Case Histories Involving the Formosan Subterranean Termite in Atlanta, Georgia USA (Isoptera: Rhinotermitidae)

by

Brian T. Forschler[1], James Harron[2] & Tracie M. Jenkins[3]

ABSTRACT

The University of Georgia Department of Entomology and the Georgia State Department of Agriculture have been involved in identifying and working with Pest Control Operators and homeowners dealing with Formosan subterranean termite infestations in the Atlanta, Georgia metropolitan area since 1993. Our involvement with seven separate infestations is outlined in this paper in the form of case histories to highlight the need for the development of community–based action plans to deal with the inevitable introduction of this economically important insect pest to other non–endemic areas.

Key words: Isoptera, Rhinotermitidae, introduced exotic pest, community-based control, *Coptotremes formosanus*

INTRODUCTION

Subterranean termites from the family Rhinotermitidae disperse to new habitats in one or more of three ways. The first is through the flight of the adult (alate) caste members that leave mature colonies on a seasonal basis. The alates fly some distance, form tandem pairs, mate, and begin new colonies (Weesner 1970, Thorne 1998). Budding is a second method of dispersal. It occurs when a portion of an established colony migrates away from or loses contact with the main group and following formation of secondary reproductives establishes a separate colony (Weesner 1970, Thorne 1998). Lastly, another mode of dispersal, similar to budding, is accomplished through passive transport of infested materials (Spink 1967, Gay 1970, Oi 1998).

The 'natural' dispersal rate of the Rhinotermitid *Coptotermes formosanus* Shiraki (the Formosan subterranean termite) is approximately 1km per decade (Su and Tamashiro 1987). But maritime commerce has spread this insect pest far from its indigenous Chinese mainland home range (Gay 1970, Su & Tamashiro 1987). *Coptotermes*

[1]Department of Entomology, University of Georgia, Athens, GA 30602 USA
[2]Division of Pesticides, Georgia State Department of Agriculture, Atlanta, GA 30334 USA
[3]Department of Entomology, University of Georgia, Griffin, GA 30223 USA

formosanus was first reported in Japan in the 16th Century, in Hawaii at the turn of this century, South Africa in the 1920's and along the coast of the Continental United States in the mid–20th century (Su & Tamashiro 1987).

In the United States, Formosan subterranean termites (FST's) have dispersed from the coastal areas northward through the commercial transport of products such as infested lumber, wooden crates, and old railroad ties (Spink 1967). Since 1965, isolated FST infestations have been reported in Houston, Texas, Lake Charles and New Orleans, Louisiana, Mobile and Auburn, Alabama, Memphis, Tennessee, several cities in Florida, Charleston, South Carolina and San Diego, California (Spink 1967, Su & Scheffrahn 1986, Appel & Sponsler 1989, Oi *et al.* 1992, Oi 1998).

In 1993 our research program verified two FST infestations in the Atlanta, Georgia metropolitan area (Fig. 1). With the help of the Georgia State Department of Agriculture and local Pest Control Operators (PCO's) five additional FST infestations were identified in Atlanta between 1993 and 1997. In this manuscript, we relate our involvement with these separate infestations in the form of case histories.

Case History 1: Tucker

The Georgia State Department of Agriculture brought the first Atlanta area FST infestation to the attention of our research program in 1993. The homeowners had reported two major flights of insects within two years. The insects observed at the time of the first swarm in 1992 were identified as ants by a PCO. In 1993, the technician involved the branch manager of a pest control company whose concerns eventually resulted in specimens being sent to the University of Georgia for identification. Following inspection of the property it was determined that railroad ties used as landscaping timbers at one side of the house, next to a sun room-addition were infested with FST's as was the sun room and portions of the original house adjacent to the sun room. The surrounding yard and the property on either side of the infested residence was inspected for additional signs of FST's. No other signs of infestation were observed. Yet, *Reticulitermes* or native subterranean termites (NST's) were found in railroad ties at the back of the house, in woody debris collected in the backyard wood lot, and around the detached garage on the FST infested property.

