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**Annotated Bibliography of the Ambrosia Beetle *Xylosandrus Germanus* (Coleoptera: Scolytidae)**

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ANOTATED BIBLIOGRAPHY OF THE AMBROSIA BEETLE
XYLOSANDRUS GERMANUS (COLEOPTERA: SCOLYTIDAE)

B. C. Weber and J. E. McPherson

Xylosandrus germanus (Blandford) (= Xyleborus germanus) is an ambrosia beetle that is found in Japan, Korea, the Kuril Islands, Vietnam, China, Taiwan, central Europe, and the United States (Nobuchi 1981). It attacks apparently healthy plants and those that are dying or recently dead (Weber 1982). Kaneko (1967) reported X. germanus to be a serious pest on tea (Thea sp.) plants in Japan, and Heidenreich (1960) reported it on oak (Quercus sp.) trees in Germany. This beetle seems to be increasing in economic importance on black walnut (Juglans nigra L.) and other hardwood species in the U.S. (Weber 1982).

During a study by the senior author on the biology of X. germanus, we found little published biological information from research on this beetle in the U.S.; most studies had been conducted in foreign countries. We also found that in most of the literature, it was not possible to tell from the titles that the publications contained information about X. germanus. Therefore, to help other researchers who may be interested in X. germanus, we have compiled an annotated bibliography of the world literature on this beetle. The bibliography, current through January 1982, includes all articles that are listed in the Zoological Record and the Bibliography of Agriculture and several that are not included in those abstracting publications. We were not able to obtain copies of about 30 articles listed by Nobuchi (1981); most of these were published in Japan between 1938 and 1965.

Anderson, D. M. 1974. First record of Xyleborus semiopacus in the United States (Coleoptera, Scolytidae). Coop. Econ. Insect Rep. 24:863-864. X. germanus was included in a listing of other Xyleborine ambrosia beetles that have been introduced into the U.S.

Anderson, R. L. and W. H. Hoffard. 1978. Fusarium canker-ambrosia beetle complex on tulip poplar in Ohio. Plant Dis. Rep. 62:751. A 6-year-old tulip poplar plantation was attacked in spring 1978 by X. germanus and Xyleborus savi ambrosia beetles. Cankers caused by Fusarium solani were associated with dieback in the beetle-attacked trees. About 36% of the trees in the 5-acre plantation were affected. Affected trees averaged about 2 inches in diameter.

Anonymous. 1972. A list of plant diseases, insect pests, and weeds in Korea. Korean Soc. Plant Prot. 424 p. X. germanus was included in the insect fauna of Korea and was called the smaller alnus bark beetle. Host plants were also listed.

Anonymous. 1979. Summary of forest pests for 1979. Indiana For. Pest Informer, February. 25 p. Three black walnut plantations in Dubois, Green, and Washington counties, Indiana, were damaged by X. germanus and Fusarium cankers (dates of attack not given). Sanitation of affected trees was the recommended control procedure.

Baker, W. L. 1972. Eastern forest insects. USDA For. Serv. Misc. Publ. No. 1175:1-642. X. germanus was reported from stumps and logs of elm and other hardwoods in New York City and the Ohio River Valley and noted as capable of transmitting Dutch elm disease.


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1Part of a dissertation submitted to Southern Illinois University by the senior author in partial fulfillment of the requirements of the Ph.D. degree in Zoology.
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For. Serv. Gen. Tech. Rep. SO-10:1-34. Several publications concerning X. germanus were included.

Batra, L. R. 1963. Ecology of ambrosia fungi and their disseminations by beetles. Trans. Kansas Acad. Sci. 66:213-236. The term "mycangia" was coined to describe sac-like structures for carrying the ambrosial fungi of scolytids. Although the ambrosial fungi of some ambrosia beetles were described and discussed, the ambrosial fungus of X. germanus was unnamed. Ceratocystis ulmi (Buisman) was associated with X. germanus adults collected from American elm in Pennsylvania.

---. 1967. Ambrosia fungi: a taxonomic revision and nutritional studies of some species. Mycologia 59:976-1017. The ambrosial fungus of X. germanus in Germany and in Japan was named as Ambrosiella hartigii Batra and described.


