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First report of caper (*Capparis spinosa*) serious infestation by *Eurydema eckerleini* in Cyclades Islands, Greece (Hemiptera: Heteroptera, Pentatomidae)

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Abstract
The islands of Tinos and Syros in the Cyclades Archipelago, Greece, have a hilly terrain, a mild Mediterranean climate and vegetation adapted to drought conditions. Caper (*Capparis spinosa* L.) is highly adapted to arid environments and grows successfully during the Mediterranean summer. In August 2015, we detected serious infestations on wild caper by *Eurydema eckerleini* (Pentatomidae), which was formerly considered a species endemic to Crete and the Peloponnese, with an isolated report in Turkey. This is the first record of the presence of *E. eckerleini* in the Cyclades.

Key words: *Eurydema eckerleini*, Pentatomidae, Caper, Cyclades, Greece.

Introduction

Six Heteroptera insect pests, of the Pentatomidae family, have been reported worldwide to infest caper: *Bagrada hilaris* (Burmeister), *Nezara viridula* (L.), *Eurydema ventralis* Kol., *Eurydema ornata* (L.), *Holcostethus punctatus* (Lindberg), *Antheminia lunulata* (Goeze) (Infantino et al. 2007). All these species are polyphagous and rarely represent a serious problem for caper, but *B. hilaris* is an oligophagous species which, besides infesting crucifers (Huang et al. 2011), is a major pest of caper crops in many parts of Asia and Africa (Colazza et al. 2004, Infantino et al. 2007). Another species, *Eurydema eckerleini* Josifov, 1961, considered endemic to the island of Crete and Peloponnese, Greece (Josivov & Simov 2006; Derjanschi & Péricart 2006), was reported also in Turkey (Rider 2006); it is monophagous on caper.

In August 2015, extensive infestations by nymphs and adults of a Pentatomidae insect species were observed on foliage of wild caper plants (*Capparis spinosa* L.) on the islands of Tinos and Syros (Northern Cyclades, Aegean Archipelago, Greece). Both adults and nymphs were observed feeding on the foliage and flower buds of caper, causing white chlorotic spots from the sucking of the leaf parenchyma tissues. The pale spots where progressively merged in severely infested plants. These plants had a diffuse pale yellow tint. Local, brown necrotic lesions on the leaves at the insects' feeding points were also observed (Fig. 3). No heavily infested plant was observed bearing flowers. According to local agronomists, infestations of caper were observed in the last three or four years. The establishment of *E. eckerleini* on Tinos is probably recent; in August 1993 Attilio Carapezza (pers. communication) collected extensively on the island inspecting several wild plants of *Capparis*, but no specimen of this Pentatomidae was observed.

Methods of identification and results

Adult specimens were collected from infested plants and were retained in 70% alcohol for species identification.

Based on both external shape and male genitalia morphology, the species was identified as *Eurydema eckerleini* Josifov, 1961, by the second author. The species is new to the Cyclades.

The genus *Eurydema* Laporte, 1833 is classified in the Strachiini tribe of the Pentatominae subfamily (Rider 2006). The species of this genus are generally coloured white/yellow and black or red and blue and black. This aposematic coloration functions as a warning signal of toxicity even when the species possesses chemical or physical defences to deter predators. Species of this genus are usually trophically bound to the plants of the family *Brassicaceae* and some of them, especially *Eurydema* (*Eurydema*) *oleracea* (Linnaeus, 1758), are known to cause damage to cultivated crops (Bohinc & Trdan 2012).

Today, 33 species of Palaearctic *Eurydema* are cata-

logued (Rider 2006). They are classified into three subgenera: *Eurydema* s. str. (13 species), *Horvatheurydema* Dupuis, 1951 (4 species) and *Rubrodorsalium* Stichel, 1944 (10 species). Six species remain *incertae sedis*. A review and an illustrated key to western Palaearctic *Eurydema* are provided by Derjanschi & Péricart (2006).

