

Research article

New infestation of Asian chestnut gall wasp in eastern Black Sea Region, Turkey: a potential threat to natural regional chestnut population

Musa AZMAZ^{1,*}, Yusuf KATILMIŞ²

¹Pamukkale University, Acıpayam Vocational High School, Department of Veterinary, Laborant & Veterinary Health Program, Acıpayam, Denizli, Turkey.

²Pamukkale University, Faculty of Arts & Sciences, Department of Biology, Denizli, Turkey.

* Corresponding author e-mail: musazmaz@pau.edu.tr

Abstract: The chestnut gall wasp (*Dryocosmus kuriphilus* Yasumatsu, 1951) is currently the most dangerous pest for the Anatolian chestnut (*Castanea sativa* Mill.). *C. sativa* is one of the most important wood species due to its economic role for the country's economy. The chestnut gall wasp causes economic damage owing to crop loss in chestnut production, and severe invasions may cause in the death of chestnut trees. In this study, we reported the infestation of the *D. kuriphilus* from a new distribution area (the Eastern Black Sea Region of Turkey). Distribution of the introduced species has just been detected in a very narrow vicinity of a single valley and the presence of the species is thought to be very new. Moreover, the reason of the infestation is thought to be the plantation of chestnut seedlings which had been imported from abroad. We discussed the possible effects of the pests on chestnut trees and if precautions are not taken against to this species it was predicted that the pest would spread across the entire Black Sea region and Caucasia within 10-15 years. Data on the biology, host plant and the distribution of the chestnut gall wasp in Turkey, are also reported.

Keywords: Cynipidae, gall wasp, pest, *Dryocosmus kuriphilus*, invasive species, Anatolian chestnut, Turkey.

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Introduction

Dryocosmus kuriphilus Yasumatsu is a member of gall inducer cynipids (Hymenoptera Cynipidae Cynipini). The species that is belonging to tribe Cynipini attacks mostly *Quercus* spp., while the chestnut gall wasp induces galls on *Castanea* spp. (EPPO, 2005; Radócz et al., 2016). On the other hand, the chestnut gall wasp, as a harmful pest, causes great damage to chestnuts worldwide (Payne et al., 1983; Moriya et al., 1989; Murakami et al., 1995; Brussino et al., 2002; Vollmeier et al., 2018). Thus, it was declared as a quarantine pest in 2003 by the European and Mediterranean Plant Protection Organization. The pest disrupts the shoot growth and reduces the fruit. It

consequently decreases the agricultural production which is resulting in 70% crop loss (Dixon et al., 1986; EPPO, 2005).

Chestnut is a highly important nutrient and it is playing a crucial role for the country's economy, therefore, for the Turkish citizens. Turkey is ranked third after China and Bolivia in the world in chestnut production. China is the largest producer with nearly 2 million tonnes of production, while Turkey comes third with nearly 65 thousand tons (3%) of chestnut production (FAO, 2019). In addition, *C. sativa* grows naturally on three continents of the Northern Hemisphere and its trees are used for chestnut production worldwide.

Castanea sativa was distributed in Turkey from the Caucasus to the border of Bulgaria along the North Anatolia (Black Sea coast), around the Marmara and Western Anatolia (Fig. 1). It is also locally observed in the Mediterranean Region (Isparta, Manavgat, Alanya) (OGM, 2013). The vast majority of chestnut production of Turkey takes place in Aegean Region (Coşkun, 2010).

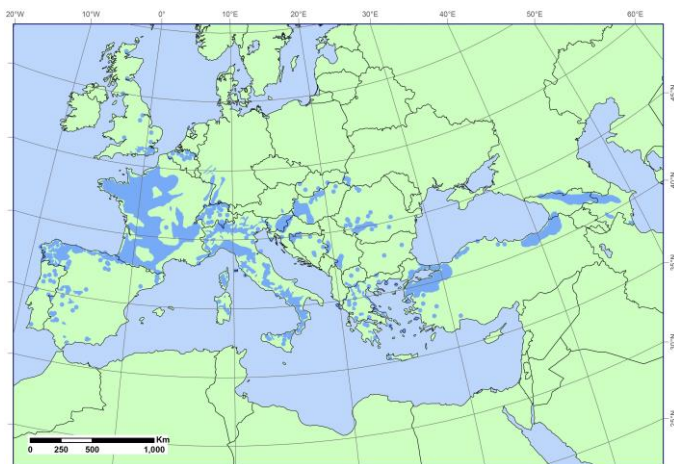


Figure 1. Distribution map of *Castanea sativa* in Palearctic region (EUFORGEN, 2019).