The house was treated using a multiple-tactic approach. The sun room, around which the infestation was centered, was constructed on a raised slab adjacent to the crawl space of the original structure. The rubble fill under the sun room slab was foamed with Dragnet (permethrin),

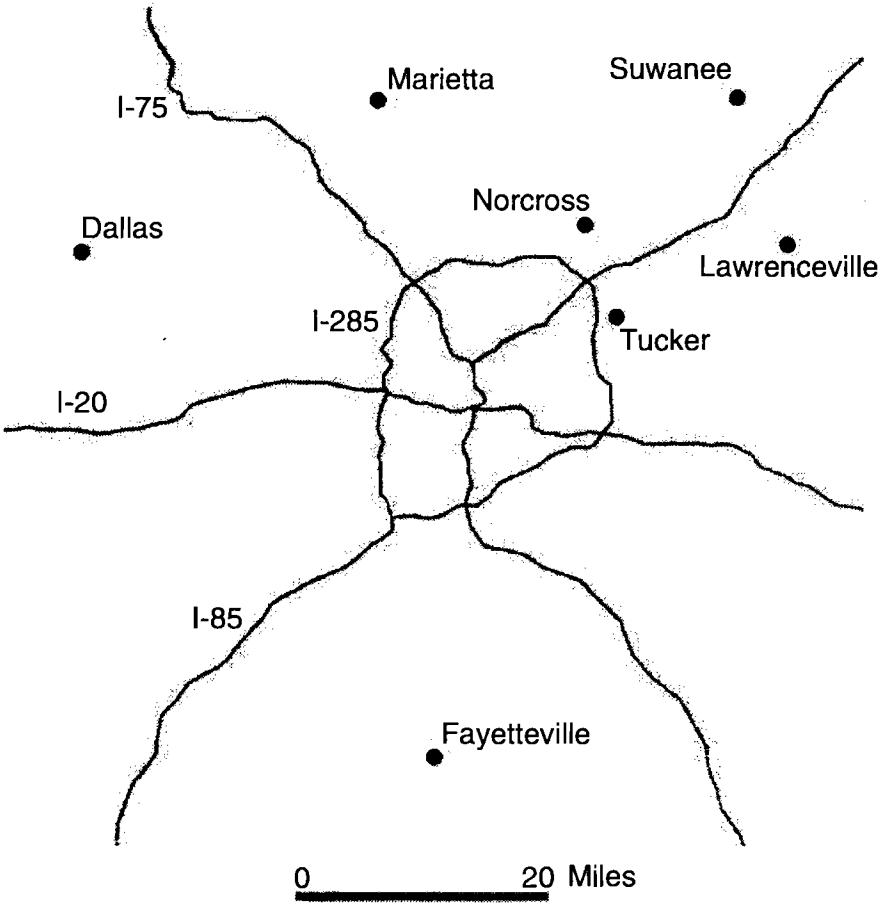

Fig. 1. Location of Atlanta Metro Area Formosan Subterranean Termite Infestations.

a repellent termiticide. The railroad ties were removed, fumigated and destroyed by burning. The entire structure was trenched and treated with Dragnet according to label and State standards. The exposed wood in the crawl space was treated with a borate solution (Tim-Bor) and the entire house was then fumigated with Vikane (sulfuryl fluoride). Two inspections of the structure and surrounding landscape (including wooden stakes placed on the property) within the following year failed to detect the presence of FST's and no swarms have been reported since 1993.

Case History 2: Lawrenceville

The State Department of Agriculture inspectors identified this FST infestation using alates collected by the homeowner following a swarm in the spring of 1993. The first swarm, in 1992, was misidentified as ants by a PCO. The structure was a two–story frame house with a poured concrete basement foundation. FST's were identified in all four sides of the structure. Although there were no railroad ties on the property with the FST infestation the neighbors on both sides had railroad ties used for landscaping the sloping terrain. The PCO treated the structure in the summer of 1993, using Dragnet and a borate solution (Boracare) according to label and State guidelines. The structure needed an additional spot treatment approximately six months after the initial treatment at the garage slab/driveway cold joint. Further, the entire structure was fumigated with Vikane at that time. One month after this fumigation and spot treatment, using the same termiticide as the original treatment, the structure was inspected and deemed free of infestation.

