INTERACTION BETWEEN BEECH AND BEECH SCALE[1]

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Abstract.--Trees heavily infested with beech scale are commonly observed either singly or in small groups within infested forests. This appears to be due partly to the presence of resistant trees and also, in the U.K. at least, to the existence of sub-populations of scale insects, some of which appear to be adapted to individual host trees. It is suggested that the greater susceptibility of American beech to attack by beech scale may be due in part to the absence of co-evolved defence mechanisms.

In Europe, beech scale (*Cryptococcus fagisuga* Lind.) is indigenous and some scale insects are present in most stands over about 20 years old. Recent observations have indicated that many trees within the forest remain either uninfested or only lightly infested for several years (E.J. Parker, D. Lonsdale, D. Wainhouse unpublished data) even when artificially inoculated (Houston *et al.* 1979). This suggests that some trees are resistant at least for part of their life. It is a common observation that trees heavily infested with scale occur singly or in small groups throughout infested stands and that heavily infested and uninfested trees frequently occur together (Boodle and Dallimore 1911, Thomson *et al.* 1949, Kuthe and Krämer 1961). This further indicates heterogeneity in susceptibility of trees to attack. Work in the U.K. suggests that there is a genetic basis to this resistance (Wainhouse and Deeble 1980, Wainhouse and Howell this volume).

Recent experiments in England in which trees were artificially infested with beech scale show that there is intraspecific variation within scale populations in their ability to attack individual trees (Wainhouse and Howell 1983). This variation was shown by differences in survival of larvae from different individual infested trees when they were inoculated onto a single susceptible tree. Some populations appear to be adapted to individual trees and their survival when they are experimentally re-inoculated onto their own host tree is higher than that of larvae derived from other infested trees. Although some unattacked trees in the forest may be more or less completely resistant (Wainhouse and Howell 1983, D.R. Houston pers. comm.) the level of resistance exhibited by other trees may depend on the origin of larvae used to infest them. This suggests that resistance in some trees may only be partial and must be defined in the context of the particular attacking sub-population of scales (Edmunds and Alstad 1978). The rate of development of scale populations within forests therefore may depend on a complex interaction between host resistance and variation in the scale insect's ability to survive on individual trees.

In North America some trees resistant to beech scale appear to be present in the mixed hardwood forests (D.R. Houston pers. comm.), however, the majority of trees are affected by the disease. In previously uninfested forests 90% of trees may be infected with *Nectria* which occurs on trees previously infested with beech scale (Ehrlich 1934). The rate of spread of beech scale into uninfested areas also appears to be quite rapid, averaging 6-8 km/year (Wainhouse, 1980, Houston *et al.* 1979). The apparently greater susceptibility of *Fagus grandifolia* may be partly due to the absence of the kind of interactions we have described between European beech and beech scale. The interaction between tree defences and scale populations would tend to reduce the rate of spread of beech scale through forests. The absence of beech scale from the U.S.A. until about 1900 (Ehrlich 1934) reinforces the view

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that intraspecific diversity of defences to beech scale may be absent in American beech.

Clearly more information is needed on the nature of resistance of trees to beech scale attack, its stability when the trees are growing on different sites (see Wainhouse and Howell, this volume) and its relationship to tree age. The relative role of tree resistance and scale insect sub-populations in determining the dynamics of scale populations and ultimately beech bark disease would repay further study.

ZUSSAMMENFASSUNG

Stark von der Buchenwollaus befallene Bäume sind gewöhnlich entweder einzeln oder in kleinen Gruppen in den befallenen Beständen anzutreffen. Dies scheint zum Teil mit der Resistenz der Buchen zusammenzuhängen und, zumindest in England, mit dem Verkommen von Teilpopulationen der Buchenwollaus, die teilweise an ihre Wirtsbäume speziell angepasst zu sein scheinen. Es ist gut denkbar, dass die höhere Anfälligkeit von Fagus grandifolia gegenüber der Buchenwollaus zum Teil darauf beruht, dass Resistenzmechanismen wegen des Fehlens einer gemeinsamen Evolution von Wirt und Pathogen bei der amerikanischen Buche nicht entwickelt werden konnten.

RÉSUMÉ

Les arbres gravement infestés par la cochenille du hêtre s'observent communément soit isolés, soit en petits groupes à l'intérieur des forêts infestées. Ceci semble être dû en partie à la présence d'arbres résistants et aussi, du moins dans le Royaume-Uni, à l'existence de sous-populations de cochenilles, certaines semblant s'être adaptées à des arbres hôtes donnés. Il semblerait donc que la grande susceptibilité du hêtre à grandes feuilles aux attaques de la cochenille soit due en partie à l'absence de mécanismes de défense co-évolutionnaires.

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