. Bern.
[101] Haverty, M.I. (1977) The proportion of soldiers in termite colonies: a list and a bibliography (Isoptera). Sociobiology 2, 199 ± 216.