

Linzer biol. Beitr.	42/2	1421-1435	19.12.2010
---------------------	------	-----------	------------

## **Sunn pest (*Eurygaster integriceps* PUTON, Hemiptera: Scutelleridae) and its scelionid (Hymenoptera: Scelionidae) and tachinid (Diptera: Tachinidae) parasitoids in Iran**

N. SAMIN, M. SHOJAI, S. ASGARI, H. GHAHARI & E. KOCAK

**A b s t r a c t :** Sunn pest, *Eurygaster integriceps* PUTON (Heteroptera: Scutelleridae) is the main pest in wheat fields of Iran. The list of Scelionidae (Hymenoptera) and Tachinidae (Diptera) as the parasitoids of sunn pest are summarized in this paper. Totally 19 scelionid and 7 tachinid species are listed as the parasitoids of sunn pest in Iran.

**Key words :** *Eurygaster integriceps*, Scutelleridae, Parasitoid, Scelionidae, Tachinidae, Iran.

### **Introduction**

The areas cultivated with wheat and barley in Iran are 6.5 million ha and 2.5 million ha, respectively. Production for irrigated wheat is around 2,900 kg per hectare, while rain-fed wheat production averages 800 kg per hectare. Irrigated and rain-fed barley yield approximately the same as irrigated and rain-fed wheat. The major hemipteran pests are *Eurygaster integriceps* PUTON, *Aelia furcula* FIEBER and *Dolycoris penicillatus* HORVATH. At present, *E. integriceps*, the most destructive species is found wherever wheat is grown. The main infestation areas are in the provinces of Tehran, Markazi, Isfahan, Fars, Chaharmahal & Bakhtiari, Kordestan, Lorestan, Zanjan, Ilam and Khorasan. Sunn pest is absent from narrow strips along the Oman Sea, the Arabian Gulf and the Caspian Sea. *E. integriceps* currently infests about 1 million ha of wheat and barley. The average yield losses are estimated at 20 to 30 percent if the insects are not controlled. There has been a nearly tenfold increase in the infested area over the last 20 years. The mentioned pests especially sunn pest contain some efficient parasitoids especially Scelionidae (Hymenoptera) and Tachinidae (Diptera) which have efficient powerful role in biological control (LODOS 1982; KARIMI 1992; RADJABI 2000).

The Scelionidae comprise a large family with about 3,000 described species (MASNER 1993) that primarily attack eggs of Heteroptera and Lepidoptera and less frequently are reported as egg parasitoids of Diptera, Orthoptera, Coleoptera, and Araneae (ARIAS-PENNA 2002; AUSTIN et al. 2005). Many of the characteristics considered most desirable in a natural enemy can be found within members of this family. Species have been studied which demonstrate high searching abilities and reproductive rates, lack of hyperpa-

parasitoids, have synchrony with host populations, have positive host-density responsiveness, have simple adult diets, and can be reared easily. The advancements made in rearing techniques for these natural enemies should prove valuable in the future both in classical biological control and in augmentative efforts.

Tachinidae are important natural enemies in most terrestrial ecological communities, particularly as natural enemies of larval Lepidoptera. The Tachinidae are one of the most speciose families of Diptera, with approximately 10,000 described species worldwide (IRWIN et al. 2003). One of the few traits that unites this diverse assemblage of flies is that all tachinids (with known life histories) are parasitoids of insects and other arthropods. In this respect, they are second only to the parasitic Hymenoptera (e.g., Ichneumonoidea, Chalcidoidea) in diversity and ecological importance as insect parasitoids. Because of their predominance as parasitoids of the larval stage of Lepidoptera and other major groups of insect herbivores (e.g., Heteroptera, Scarabaeidae, Symphyta, Chrysomelidae), tachinids often play significant roles in regulating herbivore populations and structuring ecological communities, both natural and managed. On the order of 100 species have been employed in biological control programs of crop and forest pests, and many of these programs have been met with partial or complete success (GREATHEAD 1986; GRENIER 1988; ENGLISH-LOEB et al. 1990).

Iranian Scelionidae and Tachinidae were poorly studied so far and therefore faunistic surveys on these taxa are necessary. On the other hand, sunn pest is a serious pest in almost regions of Iran and determining its natural enemies will be resulted to successful control. In this paper, list of scelionid and tachinid parasitoids of sunn pest in Iran is given. Almost the hosts and distributional data were adapted from different resources especially ASGARI (1995, 2002), IRANIPOUR (1996), MODARRES AWAL (1997), MEHRAVAR (2000) and SAMIN et al. (2010).