Eurydema eckerleini (Fig. 1), is distinguished by its larger dark spots on the apical parts of the corium than *E. spectabilis* Horváth, 1882 and the base of the scutellum is coarsely punctuated, with a large dark spot extended to the base of the corium and the clavus. But the distinguishing characteristic is the different shape of the paramera allowed into the genital capsula: the blade of the paramera is much thinner than that of *E. spectabilis*.

The body is oval, oblong and shiny, the dorsum is black with orange-red drawings and more densely rugulose and heavily dotted on the head, rather coarsely punctuated on the pronotum and more finely and densely on the hemielytra; the antennae, rostrum and legs are black, including the trochanteres and the coxae.

Head with juga strongly bisinuate. Eyes rounded and contiguous forward. Rostrum reaching the metacoxae. Pronotum with the forelimbs angles with a small tip. All widely partour orange-red as a large longitudinal median strip. The rest of it is occupied by two anterior and four posterior black spots, or by only two large black spots, each of them results from the merger, more or less complete, of the previous three. Disk of pronotum coarsely punctuated, with a fairly clear anterior bulge followed by a transverse furrow. Scutellum black, a little longer as wide, convex forward, with medio-apical red spot, arrow-shaped, with enlarged base in two arms and the triangular tip that corresponds to the whole apex of the scutellum. Hemielytra red with black-blue spots: clavus completely black, corium with a central black spot and, apically, a smaller one. Esocorium with a medial, sub-rectangular, black spot. Membrane black with bluish reflections.

Fig. 1 – *Eurydema eckerleini* (photo by P. Dioli).

Discussion

The general distribution of *E. eckerleini* is restricted to Crete, the Peloponnese (Derjanski & Péricart 2006) and Turkey (Rider 2006).

This taxon is very similar to *E. spectabilis*, a Ponto-East-Mediterranean species, as it was recorded in seacoasts of Albania, Greece, Crete, Bulgaria, Romania, Ukraine, the South European Territory of Russia, Georgia and the Asian part of Turkey (Rider 2006; Derjanschi & Péricart 2006; Kment & Jindra 2008). The records from Israel and Syria (Bodenheimer 1937) are doubtful.

Eurydema eckerleini, E. spectabilis and *E. ventralis* (Fig. 2) appear to coexist in Greece where they occupy three different ecological niches:
E. ventralis is the most common throughout the Palaearctic Region and lives in gardens and cultivated fields of *Brassicaceae* (Derjanski & Péricart 2006).

E. spectabilis was recorded behind the dunes on *Cakile maritima* Scop., *Crambe maritima* L. (syn.: *C. pontica* Rupr.) (Brassicaceae) and on *Salsola kali* L. (Amaranthaceae) (Josifov 1957; Derjanski & Péricart 2006). It was also recorded in Turkey (Dursun et al. 2008) on *Ornithogalum sigmoideum* Freyn and Sint. (Asparagaceae) and *Sinapis arvensis* L. (Brassicaceae).

Finally, *E. eckerleini* is monophagous on *Capparis spinosa* (Josifov, 1960).

The Cyclades islands comprise one of the thirteen distinct phytogeographical regions of Greece according to the Flora Hellenica Project (Strid & Tan 1997). The islands of Tinos and Syros belong to the specific biogeographical module of the Northern Cyclades (Kougioumoutzis et al. 2014). Thirtythree cruciferous plant species (Brassicaceae) have been recorded on the islands of Tinos and/or Syros and could potentially be hosts of *E. spectabillis* along the coasts of the Islands (Tan 2002b). In addition, *Salsola kali* L., a member of the subfamily Salsoloideae in Amaranthaceae (Bremer et al. 2009) has been recorded in Tinos and Syros Islands (Tan 1997), which is a known host plant of *E. spectabilis* (Josifov 1957).