However, FST's were present in the surrounding landscape as evidenced by their presence at the base of several trees on the property. One of the adjoining properties was inspected with the permission of the owner and no signs of FST's were recorded. The other adjoining property was in receivership and permission could not be obtained for an inspection. The original property was staked using wooden survey stakes (bait stakes) but the FST's were never found in the same location two months in a row. We attempted baiting the FST's using 0.1% hexaflumuron–treated wooden sawdust. Because the FST's did not return to a site following disturbance, we buried a 'bait tube' (a plastic unit measuring 17cm in length by 3.5cm in diameter) containing 35g of treated sawdust at the base of a tree where FST activity was observed. When that tube was excavated three months later no treated sawdust was present. We assumed that the sawdust bait was consumed by FST's based on the proximity of FST activity at the base of the tree near the bait tube placement.

The structure has been inspected annually since 1993 and no termites have been found in the house. However, in the spring of 1999 three FST swarms occurred from the yard of the original FST–infested property and from the neighboring yard where inspections were not conducted. Inspection of both properties, in 1999, found FST's in two dead trees in the neighboring yard (the house that was in receivership but currently has a owner/occupant) but only NST's were detected in a survey of woody debris on both properties. According to homeowners, none of the houses within the adjoining properties is currently infested.

Case History 3: Fayetteville

This FST infestation was identified by a PCO after the first swarm in May of 1994. A spot treatment using Dursban (chlorpyrifos) termiticide was conducted using a trenching method along the exterior wall of the garage below where the infestation was observed. Although the garage remained free of FST's, they were discovered the following year (1995) in the basement and kitchen wall of the structure. The backyard of the property was landscaped with over 400 railroad ties and FST infestation was observed in the retaining wall nearest the structure and within 3m of the structural infestation site(s). In the summer of 1994 we placed wooden bait–stakes and prototype Sentricon™ stations in the back yard but FST's were never observed in any of the bait–stakes or stations. The lack of FST activity could have been due, in part, to the family dog that consistently dug up any station or stake placed within the free–roaming range of this family pet. Despite this inconvenience, we did find NST's in one station and two bait–stakes in the side and back yard during 1995–96 in areas where the dog was excluded. In 1994 we attempted to bait the FST's using sawdust treated with 0.1% hexaflumuron at two locations where flight–tubes (swarm castles) were observed in one of the railroad ties and the top sill above the kitchen window. The bait was presented in a paper towel 'bag' that was attached to the site using a staple gun and ¼ inch staples. The bait–bags were then covered with plastic using the same staple gun. None of the bait offered at the flight–tube sites was consumed although termites did mud over the bait/wood interface at the kitchen top sill site.

Starting in June of 1996 this FST infestation was baited using hexaflumuron treated paper towels (0.1%) at infested floor joists and joist headers, in the basement. The bait was provided in 'pads' of treated paper placed inside prototype, proprietary 'soft stations'. These soft stations were composed of pliable plastic/foam material in two layers to position and hold a pad of paper towel bait against wooden structural members. Ten separate baiting sites were established in the basement in areas with visible termite activity. Of those ten sites only three provided greater than 60% of a single bait pad consumed over the next five months. Three additional sites provided limited evidence of bait consumption at 20% or less of a single bait pad consumed and four sites provided no evidence of feeding activity. At the end of five months we calculated that the equivalent of approximately 5 complete bait pads were consumed for a total of about 500mg of hexaflumuron. Since December of 1996 no further evidence of FST's have been recorded at this site.

Case History 4: Suwanee

We were notified of a FST swarm at a commercial building in May of 1995. This was the second recorded swarm at this site. In 1994 the infestation was classified as ants by a PCO. The entire length of the rear of the structure was within 2m of a retaining wall composed of railroad ties that were infested with FST's. In June of 1995 we placed wooden bait–stakes and prototype Sentricon™ stations at the rear of the structure. Over the next two years we found NST's in one Sentricon™ station and one bait-stake but no FST's. Beginning in June of 1995 and over the next 8 months we installed 12 prototype 'soft' stations, described in Case History 3, at various locations (behind baseboards, along top plates and sill jacks or header jacks) in two of the businesses within the structure where FST activity was observed. Bait consumption was first recorded at one station in July. Yet, only minimal feeding (less than 5%) was observed at that site, and one additional site (out of 9 possible sites), over the next three months. Because of the lack of feeding on the baits at this infestation site it was decided to spend extra time on our visits and to pay close attention to producing minimal disturbance when checking each baiting 'station'. We believe, as a result of this attention to detail, we recorded feeding (>10% per station) at six bait sites over the next three months. Near the end of February 1996 a FST swarm occurred in the structure. FST activity (presence of termites and feeding at bait sites) continued until May of 1997. We calculate that a total of 9 'pads' of paper towel bait was consumed (approximately 900mg of hexaflumuron) from 6 of 11 bait placements established inside the structure. Since May of 1997 no FST activity has been observed or reported at this site.