Böhni, H. 1958. Der "Schwarze Nutzholzborkenkafer," ein Quarantäneschädling. Pflanzenarzt 11(3):41. X. germanus was given the status of a quarantined pest in Switzerland to prevent its introduction into that country from Germany.

Bright, D. E. 1968. Review of the tribe Xyleborini in America north of Mexico (Coleoptera: Scolytidae). Canadian Entomol. 100:1288-1323. Keys to species of Xylosandrus (including X. germanus) and Xyleborus ambrosia beetles were provided. A brief review of the literature and distribution maps were included.

Browne, F. G. 1963. Taxonomic notes on Scolytidae (Coleoptera). Entomol. Ber. (Amsterdam) 23:53-59. X. germanus was included in a list of the known species in the genus Xylosandrus and was (incorrectly) stated to be the type of the genus.

Buchanan, W. D. 1940. Ambrosia beetle Xylosandrus germanus transmits Dutch elm disease under controlled conditions. J. Econ. Entomol. 33:819-820. Ceratostomella (= Ceratocystis) ulmi Buisman was isolated from 0.24% of all X. germanus adults collected from elm trees. In a laboratory experiment, adults transmitted C. ulmi to five out of six caged elm trees.

---. 1941. Experiments with an ambrosia beetle, Xylosandrus germanus (Bldf.). J. Econ. Entomol. 34:367-369. Further laboratory experiments with X. germanus provided additional evidence that this beetle, when reared on caged elm or red pine, can transmit Dutch elm disease to healthy trees. Living trees injected with ethyl alcohol were heavily attacked by X. germanus. Larvae were successfully reared to adults on agar plates with Ceratostomella (= Ceratocystis) ulmi Buisman, C. plurianulata (Hedges), Pestalozzia sp., and one unidentified species of fungus.


Clausen, C. P. 1931. Insects injurious to agriculture in Japan. USDA Circ. 168:1-115. X. germanus was listed as injurious to mulberry.

Collins, C. W. 1941. Studies of elm insects associated with Dutch elm disease fungus. J. Econ. Entomol. 34:369-372. Studies on Dutch elm disease and its vectors, including X. germanus, were reviewed.


Deyrup, M. 1978. Impact of bark and ambrosia beetles (Scolytidae) on Indiana hardwoods. p. 540-549 in Proc. Centr. Hardwood For. Conf. II, Purdue Univ., West Lafayette, IN. X. germanus was reported as one of the most serious scolytid pests of Indiana hardwoods. It was found to be abundant in live black walnut and Rhododendron sp.

---. 1981. Annotated list of Indiana Scolytidae (Coleoptera). Great Lakes Entomol. 14:1-9. X. germanus was one of 80 species of scolytids collected in Indiana from 1978 to
1979 and was the most frequently collected ambrosia beetle species. Several new host plants were reported.


Felt, E. P. 1932. A new pest in greenhouse grown grape stems. J. Econ. Entomol. 25:418. The occurrence of *X. germanus* in the U.S. was reported for the first time. The beetle was found in a greenhouse on Long Island, New York.

Felt, E. P. and W. S. Bromley. 1937. A new ambrosia beetle, *Xyleborus germanus* Blandf., in America. Bartlett Tree Res. Lab. Bull. 2:20. *X. germanus* was collected in January 1932 from grape stems with diameters of 3.7 to 5.0 cm. Hundreds of beetles were reared from stem sections that had a total length of about 1 m. The infested grape stems were apparently not severely damaged nor were the vines seriously injured.

Francke-Grosmann, H. 1956. Hautdriisen als Träger der Pilzsymbiose bei Ambrosiakäfern. Z. Morphol. Ökol. Tiere 45:275–308. The spore storage organs (= mycangia) of *X. germanus* were described for the first time and noted to be in the intersegmental membrane between the pro- and mesonota.

———. 1963. Some new aspects in forest entomology. Annu. Rev. Entomol. 8:415–438. The mycangia of *X. germanus* were again described. The ambrosial fungus of *X. germanus* (unnamed) was isolated from the mycangia. It was reported as closely related to *Trichosporium ferrugineum* Mathiesen-Käärik, the ambrosial fungus of *Trypodendron* spp. ambrosia beetles, and was living in symbiosis with *Monilia candida* Hartig.


