EPPO Datasheet: *Dryocosmus kuriphilus*

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IDENTITY


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Preferred name: *Dryocosmus kuriphilus*
Authority: Yasumatsu
Taxonomic position: Animalia: Arthropoda: Hexapoda: Insecta: Hymenoptera: Cynipidae
Common names: Asian chestnut gall wasp, chestnut gall wasp, oriental chestnut gall wasp
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EPPO Categorization: A2 list
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EU Categorization: Emergency measures (formerly), PZ Quarantine pest (Annex III)
EPPO Code: DRYCKU

Notes on taxonomy and nomenclature

The superfamily of Cynipoidea contains almost 3 000 species belonging to seven families. All are parasitoids except the Cynipidae and one genus of Figitidae (Csoka *et al.*, 2005). The oak gall wasps (Cynipini tribe) is a group of almost 1 000 species worldwide, among which around 140 are reported from the west Palaearctic region (Stone *et al.*, 2002). Only four species of oak gall wasps are reported on hosts other than *Quercus* spp. (Buffington & Morita, 2009). *Dryocosmus kuriphilus* is one of these exceptions and is the only Palaearctic species (out of two) developing on *Castanea* species (Acs *et al.*, 2007).

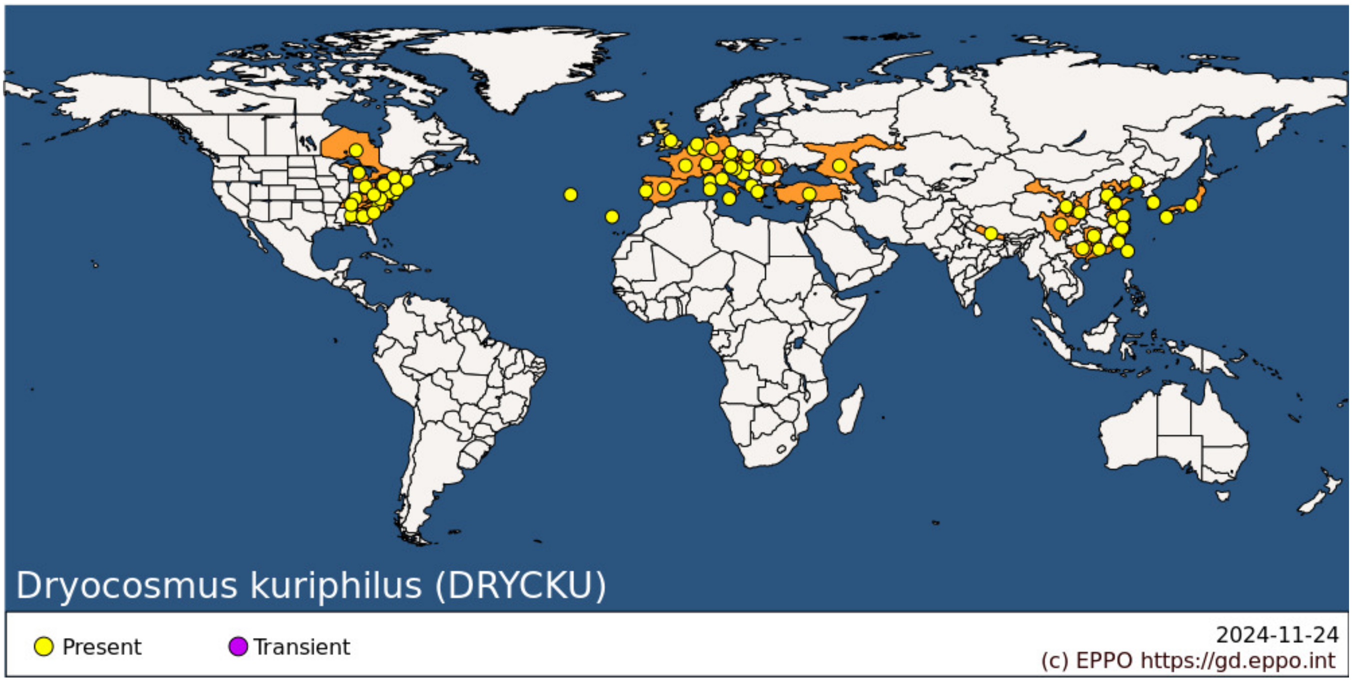
HOSTS

D. kuriphilus develops on *Castanea crenata* (Japanese chestnut), *Castanea dentata* (American chestnut), *Castanea mollissima* (Chinese chestnut) and *Castanea sativa* (European chestnut) and their hybrids. It also infests *Castanea seguinii* in China, but is not known to attack the wild North American species *Castanea pumila* and *Castanea alnifolia*, which are very often grown adjacent to infested chestnuts.

Host list: *Castanea crenata*, *Castanea dentata*, *Castanea mollissima*, *Castanea sativa*, *Castanea seguinii*

GEOGRAPHICAL DISTRIBUTION

D. kuriphilus is native to China where it is recorded from several provinces but without details on its population levels (Murakami *et al.*, 1980; Zhang *et al.*, 2009). In the 1940s, it was reported in Japan (Murakami *et al.*, 1980) and after several other introduction events between 1941 and 1999 (Japan, South Korea, USA, Nepal), it was first reported in Europe in 2002 (Brussino *et al.*, 2002) where *Castanea*-based forests cover around 2.5 million hectares distributed across 17 countries (Conedera *et al.*, 2016). Following its introduction, *D. kuriphilus* over 15 years colonized most of the European area where *Castanea sativa* are grown.