Case History 5: Marietta

In April 1996, we received a phone call from a PCO who reported a FST swarm at a house in Marrietta, Georgia. During our phone conversation the PCO stated that there were no railroad ties on the property. However, upon inspection, infested railroad ties were found around a tree in the middle of the driveway within 4m of the house. Additional railroad ties were found around every tree in the front yard, yet none showed sign of active infestation. The structure had been trenched and treated using Premise (imidacloprid) around the exterior and interior of the crawl space and a wood injection treatment using PT–270 (chlorpyrifos) was applied to the floor joists in the crawl space where active FST's were observed. This explained the thousands of dead and dying termites we found on the vapor barrier in the crawl space during our inspection one week post treatment. Moisture meter readings were

taken inside the house. The highest moisture meter readings were recorded in walls within the structure adjacent to the carport. This area of the house was near the infested railroad ties. We provided advice concerning treatment options and had no further involvement with this infestation as a research site. Through conversations with the company conducting the treatments we learned that they attempted another treatment using foam application of Empire (chlorpyrifos) to the carport slab area and around the chimney. The infestation was still active in portions of the house in 1997 when the PCO installed the Sentricon™ System. Since 1999 no FST's have been found in any of the bait stations attached to the structure or in the yard and no swarms have occurred.

Case History 6: Dallas

We received a call from the State Department of Agriculture concerning another FST infestation involving a church near Dallas, Georgia in May of 1996. Upon inspection we discovered that the front of the church property sloped to the parking lot and was landscaped with over 50 railroad ties. The railroad ties were infested with FST's and FST's were also noticed in the front portion of the church. The PCO trenched and treated the entire exterior perimeter of the church using a repellent termiticide (type unknown from the one interview we conducted). We recommended that they remove and destroy the railroad ties and provided them with the available treatment options with emphasis on eradicating the infestation. The church took no action until 1998 when they removed the railroad ties from the landscape, stacked them on the adjacent property and applied a repellent liquid termiticide to the ground under the railroad ties. We have no further information concerning this infestation.

Case History 7: Norcross

In December of 1997 we were notified by the State Department of Agriculture concerning a FST infestation in a townhouse in Norcross, Georgia. The infestation was identified as termites by the homeowner in 1996 and the PCO identified the termites as the NST, *Reticulitermes hageni*. The homeowners reported observing swarms of insects in the house and around the lights in the cul–de–sac in the spring of 1996 and 1997. We identified the old, brittle alates sent to us as *C. formosanus* in December, 1997. According to the homeowner the structure had been retreated twice in the past two years, 1995 and 1996. The treatment regime was never identified. An inspection of the structure at the end of 1997 showed no active FST infestation and we could find no termite activity in the railroad ties in the side yard. Thereafter, we lost contact with the homeowner. However, we received a phone call in

the spring of 1999 from another homeowner at the opposite end of the same structure involved in the original infestation. This person had recently purchased the townhouse and found, within 9 months of the closing, extensive termite damage. This homeowner was told it was a FST infestation. We inspected the site in the spring of 2000 and verified an active FST infestation in the structure but it seems to be confined to the townhouse property opposite the original infestation site. An inspection of the property yielded NST's in a stump and wood debris near the current FST infestation. Because this homeowner is involved in a lawsuit we have no further information on this infestation yet according to interviews there is no termite activity in either of the other two townhouses in this structure.

DISCUSSION

We believe the Atlanta Formosan subterranean termite infestations present a unique opportunity to study the dispersal, establishment and eradication of imported subterranean termite pests. However, limited resources at the State, University and homeowner levels have prevented any systematic, long term study of these sites. The natural range of *C. formosanus* in China indicates that it is uncommon above 35° north latitude (Fusheng *et al.* 2000). This places the Atlanta infestations above the 'expected' home range of this destructive insect pest. However, the fact that each of the known infestations in the Atlanta metro area swarmed and maintained active infestations indicates their potential to succeed in north Georgia and other areas of the United States. By studying the distribution of the insects at each of the aforementioned sites a better understanding of how the FST adapts, maintains and spreads from known isolated infestation sites could be used to design an action plan for eradication of future introductions.