———. 1975. Zur epizoischen und endozoischen Übertragung der symbiotischen Pilze des Ambrosiakäfers *Xyleborus saxeseni* (Coleoptera: Scolytidae). Entomol. Ger. 22:168–172. The presence of *X. germanus* in Germany on *Acer pseudoplatanus* L. was associated with *Fusarium* and *Phomopsis* fungi. Only one generation of beetles per year was observed. Gallery characteristics and other aspects of the biology of *X. germanus* were compared to those of *X. dispar* (Fabricius). A wasp, *Tetrastichus* sp., and a mite, *Histiogaster hylocoeti* Koch, were found in galleries but their relationships to *X. germanus* were not known. No other parasites were found.

Groschke, F. 1952. Der "Schwarze Nutzholzborkenläufer" *Xylosandrus germanus* Blandf., ein neuer Schadling in Deutschland. Z. Angew. Entomol. 34:297–302. The occurrence of *X. germanus* in Germany was reported for the first time. The known literature up to that time was reviewed.

———. 1953. Der "Schwarze Nutzholzborkenläufer," eine neue Gefahr für Forstwirtschaft. Obst-und Weinbau. Anz. Schädling. 9:81–84. *X. germanus* attacked weakened trees in forests and was considered a secondary pest. In fruit orchards and vineyards, however, it was considered an agricultural pest of some importance.

Heidenreich, E. 1960. Primärbefall durch *Xylosandrus germanus* an Jungeichen. Anz. Schädling. 9:3–5. In 1959, 7-year-old red oak trees were attacked, with 10–30 borer holes per tree up to a height of 2.5 m. Dissected galleries yielded 12–20 offspring per female. Two generations per year were reported; the first generation caused the most damage. The first attack period occurred about mid-May, and a second attack period occurred about mid-June. Females were considered to be poor fliers and strongly temperature-dependent. *X. germanus* was determined to be a primary pest on young oak trees.


———. 1964. Ökologische Bedingungen für Primärbefall durch *Xylosandrus germanus*. Z. Angew. Entomol. 51:131–140. In 1961, young red oak trees were again attacked, particularly late-leafing trees. *X. germanus* preferred moist, shaded stumps and logs as the
best sites to grow its ambrosial fungus. Females reportedly were able to fly as far as 300 m to find new hosts.


Hoffmann, C. H. 1941. Biological observations on Xylosandrus germanus (Blndf.). J. Econ. Entomol. 34:38-42. Distribution of X. germanus was given as New York, New Jersey, West Virginia, and Ohio; hosts included oak, elm, red maple, beech, hickory, and poison ivy. Two instances of attack in apparently healthy trees were noted. Gallery structure was briefly described. Two, or three, generations were reported in New Jersey; the beetles first attacked trees in early May. All stages of development were present from June to September. Various other aspects, including moisture content of host plants and associate insects, were also discussed.

Inouye, M. 1955. Wichtige, in Hokkaido (Japan) durch schädliche Forstinsekten verursachte Probleme. Anz. Schadlingskd. 28:161-162. X. germanus was found in Todo fir in Hokkaido, Japan, after a severe ice storm on 10 May 1954.

Jones, T. H. and C. S. Moses. 1943. Isolation of Ceratostomella from insects attracted to felled elm trees. J. Agric. Res. 66:77-85. Ceratostomella (= Ceratoctysis) ulmi Buisman was isolated from 0.2% of X. germanus beetles collected from elm.


Kamp. H. J. 1953. Neues über den eingeschleppten "Schwarzen Nutzholzborkenkäfer." Holz-Zentralbl. 79:1194. Attack patterns on birch, beech, and spruce in Germany were described. Under certain conditions, X. germanus was reported capable of becoming a serious pest because it introduced fungi into a tree at the time of attack. Girdling of a tree was possible if the attack was strong enough. Control recommendations included the removal of fallen trees before 1 April.


Kamp. H. J. 1954. Nutzholzschädlinge an Eiche und ihre Bekämpfung. Merck Bl. 4:1-14. X. germanus was included in a list of important pests of oak; signs of attack and other host plants were also listed. It was ranked the third most frequent pest of oaks in 1953. Mechanical and chemical controls were discussed.

Kamp. H. J. 1958. Kleine Mitteilungen Nummer 1610 Scolytidae. Entomol. Bl. Biol. Syst. Käfer 54:64. X. germanus was reported as one of four species of scolytids that attack both deciduous and coniferous trees in Germany.