EPPO Region: Albania, Austria, Belgium, Bosnia and Herzegovina, Croatia, Czech Republic, France (mainland, Corse), Germany, Greece (mainland), Hungary, Italy (mainland, Sardegna, Sicilia), Netherlands, Portugal (mainland, Azores, Madeira), Romania, Russia (Southern Russia), Slovakia, Slovenia, Spain (mainland), Switzerland, Türkiye, United Kingdom
Asia: China (Anhui, Fujian, Gansu, Guangdong, Guangxi, Hebei, Hunan, Jiangsu, Liaoning, Shaanxi, Shandong, Sichuan, Zhejiang), Japan (Honshu, Kyushu), Korea, Republic, Nepal, Taiwan
North America: Canada (Ontario), United States of America (Alabama, Connecticut, Delaware, Georgia, Kentucky, Maryland, Massachusetts, Michigan, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, West Virginia)

BIOLOGY

D. kuriphilus is univoltine (one generation per year) and reproduces by thelytokous parthenogenesis (virgin females produce only daughters). Males are unknown. The thelytokous reproduction of *D. kuriphilus* is not induced by *Wolbachia* infection (Hou *et al.*, 2020; Zhu *et al.*, 2007). Since most of the Cynipini species reproduce by cyclical parthenogenesis with a strict alternation between one arrhenotokous generation and one thelytokous generation, the univoltine thelytokous life cycle observed for *D. kuriphilus* and some other oak gall wasps is considered to be derived from the loss of the bisexual generation (Stone *et al.*, 2002). The biology of *D. kuriphilus* is highly synchronized with chestnut phenology (Bernardo *et al.*, 2013). The adult females are short-lived (2-10 days) (Yasumatsu, 1951; Bernardo *et al.*, 2013). They emerge in early summer (end of May to July depending on latitude) and immediately lay eggs inside chestnut buds that will develop the following spring. Each female generally lay up to 300 eggs (Graziosi & Rieske, 2014; Nohara, 1956; Tokuhisa, 1981) with up to 30 eggs found in one bud (Otake, 1980; 1989; Kim *et al.*, 2005; Gil-Tapetado *et al.*, 2021). Described as proovigenic (emerging with a full complement of eggs and the ability to oviposit immediately after emergence), *D. kuriphilus* may be resorping eggs in the absence of suitable hosts, suggesting potential facultative synovigeny (i.e. the number of mature eggs within ovaries increases rapidly after adult emergence) (Graziosi & Rieske, 2014). Eggs hatch in 30-40 days and first instar larvae remain within chestnut buds where they overwinter. At bud burst in spring, larval feeding induces the formation of green- or rose-coloured galls, which are 5-20 mm in diameter on *C. crenata* in Japan (Otake, 1980; 1989) or 8-15 mm in diameter on *C. sativa* or *C. sativa* x *C. crenata* in Europe (Breisch & Streito, 2004). Each larva develops within an ovoid shaped chamber (Warmund, 2013). Depending on the climate (altitude, latitude), pupation takes around two months and occurs within the galls from mid-May to mid-July.

DETECTION AND IDENTIFICATION

Symptoms

Galls are uni- or multilocular and contain from 1 to 25 larval chambers (Kato & Hijii, 1993; Bernardo *et al.*, 2013). This multilocularity may be a strategy to protect larvae from parasitoids, with larvae in peripherical chambers being more vulnerable than those developing deeper within the structure (Reale *et al.*, 2016). Galls are localized on shoots, leaf midribs or leaf stipules (Gehring *et al.*, 2018). After the emergence of *D. kuriphilus* adults, galls dry, become wood-like and remain on the tree for several years. While galls are easily detected on plants or parts of plants, presence of eggs or young larvae inside buds cannot be detected by simple visual inspection. Gall size, in terms of number of chambers per gall, increases with time since invasion, as the abundance of *D. kuriphilus* increases in an area (Gil-Tapetado *et al.*, 2021). Moreover, gall morphology (volume, mass) may be influenced by exposure to sun and precipitation (Gil-Tapetado *et al.*, 2020a).

Morphology

Eggs

Eggs are flattened, ellipsoid in shape, milky white in colour, somewhat transparent, and are about 0.15 mm long and 0.10 mm wide, with a long, thin stalk of about 0.4 mm in length at one end of the long axis (Nakamura *et al.*, 1964).

Larva

D. kuriphilus has three larval instars:

First larval instars appear in chestnut buds around 1 month after oviposition (July-August) and then develop very slowly until the next spring. They are 0.2-0.6 mm long, subglobular, with very small mandibles. This stage is hardly distinguishable from the egg (Viggiani & Nugnes, 2010).

Second larval instars are 0.8-1.5 mm long, hymenopteriform with mandibles with distally two teeth. This second larval stage appears in April-May and develops in less than one month (Viggiani & Nugnes, 2010).

Last larval instars are on average 2.3 mm long, hymenopteriform with asymmetric mandibles with teeth. This stage, present in the field from late April to the end of May, is characterized by a wide variation in the morphology of mandibles and the respiratory system (Viggiani & Nugnes, 2010).