Dryocosmus kuriphilus originated in China and was first identified in Japan in 1941 (Murakami et al., 1980), then in Korea in 1958 (Cho and Lee, 1963; Aebi et al., 2007), and reached Nepal in 1999 (Ueno, 2006; Abe et al., 2007). It also spread to America in 1974 (Payne et al., 1975) and Canada in 2012 (Huber and Read, 2012).

It was first observed in Europe in 2002 in Italy (Brussino et al., 2002). Following Italy, it was found in Slovenia and France in 2005 (Aebi et al., 2006; Knapič et al., 2010), in Switzerland and Hungary in 2009 (Csóka et al., 2009; Förster et al., 2009), Croatia and Netherlands in 2010 (EPPO, 2010; Matošević et al., 2010), the Czech Republic, Germany and Spain in 2012 (EPPO, 2012, 2013b; Pujade-Villar et al., 2013), Austria in 2013 (EPPO, 2013a), Turkey and Portugal in 2014 (Çetin et al., 2014; EPPO, 2014), Belgium and United Kingdom in 2015 (EPPO, 2015, 2016), Bosnia and Herzegovina, the North Caucasus of Russia, Greece and Romania in 2016 (Michaelakis et al., 2016; Radócz et al., 2016; Gninenko and Lyanguzov, 2017; Delalić, 2019). Furthermore, the pest spreads rapidly throughout Holarctic region.

Researchers have developed large number of methods to the struggle against invasive the chestnut gall wasp where a method (biological control with *Torymus sinensis* Kamijo (Hymenoptera, Torymidae)) is found effective to invasion of the pest (Quacchia et al., 2012; Ferracini et al.,

2019). However, the other part of efforts (insecticides, pruning or the net protection, the breeding of resistant chestnut) failed to control over the pest in invaded areas (Murakami, 1981; Zhang et al., 2009; Bernardo et al., 2013). In addition to these methods, a new effective method for the control of *D. kuriphilus* was released last year that is named “Hot Water Treatment (HWT)” which is known to use for pathogen control. According to the method HWT, it is found that the bath temperature of 49°C is effective to kill *D. kuriphilus* larvae on *C. sativa* scions (Ciordia et al., 2019).

The first study in Turkey, is about the counter measures to be taken against to the *D. kuriphilus* (Coşkun, 2010). In 2014, the species was recorded for the first time in the Western of Turkey (Yalova and Bursa) (Çetin et al., 2014). Following that, İpekdağ et al., (2014) published a review paper about the spread of the pest as well as the sustainable conservation of natural chestnut population. In the same year, Doğanlar (2014) conducted a research on the natural parasitoids of the chestnut gall wasp in Yalova, Turkey. Moreover, İpekdağ et al., (2017) stated that the use of *T. sinensis*, which is the native parasitoid of the chestnut gall wasp, is the most effective method in biological control over the pest.

In this study, *D. kuriphilus* was also recorded for the first time in a narrow valley of Giresun, Turkey (the Eastern Black Sea Region). Therefore, the chestnut population of the entire Black Sea Region and Caucasus is potentially under a risk of the invasion if the effective precautions are not taken against the spread of *D. kuriphilus*.

Materials and Methods

The field studies of our more comprehensive research were carried out in the entire Eastern Black Sea Region (Ordu, Giresun, Trabzon, Gümüşhane, Rize, Bayburt and Artvin) between 2017-2019. However, the samples of chestnut galls were collected (on *C. sativa* Miller) from a local area of Giresun in July, August and September 2019 as the species were found for the first time in this year. The collected gall samples were reared in the laboratory conditions and emerging cynipids were preserved in 95% ethanol. Following the preservation, they were kept air-dried and pinned adult specimens as museum material. The specimens are stored in the Entomology Research Laboratory, Pamukkale University (PAU), Denizli, Turkey.

During the field study, local people were informed about the biology, distribution and control of the species in order to protect the chestnut forests.

Results

Dryocosmus kuriphilus Yasumatsu (Asian Chestnut Gall Wasp)

Material examined: GİRESUN, Yağlıdere, Kuruçalı, 40°51'N, 38°39'E, 570 m, 18.07.2019, 3♀♀.