Kamp. H. J. 1963. Kleine Mitteilungen Nummer 1748 Xylosandrus germanus. Entomol. Bl. Biol. Syst. Käfer 59:125. X. germanus was reported to overwinter in its brood galleries. Females became active soon after they were brought inside on 17 February 1963, after a very cold winter.

Kamp. H. J. 1965. Ein Beitrag zur südbadischen Käferfauna. Mitt. Bad. Landesver. Naturk. Naturschutz 8:565-568. Bark and ambrosia beetles of southern Germany were briefly reviewed. X. germanus was reported to be occasionally abundant because of the mild climate.

Kamp. H. J. 1966. Ein weiterer Beitrag zur südbadischen Käferfauna. Mitt. Bad. Landesver. Naturk. Naturschutz 9:329-334. Larvae of X. germanus were collected in Germany in a dying cherry tree on 28 July 1966; the species was also collected from beech, oak, and fir trees from altitudes up to 600 m.


Decheniana 20:22-28. X. germanus was reported on both deciduous and coniferous trees in Germany.

Kaneko, T. 1965. Biology of some scolytid ambrosia beetles attacking tea plants. I. Growth and development of two species of scolytid beetles reared on sterilized tea plants. Japanese J. Appl. Entomol. Zool. 9:211-216. X. germanus and X. compactus (Eichhoff) were reared on tea plants in the laboratory. X. germanus preferred roots about 15-20 mm in diameter. Development time was a minimum of 15 days at 20°C. Adult sex ratios were 9:1 (♂:♀) in the first generation and 8:1 in the second. The numbers of eggs per adult female ranged from 33-50. Other aspects of the biology were also discussed.


Miller, W. E. 1973. Insects as related to wood and nut production, p. 91-96 in Black walnut as a crop. USDA For. Serv. Gen. Tech. Rep. NC-4. X. germanus was reported in Illinois and Indiana, and on black walnut, for the first time.

---. 1931. Revision des familles des Ipides et Platypides (Coleopteres) de L'Ile de Quelpart. Annot. Zool. Japonenses 13:39-61. X. germanus was collected from the three host plant species in Korea listed above (Murayama 1930). Scolytid associates were also listed.


---. 1936. Notes sur les Scolytides (Coleopteres) de Honshu et Kyushu, Japan. Tenthredo 1:121-149. Collection dates, host plants, and distribution records for X. germanus in Japan were summarized.


Niisima, Y. 1909. Scolytiden Hokkaidos unter Berucksichtigung ihrer Bedeutung fur Forstschaden. 1. Coli. Agric., Tohoku Imperial Univ. (Sapporo, Japan) 3:109-179. X. germanus was collected in Sapporo (northern) and central Japan.


---. 1913. Neue Borkenkaefer nebst Frasspflanzen. Trans. Sapporo Natur. Hist. Soc. 5:1-16. Several specimens of X. germanus were collected from dead alder stems in fall 1911. More specimens were collected from tea plants in summer 1913.

Nobuchi, A. 1966. Bark beetles injurious to pine in Japan. Gov. For. Exp. Sta. Bull. 185:1-50. X. germanus was collected from two species of pine, and was included in a key to all scolytids injurious to pine, in Japan. All other host plants were also listed.

---. 1967. Formosan Scolytoidae (Coleoptera). Gov. For. Exp. Sta. Bull. 207:11-30. X. germanus was included in a list of scolytids collected in Formosa (Taiwan) and had been intercepted from logs imported from Formosa into Japan.

---. 1969. A comparative morphological study of the proventriculus in the adult of the superfamily Scolytoidae (Coleoptera). Gov. For. Exp. Sta. Bull. 224:39-110. The proventriculi of 100 genera of scolytids, including that of X. germanus, were described and illustrated. Possible phylogenetic relationships among the genera were also discussed.

---. 1972. The biology of Japanese Scolytidae and Platypodidae. Rev. Plant Prot. Res. 5:61-75. X. germanus was noted as a pest of actual or potential importance on conifer and broadleaf trees in Japan. It was reported to attack standing green trees and to breed for generations in living wood. Canker-causing and wood-rotting fungi were introduced by the beetles into their host trees. No parasites of X. germanus were recorded.