Most of the Cyclades islands have hilly interiors, rocky valleys and precipitous coastlines, with few fertile plains. The general maximum altitude is between 600 and 700 m in most of the Cyclades. The climate is mild temper-

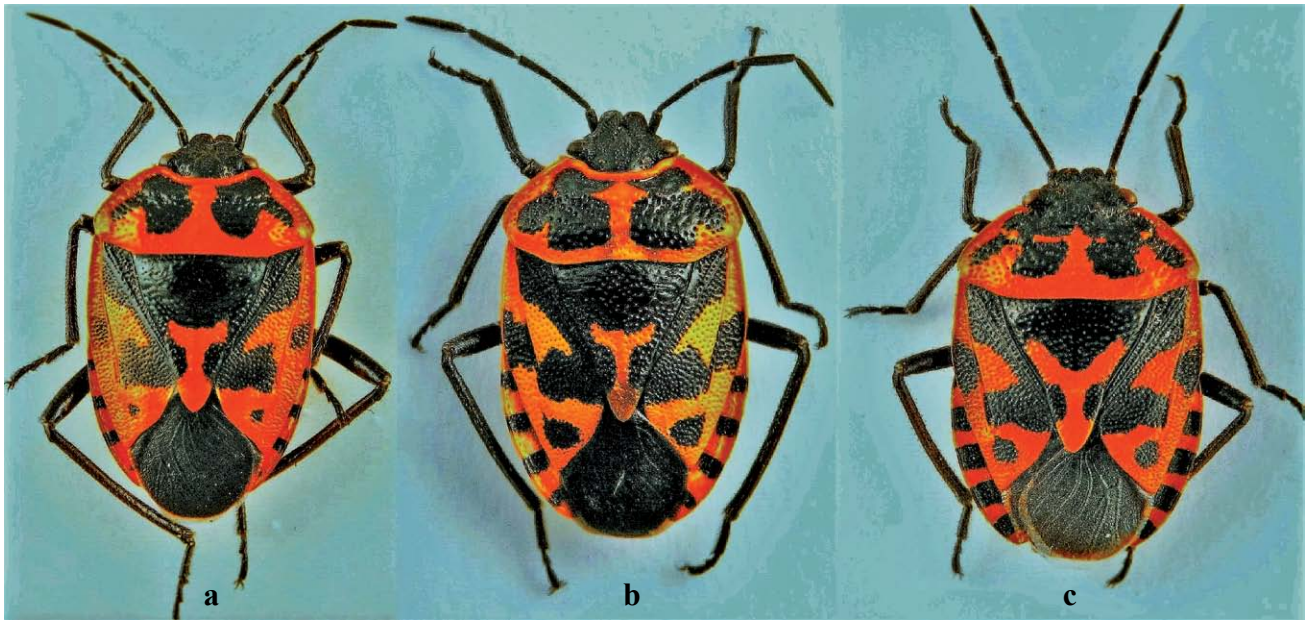

Fig. 2 – **a**, *Eurydema spectabilis*; **b**, *E. eckerleini*; **c**, *E. ventralis* (photos by P. Dioli).

ate Mediterranean and frosts are absent or rare (Polunin 1987; Gouvas & Sakellarios 2011). Winds blow predominantly from the north-west but in summer fierce north-east winds, the *etesians*, prevail (Tyrlis & Lelieveld 2013) with mean wind speeds between 10-14 kt (18-26 km/h) (HNMS 2015). The Mediterranean climate is distinguished by its hot and rainless summers, contrasting strongly with the rainy but mild winter months. The annual total rainfall may be below 400 mm in the Cyclades. Rain falls almost entirely during the winter months, from November to April (Polunin 1987; Gouvas & Sakellarios 2011) with a low overall rainfall erosivity factor (Panagos et al. 2016). This is followed by as much as 3-5 months of summer drought, with an average monthly rainfall below 25 mm (Polunin 1987; Ljubenkov 2013).