Pupa

The pupa of *D. kuriphilus* is 2.5 mm long, black or dark brown. In the field, pupae are present in galls from mid-May to mid-July (EPPO, 2005).

Adults

The adult female is 2.5 to 3 mm long and the body is brownish black; legs, scapus and pedicels of antennae, apex of clypeus and mandibles are yellow brown; head is finely sculptured; vertex is black; scutum, mesopleuron and gaster appear highly shiny and smooth; propodeum with 3 distinct longitudinal carinae; propodeum, pronotum (especially above) strongly sculptured; scutum with 2 uniformly impressed and pitted grooves (notaulices) that converge posteriorly; radial cell of forewing open; antennae 14-segmented with apical segments not expanded into a clava. Adults of *D. kuriphilus* are morphologically close to *D. cerriphilus*, a European oak gall wasp known to induce galls on *Quercus cerris*. However, *D. cerriphilus* has a vertex with large yellowish-red markings, a 15-segmented antennae and a propodeum without median longitudinal carina (Yasumatsu, 1951; EPPO, 2005).

Detection and inspection methods

The induction of galls starts at bud burst in spring. Attacked buds remain therefore the infestation is asymptomatic by external plant inspection from oviposition (June-July) until bud burst. Stereoscopic observations may however reveal brown scars on attacked buds, as well as eggs or young larvae within buds. This technique is however time consuming (Reale *et al.*, 2016). Molecular techniques (PCR) using several markers can be used to rapidly detect the presence of *D. kuriphilus* within buds even in absence of external symptoms (Sartor *et al.*, 2012).

PATHWAYS FOR MOVEMENT

D. kuriphilus can be transported over long distances in chestnut plants for planting and cut branches (EPPO, 2003). When present in the bud tissue, the pest cannot be detected by visual examination and the introduction of infested plant material is very likely to occur (EFSA, 2010).

Further diffusion occurs by natural spread. *D. kuriphilus* is thelytokous and each female can lay up to 300 eggs. Therefore, a single female can found a new population. *D. kuriphilus* follows a stratified dispersal comprising two components: local or short-distance dispersal and long-distance dispersal. Short-distance dispersal mainly includes the continuous dispersal of individuals at low spatial scale within the invasion front due to the natural random movement of adults as well as dispersal caused by natural (e.g. wind) or artificial (e.g. direct human transportation) driving forces. Long-distance dispersal is the result of discrete events that lead to the establishment of new infestation foci separated from the closest infested area by a non-infested zone. Long-distance dispersal events are mainly caused by artificial dispersal due to the transportation of biological material to new areas. According to recent studies, the mean speed of dispersal of the population front (short-distance dispersal) is around 7 km per year, with the mean distance of long-distance dispersal events being 76 km (Gil-Tapetado *et al.*, 2020b; Gilioli *et al.*, 2013). This distance is significantly shorter than the other values reported in the literature (Graziosi & Santi, 2008; Payne, 1981; Rieske, 2007), suggesting that although long-distance dispersal events represent a small proportion of the fraction of offspring dispersing locally, they drove the rate of colonization of *D. kuriphilus* in chestnut forest areas.

PEST SIGNIFICANCE

D. kuriphilus outbreaks severely alter branch architecture of chestnut trees, with a leaf area reduction of up to 70%, a decrease of dormant buds and a decrease of flower, fruit and wood production (Battisti *et al.*, 2014; Gehring *et al.*, 2018a; Ugolini *et al.*, 2014).

Economic impact

High infestation rates by *D. kuriphilus* are reported to cause severe decrease of chestnut production. This pest is reported to cause 15-30% of yield reduction annually in China (Zhang *et al.*, 2009) and 50-75% of yield reduction in the infested areas of the USA (Payne *et al.*, 1983). In Italy, Sartor *et al.* (2015) showed that infestation rates above 0.6 galls per bud induce high yield losses, and Battisti *et al.* (2014) reported yield losses up to 80% when the mean number of galls exceeded six galls per twig. Although most of the chestnut cultivars are sensitive to *D. kuriphilus*, controlled infestations of *D. kuriphilus* on 64 cultivars resulted in variable impacts depending on the cultivars, with 14 cultivars classified as very susceptible (i.e. with more than 0.6 galls per bud), such as ‘Marsol’, ‘Marigoule’ or ‘Torcione Nero’, and 7 being resistant (i.e. no gall development). Among these, two are *C. sativa* cultivars, 4 are *C. crenata* x *C. sativa* hybrids and one is a *C. crenata* cultivar (Sartor *et al.*, 2015).

Evaluation of the economic impact of *D. kuriphilus* focused on chestnut production but, since this pest is affecting leaf area, branch architecture, production of flowers and fruits, its impact may be wider, in particular on natural ecosystems. For example, in the Southern Alps, *D. kuriphilus* is reported to induce significant changes in honey composition starting from an infestation level of 30%, with nearly all the chestnut component being lost when infestation levels exceed 40% of attacked buds (Gehring *et al.*, 2018b).