Gall collected (Fig. 2): GİRESUN, Keşap, Ceylanpınar, 40°47'N, 38°32'E, 415 m, 26.VIII.2019; Keşap, Halkalı, 40°48'N, 38°32'E, 400 m, 26.VIII.2019; Keşap, Karadere, 40°52'N, 38°32'E, 200 m, 26.VIII.2019; Keşap, Yivdincik, 40°51'N, 38°34'E, 570 m, 26.VIII.2019; Yağlıdere, 40°51'N, 38°37'E, 40°50'N, 38°37'E, 140-180 m, 18.VII.2019; Yağlıdere, Akdarı, 40°51'N, 38°35'E, 410-520 m, 26.VIII.2019; Yağlıdere, Kızılelma, 40°51'N, 38°36'E, 290-320 m, 18.VII.2019, 26.VIII.2019; Yağlıdere, Kuruçalı, 40°51'N, 38°39'E, 570 m, 18.07.2019, 26.IX.2019; Yağlıdere, Küçükköy, 40°50'N, 38°39'E, 430-490 m, 26.IX.2019; Yağlıdere, Tepeköy, 40°50'N, 38°37'E, 150-330 m, 18.VII.2019, 26.IX.2019.

Host plant: *Castanea sativa* (Anatolian chestnut).

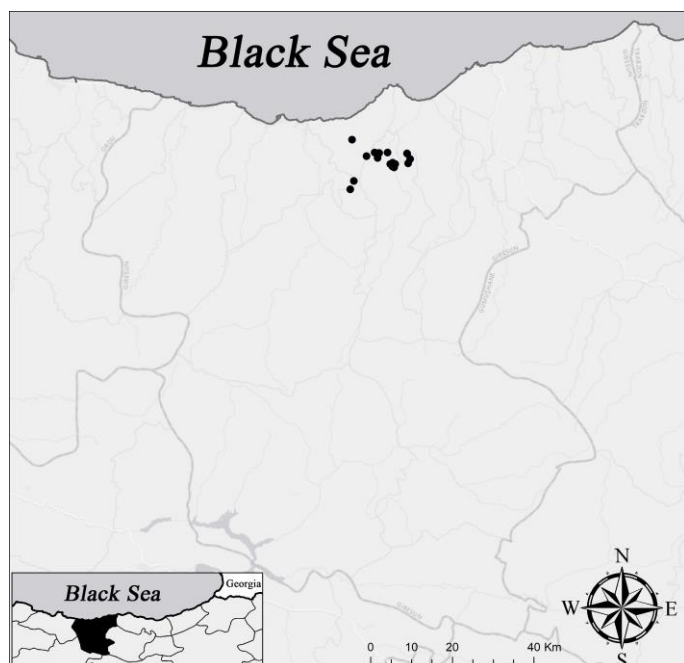


Figure 2. Infested locations of Giresun with *Dryocosmus kuriphilus* in Eastern Black Sea Region, Turkey.

As a result of interviews with local people, it was revealed that the pest had been present in the villages for the last 5-6 years. Furthermore, the local people stated that

the chestnut yield has been decreasing for the same period of the time. In addition, the galls of *D. kuriphilus* on chestnut plant were densely observed during the field studies which is consistent with outcomes of interviews with the dwellers.

In non-infested villages, the locals were informed about the pest and its damage in order to take early precautions. Moreover, it was emphasized that they should promptly inform the General Directorate of Forestry (OGM) in case they encounter the oriental chestnut gall on *C. sativa*.

Biology: The species has one generation per year and reproduces parthenogenetically. First-instar larvae overwinter, the adult females emerge from galls (Fig. 3) between end of May and end of July depending on locality (altitude, exposure, chestnut cultivars and varied climates etc.) (EPPO, 2005). In addition, Bernardo et al., (2013) reported that adults emerged from the galls between mid-June and end-July. Moreover, the timing of adult emergence does not depend on the duration of the pupal or the adult stage.



Figure 3. *Dryocosmus kuriphilus* galls on *Castanea sativa* (photos by Y. Katılmış).

Another survey, which was conducted in Italy, showed that the adults emerged between early June and mid-August (Bosio et al., 2010; Bombi et al., 2019). In the study, the galls were collected in July, August and September 2019. The adults emerged in first week of August depending on the rainy and cold chestnut forests as well as adverse conditions and Anatolian chestnut cultivars. No parasitoid emergence was recorded from the collected galls.