The periodicity of rainfall has an overriding effect on the vegetation of the Mediterranean Basin. In consequence of the long period of drought and often uncertain rainfall, plants have evolved protective adaptations against desiccation, such as the evergreen shrubs` sclerophyll feature,

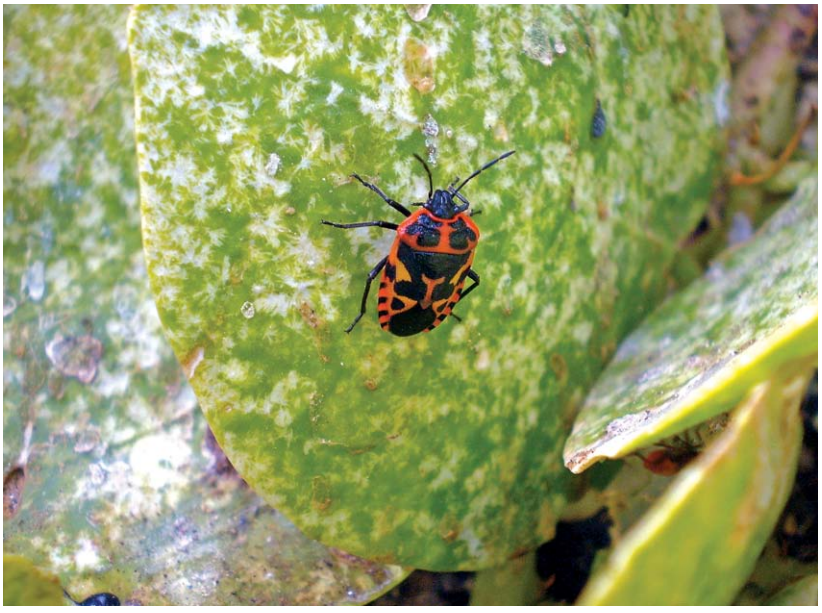

Fig. 3 – Infested caper plants in Tinos Island (photo by K.B. Simoglou).

leaf shedding of above-ground shoots, bulb and rhizome formation (Polunin 1987), or the formation of extended root systems, as in the case of caper (Rhizopoulou & Kapolas 2015).

Caper (*Capparis* L., Capparaceae) is found growing both in the wild and under cultivation and its flower buds are widely accepted for their pungent and strong aromatic properties. *Capparis spinosa* ssp. *rupestris* is found all over the Cyclades Islands, on coastal rocks and cliffs, mostly limestone, at altitudes between 0-500 m (Heywood et al. 1993; Tan 2002a; Fici 2014). It is a perennial deciduous plant that becomes woody at maturity. It has a very large root system which may account for 65% of the total biomass. The plant canopy is made up of 4-6 radial decumbent branches from which many secondary stems grow. Flowers are 5-7 cm across, axillary, solitary and have four imbricate, white petals. The flowering period is from May to July (-September). The fruit is ellipsoid, ovoid with a thin pericarp (Sozzi 2001).

Caper is one of the few perennial shrubs that grow and flower entirely during summer (Sozzi 2001). It possesses many adaptations that enable it to survive in arid environments such as that of the Cyclades. The caper bush can withstand temperatures above 40ºC in the summer (Sozzi 2001), as well as combat desertification (Sakcali et al. 2008; Suleiman et al. 2009). This is achieved by the extension of the root system downward to a depth of up to 20 m in order to reach subsoil water (Rhizopoulou & Kapolas 2015) and horizontally in order to maximize access to rainfall water (Sozzi 2001). This characteristic is supported by a high hydraulic conductivity achieved by highly specialized conducting tissue, both in roots and stems, along with the presence of thick, amphistomatous and highly photosynthetically efficient leaves (Rhizopoulou et al. 1997; Sozzi 2001; Rhizopoulou & Psaras, 2003; Sakcali et al. 2008; Gan et al. 2013).

Caper, as a member of Capparaceae (Brassicales), is closely related, on the basis of molecular and morphological analysis, to the members of the Brassicaceae (Sozzi 2001; Hall et al. 2002; Bremer et al. 2009; Iltis et al. 2011), to which the host plants of the other two *Eurydema* species (*E. ventralis*, *E. spectabilis*) belong. Bioactive secondary metabolites (glucosinolates) are abundant in crucifers as well as in caper species (Kiddle et al. 2001; Bor et al. 2009; Argentieri et al. 2012; Bianco et al. 2012; Lansky 2014). Volatile, glucosinolate hydrolysis products play an important role as plant defense chemicals against polyphagous insect-pests including aphids, grasshoppers and many non crucifer-feeding lepidopterans (Sadasivam & Thayumanavan 2003; Walters 2011).