We learned several lessons from our experiences with the FST infestations in the Atlanta metro area. These case histories highlight the importance of educating the PCO, State inspectors and homeowners to obtain timely identification of FST infestations in non–endogenous areas. The first infestations we verified (Case Histories 1, 2) had been misidentified as ants prior to our involvement. The Georgia Pest Control Association (GPCA) was instrumental in disseminating a fact sheet on identification, biology and control of FST during 1993–94. Every year since distribution of that fact sheet, and inclusion of FST identification in training sessions conducted by GPCA, we receive samples of potential FST infestations. Most of these samples turn out to be NST's yet we do occasionally verify additional FST infestations (Case Histories 6 and 7). Despite the fact that one FST infestation was misidentified as a NST the

light southeastern subterranean termite, *Reticulitermes hageni* (Case History 7) we believe progress has been made because the insect was identified as a termite and not an ant.

Despite the widespread distribution (Fig. 1), used railroad ties employed as landscape timbers was a common denominator in all of the Atlanta metro area FST infestations we examined. Thus, it was believed that these infestations were the result of railroad ties already inhabited by FST when transported to Atlanta. Additionally, interviews with the property owners who had knowledge of the purchase of the railroad ties indicated that they were purchased between 1989 and 1990. The State Department of Agriculture traced the vendor of the railroad ties who claimed to have, on occasion, purchased them from the Charleston area. It was assumed, therefore, that the Atlanta FST infestations were most likely the result of one or more shipments of railroad ties from Charleston, South Carolina.

At the University of Georgia we decided to verify the source of these infestations using molecular techniques. Mitochondrial DNA (mtDNA) is matrilineally inherited and because *C. formosanus* colony structure is predicated on a single founding primary reproductive pair each colony member would carry the founding females' mtDNA genotype or haplotype (Avise 1994). If all or part of a FST colony were transported from one geographic site to another it could be traced through identification of this mtDNA genotype. We, therefore, sequenced the COII gene from selected individuals from four of the FST infestations in Atlanta according to protocols described in Jenkins *et al.* (1999). These mtDNA haplotypes were then evaluated and compared to haplotypes from Charleston, South Carolina as well as other potential sources of introduction that included New Orleans, Louisiana, Mobile, Alabama, Ft. Worth, Texas and Honolulu, Hawaii. All mtDNA haplotypes were compared. We demonstrated that the FST's from the four Atlanta sites we tested all had identical COII sequence. This indicated that the infestations in Atlanta were likely the result of a single shipment of infested railroad ties. In addition, comparison of the Atlanta COII sequence with the other *C. formosanus* populations sampled demonstrated that the haloptye common to all the Atlanta FST populations was identical to one of the two halotypes from New Orleans, Louisiana. Thus we were able to show that the Formosan termite infestations in Atlanta were most likely the result of single shipment of infested railroad ties from New Orleans, Louisiana not from Charleston, South Carolina (Jenkins *et al.* unpublished data, in review).

Case Histories 1, 3, 4, and 5 demonstrate the potential, through concerted treatment regimes or baiting, for eradicating isolated FST

infestations. However, because the termites at each site produced alates that swarmed prior to intervention the possibility exists that new FST colonies have been established. To verify eradication of the termites at these sites a thorough survey of the area around each site must be conducted. Because these swarms occurred more than 5 years ago the presence of new FST colonies could be identified through traditional bait stake survey, directed collection of woody debris, structural inspection, and light trap collections (during May and June). Surveys have not been attempted, however, due of limited funds.

Case Histories 2, 7, and 8 demonstrate the importance of an area wide management program in containing or eradicating isolated FST infestations. The individual homeowner can protect their structure but by allowing the infestation to continue in the surrounding soil the potential for new infestation of nearby structures as in Case History 8 proclaim the need for a community-based action plan. Solving the problem(s) presented by the importation of this insect pest requires control tactics that are based on population management not structural protection. This necessitates use of a treatment regime that targets the termite population and is aimed at killing all of the termites or at the very least reducing their capacity for population growth thereby contributing to the demise of the offending colony.

