

October 1982

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

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### Recommended Citation

Weber, B. C. and McPherson, J. E. 1982. "Annotated Bibliography of the Ambrosia Beetle *Xylosandrus Germanus* (Coleoptera: Scolytidae)," *The Great Lakes Entomologist*, vol 15 (3)

DOI: <https://doi.org/10.22543/0090-0222.1433>

Available at: <https://scholar.valpo.edu/tgle/vol15/iss3/7>

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**ANNOTATED BIBLIOGRAPHY OF THE AMBROSIA BEETLE  
*XYLOSANDRUS GERMANUS* (COLEOPTERA: SCOLYTIDAE)<sup>1</sup>**

B. C. Weber<sup>2</sup> and J. E. McPherson<sup>3</sup>

*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 sayi* 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. Attacked 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.
- Barras, S. J. and T. J. Perry. 1975. Interrelationships among microorganisms, bark or ambrosia beetles, and woody host tissue: an annotated bibliography, 1965-1974. USDA

<sup>1</sup>Part 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.
- Blandford, W. F. H. 1894. The rhynchophorus Coleoptera of Japan. Part III. Scolytidae. Trans. Entomol. Soc. London, Part I:53-141. A new scolytid species, *Xyleborus germanus* Blandford, was named and the female described. It was listed as common Japan.
- Böhm, H. 1958. Der "Schwarze Nutzholzborkenkäfer," 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. pluriannulata* (Hedges), *Pestolozzia* sp., and one unidentified species of fungus.
- Carter, W. 1973. Insects in relation to plant diseases. John Wiley & Sons, Inc., New York, NY. 759 p. *X. germanus* was listed as a possible but unimportant vector of Dutch elm disease.
- Chamberlin, W. J. 1939. The bark and timber beetles of North America. Oregon State Coll. Coop. Assoc., Corvallis, OR. 513 p. *X. germanus* was included as a species recently introduced into North America.
- 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.
- Craighead, F. C. 1950. Insect enemies of eastern forests. USDA Misc. Publ. No. 657:1-679. Distribution of *X. germanus* was given as Connecticut, New York, New Jersey, and Ohio. Beetles reportedly attacked branches, peeled and unpeeled logs, and stumps of elm trees.
- 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 *Rhodendron* 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.
- Eggers, H. 1926. Japanische Borkenkäfer I. Entomol. Bl. Biol. Syst. Käfer 22:145-146. Males of *X. germanus* were described for the first time.
- 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. Hautdrüsen 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.
- . 1967. Ectosymbiosis in wood-inhabiting insects. p. 141-205 in S. M. Henry (ed.). Symbiosis. Vol. II. Academic Press, New York, NY. The principal ambrosial fungus of *X. germanus* was reported as *Monilia candida* Hartig. *Ceratocystis ulmi* (Buisman) was a "weed fungus" in the galleries. A sagittal cross-section drawing of an adult female showed the location of the mycangium.
- . 1975. Zur epizoischen und endozoischen Übertragung der symbiotischen Pilze des Ambrosiakäfers *Xyleborus saxeseni* (Coleoptera: Scolytidae). Entomol. Ger. 1:279-292. The location of the mycangium in *X. saxeseni* was compared to that in *X. germanus*.
- Gauss, R. 1960. Ist *Xylosandrus germanus* Blandf. ein Primärschädling? Anz. Schädlingskd. 33:168-172. 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 Nutzholzborkenkäfer" *Xylosandrus germanus* Blandf., ein neuer Schädling 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 Nutzholzborkenkäfer," eine neue Gefahr für Forstwirtschaft, Obst- und Weinbau. Anz. Schädlingskd. 26:81-84. *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. Schädlingskd. 33:5-10. 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.
- . 1960. Weitere Beobachtungen an *Xylosandrus germanus*. Anz. Schädlingskd. 33:187-188. One year after attacks by *X. germanus* on young red oak trees, no new attacks could be found.
- . 1964. Ökologische Bedingungen für Primärbefall durch *Xylosandrus germanus*. Z. Angew. Entomol. 54:131-140. In 1961, young red oak trees were again attacked, particularly late-leaving 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.
- Hoffard, W. H. and R. L. Anderson. 1977. Disease, insect, and animal damage survey of yellow-poplar tree evaluation plantations. Wayne-Hoosier National Forest, 1977. USDA For. Serv., State & Private Forest., Forest Insect & Dis. Manage. Surv. Rep. D-12-77:1-7. *X. germanus* attacked 36% of the trees in a tulip poplar plantation in SE Ohio in June 1977. *Fusarium* canker was associated with the attacks.
- Hoffmann, C. H. 1941. Biological observations on *Xylosandrus germanus* (Bldfd.). 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. Schädlingkd. 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* (= *Ceratocystis*) *ulmi* Buisman was isolated from 0.2% of *X. germanus* beetles collected from elm.
- Kamp, H. J. 1953. Ein neuer Holzschädling in Deutschland, der "Schwarze Nutzholzborkenkäfer" Holz-Zentralbl. 79:242. *X. germanus* attacked physiologically weakened trees that had a dbh of about 12 cm.
- . 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.
- . 1954. Kleine Mitteilungen Nummer 1474 *Xylosandrus germanus*. Entomol. Bl. Biol. Syst. Käfer 50:124. *X. germanus*, in Germany, was reported on red beech in 1952 and on oak, red beech, birch, and spruce in 1953.
- . 1954. Nutzholzschildlinge 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.
- . 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.
- . 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.
- . 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.
- . 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.
- . 1968. Der "Schwarze Nutzholzborkenkäfer" *Xylosandrus germanus* Blandf., ein Neuling der heimischen Insektenfauna. Entomol. Bl. Biol. Syst. Käfer 64:31-39. The German literature for *X. germanus* up to 1968 was reviewed.
- . 1970. Zur Biologie und derzeitigen Verbreitung von *Gnathotrichus materiarius*