On the contrary, glucosinolates are attractive to the major specialized crucifer herbivores, by possessing phagostimulatory effects and playing a key role on the oviposition behavior of crucifer-infesting insects [e.g. *Pieris brassicae* L. (Lepidoptera: Pieridae), *Plutella xylostella* L. (Lepidoptera: Plutellidae), *Brevicoryne brassicae* L. (Hemiptera: Aphididae), *Delia radicum* L. (Diptera: Anthomyiidae)] (Bernays & Chapman 1994; Price et al. 2011). Similarly, it has been assumed that secondary metabolites present in *Brassica oleracea* (L.) play an important role in selection of host plant by *Eurydema pulchrum* Westwood, an oligophagus, crucifer-infesting pest (Rather et al. 2010). We speculate here that, in the same way, *E. eckerleini* as a monophagous species is also attracted by similar volatile secondary metabolites of caper plants, during the host selection process, under hot and dry summer conditions, when probably the choice of available hosts is limited in the isolated Cyclades Islands. Nevertheless, more research is needed to confirm this.

In conclusion, this is the first record, to our knowledge, of the presence of *E. eckerleini* in the Cyclades Islands. Also, we report for the first time the detection of severe infestation (Fig. 3) on wild caper plants in the Cyclades, caused by *E. eckerleini*. More research is needed to guarantee possible environmentally friendly control methods in the case of infestation of cultivated caper plants.

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References

Argentieri M., Macchia F., Papadia P., Fanizzi F.P., Avato P. 2012. Bioactive compounds from *Capparis spinosa* subsp. *rupestris*. Industrial Crops and Products, 36: 65–69.

Bernays A.E., Chapman R.E. 1994. Host-plant selection by phytophagous insects. Chapman and Hall.

Bianco, G., F. Lelario, F.G. Battista, S.A. Bufo and T.R.I. Cataldi. 2012. Identification of glucosinolates in capers by LC-ESI-hybrid linear ion trap with Fourier transform ion cyclotron resonance mass spectrometry (LC-ESI-LTQ-FTICR MS) and infrared multiphoton dissociation. Journal of Mass Spectrometry, 47: 1160–1169.

Bodenheimer F.S. 1937. Prodromus Faunæ Palestinæ. Essai sur les éléments zoogéographiques et historiques du sud-ouest du sous-règne paléarctique. Mémoires Présentés à l'Institut d'Égypte et Publiés sous les Auspices de sa Majesté Farouk Ier, Roi d'Égypte, 32: 1–286.

Bohinc T., Trdan S. 2012. Trap crops for reducing damage caused by cabbage stink bugs (*Eurydema* spp.) and flea beetles (*Phyllotreta* spp.) on white cabbage: fact or fantasy? Journal of Food, Agriculture and Environment, 10(2): 1365–1370.

Bor M., Ozkur O., Ozdemir F., Turkan I. 2009. Identification and Characterization of the Glucosinolate–Myrosinase System in Caper (*Capparis ovata* Desf.). Plant Molecular Biology Repotrer, 27: 518–525.

Bremer B., Bremer K., Chase M.W., Fay M.F., Reveal J.L., Soltis D.E., Soltis P.S., Stevens P.F. 2009. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III. Botanical Journal of the Linnean Society, 161: 105–121. DOI:10.1111/j.1095-8339.2009.00996.x

Colazza S., Guarino S., Peri E. 2004. *Bagrada hilaris* (Burmeister) (Heteroptera: Pentatomidae) fitofago dannoso al cappero nell'isola di Pantelleria. Informatore Fitopatologico, 53 (12): 30–34.

Derjanschi V., Péricart J. 2006. Hémiptères Pentatomoidea Euro-Méditerranéens. Volume I. Faune de France. Vol. 90. Fédération Française des Sociétés de Sciences Naturelles, Paris, 494 pp. + 16 pls.