## Results

In a total of 19 scelionid and 7 tachinid species are listed in this paper as the parasitoids of sunn pest in Iran. The list of species is given below with their host record and distribution in Iran.

### Family S c e l i o n i d a e (HALIDAY 1840)

#### Subfamily S c e l i o n i n a e FOERSTER 1856

#### Genus *Gryon* HALIDAY 1833

##### *Gryon fasciatum* (PRIESNER 1951)

Host in Iran: *Eurygaster intergriceps*.

Distribution in Iran: Golestan.

##### *Gryon monspeliense* (PICARD 1924)

Host in Iran: *Eurygaster intergriceps*, *Dolycoris baccarum*.

Distribution in Iran: Hamadan, Markazi, Lorestan, Tehran.

***Gryon pedestre* (NEES 1834)**

Host in Iran: *Dolycoris penicillatus*, *Eurygaster intergriceps*.

Distribution in Iran: Tehran.

**Subfamily Telenominae THOMSON 1860**

**Genus *Telenomus* HALIDAY 1833**

***Telenomus chloropus* (THOMSON 1861)**

Host in Iran: *Eurygaster integriceps*, *Eurygaster testudinaria*, *Dolycoris baccarum*.

Distribution in Iran: Isfahan, Mazandaran, Tehran.

***Telenomus politus* (THOMSON 1861)**

Host in Iran: *Eurygaster intergriceps*.

Distribution in Iran: Tehran.

**Genus *Trissolcus* ASHMEAD 1893**

***Trissolcus basalis* (WOLLASTON 1858)**

Host in Iran: *Aelia acuminata*, *Apodiphus amygdali*, *Carpocoris fuscipinus*, *Dolycoris baccarum*, *Eurygaster intergriceps*, *E. maura*, *Nezara viridula*.

Distribution in Iran: Hamadan, Isfahan, Lorestan, Markazi, Tehran, Zandjan.

***Trissolcus delucchii* KOZLOV 1968**

Host in Iran: *Eurygaster integriceps*, *E. maura*.

Distribution in Iran: Tehran, Khuzestan.

***Trissolcus djadetshko* (RJACHOVSKY 1959)**

Host in Iran: *Eurydema ornatum*.

Distribution in Iran: Mazandaran.

***Trissolcus esmailii* RADJABI 2001**

Host in Iran: *Eurygaster integriceps*, *Dolycoris baccarum*.

Distribution in Iran: Fars.

***Trissolcus festivaе* (VIKTOROV 1964)**

Host in Iran: *Eurydema ornatum*, *Eurygaster intergriceps*.

Distribution in Iran: Ghazvin, Markazi, Tehran, Zandjan.

***Trissolcus grandis* (THOMSON 1861)**

Host in Iran: *Aelia acuminata*, *Apodiphus amygdali*, *Carpocoris fuscipinus*, *Dolycoris baccarum*, *Eurygaster intergriceps*, *Graphosoma lineatum*, *Eurygaster maura*, *Podisus maculiventris*.

Distribution in Iran: Generally distributed.

***Trissolcus manteroi* (KIEFFER 1909)**

Host in Iran: *Carpocoris coreanus iranus*, *Dolycoris penicillatus*, *Eurygaster* sp.

Distribution in Iran: Mazandaran.

***Trissolcus mentha* KOZLOV & LE 1977**

Host in Iran: *Eurygaster intergriceps*.

Distribution in Iran: Tehran.

***Trissolcus pseudoturesis* (RJACHOVSKY 1959)**

Host in Iran: *Eurygaster integriceps*, *Eurygaster testudinaria*.

Distribution in Iran: Mazandaran.

***Trissolcus rufiventris* (MAYR 1908)**

Host in Iran: *Aelia furcula*, *Dolycoris penicillatus*, *Eurygaster intergriceps*.

Distribution in Iran: Hamadan, Isfahan, Lorestan, Markazi, Mazandaran, Tehran.

***Trissolcus semistriatus* (NEES 1834)**

Host in Iran: *Aelia acuminata*, *Apodiphus amygdali*, *Carpocoris fuscipinus*, *Dolycoris baccarum*, *Eurygaster intergriceps*, *E. maura*, *Graphosoma lineatum*, *Carpocoris pudicus*, *Holcostethus sphacelatus*.

Distribution in Iran: Ardabil, Chaharmahal & Bakhtiari, Fars, Hamadan, Isfahan, Khorasan, Lorestan, Markazi, Mazandaran, Tehran, Zandjan.