- Fitch und *Xylosandrus germanus* Blandf. in der Bundesrepublik Deutschland. Mitt. Entomol. Ver. Stuttgart 5:34-40. Not seen.
- . 1977. Ein Beitrag zur Scolytoidea-Fauna der Rheinprovinz (Coleoptera). 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.
- . 1967. Shot hole borer of tea plant in Japan. Japanese Agric. Res. Quart. 2:19-21. *X. germanus* was noted as a serious pest of tea in Japan, attacking roots 0-50 cm below ground. Other hosts were *Morus alba* L., *Castanea crenata* Seibold & Zuccarini, and *Diospyros kaki* Thunberg. *X. germanus* was reported to have two generations/year and to overwinter in roots. Drenching tea plants in cyclodiene insecticides to control *X. germanus* and *X. compactus* proved unsuccessful. The hypothesis was advanced that *X. germanus* adults pick up their ambrosial fungus by everting their mycangia and scraping the sides of the galleries.
- Kaneko, T. and K. Takagi. 1965. Biology of some scolytid ambrosia beetles attacking tea plants. IV. Parthenogenesis of *Xyleborus germanus* Blan. in relation to the *germanus* ambrosia fungus. Japanese J. Appl. Entomol. Zool. 9:303-304. *X. germanus* was reported as haplo-diploid: unmated females produced only male progeny in laboratory cultures. The sex ratio was 10 females: 1 male.
- . 1966. Biology of some scolytid ambrosia beetles attacking tea plants. VI. A comparative study of two ambrosia fungi associated with *Xyleborus compactus* Eichhoff and *Xyleborus germanus* Blanford (*sic*) (Coleoptera: Scolytidae). Appl. Entomol. Zool. 1:173-176. The optimum temperature for sporulation of *X. germanus* ambrosial fungus (unnamed) was 20-25°C. Spores stored in the mycangia were examined. The ambrosial fungi of *X. germanus* and *X. compactus* were exchanged and the larvae of each beetle were reared successfully. The authors suggested that the ambrosial fungi of the two beetle species are closely related or are the same.
- Kaneko, T., Y. Tamaki, and K. Takagi. 1965. Biological observations on the scolytid ambrosia beetles, tea root borer, *Xyleborus germanus* Blanford (*sic*) and tea stem borer, *Xyleborus compactus* Eichhoff. Japanese Tea Res. Sta. Stud. Tea 30:59-63. The artificial culture of *X. germanus* and *X. compactus* in the laboratory was described. Biological information is provided.
- . 1965. Preliminary report on the biology of some scolytid beetles, the tea root borer, *Xyleborus germanus* Blanford (*sic*), attacking tea roots, and the tea stem borer, *Xyleborus compactus* Eichhoff, attacking tea twigs. Japanese J. Appl. Entomol. Zool. 9:23-29. Optimum temperature range for development of *X. germanus* was 21-23°C. Diameter of tea roots attacked was 1.0-1.5 cm at about 30 cm below ground. Adult females flew at about 1 m in the laboratory with main flight activity from 1-3 p.m. These results, and others from studies of *X. germanus*, were contrasted with those from *X. compactus*.
- Kessler, K. J., Jr. 1974. An apparent symbiosis between *Fusarium* fungi and ambrosia beetles causes canker on black walnut stems. Plant Dis. Rep. 58:1044-1047. Black walnut cankers caused by *Fusarium lateritium* Nees and *F. oxysporum* Schlechter were associated with attacks by *X. germanus*.
- 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.
- Murayama, J. 1930. Revisions des familles des Ipides et des Platypides de Coree. J. Chosen Natur. Hist. Soc. 11:6-38. *X. germanus* was collected from *Benzoin thunbergii* Siebold & Zuccarini, *Carpinus laxiflora* Blume, and *Styrax japonicum* Siebold & Zuccarini from central and southern Korea.