Dursun A., Kartal V. 2008. Orta Karadeniz Bölgesi Strachiini Mulsant and Rey, 1866, Pentatomini Leach, 1815 ve Piezodorini Atkinson, 1888 (Heteroptera: Pentatomidae: Pentatominae) türleri üzerine faunistik bir araştırma. Türkiye Entomoloji Dergisi, 32(3): 225–239.

Fici S. 2014. A taxonomic revision of the *Capparis spinosa* group (Capparaceae) from the Mediterranean to Central Asia. Phytotaxa, 174 (1): 001–024. DOI: http://dx.doi.org/10.11646/phytotaxa.174.1.1

Gan L., Zhang C., Yin Y., Lin Z., Huang Y., Xiang J., Fu C., Li M. 2013. Anatomical Adaptations of the Xerophilous Medicinal Plant, *Capparis spinosa*, to Drought Conditions. Horticulture Environment and Biotechnology, 54 (2): 156–161.

Gouvas M., Sakellariou N. 2011. Climate and forest vegetation of Greece. National Observatory of Athens, Institute of Environmental Research and Sustainable Development, Technical Library Report Nr: 01/2011 [in Greek]. https://www.researchgate.net/profile/Markos_Gouvas.

Hall C.H., Sytsma K.J., Iltis H.H. 2002. Phylogeny of Capparaceae and Brassicaceae based on chloroplast sequence data. American Journal of Botany, 89 (11): 1826–1842.

Heywood H.V., Higton R.N., Akeroyd J.R. 1993. *Capparis* L. *In*: Tutin G.T., Burges N.A., Chater A.O., Edmondson J.R., Heywood V.H., Moore D.M., Valentine D.H., Walters S.M., Webb D.A. (eds) 1993. Flora Europaea, v. 1. Cambridge University Press.

HNMS-Hellenic National Meteorological Service. Climatology data: Naxos Island (Cyclades). (http://www.hnms.gr/hnms/english/climatology/climatology_region_diagrams_html?dr_city=Naxos), accessed on 14-01-2016.

Horváth G. 1882. Hemiptera nova vel minus cognita. II. Természetrajzi Füzetek, 5: 217–225.

Huang I.T., Reed D.A., Palumbo J.C., Perring T.M. 2014. Feeding damage by *Bagrada hilaris* (Hemiptera: Pentatomidae) and impact on growth and chlorophyll content of Brassicaceous plant species. Arthropod-Plant Interactions, 8 (2): 89–100.

Iltis H.H., Hall J.C., Cochrane T.S., Sytsma K.J. 2011. Studies in the Cleomaceae I: On the separate recognition of Capparaceae, Cleomaceae, and Brassicaceae. Annals of the Missouri Botanical Garden, 98 (1): 28–36. DOI: 10.3417/2007017

Infantino A., Tomassoli L., Peri E., Colazza S. 2007. Viruses, Fungi and Insect Pests Affecting Caper. The European Journal of Plant Science and Biotechnology, 1 (2): 170–179.

Josifov M.V. 1957. Über *Eurydema spectabilis* Horv. (Heteroptera, Pentatomidae). Acta Entomologica Musei Nationalis Pragae, 31 (474): 103–108.

Josifov M.V. 1961. *Eurydema eckerleini* n. sp. - Eine neue Pentatomidenart von der Insel Kreta (Hemiptera,Heteroptera). Comptes Rendus de l'Académie Bulgare des Sciences, 14 (4): 397–400.

Josivov M.V., Simov N. 2006. Endemism among the Heteroptera on the Balkan Peninsula. Denisia, 19: 879–898.

Kiddle G., Bennett R.N., Botting N.P., Davidson N.E., Robertson A.A.B., Wallsgrove R.M. 2001. High-performance liquid chromatographic separation of natural and synthetic desulphoglucosinolates and their chemical validation by UV, NMR and Chemical Ionisation-MS Methods.

Kment P., Jindra Z. 2008. New records of *Eurydema fieberi* from the Czech Republic with corrections to some previously published records of Palaearctic *Eurydema* species (Hemiptera: Heteroptera: Pentatomidae). Acta Musei Moraviae, Scientiae biologicae, 93: 11–27.