***Trissolcus simoni* (MAYR 1879)**

Host in Iran: *Aelia acuminata*, *Apodiphus amygdali*, *Carpocoris fuscipinus*, *Dolycoris baccarum*, *Eurydema ornatum*, *Eurygaster intergriceps*, *Aelia melanota*.

Distribution in Iran: Isfahan, Mazandaran, Tehran.

***Trissolcus tumidus* (MAYR 1879)**

Host in Iran: *Aelia acuminata*, *Apodiphus amygdali*, *Carpocoris fuscipinus*, *Dolycoris baccarum*, *Eurygaster intergriceps*.

Distribution in Iran: Fars, Isfahan, Tehran, Zanjan.

***Trissolcus vassilievi* (MAYR 1903)**

Host in Iran: *Aelia acuminata*, *Apodiphus amygdali*, *Carpocoris fuscipinus*, *Carpocoris mediterraneus*, *Dolycoris baccarum*, *Eurygaster integriceps*, *E. maura*, *Graphosoma lineatum*, *Graphosoma semipunctatum*.

Distribution in Iran: Chaharmahal & Bakhtiari, Fars, Hamadan, Isfahan, Kerman, Kermanshah, Kordestan, Lorestan, Markazi, Mazandaran, Qazvin, Tehran, Zandjan.

**Family T a c h i n i d a e ROBINEAU-DESVOIDY 1830**

***Cistogaster globosa* (FABRICIUS 1775)**

Host in Iran: *Eurygaster integriceps*, *E. maura*.

Distribution in Iran: East Azarbayjan, West Azarbayjan.

***Ectophasia crassipennis* (FABRICIUS 1794)**

Host in Iran: *Eurygaster integriceps*.

Distribution in Iran: Chaharmahal & Bakhtiari, Isfahan, Tehran, Khorasan.

***Ectophasia oblonga* (ROBINEAU-DESVOIDY 1830)**

Host in Iran: *Dolycoris baccarum*, *Eurygaster integriceps*, *E. maura*, *Eurydema ornatum*.

Distribution in Iran: Tehran.

***Eliazeta helluo* (FABRICIUS 1805)**

Host in Iran: *Eurygaster integriceps*.

Distribution in Iran: Hamadan, Kermanshah.

***Elomya lateralis* (MEIGEN 1824)**

Host in Iran: *Aelia rostrata*, *Dolycoris baccarum*, *Eurydema ornatum*, *Eurygaster integriceps*.

Distribution in Iran: Ardabil, East Azarbayjan, West Azarbayjan.

***Gymnosoma desertorum* (ROHDENDORF 1947)**

Host in Iran: *Dolycoris baccarum*, *Eurygaster integriceps*.

Distribution in Iran: Khorasan, Tehran.

***Phasia subcoleoprata* (LINNAEUS 1767)**

Host in Iran: *Eurygaster integriceps*, *E. maura*.

Distribution in Iran: Tehran.

## Discussion

The result of this paper indicates that there is diverse and powerful fauna of scelionid and tachinid parasitoids for sunn pest in Iran. Although conservation of these parasitoids will be resulted to increasing of percent parasitism but applications of wide spectrum insecticides is the main destructive factor for natural enemies. The basic cause of the expansion of sunn pest-infested areas over the last two decades may be the degradation of rangelands throughout Iran. Deterioration has resulted from the imposition of wheat cultivation on rangelands that are unsuitable for cultivation and from excessive grazing. The rate of degradation will ultimately prove catastrophic. Some 30 species, subspecies and varieties of wild plants belonging to the families Gramineae, Compositae, Caryophyllaceae and Papaveraceae have been found as sunn pest hosts and as hibernation refuges at higher altitudes. Parasitized eggs of sunn pest have also been found at higher altitudes. They are frequently found in mountainous areas where vegetation is abundant.

Food quality affects the ability of the sunn pest to migrate to mountain hibernation sites and to survive the winter. Cyclic, six- to eight-year population explosions of sunn pest in permanently infested areas of Isfahan prior to the use of chemical insecticides, probably resulted from changes in food supply and quality. These observations led to giving serious consideration to early and rapid harvesting which might deprive the sunn pest of accumulated food reserves. Disruption of body fat accumulation might reduce the immediate sunn pest population as well as having a negative impact on future generations. Females from subsequent generations possessing fewer food reserves would in turn be more vulnerable to early and rapid harvesting. *E. maura* L. is distributed mainly in the Caspian Sea region and around Marand and Maku. *E. testudinaria* is a recently identified species from Mazandaran. *Aelia furcula* is found in the western, central and northeastern parts of the country. *A. melanota* is found in some central, western and southern areas of Iran, as is *A. virgata*. *A. rostrata* is found at low densities in some parts of the country. *Dolycoris pennicillatus* is distributed mainly in eastern, northeastern, central and southwestern Iran, while *Carpocoris fuscispinus* is found at low densities almost everywhere.