Control

Only a few management options have been identified for *D. kuriphilus* (Bosio *et al.*, 2010; EFSA, 2010; Zhang *et al.*, 2009). Even if conventional chemical control may be effective in controlling *D. kuriphilus* adults in chestnut orchards (Zhang *et al.*, 2009), this method is expensive, hard to implement for large trees or in forests, and there are risks of side effects on the environment as well as on human health (toxic residues in honey for example) (Bosio *et al.*, 2010). Pruning or hot water treatments seem not to be effective enough to be widely used (Maltoni *et al.*, 2012; Warmund, 2014). Interestingly, mixed forests seem to be more resistant to *D. kuriphilus* since infestations of the pest decreased with the decrease of the relative proportion of chestnut (Fernandez-Conradi *et al.*, 2018).

The most effective methods for reducing *D. kuriphilus* populations are the use of resistant varieties of *Castanea* species and biological control using natural enemies. Following the introduction of the pest in Japan in 1941, the first attempts to manage *D. kuriphilus* focused on the development of resistant varieties, leading to an increase of the area of *C. crenata* in Japan (Shimura, 1972). However, damage caused by *D. kuriphilus* increased on resistant varieties in the 1970s (Moriya *et al.*, 2003). Despite 40 years of selection of *C. crenata* in Japan and the wide use of resistant varieties, the mode of inheritance of resistance was not established (EFSA, 2010). In Europe, some resistant varieties were found to be completely effective in preventing damages by *D. kuriphilus*, such as 'Bouche de Bétizac' (*C. sativa* x *C. crenata*), 'Idea' (*C. mollissima* x *C. crenata*), 'Muraie' (*C. sativa*) or 'Vignols' (*C. crenata* x *C. sativa*) (Botta *et al.*, 2009; Dini *et al.*, 2012; Sartor *et al.*, 2015).

In addition to the use of resistant varieties, and since increasing damage was reported on these varieties in Japan, the use of biological control using natural enemies was considered by researchers. In all the invaded countries, native parasitoids were reported to switch from native oak cynipids to invasive *D. kuriphilus*. Around 40 species of parasitoids were thus recorded worldwide (Aebi *et al.*, 2007; Cooper & Rieske, 2007; Jara-Chiquito *et al.*, 2020; Kos *et al.*, 2020; Matosevic & Melika, 2013; Murakami *et al.*, 1994; Muru *et al.*, 2020; Quacchia *et al.*, 2013). All these species are polyphagous and multivoltine (i.e. several generations each year). Among these species, *Bootanomyia dorsalis*, *Torymus flavipes* and *Eupelmus urozonus* are the most abundant. Nevertheless, the effectiveness of these native parasitoids to control *D. kuriphilus* remains low due to phenological asynchrony (Aebi *et al.*, 2007; Bonsignore *et al.*, 2019; Budroni *et al.*, 2018; Panzavolta *et al.*, 2018). Their use as biological control agents may thus be difficult. Moreover, increasing the level of parasitism by native parasitoids may lead to unintentional effects on their primary hosts (mostly cynipids) since the second generation of these parasitoids, more numerous due to additional progeny from the 'new' host *D. kuriphilus*, can parasitize only the asexual generation of their primary hosts.

To date, the most effective method to control *D. kuriphilus* is the use of *Torymus sinensis*, a parasitoid originating from the same area of origin as the pest. In the 1970s, field expeditions in China led to the discovery of this parasitoid that was the only species with high host-specificity and a life cycle synchronised with that of *D. kuriphilus* (Moriya *et al.*, 2003). Releases of this parasitoid in Japan starting in the late 1970s have very successfully reduced *D. kuriphilus* infestation levels (Moriya *et al.*, 2003; Murakami *et al.*, 1977). This parasitoid was also introduced in the USA where it reduced pest populations (Rieske, 2007). Following the introduction of the pest in 2002 in Italy and its spread all over Europe, several countries (Croatia, France, Hungary, Italy, Portugal, Slovenia, Spain) have implemented classical biological control programs more or less recently (Avtzis *et al.*, 2019). In Italy and France, where *T. sinensis* was first released in 2005 and 2010 respectively, results showed a drastic reduction of *D. kuriphilus* populations (Borowiec *et al.*, 2018; Ferracini *et al.*, 2019). Moreover, post-introduction dynamics of *T. sinensis* were found to follow a two-phase process: firstly exponential growth of *T. sinensis* populations without significant decrease in *D. kuriphilus* populations, and secondly a general decrease in both *T. sinensis* and *D. kuriphilus* populations starting 5 years after the first releases (Borowiec *et al.*, 2018). The use of *T. sinensis* to control invasive *D. kuriphilus* is considered as one of the most successful cases of classical biological control against a forest pest.