Discussion

Chestnut gall wasp is currently located in the Marmara region (Yalova and Bursa) (Çetin et al., 2014). It is considered that the entry of the pest to Turkey took place in 2009 or earlier, and the species which has an average annual spreading rate of 25 km (Rieske, 2007; Graziosi and Santi, 2008), would spread to the entire Black Sea region within 40 years (İpekdal et al., 2014). On the other hand, it is estimated that it will spread to the entire Black Sea region within 10-15 years as it spreads rapidly in other countries (EPPO, 2007; Battisti et al., 2013; İpekdal et al., 2014), unless precautions are taken against the pest that is recorded only in a local area of Giresun.

The use of parasitoids is the most effective method in biological control (Bosio et al., 2013). Among all parasitoids of the chestnut gall wasp, *T. sinensis*, native to China is the most effective species that exhibits a host-specific behaviour for biological control (Kamijo, 1982; Moriya et al., 1989; Piao and Moriya, 1999; Ferracini et al., 2015). The biological control method using *T. sinensis* started in Japan in the 1980s and was successfully applied in Asia and America (Aebi et al., 2007; Quacchia et al., 2012).

In Turkey, 11 species of parasitoid to chestnut gall wasp were recorded, however *T. sinensis* was not found among those species (Doğanlar, 2014). In order to decrease the damage of chestnut gall wasp, producing and releasing of the parasitoid *T. sinensis* were planned for biological control in Turkey (İpekdal et al., 2014). In the light of these studies, the Department of Combating Forest Pest (the General Directorate of Forestry) has started to work on the use of *T. sinensis* against chestnut gall wasp in Turkey. In 2015 and 2016, *T. sinensis* was introduced to the invaded areas in Western of Turkey for the biological control.

In order to protect the natural distribution areas of chestnut, which is an economic resource and food product, precautions should be taken with the consultation of the Ministry of Agriculture and Forestry, Republic of Turkey. As biological control efforts are continuing in the Western Turkey, similar studies should be conducted in affected areas of the Black Sea region before being late.

On the other hand, it is crucial to begin the development of conservation actions. Because the failure to biological control of the pest should be considered as the spread risk to all over Caucasus and the Black Sea region. Therefore, damages of the *D. kuriphilus* will have

a significant influence on the loss of natural chestnut population in the Caucasus and the Black Sea region.

Ethical Approval

The authors don't declare ethical approval.

Conflicts of Interest

The authors declare that they have no conflict of interest.

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References

- Abe Y., Melika G., Stone G.N. 2007. The diversity and phylogeography of cynipid gallwasps (Hymenoptera: Cynipidae) of the Oriental and eastern Palearctic regions, and their associated communities. *Oriental Insects*, 41(1): 169-212. DOI: 10.1080/00305316.2007.10417504
- Aebi A., Schönrogge K., Melika G., Alma A., Bosio G., Quacchia A., Picciau L., Abe Y., Moriya S., Yara K., Seljak G., Stone G.N. 2006. Parasitoid Recruitment to the globally invasive chestnut gall wasp *Dryocosmus kuriphilus*. In: K. Ozaki, J. Yukawa, T. Ohgushi, P.W. Price (Eds.) *Galling Arthropods and Their Associates*, Tokyo: Springer-Verlag: 103-121. DOI: 10.1007/4-431-32185-3_9
- Aebi A., Schönrogge K., Melika G., Quacchia A., Alma A., Stone G.N. 2007. Native and introduced parasitoids attacking the invasive chestnut gall wasp *Dryocosmus kuriphilus*. *Bulletin OEPP/EPPO Bulletin*, 37(1): 166-171. DOI: 10.1111/j.1365-2338.2007.01099.x
- Battisti A., Benvegnù I., Colombari F., Haack R. A. 2013. Invasion by the chestnut gall wasp in Italy causes significant yield loss in *Castanea sativa* nut production. *Agricultural and Forest Entomology*, 16(1): 75-79. DOI: 10.1111/afe.12036
- Bernardo U., Iodice L., Sasso R., Tutore V.A., Cascone P., Guerrieri E. 2013. Biology and monitoring of *Dryocosmus kuriphilus* on *Castanea sativa* in Southern Italy. *Agricultural and Forest Entomology*, 15: 65-76. DOI: 10.1111/j.1461-9563.2012.00588.x
- Bombi P., Fedi C., Zapparoli M., Cammarano M., Guidolotti G., Pallozzi E., Gaudet M., Mattioni C., Cherubini M., Beritognolo I., Villani F. 2019. Infestation potential of *Dryocosmus kuriphilus* Yasumatsu, 1951 (Hymenoptera:

- Cynipidae) in different natural populations of *Castanea sativa* Miller: an experimental ex situ test. *International Journal of Pest Management*, 65(2): 147-153. DOI: 10.1080/09670874.2018.1483091
- 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. DOI: 10.17660/ActaHortic.2010.866.43
- Bosio G., Armando M., Moriya S. 2013. Toward biological control of the chestnut gall wasp. *L'Informatore Agrario*, 14: 60-64. (in Italian)
- Brussino G., Bosio G., Baudino M., Giordano R., Ramello F., Melika G. 2002. A dangerous exotic insect threatening European chestnut. *L'Informatore Agrario*, 58: 59-61. (in Italian)
- Çetin G., Orman E., Polat Z. 2014. First record of the Oriental chestnut gall wasp, *Dryocosmus kuriphilus* Yasumatsu (Hymenoptera: Cynipidae) in Turkey. *Bitki Koruma Bülteni*, 54(4): 303-309.
- Cho D.Y., Lee S.O. 1963. Ecological studies on the chestnut gall wasp, *Dryocosmus kuriphilus* Yasumatsu, and observations of the damage caused to the tree by this insect. *Korean Journal of Plant Protection*, 2: 47-54. (in Korean)
- Ciordia M., García J.C., Loureiro M.D. 2019. Hot water treatment: an effective method for disinfecting *Castanea sativa* mill. dormant scions against *Dryocosmus kuriphilus* Yasumatsu. *Pest Management Science*, DOI: 10.1002/ps.5727
- Coşkuncu K.S. 2010. A Review on The Chestnut gall wasp *Dryocosmus kuriphilus* Yasumatsu (Hymenoptera: Cynipidae). *Journal of Agricultural Faculty of Uludag University*, 24(2): 129-135.
- Csóka G., Wittmann F., Melika G. 2009. The oriental sweet chestnut gall wasp (*Dryocosmus kuriphilus* Yasumatsu 1951) in Hungary. *Növényvédelem*, 45(7): 359-360.
- Delalić Z. 2019. Intense Appearance of Chestnut Gall Wasp (*Dryocosmus kuriphilus* Yasumatsu) in Bosnia and Herzegovina. *Acta Scientific Agriculture*, 3(9): 10-14. DOI: 10.31080/ASAG.2019.03.0597
- Dixon W.N., Burns R.E., Stange L.A. 1986. Oriental chestnut gall wasp *Dryocosmus kuriphilus* Yasumatsu (Hymenoptera: Cynipidae). *Entomology Circular*, 287.
- Doğanlar M. 2014. First reports on the natural enemy fauna of the Chestnut Gall-wasp, *Dryocosmus kuriphilus* Yasumatsu (Hymenoptera: Cynipidae) in Yalova, Turkey. *Türkiye Biyolojik Mücadele Dergisi*, 5(1): 67-74.
- EPPO (European and Mediterranean Plant Protection Organization). 2005. Data sheets on quarantine pests - *Dryocosmus kuriphilus*. *Bulletin OEPP/EPPO Bulletin*, 35(3): 422-424. DOI: 10.1111/j.1365-2338.2005.00849.x
- EPPO (European and Mediterranean Plant Protection Organization). 2007. *Dryocosmus kuriphilus* found in the south of France (Alpes-Maritimes). *EPPO Reporting Service* 5, 2007/086.
- EPPO (European and Mediterranean Plant Protection Organization). 2010. First report of *Dryocosmus kuriphilus* in the Netherlands. *EPPO Reporting Service* 8, 2010/134.
- EPPO (European and Mediterranean Plant Protection Organization). 2012. First report of *Dryocosmus kuriphilus* in the Czech Republic. *EPPO Reporting Service* 7, 2012/141.
- EPPO (European and Mediterranean Plant Protection Organization). 2013a. First report of *Dryocosmus kuriphilus* in Austria. *EPPO Reporting Service* 7, 2013/140.
- EPPO (European and Mediterranean Plant Protection Organization). 2013b. First report of *Dryocosmus kuriphilus* in Germany. *EPPO Reporting Service* 7, 2013/141.
- EPPO (European and Mediterranean Plant Protection Organization). 2014. First report of *Dryocosmus kuriphilus* in the Portugal. *EPPO Reporting Service* 6, 2014/103.
- EPPO (European and Mediterranean Plant Protection Organization). 2015. First report of *Dryocosmus kuriphilus* in the United Kingdom. *EPPO Reporting Service* 6, 2015/108.
- EPPO (European and Mediterranean Plant Protection Organization). 2016. First report of *Dryocosmus kuriphilus* in Belgium. *EPPO Reporting Service* 2, 2016/029.
- EUFORGEN (European Forest Resources Programme). 2019. Distribution Map of Chestnut (*Castanea sativa*). Available from: <http://www.euforgen.org/species/castanea-sativa/>, Retrieved 03/11/2019.
- FAO (Food and Agriculture Organization of the United Nations). 2019. Crop data. Available from: <http://www.fao.org/faostat/en/#data/QC>, Retrieved 03/11/2019.
- Ferracini C., Ferrari E., Pontini M., Saladini M.A., 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. DOI: 10.1007/s10340-018-0989-6
- Ferracini C., Gonella E., Ferrari E., Saladini M.A., 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(2): 169-177. DOI: 10.1007/s10526-014-9633-4
- Förster B., Castellazzi T., Colombi L., Fürst E., Marazzi C., Meier F., Tettamanti G., Moretti G. 2009. First record of the chestnut gall wasp *Dryocosmus kuriphilus* (Yasumatsu) (Hymenoptera, Cynipidae) in Southern Switzerland. *Mitteilungen der Schweizerischen Entomologischen Gesellschaft*, 82: 271-279.
- Gninenko Y.I., Lyanguzov M.E. 2017. East Chestnut Gall Wasps *Dryocosmus kuriphilus* Yasumatsu, 1951 (Hymenoptera, Cynipidae)-New Invader in the Forests of the