Lansky P.E., Paavilainen H.M., Lansky S. 2014. Caper. The genus *Capparis*. CRC Press.

Ljubenkov I. 2013. Hydro climatic ranking of small Mediterranean islands. Journal of Environmental Science and Water Resources, 2 (4): 112–121.

Pagonis A.K., Nastos P.T. 2002. Number of rainy days over Greece. Proceedings of the 6th Pan-Hellenic Geographical Conference of the Hellenic Geographical Society, Thessaloniki, 3-6 October 2002. Volume I. Physical Geography, Human Geography, Geographical Education [In Greek]. http://geolib.geo.auth.gr/index.php/pgc/article/view/9187/8939.

Panagos P., Ballabio C., Borrelli P., Meusburger K. 2016. Spatio-temporal analysis of rainfall erosivity and erosivity density in Greece. CATENA, 137: 161–172.

Polunin O. 1987. Flowers of Greece and the Balkans. A field Guide. Oxford University Press.

Price W.P., Denno R.F., Eubanks M.D., Finke D.L., Kaplan I. 2011. Insect Ecology. Behavior, Populations and Communities. Cambridge University Press.

Rather H.A., Azim M.N., Maqsood S. 2010. Host plant selection in a pentatomid bug *Eurydema pulchrum* Westwood. Journal of Plant Protection Research, 50 (2): 229–232.

Rhizopoulou S., Kapolas G. 2015. *In situ* study of deep roots of *Capparis spinosa* L. during the dry season: Evidence from a natural "rhizotron" in the ancient catacombs of Milos Island (Greece). Journal of Arid Environments, 119: 27–30.

Rhizopoulou S., Psaras G.K. 2003. Development and Structure of Drought-tolerant Leaves of the Mediterranean Shrub *Capparis spinosa* L. Annals of Botany, 92: 377–383.

Rhizopoulou S., Heberlein K., Kassianou A. 1997. Field water relations in *Capparis spinosa* L. Journal of Arid Environments, 36: 237–248.

Rider D.A. 2006. Family Pentatomidae Leach, 1815. In: Aukema B., Rieger C. (eds): Catalogue of the Heteroptera of the Palaearctic Region. Volume 5. Pentatomomorpha II. The Netherlands Entomological Society, Amsterdam, xiii + 550 pp.

Sadasivam S., Thayumanavan B. 2003. Molecular host plant resistance to pests. Marcel Dekker.

Sakcali S.M., Bahadir H., Ozturk M. 2008. Eco-physiology of *Capparis spinosa* L.: A plant suitable for combating desertification. Pakistan Journal of Botany, 40 (4): 1481–1486.

Sozzi G.O. 2001. Caper bush: botany and horticulture. Horticultural Reviews, 27: 125–188.

Strid A., Tan K. (eds) 1997. Flora Hellenica, v. 1. Gantner Verlag.

Suleiman K.M., Bhat N.R., Abdal M.S., Jacob S., Thomas R.R., Al-Dossery S., D'Cruz G., Bellen R. 2009. Growth of *Capparis spinosa* var. *inermis* under different irrigation levels. Journal of Horticulture and Forestry, 1 (2): 017–021.

Tan K. 1997. Salsola L. *In*: Strid A., Tan K. (eds). Flora Hellenica, v. 1. Gantner Verlag.

Tan K. 2002a. Capparaceae. *In*: Strid A., Tan K. (eds). Flora Hellenica, v. 2. Gantner Verlag.

Tan K. 2002b. Cruciferae. *In*: Strid A., Tan K. (eds). Flora Hellenica, v. 2. Gantner Verlag.

Tyrlis E., Lelieveld J. 2013. Climatology and Dynamics of the Summer Etesian Winds over the Eastern Mediterranean. Journal of the Atmospheric Sciences, 70: 3374–3396.

Walters R.D. 2011. Plant Defense. Warding off attack by pathogens, herbivores and parasitic plants. Wiley-Blackwell.