Communities should have, in place, a concerted action plan that cuts across property boundaries. This would require survey of the surrounding properties and initiation of control tactics aimed at termite population management. The community based action plan should initiate a detailed survey of the area to delimit the extent of the infestation, and oversee treatment tactics that will eradicate the termite population. The control tactics must be tailored to the structural, landscape and termite colony characteristics presented by each and every infestation. Case History 1 demonstrated that a multidisciplinary approach could be successful when the extent of the infestation is isolated to a small area. Case Histories 3, 4, and 5 demonstrated that a baiting program by itself could also be successful. Yet, without a timely intervention aimed at population management the likelihood of success may only be limited to protection of specific structures as evidenced by Case Histories 6 and 7. The need for a concerted, long–term commitment is highlighted by Case History 2 where structural protection has been successful for the past 7 years but a limited baiting attempt has failed to eradicate the infestation. Because this FST population is now believed to extend across several properties a long–term, area wide management plan must be enacted to ensure successful eradication.

We currently have a proposal before the Governor of the State of

Georgia for initial, limited funding to conduct a survey of the 7 FST infestation sites listed in this paper. This survey will allow us to measure the apparent success of treatments conducted to date and provide information on the spread of those infestations known to still be active. This information will be invaluable toward understanding the ability of the FST to maintain populations in non–endogenous areas and provide additional information on potential action plans for use in future eradication programs.

ACKNOWLEDGMENTS

We would like to thank Monica Townsend and Sherry Ridgeway at UGA and all of the State Inspectors for their technical support with the survey and control attempts against the Formosan subterranean termite infestations discussed in this paper. We also acknowledge Jennifer Blanten's technical assistance with the molecular work and Mark Hopkins and Rob Dean for invaluable biotechnical support.

REFERENCES

Appel, A.G., & R.C. Sponsler. (1989). Formosan termites now in Alabama. Highlights. 36:34.

Avise, J.C. (1994). Molecular Markers, Natural History and Evolution. Chapman & Hall, New York. 511 pp.

Fusheng, H., Z. Shimo, P. Zehngming, H. Xiusong, L. Guixiang, G. Daorong. Insecta Vol. 17. Isoptera. *In*: Fauna Sinica. Science Press. Beijing, China. pp. 100.

Gay, F.J. (1970). Species introduced by man. In: Krishna K and Wessner FM (eds) Biology of Termites, Vol. 1. pp. 459-494. Academic Press, New York.

Jenkins, T.M., C.J.Basten., S. Kresovich & B.T. Forschler. (1999) Mitochondrial gene sequence questions *Reticulitermes* sp. Social structure (Isoptera: Rhinotermitidae) populations. Sociobiology. 33:239-263.

Jenkins, T.M., J.L. Blanten, R. Dean & B.T. Forschler. Mitochondrial DNA gene sequence and the source of Formosan subterranean termite (Isoptera: Rhinotermitidae) invasions. (Submitted to Biological Invasions)

Oi, F.M., P.G. Koehler, N.-Y. Su, & R.H. Scheffrahn. (1992) The Formosan subterranean termite. ENY-216, Florida Cooperative Extension Service. IFAS, University of Florida, 6 pp.

Oi, F.M. (1998). Formosan subterranean termites. Alabama Cooperative Extension System Circular ANR-1035, 4 pp.

Spink, W.T. (1967). The Formosan subterranean termite in Louisiana. Louisiana State University and Agricultural and Mechanical College Agricultural Experiment Station Circular No. 89, 12 pp.

Su, N-Y, & R.H.Scheffrahn. (1986). The Formosan subterranean termite, *Coptotermes formosanus* (Isoptera: Rhinotermitidae), in the United States: 1907-1985. *In*: Proceedings of the National Conference on Urban Entomology, pp 31-38. University of Maryland, College Park, Maryland.

Su, N-Y, & M. Tamashiro (1987). An overview of the Formosan subterranean termite (Isoptera: Rhinotermitidae) in the world. *In*: Tamashiro M and Su NY (eds) Proceedings of the International Symposium on the Formosan Subterranean Termite, pp 3-15, College of Tropical Agriculture and Human Resources, University of Hawaii, Research Extension Series 083, Honolulu, Hawaii.

Thorne, B.L. (1998). Biology of subterranean termites from the genus *Reticulitermes*. *In*: NPCA Research Report on Subterranean Termites, pp 1-30. NPCA, Dunn Loring, Virginia.

Weesner, F.M. (1970). Termites of the Nearctic region. *In*: Krishna K and Wessner FM (eds) Biology of Termites, pp 477-524. Academic Press, New York.