T. sinensis is univoltine but can undergo an extended diapause within a 2-year cycle (Ferracini *et al.*, 2015). Moreover, only a small proportion of the population (up to 17% of the adults) emerged only a few months after female oviposition (June to August) (Borowiec *et al.*, 2018). Risk assessment concerning the release of exotic *T. sinensis* in Europe highlighted two types of unintentional effects that should be investigated: the attack of non-target species (i.e. oak cynipids) and the hybridization with native *Torymus* species (Gibbs *et al.*, 2011). Because of the asynchrony between *T. sinensis* and native oak cynipids, the attack of non-target species should be limited. However, *T. sinensis* was collected from 15 oak cynipids species in Italy, representing 1% of the total number of parasitoids collected (Ferracini *et al.*, 2017). First concerns about hybridization between *T. sinensis* and other *Torymus* species appeared during the translocations of *T. sinensis* from China to other Asian countries. Indeed, there are three *Torymus* species parasitizing *D. kuriphilus*, all belonging to the subgenus *Syntomaspis*: *T. beneficus* in Japan, *T. koreanus* in Korea and *T. sinensis* in China (Yasumatsu & Kamijo 1979). Integrative taxonomy showed the high similarity between these three entities, and particularly between *T. sinensis* and one 'ecotype' of *T. beneficus* ('*T. beneficus* late') (Yara, 2004). In Japan, hybridizations between *T. sinensis* and *T. beneficus* were reported (Yara, 2004). Based on around 800 *T. sinensis* specimens collected in France and Italy, a recent study showed for the first time that the European stock of *T. sinensis* has some rare molecular signatures of historical hybridization with *T. beneficus* that took place in Japan (Viciriuc *et al.* in press). To date, hybridizations between *T. sinensis* and other European *Torymus* species have never been reported. Among these species, the morphologically and phylogenetically closest to *T. sinensis* is *T. notatus* (Pogolotti *et al.*, 2019), indicating that a specific survey should be carried out to investigate more precisely the risk of potential hybridization between these two species.

Phytosanitary risk

D. kuriphilus is considered the most serious pest of chestnut worldwide. Following the first report of *D. kuriphilus* in Europe in 2002, a risk assessment for this pest was produced by the European Food Safety Authority (EFSA, 2010). In its conclusions, experts concluded that the risk of establishment and spread of *D. kuriphilus* in Europe was high, chestnut being widely grown in Europe for timber, fruit, landscape conservation and as ornamentals. *D. kuriphilus* is now reported in all the main areas at risk, i.e. areas of the EPPO region which have the highest degree day accumulations and the largest areas of chestnut production.

PHYTOSANITARY MEASURES

When *D. kuriphilus* is regulated as a quarantine pest, plants for planting (except seeds) and cut branches originating in countries where the pest occurs should be produced in pest free areas. Plants for planting should be transported in appropriate conditions (not transported through infested areas, transported outside the flight period, or transported closed to prevent infestation) (EPPO, 2017). EFSA (2010) also suggested the production of plants in pest free places of production surrounded by a buffer zone. The technical feasibility of insect screening was considered to be very low by EFSA (2010) due to the small size of the insect. No management options are available to reduce the likelihood of spread following introduction to *Castanea* forests/woodland (EFSA, 2010).

Once introduced, sustainable management with new planting using resistant varieties and the use of biological control agents have shown to be effective in controlling the pest (see Control section).

REFERENCES

Acs Z, Melika G, Penzes Z, Pujade-Villar J & Stone GN (2007) The phylogenetic relationships between *Dryocosmus* , *Chilaspis* and allied genera of oak gallwasps (Hymenoptera, Cynipidae : Cynipini). *Systematic Entomology* **32**, 70-80.

Aebi A, Schonrogge K, Melika G, Quacchia A, Alma A, & Stone GN (2007) Native and introduced parasitoids attacking the invasive chestnut gall wasp *Dryocosmus kuriphilus*. *EPPO Bulletin* **37**, 166-171.

Avtzis DN, Melika G, Matosevic D & Coyle DR (2019) The asian chestnut gall wasp *Dryocosmus kuriphilus*: A global invader and a successful case of classical biological control. *Journal of Pest Science* **92**, 107-115.

Battisti A, Benvegnu I, Colombari F & Haack RA (2014) Invasion by the chestnut gall wasp in italy causes significant yield loss in *Castanea sativa* nut production. *Agricultural and Forest Entomology* **16**, 75-79.

Bernardo U, Iodice L, Sasso R, Tutore VA, Cascone P & Guerrieri E (2013) Biology and monitoring of *Dryocosmus kuriphilus* on *Castanea sativa* in southern Italy. *Agricultural and Forest Entomology* 15, 65-76.

Breisch H & Streito JC (2004) Le cynips du châtaignier : un nouveau fléau pour l’Europe. *Infos CTIFL* 204, 34-37.

Brussino G, Bosio G, Baudino M, Giordano R, Ramello F & Melika G (2002) Dangerous exotic insect for the European chestnut. *Informatore Agrario* **58**, 59-61.

Bonsignore CP, Vono G & Bernardo U (2019) Environmental thermal levels affect the phenological relationships between the chestnut gall wasp and its parasitoids. *Physiological Entomology* **44**, 87-98.

Borowiec N, Thaon M, Brancaccio L, Cailleret B, Ris N & Vercken E (2018) Early population dynamics in classical biological control: Establishment of the exotic parasitoid *Torymus sinensis* and control of its target pest, the chestnut gall wasp *Dryocosmus kuriphilus,* in France. *Entomologia Experimentalis et Applicata* **166**, 367-379.

Bosio G, Gerbaudo C & Piazza E (2010) *Dryocosmus kuriphilus* Yasumatsu: An outline seven years after the first report in Piedmont (Italy). *Acta Horticulturae* **866**, 341-348.

Botta R, Sartor C, Marinoni DT, Quacchia A & Alma A (2009) Differential gene expression in chestnut buds following infestation by gall-wasp (*Dryocosmus kuriphilus* Yasumatsu, Hymenoptera: Cynipidae). Acta Horticulturae **844**, 405-409.