- . 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.
- . 1934. Notes on the Ipidae (Coleoptera) from Kiushu. Annot. Zool. Japonenses 14:287–300. Five new host plants of *X. germanus* in Japan were reported.
- . 1936. Notes sur les Scolytides (Coleopteres) de Honshu et Kiushu, Japan. Tenthredo 1:121–149. Collection dates, host plants, and distribution records for *X. germanus* in Japan were summarized.
- Nakane, T., K. Ohbayashi, S. Nomura, and Y. Kurosawa. 1963. Iconographia Insectorum Japonicum Colore. Naturali Edita Vol. II (Coleoptera). Hokuryukan Publishing Co., Ltd., Tokyo, Japan. 443 p. *X. germanus* was included in a list of the beetle fauna of Japan.
- Niisima, Y. 1909. Scolytiden Hokkaidos unter Berücksichtigung ihrer Bedeutung für Forstschäden. J. Coll. Agric., Tohoku Imperial Univ. (Sapporo, Japan) 3:109–179. *X. germanus* was collected in Sapporo (northern) and central Japan
- . 1910. Die Borkenkaefer Nord- und Mittel-Japans. Trans. Sapporo Natur. Hist. Soc. 3:1–18. *X. germanus* was collected from *Alnus incana* var. *glauca* Aiton in Tomakomai, Iburi Province, 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 Scolytoidea (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 Scolytoidea (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.
- . 1978. Ambrosia beetles found in imported tropical timbers from southeast Asia and others (Coleoptera: Scolytidae). Forest. For. Prod. Res. Inst. Bull. 301:1–46. *X. germanus* was collected from camphor logs imported from Formosa into Japan.
- . 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.
- . 1981. Studies on Scolytidae XXIII. The ambrosia beetles of the genus *Xylosandrus* Reitter from Japan (Coleoptera). Forest. For. Prod. Res. Inst. Bull. 314:27–37. Japanese host plants, world distribution, and biology of *X. germanus* in Japan were reviewed. Also included was a world listing of all known publications about *X. germanus*.
- 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*.
- Schedl, K. E. 1966. Pin-hole borers and bark beetles (Scolytidae and Platypodidae) intercepted from imported logs in Japanese ports. Kontyu 34:29–43. *X. germanus* was intercepted in Tokyo in a camphor log imported from Keelung, Formosa, on 22 November 1961.

- 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 (*Xyleborus 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.
- . 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  $\mu$  in diameter. Spores cultivated from galleries were also globular but 15-18  $\mu$  in diameter.
- . 1965. Biology of some scolytid ambrosia beetles attacking tea plants. III. Sporulation of *Xyleborus germanus* ambrosia fungus. *Japanese J. Appl. Entomol. Zool.* 9:298-300. The ambrosial fungus of *X. germanus* was unnamed but described as living parasitically on plants and causing root rot of tea plants. The fungus had three growth types: mycelial, type A (in plants), and type B (in the mycangium).
- . 1966. Biology of some scolytid ambrosia beetles attacking tea plants. V. Chromosome numbers and sex determination of tea root borer, *Xyleborus germanus* Blanford (sic) (Coleoptera: Scolytidae). *Appl. Entomol. Zool.* 1:29-31. *X. germanus* was reported as haplo-diploid with eight chromosomes in the male and 16 in the female.
- Takenouchi, Y. and K. Takagi. 1967. A chromosome study of two parthenogenetic scolytid beetles. *Annot. Zool. Japonenses* 40:105-110. Cytological evidence of haplo-diploidy in *X. germanus* and *X. compactus* (Eichhoff) was presented.
- 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.
- . 1962. On the bionomics and control of the wood boring beetles (Ipidae, Coleoptera) attacking persimmons in Japan. (Abstr.) *Rev. Appl. Entomol.* 50:450. This is the abstract of the previous paper that reported *X. germanus* as a pest of persimmon trees in Japan.
- 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.
- . 1969. A scolytid beetle (*Xylosandrus germanus*)—Missouri. *Coop. Econ. Insect Rep.* 19:16. *X. germanus* adults were collected from dogwood in 1968 in Cape Girardeau County.
- . 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.
- . 1975. A scolytid beetle (*Xylosandrus germanus*)—Indiana. *Coop. Econ. Insect Rep.* 25:783. *X. germanus* infested 30-40% of 7,000 30-inch tall black walnut trees on 26 June 1975 in a plantation in Fountain County.
- . 1978. 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.
- Weber, B. C. 1977. Black walnut dieback. *Walnut Council Newsl.* 4(1):4. Symptoms associated with dieback caused by *X. germanus*/Fusarium cankers were described.

- \_\_\_\_\_. 1978. Dieback of black walnut saplings. Walnut Council Newsl. 5(1):5. Dieback caused by *Fusarium* cankers/ambrosia beetles was again discussed.
- \_\_\_\_\_. 1978. Protection committee report. Walnut Council Newsl. 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* (Blandf.) (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* (Blandf.) (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. Serv. 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. Hoffard. 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.
- Yoshida, T., J. Fukami, K. Fukunaga, and A. Matsuyama. 1975. Control of the harmful insects in timbers by irradiation: doses required for kill, sterilization, and inhibition of emergence in three species of ambrosia beetles in Japan. Japanese J. Appl. Entomol. Zool. 19:193-202. Doses required for growth inhibition of *X. germanus* were 3 krad for 5-day old eggs, 5-7 krad for 3rd instar larvae, and 10+ krad for pupae. After female adults were sterilized with 2-4 krad, they produced only male progeny.