---. 1979. Studies on Scolytidae XVI. Bark and ambrosia beetles collected by Dr. Kintaro Baba (Coleoptera: Scolytidae and Platypodidae). J. Japanese Entomol. Soc. 50:115-121. X. germanus was commonly collected in hardwood and coniferous tree species. Collecting dates and locations were given.


Norris, D. M. 1979. The mutualistic fungi of Xyleborini beetles. p. 53-63 in L. R. Batra (ed.). Insect-fungus symbiosis. Allanheld, Osmun Publishing Co., Montclair, NJ. Fusarium solani (Martius) and other Fusarium species were given as the dominant fungal symbiotes of X. germanus. Ceratocystis ulmi (Buisman) was also listed as an ambrosial fungus of X. germanus.

Schneider, I. 1975. Untersuchungen über die biologische Bedeutung der Mycetangien bei einigen Ambrosiakäfern. Mater. Org. (Berlin) 3:489-497. *X. germanus* was noted to overwinter in wood but not to diapause.

Schneider, I. and M. H. Farrier. 1969. New hosts, distribution, and biological notes on an imported ambrosia beetle, *Xylosandrus germanus* (Coleoptera: Scolytidae). Canadian Entomol. 101:412-415. *X. germanus* was reported from *Nyssa aquatica* L., *Taxodium distichum* (L.), and *Prunus serotina* Ehrhart in North Carolina. The hosts and the state were new records. The U.S. literature was reviewed briefly.

Takagi, K. and T. Kaneko. 1965. Biological observation on the scolytid tea root borer (*Xylebortus germanus* Blanford [sic]) and tea stem borer (*Xyleborus compactus* Eichhoff)—some notes on their ambrosia fungi. Japanese Tea Res. Sta. Stud. Tea 31:54-58. The mycangium of an adult *X. germanus* was pictured in cross-section. Also shown were the fungus mat inside the mycangia and the 2-3 celled ambrosial fungus.

Takagi. K. and T. Kaneko. 1965. Biology of some scolytid ambrosia beetles attacking tea plants. II. Spore storage organ of tea root borer, *Xyleborus germanus* Blanford (sic). Japanese J. Appl. Entomol. Zool. 9:247-248. The mycangia were pictured and described. Ambrosial spores inside the mycangia were described as globular in shape and 11-12 μ in diameter. Spores cultivated from galleries were also globular but 15-18 μ in diameter.


Ueno, H. On the bionomics and control of the wood boring beetles (Ipidae, Coleoptera) attacking persimmons in Japan. Japanese J. Appl. Entomol. Zool. 4:166-172. *X. germanus* was the most common of eight wood boring pest species of persimmon in Japan from 1958 to 1960. Most attacked trees wilted and died. Stems and branches were attacked in late April or early May.

USDA. 1968. A scolytid beetle (*Xylosandrus germanus*)—Missouri. Coop. Econ. Insect Rep. 18:821. *X. germanus* adults were collected from the roots of dogwood nursery stock on 12 June 1968 in Cape Girardeau County; this report was a new state and a new host record.


USDA. 1972. A scolytid beetle (*Xylosandrus germanus*)—Virginia. Coop. Econ. Insect Rep. 22:640. *X. germanus* adults were collected from a redbud limb on 6 June 1971 in Pittsylvania County; this report was a new state and a new host record.


USDA. 1977. A scolytid beetle (*Xylosandrus germanus*)—Louisiana. Coop. Plant Pest Rep. 3:350. *X. germanus* adults were collected from a small pecan tree on 10 May 1978 in Pointe Coupee Parish; this report was a new state and a new host record.

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---. 1978. Protection committee report. Walnut Council News. 5(3):3. *X. germanus* was included in a brief discussion of insect problems on black walnut in 1978. Three Indiana plantations, ranging in age from 4−8 years and consisting of trees ranging in height from 0.9 to 7.6 m, were attacked in spring 1978.

---. 1978. *Xylosandrus germanus* (Blandford) (Coleoptera: Scolytidae), a new pest of black walnut. (Abstr.) 23rd Southern For. Insect Work Conf., Minutes, p. 35. *X. germanus* was reported from 11 states and 18 genera of host plants in the U.S. It was associated with *Fusarium* canker dieback in young black walnut trees.