The only chemical compound now used to control sunn pest is fenitrothion 50 % applied as an emulsifiable concentrate at a rate of 1.2 litres per hectare. At present there are no biological control efforts against sunn pest in Iran. Research is currently being conducted on cultural control methods such as the use of resistant varieties, the practice of double-harvesting and the value of varying sowing dates. Of particular interest are double-harvesting and the effectiveness of early and rapid harvesting. In conjunction with these techniques, attempts are being made to convince farmers of their advantages. In areas with pest populations above the economic level, fenitrothion is used exclusively as a sunn pest spray. A network of forecasting stations estimates the specific areas to be sprayed. Forecasting is based on regular sampling in aestivation and hibernation sites as well as in cereal fields in early spring.

Parasitoids are organisms whose larvae develop to the detriment of a single host (GODFRAY 1994). Their mode of development lies between that of predators and true parasites since the host is generally killed and there is a tight physiological interaction between the two partners. The adult parasitoids are free-living. According to recent estimates, parasitoids represent between 8 % and 20 % of all insect species. Most parasitoids

are Hymenoptera (around 50,000 described species) or Diptera (around 16,000 species). Some species can also be found within Coleoptera, Lepidoptera, Trichoptera, and Strepsiptera (MACKAUER et al. 1990; QUICKE 1997). From an evolutionary point of view, 'parasitoidism' appears in a different way within the two main orders. More accurately, it seems that all hymenopterian parasitoids probably originated from a single mycophagous ancestor inhabiting dead wood. In the Diptera, however, parasitoids appear to have arisen independently numerous times from different saprophagous or predatory ancestors. These different evolutionary origins may explain the important interspecific variations, but other factors (including ecological ones) must be taken into account to understand the processes of speciation and diversification (BEGON & MORTIMER 1986; WAJNBERG & HASSAN 1994; PENNACCHIO & STRAND 2006).

Most parasitoids attack other insects, but some species attack other arthropod hosts or even hosts from other phyla (molluscs or even some chordates). Sometimes, the host is itself a parasitoid species leading to a tritrophic interaction between a host, a parasitoid, and a so-called hyperparasitoid. The parasitized host stage greatly varies according to the parasitoid biology but we can distinguish parasitoids of eggs, larvae, nymphs, or even adults. In some cases, oviposition (i.e. the deposition of an egg in (or on) the host) occurs at an early host stage (for instance the egg) but the development occurs in later stages (larvae or nymphs). Some parasitoid species are also able to infest more than one host stage. The host range greatly varies between species. For example, some tachinids are highly generalist, being able to develop successfully within several dozen species belonging to different families (VAN LENTEREN 2003; STIREMAN et al. 2006) whereas numerous species are specialized and restricted to a limited number of host species.

There are numerous reasons for the particular host range (GODFRAY 1994; STIREMAN et al. 2006). For instance, dipteran parasitoids are generally more generalist than hymenopterian species, suggesting that some physiological constraints or pre-adaptation may favour or restrict the host range. The taxonomy of the potential hosts may also influence evolution of the host range since a parasitoid species can probably adapt more easily to new species that share similar physiological features and defence mechanisms with its original host. Similarly, parasitoids are more likely to infest hosts facing similar ecological constraints. However, the host range may evolve through time and space but, contrary to other organisms with a parasitic lifestyle, only a few data are currently available on intraspecific variability in the number of potential hosts that can be attacked or, more generally, on ecological specialization phenomena (WILLIAMSON 1998; SHAW 2006; WAJNBERG et al. 2001, 2008).