- North Caucasus. Russian Journal of Biological Invasions, 8: 206-211. DOI: 10.1134/S207511171703002X
- Graziosi I., Santi F. 2008. Chestnut gall wasp (*Dryocosmus kuriphilus*): spreading in Italy and new records in Bologna province. Bulletin of Insectology, 61(2): 343-348.
- Huber J.T., Read J. 2012. First Record of The Oriental Chestnut Gall Wasp, *Dryocosmus kuriphilus* Yasumatsu (Hymenoptera: Cynipidae), in Canada. Journal of the Entomological Society of Ontario, 143: 125-128.
- İpekdal K., Coşkuncu K.S., Aytar F., Doğanlar M. 2014. Chestnut Gall Wasp *Dryocosmus kuriphilus* Yasumatsu (Hymenoptera: Cynipidae): An update for its situation on the world and in Turkey and its management. Türkiye Entomoloji Bülteni, 4(4): 241-257.
- İpekdal K., Emin A., Kuzucu A.Ş., Karadağ M., Koçluk M., Açıcı Ö., Şah S., Aksu Y., Colombari F. 2017. Rearing and releasing *Torymus sinensis* Kamijo (Hymenoptera: Torymidae), larval parasitoid of the chestnut gall wasp, *Dryocosmus kuriphilus* Yasumatsu (Hymenoptera: Cynipidae). Türkiye Entomoloji Bülteni, 7(2): 173-189.
- Kamijo K. 1982. Two new species of *Torymus* (Hymenoptera, Torymidae) reared from *Dryocosmus kuriphilus* (Hymenoptera, Cynipidae) in China and Korea. Kontyû, 50: 505-510.
- Knapič V., Seljak G., Kolšek M. 2010. Experience with *Dryocosmus kuriphilus* Yasumatsu eradication measures in Slovenia. Bulletin OEPP/EPPO Bulletin, 40(2): 169-175. DOI: 10.1111/j.1365-2338.2010.02371.x
- Matošević D., Pernek M., Hrašovec, B. 2010. First record of Oriental chestnut gall wasp (*Dryocosmus kuriphilus*) in Croatia. Šumarski List, 9/10: 497-502. (in Croatian)
- Michaelakis A., Papachristos D., Chytas D.A., Antonopoulou P.D., Milonas P.G., Avtzis D.N. 2016. First record of *Dryocosmus kuriphilus* in Greece. Bulletin OEPP/EPPO Bulletin, 46(2): 290-294. DOI: 10.1111/epp.12305
- Moriya S., Inoue K., Mabuchi M. 1989. The use of *Torymus sinensis* to control chestnut gall wasp, *Dryocosmus kuriphilus*, in Japan. Food and Fertilizer Technology Center (FFTC) Technical Bulletin, 118: 1-12.
- Murakami Y. 1981. The parasitoids of *Dryocosmus kuriphilus* Yasumatsu (Hymenoptera: Cynipidae) in Japan and the introduction of a promising natural enemy from China (Hymenoptera: Chalcidoidea). Journal of Faculty of Agriculture, Kyushu University, 25: 167-174.
- Murakami Y., Ao H.B., Chang C.H. 1980. Natural enemies of the chestnut gall wasp in Hopei Province, China (Hymenoptera: Chalcidoidea). Applied Entomology and Zoology, 15: 184-186. DOI: 10.1303/aez.15.184
