

A history of studies on the chestnut gall wasp in Japan

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Around 1941, unknown cynipid galls were found on chestnut trees in Okayama Prefecture. The gall wasp had spread rapidly throughout Japan by 1962, and became one of the most important pests of chestnut trees. Yasumatsu (1951) described the cynipid as a new species, *Dryocosmus kuriphilus*. Afterwards it was determined that the cynipid had been accidentally introduced from China.

From the discovery of the gall wasp, it had been known that it reproduced thelytokously and had only one generation per year, differing from most other gall-making oak cynipids. Tamura (1960a, b, 1965) and other entomologists studied the life cycle of this cynipid. Females emerging from June to July immediately lay eggs gregariously in buds, the eggs hatch almost a month after deposition and then young larvae enter the inner part of buds and make larval chambers there, where they hibernate. The next spring, when buds begin to grow, the larvae develop rapidly, forming galls, then develop to pupae inside chambers.

Shiraga (1948) found that some horticultural varieties were resistant to the cynipid. The resistance mechanism was studied by Fukuda and Okudai (1951), who concluded that the oviposition selectiveness was not different between resistant and susceptible varieties but that on resistant varieties young larvae died in the larval chambers. Several new resistant varieties were bred and prevailed throughout Japan, and infestation by the cynipid was avoided for several years. However, a new biotype of the chestnut gall wasp that could tolerate resistant varieties developed soon, and it spread widely.

Biological control of the chestnut gall wasp was investigated from an early time. Yasumatsu (1954) investigated native parasitoids, and 11 parasitoid species were recorded by Yasumatsu and Kamijo (1979). Tachikawa (1973), Kamijo (1981), Ôtake *et al.* (1982), Murakami *et al.* (1989) and Ohkubo (1992) found 9 additional parasitoid species of the cynipid. These native parasitoids were originally parasitoids of oak cynipids and their inquilines, and some of them probably decreased the chestnut gall wasp populations to some degree. Among them *Torymus beneficus* was most important but not effective in economically suppressing the cynipid populations.

In 1975, a small number of chestnut cynipid galls collected in Shensi Province, China, were imported. From them, 7 individuals of *Torymus* sp. closely related to native *T. beneficus* emerged the next spring (Murakami *et al.*, 1977). The parasitoid was described as a new species, *Torymus sinensis*, by Kamijo (1982) and was considered the most promising biological control agent. In 1979 and 1981, a large number of the parasitoids were imported from Hopei Province, China, and release tests started in 1982 in Tsukuba, Ibaraki Prefecture, and Ohzu, Kumamoto Prefecture. In Tsukuba the parasitoid increased rapidly and the gall density decreased to a level of only 3% infested buds by six years after the release (Moriya *et al.*, 1989). However, in Ohzu it took almost

twenty years to control the cynipid population to be under an economic level, probably due to high mortality of the parasitoid associated with the activity of native facultative hyperparasitoids (Murakami and Gyoutoku, 1995).

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