---. 1979. *Xylosandrus germanus* (Blandford) (Coleoptera: Scolytidae), a new pest of black walnut: a review of its distribution, host plants, and environmental conditions of attack. p. 63−68 in Walnut insects and diseases. USDA. For. Servo Gen, Tech. Rep. NC-52. The world literature on *X. germanus* was reviewed, including host plants throughout the world. The potential impact to black walnut was discussed.

---. 1980. *Xylosandrus germanus* (Blandford) (Coleoptera: Scolytidae): an ambrosia beetle pest of young hardwood plantations in the United States. (Abstr.) XVI Internat. Congr. Entomol. Abstracts, Kyoto, Japan, p. 301. *X. germanus* was reported from 22 genera of host plants and found throughout most of the eastern U.S. Tulip poplar and black walnut plantations, ranging in age from 1 to 7 years, were attacked by a *Fusarium* canker/*X. germanus* complex that caused top dieback, cankers, and basal sprouting. Impact included death of trees, loss of growth, and increased time spent in plantation management.

---. 1981. Ambrosia beetles in your black walnut plantation—how serious are they? N. Nut Grow. Assoc. Annu. Rep. 72:68−74. The biology of *X. germanus* on black walnut was briefly summarized. Signs and symptoms of attack were given as pinholes, basal sprouts, wilted leaves, and top dieback. Although tree survival was little affected by *X. germanus* attacks on black walnut, growth losses were reported as potentially serious depending on the age of the trees when attacked and the management goals of the plantation. Some management and silvicultural control recommendations were included.

---. 1982. The biology of the ambrosia beetle *Xylosandrus germanus* (Blandford) (Coleoptera: Scolytidae) and its effects on black walnut. Ph.D. thesis, Southern Illinois Univ., Carbondale. 222 p. Information on the life history of *X. germanus* in North Carolina and Illinois, particularly as associated with black walnut (*Juglans nigra* L.), was presented and included flight activity, gallery patterns, life cycle, predators, parasites and other associates, geographic distribution, host plants, laboratory rearing, behavior, and ambrosial and other fungi. Descriptions of the egg and larval instars were included. Particular emphasis was placed on the relation between *X. germanus* attack and disease symptoms in black walnut trees, on differences in susceptibility of trees to attack and dieback, and on the ability of trees to recover from attack.

Weber, B. C., R. L. Anderson, and W. H. Hoffiärd. 1980. Guide to damage in black walnut. USDA For. Serv. Gen. Tech. Rep. NC-57:1−28. Descriptions, damage, and control recommendations for *X. germanus* were discussed. Insects, diseases, and animal damage to black walnut were also discussed and a key to types of damage was included.

Weise, E. 1963. *Xylosandrus germanus* Blandf. Entomol. Bl. Biol. Syst. Käfer 59:125. *X. germanus* was observed on 11 October 1962 near Freiburg, Germany, in fir and copper beech stands. When overwintering adult females were brought inside on 17 February 1963, they immediately became active.

Wichmann, H. E. 1955. Im Europäischen Grosraum eingeschleppte Borkenkäfer. Z. Angew. Entomol. 37:92−109. *X. germanus* was felt to have originated in the Far East in Japan, China, Korea, and Formosa. The paper includes a list of the known host plant genera.

---. 1955. Zur derzeitigen Verbreitung des Japanischen Nutzholzborkenkäfers *Xylosandrus germanus* Blandf. im Bundesgebiete. Z. Angew. Entomol. 37:250−258. At least 12 species of trees in Germany were reported as hosts of *X. germanus*.

---. 1957. Einschleppungsgeschichte und Verbreitung des *Xylosandrus germanus* Blandf. in Westdeutschland (nebst einem Anhang: *Xyleborus adumbratus* Blandf.) Z.
Angew. Entomol. 40:82–99. *X. germanus* was reported from 34 new localities in Germany, mainly near Karlsruhe and Heilbronn, and was believed to have only a moderate capacity for dispersal and one generation per year. *X. germanus* was felt to be of no economic importance.

Wood, S. L. 1977. Introduced and exported American Scolytidae (Coleoptera). Great Basin Natur. 37:67–74. *X. germanus* was included in a list of scolytids introduced into the U.S., and reported as breeding in branches and stumps of a wide variety of hosts. It was said to be of possible local economic concern.