- Murakami Y., Ihkubo N., Moriya S., Gyoutoku Y., Kim C.H., Kim J.K. 1995. Parasitoids of *Dryocosmus kuriphilus* (Hymenoptera: Cynipidae) in South Korea with particular reference to ecologically different types of *Torymus* (*Syntomaspis*) *sinensis* (Hymenoptera: Torymidae). Applied Entomology and Zoology, 30: 277-284. DOI: 10.1303/aez.30.277
- OGM (Orman Genel Müdürlüğü/General Directorate of Forestry). 2013. Chestnut Action Plan 2013-2017. Orman ve Su İşleri Bakanlığı, Ankara. 56 p. (in Turkish)
- Payne J.A., Jaynes R.A., Kays S.J. 1983. Chinese chestnut production in the United States: practice, problems and possible solutions. Economic Botany, 37: 187-200. DOI: 10.1007/BF02858784
- Payne J.A., Menke A.S., Schroeder P.M. 1975. *Dryocosmus kuriphilus* Yasumatsu, (Hymenoptera: Cynipidae), an oriental chestnut gall wasp in North America. USDA Cooperative Economic Insect Report, 49/52: 903-905.
- Piao C., Moriya S. 1999. Oviposition of *Torymus sinensis* (Hymenoptera: Torymidae) under natural conditions. Entomological Science, 2: 329-334.
- Pujade-Villar J., Torrell A., Rojo M. 2013. Entomological note. First findings of *Dryocosmus kuriphilus* (Hym., Cynipidae) in the Iberian Peninsula, the species of cynipid of Asian origin, highly dangerous for chestnut (Fagaceae). Orsis, 27: 295-301. (in Catalan)
- Quacchia A., Ferracini C., Nicholls J.A., Piazza E., Saladini M.A., Tota F., Melika G., Alma A. 2012. Chalcid parasitoid community associated with the invading pest *Dryocosmus kuriphilus* in north-western Italy. Insect Conservation and Diversity, 6(2): 114-123. DOI: 10.1111/j.1752-4598.2012.00192.x
- Radócz L., Szilágyi A., Nagy M., Kovács G., Melika G. 2016. Asian sweet chestnut gallwasp, *Dryocosmus kuriphilus* (Hymenoptera, Cynipidae): first record for Romania. North-Western Journal of Zoology, 12(1): 201-204.
- Rieske L.K. 2007. Success of an exotic gallmaker, *Dryocosmus kuriphilus*, on chestnut in the USA: a historical account. Bulletin OEPP/EPPO Bulletin, 37(1): 172-174. DOI: 10.1111/j.1365-2338.2007.01100.x
- Ueno W. 2006. Occurrence and control of chestnut gall wasp in Nepal. Shokubutsu Boeki (Plant Protection), 60: 510-512. (in Japanese)
- Vollmeier R., Osterc G., Luthar Z. 2018. Preservation of sweet chestnut genetic resources (*Castanea sativa* Mill.) against attack by chestnut gall wasp (*Dryocosmus kuriphilus* Yasumatsu, 1951). Acta agriculturae Slovenica, 111(1): 209-217. DOI: 10.14720/aas.2018.111.1.20
- Zhang Z.-Y., Tarcali G., Radócz L., Feng Y.-Q., Shen Y.-Y. 2009. Chestnut gall wasp, *Dryocosmus kuriphilus* Yasumatsu in China and in Hungary. In: 5th International Plant Protection Symposium. Hungary, Debrecen. pp: 123-128.