Budroni MA, Loru L, Pantaleoni RA & Rustici M (2018) Effects of an asynchronous alien host on a native host-parasitoid system. *Ecological Complexity* **33**, 84-92.

Buffington ML & Morita SI (2009). Not all oak gall wasps gall oaks: The description of *Dryocosmus rileypokei*, a new, apostate species of Cynipini from California. *Proceedings of the Entomological Society of Washington* **111**, 244-253.

Conedera M, Tinner W, Krebs P, De Rigo D and Caudullo G (2016) *Castanea sativa* in Europe: distribution, habitat, usage and threats. *In*: Sans-Miguel-Ayanz J, De Rigo D, Caudullo G, Durrant T and Mauri A (eds) *European Atlas of Forest Tree Species*. Publications Office of the European Union, Luxembourg, 78-79.

Cooper WR & Rieske LK (2007) Community associates of an exotic gallmaker, *Dryocosmus kuriphilus* (Hymenoptera : Cynipidae), in Eastern North America. *Annals of the Entomological Society of America* **100**, 236-244.

Csoka G, Stone GN & Melika G (2005) Biology, ecology and evolution of gall-inducing Cynipidae. *In*: Raman A, Schaefer CW & Withers TM (eds) *Biology, ecology and evolution of gall-inducing arthropods*. Science Publishers, Inc. Enfield, New Hampshire, USA, 569-636.

Dini F, Sartor C & Botta R (2012) Detection of a hypersensitive reaction in the chestnut hybrid 'bouche de betizac' infested by *Dryocosmus kuriphilus* Yasumatsu. *Plant Physiology and Biochemistry* **60**, 67-73.

EFSA (2010) Risk assessment of the oriental chestnut gall wasp, *Dryocosmus kuriphilus* for the EU territories and identification and evaluation of risk management options. *EFSA Journal* 8, 1619, 114 pp.

EPPO (2003) Report of a pest risk assessment: *Dryocosmus kuriphilus*. EPPO, France. Available at https://pra.eppo.int/pra/bceaf28c-05dc-4d49-9012-adc2d1f74df8

EPPO (2005) Data sheets on quarantine pests – *Dryocosmus kuriphilus*. *EPPO Bulletin* **35**, 422-424.

EPPO (2017) EPPO Standard PM 8/4(1) Castanea. Commodity-specific phytosanitary measures. *EPPO Bulletin* 47, 445-451. Available at https://gd.eppo.int/taxon/DRYCKU/documents

Fernandez-Conradi P, Borowiec N, Capdevielle X, Castagneyrol B, Maltoni A, Robin C, Selvi F, Van Halder I, Vetillard F & Jactel H (2018) Plant neighbour identity and invasive pathogen infection affect associational resistance to an invasive gall wasp. *Biological Invasions* **20**, 1459-1473.

Ferracini C, Ferrari E, Pontini M, Nova LKH, Saladini MA & Alma A (2017) Post-release evaluation of non-target effects of *Torymus sinensis*, the biological control agent of *Dryocosmus kuriphilus* in Italy. *Biocontrol* **62**, 445-456.

Ferracini C, Ferrari E, Pontini M, Saladini MA & Alma A (2019) Effectiveness of *Torymus sinensis*: A successful long-term control of the asian chestnut gall wasp in Italy. *Journal of Pest Science* **92**, 353-359.

Ferracini C, Gonella E, Ferrari E, Saladini MA, Picciau L, Tota F, Pontini M & Alma A (2015) Novel insight in the life cycle of *Torymus sinensis*, biocontrol agent of the chestnut gall wasp. *Biocontrol* **60**, 169-177.

Gehring E, Bellosi B, Quacchia A & Conedera M (2018a) Assessing the impact of *Dryocosmus kuriphilus* on the chestnut tree: Branch architecture matters. *Journal of Pest Science* **91**, 189-202.

Gehring E, Kast C, Kilchenmann V, Bieri K, Gehrig R, Pezzatti GB & Conedera M (2018b) Impact of the Asian chestnut gall wasp, *Dryocosmus kuriphilus* (Hymenoptera, Cynipidae), on the chestnut component of honey in the southern swiss Alps. *Journal of Economic Entomology* **111**, 43-52

Gibbs M, Schonrogge K, Alma A, Melika G, Quacchia A, Stone GN & Aebi A (2011) *Torymus sinensis*: A viable management option for the biological control of *Dryocosmus kuriphilus* in Europe? *Biocontrol* **56**, 527-538.

Gil-Tapetado D, Castedo-Dorado F, Nieves-Aldrey JL & Lombardero MJ (2021) Gall size of *Dryocosmus kuriphilus* limits down-regulation by native parasitoids. *Biological Invasions*. https://doi.org/10/1007/s10530-020-02427-x

Gil-Tapetado D, Cabrero-Sanudo FJ, Polidori C, Gomez JF & Nieves-Aldrey JL (2020a) Climate as a possible driver of gall morphology in the chestnut pest *Dryocosmus kuriphilus* across Spanish invaded areas. *Bulletin of Entomological Research*, 1-14.

Gil-Tapetado D, Castedo-Dorado F, Lombardero MJ, Martel J & Alvarez-Alvarez P (2020b) Spatial propagation and patterns of abundance of *Dryocosmus kuriphilus* throughout an invaded region. *Journal of Applied Entomology*. https://doi.org/10.1111/jen.12836

Gilioli G, Pasquali S, Tramontini S & Riolo F (2013) Modelling local and long-distance dispersal of invasive chestnut gall wasp in Europe. *Ecological Modelling* **263**, 281-290.

