

# Historical approach of the role of earthworms and termites in soil functioning

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## Introduction

Recent developments of agriculture towards practices sustaining both agronomic and environmental ecosystems services raised the interest of land users, politicians and scientists for soil biological activity. Soil organisms are seen as a resource in agroecosystems. Among them, soil engineers, such as earthworms and termites, are of prime importance as they regulate soil processes, i.e., the activity of microorganisms through a modification of soil structure and availability of nutrients (Lavelle, 2002). Although earthworms and termites are now seen as emblematic soil animals, this has been quite different during history. This paper aims to describe the development of scientific knowledge regarding the effect of earthworms and termites on soil functioning.

## Key Words

History of soil science, soil organisms, soil engineers, Antiquity, Darwin.

## Historical reputation of earthworms

This part is mainly based on the syntheses by Brown et al. (2003); Feller et al. (2003); Bouché (2003); Blanchart et al. (2005). Earthworms were already well known organisms during the Greek and Egyptian antiquity. Aristotle called them “the intestines of soil” probably because they were able to dig and move in the soil while digesting it. In Egypt they were seen as important elements of soil fertility along the Nile and Cleopatra made them sacred, prohibiting farmers from killing them (Minnich 1977; Kevan 1985). Between Antiquity and the end of the 19<sup>th</sup> Century, only limited information is available on earthworms (Agricola 1549, cited by Kevan 1985). Most of this time, earthworms were considered as harmful organisms that had to be eliminated (White 1789; Rozier 1805; Chateauneuf 1844; Walton 1928). Only Rozier (1805) recognizes some beneficial effects especially as medicines and White (1779) described earthworms as beneficial for soil fertility. From a taxonomical point of view, earthworms were mixed with all worms and it is only in 1800 and the classification by Lamarck that Annelids were separated from other worms.

The first papers by the famous English naturalist Darwin (1838; 1840 and 1844) on earthworms and his book published in 1881 considerably modified the perception by humans of earthworms. In 1881, about 20 years after the publication of « On the origin of species » and six months before dying, Charles Darwin, published his last book. Though his last book was as successful as his main publication, it was nonetheless characterized by a subject considered by scientists to be of small importance at that time, which probably increased its literary success. This book, which actually dealt with earthworms, was entitled “The formation of vegetable mould through the action of worms with some observations on their habits”. This subject, which was a highly surprising one for this great naturalist, would however, change our perception of nature and favor the development of disciplines like pedology and soil biology. In his last book, Darwin explains and describes (with data to prove it) how “worms” affect soil formation and alteration processes, soil horizon differentiation and formation of “vegetal mould”, soil fertility, the erosion-sedimentation cycle, and the burial of archeological remains. This book has changed the way earthworms are considered. Darwin’s book confirmed White’s statements, and must be considered a turning point in history regarding work on earthworms and the perception of their importance. Nevertheless many scientists were quick to criticize Darwin’s conclusions and promptly began research to disprove them. One of them was the famous German soil physicist E. Wollny, whose results (1890) finally proved Darwin was correct.

In the same time, the Danish forester P.E. Müller (1878) also gave earthworms a great importance in soil fertility and humus formation. The role of earthworms on soil functioning only began to be considered in other parts of the world after the 1930’s. This delay may be explained by the important development of chemistry in agriculture, following Liebig’s work (1840). Since then, and with the specialization of scientists, thousands of papers have been published on earthworms. Most of them confirm Darwin’s conclusions and theories.

## Historical reputation of termites

This part is mainly based on the syntheses (only usable by French-speaking scientists) by Duboisset (2003) and Duboisset and Seignobos (2005). The first descriptions of termites and termite-mounds in Africa and Asia were given by explorers, in the 17<sup>th</sup> and 18<sup>th</sup> Centuries (Bosman 1705; Adanson 1757; Koenig 1779, Smeathman 1781). Explorers were impressed by the size and complexity of (fungus-growing) termite-mounds. In 1802, Golbery compared termite-mounds with Egyptian pyramids: “They erect monuments so phenomenal, so firmly built, that, compared with the extreme smallness of the insect (...), they appear more marvelous than the most considerable buildings of human industry”. Numerous descriptions of these mounds were given later (Mattei 1890; Decorse 1906; Schweinfurth 1975). At the same time, termite societies were also described. The existence of castes (i.e., king, queen, workers and soldiers) was observed by some explorers (Golbery 1802; Mattei 1890). The most impressive to European explorers was the huge numbers and the omnipresence of termites (Livingstone and Livingstone 1866). Their voracity was also an important criterion that makes termites emblematic animals of the exotic universe. Golbery (1802) wrote: “They wolf down and reduce to an extremely fine powder, the hugest trees”. Livingstone and Livingstone (1866) related how their blankets were eaten in one night. Bosman (1705) probably mistook termites for carnivorous ants: “During the night, they came to some of my living sheep and gnawed them so as in the morning, we found only carcasses”.

## In the first explorer stories, termites were thus seen as one of the main scourge of the Tropics.

The first scientific studies occurred in the 18<sup>th</sup> Century and focused on three aspects of termites: taxonomical classification, biology (mounds and societies), and importance of damage. Smeathman, in 1781, seems to be the first seeing a positive effect in termite activity as they recycle decomposable matter: “They are in one sense most pernicious, they are in the other most useful”; “There are not probably in all nature, animals of more importance”. But this beneficial effect will be overshadowed up to the mid-20<sup>th</sup> century by the search for means to eradicate termites. The economical development of European colonies was strongly disrupted by termites and their damage to seed stocks, wood buildings, railway line, telegraph posts.

As a consequence, the role of termites in ecosystem and soil functioning was not studied before the beginning of the 20<sup>th</sup> Century, with the exception of the paper by Drummond in 1886. Drummond compared termites (in the tropics) to earthworms (in temperate regions). According to him, these insects maintain the functioning of ecosystems and the fertility of soil: “The ground is literally living with them”. Other scientists, such as Cameron (1905) were dubious regarding the beneficial effects of termites on fertility, estimating that termites immobilize nutritive elements. Hegg (1922), in a very complete synthesis, estimated that “The soil of Africa is in reality a vast termite-mound”. The study of Holdaway (1933), which seems to be the first quantitative study of the effect of termites, gives the composition of the mounds of *Eutermes exitiosus* in Australia. Adamson in 1943 (like McGregor in 1950) recognized that “an adequate understanding of the influence of termite on soil fertility is obviously impossible at present”. In the 1950s, termites are still seen as harmful (Harris, 1949) or beneficial (Grassé 1950) insects. After 1950, termites would be studied by different scientific disciplines: damage, societies, biogeography, pedology. The first studies on soil transport and soil feature formation by soil-feeding termites were done by Boyer (1973), Nye (1955), Stoops (1964), and synthesised by Bachelier (1978). From 1970, many studies are realized regarding the importance of termites in the functioning of ecosystems, with different syntheses being published (Lee and Wood 1971; Wood 1976; Lal 1987; Black and Okwakol 1997)

## Conclusion

Nowadays, termites, like earthworms, are seen as very important soil organisms: they act as soil engineers and actively participate to soil and ecosystem functioning (Lavelle *et al.* 1992; Bignell and Eggleton 2000).

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