Graziosi I & Rieske LK (2014) Potential fecundity of a highly invasive gall maker, *Dryocosmus kuriphilus* (Hymenoptera: Cynipidae). E*nvironmental Entomology* **43**, 1053-1058.

Graziosi I & Santi F (2008) Chestnut gall wasp (*Dryocosmus kuriphilus*): Spreading in Italy and new records in Bologna province. *Bulletin of Insectology* **61**, 343-348.

Hou HQ, Zhao GZ, Su CY & Zhu DH (2020) *Wolbachia* prevalence patterns: Horizontal transmission, recombination, and multiple infections in chestnut gall wasp-parasitoid communities. *Entomologia Experimentalis Et Applicata* **168**, 752-765.

Jara-Chiquito JL, Askew RR & Pujade-Villar J (2020) The invasive ACGW *Dryocosmus kuriphilus* (Hymenoptera: Cynipidae) in Spain: Native parasitoid recruitment and association with oak gall inducers in Catalonia. *Forestry* **93**, 178-186.

Kato K & Hijii N (1993) Optimal clutch size of the chestnut gall-wasp, *Dryocosmus kuriphilus* Yasumatsu (Hymenoptera: Cynipidae). *Research in Population Ecology* **35**, 1-14.

Kim CS, Park IK, Kim JK, Park YS, Shin SC, Chung YJ, Choi KS & Jeon MJ (2005) Oviposition preferences of the oriental chestnut gall wasp, *Dryocosmus kuriphilus*, on various chestnut varieties. *Korean Journal of Applied Entomology* **44**, 157-159.

Kos K, Lackovic N, Melika G & Matosevic D (2020) Diversity and surge in abundance of native parasitoid communities prior to the onset of *Torymus sinensis* on the asian chestnut gall wasp (*Dryocosmus kuriphilus*) in Slovenia, Croatia and Hungary. *Journal of Forestry Research*. https://doi.org/10.1007/s11676-020-01197-5

Maltoni A, Mariotti B, Jacobs DF & Tani A (2012) Pruning methods to restore *Castanea sativa* stands attacked by *Dryocosmus kuriphilus*. *New Forests* **43**, 869-885.

Matosevic D & Melika G (2013) Recruitment of native parasitoids to a new invasive host: First results of *Dryocosmus kuriphilus* parasitoid assemblage in Croatia. *Bulletin of Insectology* **66**, 231-238.

Moriya S, Shiga M & Adachi I (2003) Classical biological control of the chestnut gall wasp in Japan. *In*: Proceedings of the 1st international symposium on biological control of arthropods. USDA Forest Service, Washington, 407-415.

Murakami Y, Umeya K & Oho N (1977) Preliminary introduction and release of a parasitoid (Chalcidoidea: Torymidae) of chestnut gall wasp, *Dryocosmus kuriphilus* Yasumatsu (Cynipidae) from China. *Japanese Journal of Applied Entomology and Zoology* **21**, 197-203.

Murakami Y, Ao HB & Chang CH (1980) Natural enemies of the chestnut gall wasp in Hopei Province, China

(Hymenoptera: Chalcidoidea). *Applied Entomology and Zoology* **15**, 184-186.

Murakami Y, Hiramatsu T & Maeda M (1994) Parasitoid complexes of the chestnut gall wasp (Hymenoptera: Cynipidae) in two localities before introduction of *Torymus* (*Syntomaspis*) *sinensis* (Hymenoptera: Torymidae), with special reference to prediction of results after release of the parasitoid. *Japanese Journal of Applied Entomology and Zoology* **38**, 29-41.

Muru D, Borowiec N, Thaon M, Ris N & Vercken E (2020) The open bar is closed: restructuration of a native parasitoid community following successful control of an invasive pest. *PCI Zoology*. http://dx.doi.org/10.1101/2019.12.20.884908

Nakamura M, Kondo M, Ito Y, Miyashita K & Nakamura K (1964) Population dynamics of the chestnut gall-wasp *Dryocosmus kuriphilus* Yasumatsu (Hymenoptera: Cynipidae) – 1. Description of the survey stations and the life histories of the gall-wasp and its parasites. *Japanese Journal of Applied Entomology and Zoology* **8**, 149-158

Nohara K (1956) Considerations on the reproductive capacity of *Dryocosmus kuriphilus* Yasumatsu (Hymenoptera: Cynipidae). *Sci. Bull. Fac. Agric. Kyushu Univ*. 15, 441-446.

Otake A (1980) Chestnut gall wasp, *Dryocosmus kuriphilus* Yasumatsu (Hymenoptera, Cynipidae) - a preliminary study on trend of adult emergence and some other ecological aspects related to the final stage of its life-cycle. *Applied Entomology and Zoology* **15**, 96-105.

Otake A (1989) Chestnut gall wasp, *Dryocosmus kuriphilus* Yasumatsu (Hymenoptera, Cynipidae) - analyses of records on cell contents inside galls and on emergence of wasps and parasitoids outside galls. *Applied Entomology and Zoology* **24**, 193-201.

Panzavolta T, Croci F, Bracalini M, Melika G, Benedettelli S, Florenzano GT & Tiberi R (2018) Population dynamics of native parasitoids associated with the asian chestnut gall wasp (*Dryocosmus kuriphilus*) in Italy. *Psyche*. https://doi.org/10.1155/2018/8078049

Payne JA (1981) Asian chestnut gall wasp in America. *In*: Proceedings of Amercian Chestnut Cooperator's meeting. US Forest Service, Broomall, PA, 14.

Payne JA, Jaynes RA & Kays SJ (1983) Chinese chestnut production in the United States: Practice, problems, and possible solutions. *Economic Botany* **37**, 187-200.

Pogolotti C, Cuesta-Porta V, Pujade-Villar J & Ferracini C (2019) Seasonal flight activity and genetic relatedness of *Torymus* species in Italy. *Agricultural and Forest Entomology* **21**, 159-167.

Quacchia A, Ferracini C, Nicholls JA, Piazza E, Saladini MA, Tota F, Melika G & Alma A (2013) Chalcid parasitoid community associated with the invading pest *Dryocosmus kuriphilus* in north-western Italy. *Insect Conservation and Diversity* **6**, 114-123.

Reale L, Tedeschini E, Rondoni G, Ricci C, Bin F, Frenguelli G & Ferranti F (2016) Histological investigation on gall development induced by a worldwide invasive pest, *Dryocosmus kuriphilus*, on *Castanea sativa*. *Plant Biosystems* **150**, 35-42.

Rieske LK (2007) Success of an exotic gallmaker, *Dryocosmus kuriphilus*, on chestnut in the USA: a historical account. *EPPO Bulletin* **37**, 172-174.

Sartor C, Dini F, Marinoni DT, Mellano MG, Beccaro GL, Alma A, Quacchia A & Botta R (2015) Impact of the Asian wasp *Dryocosmus kuriphilus* (Yasumatsu) on cultivated chestnut: Yield loss and cultivar susceptibility. *Scientia Horticulturae* **197**, 454-460.

Sartor C, Marinoni DT, Quacchia A & Botta R (2012) Quick detection of *Dryocosmus kuriphilus* Yasumatsu (Hymenoptera: Cynipidae) in chestnut dormant buds by nested pcr. *Bulletin of Entomological Research* 102, 367-371.

Shimura I (1972) Studies on the breeding of chestnut, *Castanea* spp. II. Parasitic variation in the chestnut gall wasp, *Dryocosmus kuriphilus* Yasumatsu. *Bulletin of the Horticultural Research Station* **11**, 1-13.

Stone GN, Schonrogge K, Atkinson RJ, Bellido D & Pujade-Villar J (2002) The population biology of oak gall wasps (Hymenoptera : Cynipidae). *Annual Review of Entomology* 47, 633-668.

Tokuhisa E (1981) Number of eggs deposited by the chestnut gall wasp, *Dryocosmus kuriphilus* Yasumatsu (Cynipidae). *Proc. Assoc. Plant. Prot. Kyushu* **27**, 154-156.

Ugolini F, Massetti L, Pedrazzoli F, Tognetti R, Vecchione A, Zulini L & Maresi G (2014) Ecophysiological responses and vulnerability to other pathologies in european chestnut coppices, heavily infested by the asian chestnut gall wasp. *Forest Ecology and Management* **314**, 38-49.

Viciriuc IM, Thaon M, Moriya S, Warot S, Zhang J, Aebi A, Ris N, Fusu L & Borowiec N (in press) Contribution of the integrative taxonomy to tracking past and recent interspecific hybridizations between the biological control agent *Torymus sinensis* and its related taxa. *Systematic Entomology*

Viggiani G & Nugnes F (2010) Description of the larval stages of *Dryocosmus kuriphilus* Yasumatsu (Hymenoptera: Cynipidae), with notes on their phenology. *Journal of Entomological and Acarological Research* **42**, 39-45.

Warmund MR (2014) Disinfestation of *Dryocosmus kuriphilus* Yasumatsu in *Castanea* scion wood. *In*: Double ML & MacDonald WL (eds). Vth international chestnut symposium, 243-247.

Yara K (2004) Relationship between the introduced and indigenous parasitoids *Torymus sinensis* and *T. beneficus* (Hymenoptera : Torymidae) as inferred from mt-DNA (COI) sequences. *Applied Entomology and Zoology* **39**, 427-433.

Yasumatsu K (1951) A new *Dryocosmus* injurious to chestnut trees in Japan (Hym., Cynipidae). *Mushi* **22**, 89-93.

Yasumatsu K & Kamijo K (1979) Chalcidoid parasites of *Dryocosmus kuriphilus* Yasumatsu (Cynipidae) in Japan, with descriptions of five new species (Hymenoptera). *Esakia* **14**, 93-111

Zhang ZY, Tarcali G, Radocz L, Feng YQ & Shen YY (2009) Chestnut gall wasp, *Dryocosmus kuriphilus* Yasumatsu in China and in Hungary. *Journal of Agricultural Sciences* **38**, 123-128.

Zhu DH, He YY, Fan YS, Ma MY & Peng DL (2007) Negative evidence of parthenogenesis induction by Wolbachia in a gallwasp species, *Dryocosmus kuriphilus*. *Entomologia Experimentalis Et Applicata* **124**, 279-284.

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