Scelionids females (especially *Trissolcus*) seem to adopt a random search for locating host eggs as a consequence of an arrestment response induced by chemical residues left by adults of Pentatomidae. In this way, once on infested plants, the possibility of finding host eggs are improved as a consequence of lowered flight propensity, prolonged stay on the plant, reduced movement, and increased klinokinesis (COLAZZA et al. 1999). However, the decision of *Trissolcus* females to remain in the plant canopy to search for hosts could be influenced by the reproductive success accumulated while foraging on plant surfaces contaminated by host residues. Foraging insect parasitoids are known to learn which environmental stimuli are associated with rewarding or aversive outcomes to improve their chance of future host location and hence their reproductive success (LEWIS & TURLINSON 1988; LEWIS & MARTIN 1990; VET and GROENEWOLD 1990; PETITT et al. 1992; TURLINGS et al. 1993; DUTTON et al. 2000). *Trissolcus* females have an innate

response to host chemical residues, with a strong preference for female residues. Oviposition experience enhanced the arrestment responses of the wasps when they were associated with host female residues, and this appears to be congruent with the form of experience defined as 'α-conditioning' (sensu VINSON 1998) where host or host's products can provide a reward to foraging that increases the innate response to a stimulus. The magnitude of variability observed for *Trissolcus* females responding to host female chemical residues as a consequence of oviposition experience seems fairly constant and predictable in accordance with the 'variable response model' developed by VET et al. (1995). Females that were not rewarded by successful oviposition within a certain amount of time gradually lost their arrestment response and progressively moved back to a more general host search behavior. The adaptive meaning of these results may be that chemical residues of female pentatomids cannot guarantee the presence of host eggs or provide directional information. Hence, even when searching in areas contaminated by 'promising host cues', it could be adaptive for females to give up and leave the area if host eggs are not found after a certain amount of time. Generally, experience effects on 'α-conditioned' wasps are not permanent (MCAUSLANE et al. 1991). The arrestment response of *Trissolcus basalis* females was influenced by the time elapsed between two successive unrewarding encounters, leading to the conclusion that about 72-h is the time needed by wasps to 'forget' negative experiences (PERI et al. 2006). *Trissolcus* females also respond to residues left by males and nymphs of *N. viridula* (COLAZZA et al. 1999). Moreover, we found that the innate wasp response to host male residues was not modified by experience gained during the wasp's foraging activity.

The innate wasp response to host male residues was not modified by experience gained during the wasp's foraging activity. Host residues might convey to foraging wasp females not only indirect information about host egg presence, but also direct information on the presence of their host species. The actual role of host residues on host specificity of *T. basalis* was recently addressed by Salerno et al. (SALERNO et al. 2006), who demonstrated that *T. basalis* females were able to discriminate between coevolved and non-coevolved host species which may be present on the same infested plants. An analogous situation could be predicted for another egg parasitoid, *T. brochymenae*, the females of which showed arrestment responses to residues of third and fifth instars, and adults of *M. histrionica* (CONTI et al. 2003).

Parasitoids are known for using semiochemicals as medium and long-range cues when searching for hosts (VINSON 1985, 1998; VET & DICKE 1992; Steidle and van Loon 2002; Fatouros et al. 2008). Semiochemicals that originate from the host habitat, the hosts themselves, or indirectly from stages associated to the host can be used by parasitoids during a hierarchical sequence of steps for host location and selection (VINSON 1985). Egg parasitoids face the challenge of finding hosts that are not, or are barely apparent (eggs). Therefore, they must rely on semiochemical cues that are more detectable than those from the eggs, such as those from stages of the host that are not suitable for parasitism (adults or immature stages) or from host plants (VET et al. 1991, 1995; VET & DICKE 1992; VINSON 1998; FATOUROS et al. 2008).

The use of semiochemicals for behavioral manipulation of parasitoids has been proposed and discussed extensively. In recent years, semiochemicals have also been discussed as a tool to improve biological control (VET & DICKE 1992; LEWIS & MARTIN 2000; POWELL & PICKETT 2003). Specific knowledge about host-parasitoid relationships mediated by semiochemicals is important for improving the effectiveness of applications of semiochemicals in integrated pest control.

Scelionid parasitoids show clear host preferences (SUJII et al. 2002) for stink bug eggs that maximize their biological performance (PACHECO & CORRÊA-FERREIRA 1998; KIVAN & KILIC 2002, 2004; LAUMANN et al. 2008). Egg parasitoids that search for nonapparent hosts may rely especially on easily detectable cues such as host pheromones or host allomones (VET & DICKE 1992). ALDRICH (1995) postulated that the differential use of adult stink bug host allomones by egg parasitoids should reflect the host preference observed in different species of Scelionidae.

Scelionidae that parasitize eggs from stink bugs can use several types of semiochemicals for long-range localization of habitat, microhabitat, and hosts: volatiles from plants damaged by stink bug oviposition or feeding (COLAZZA et al. 2004; MORAES et al. 2005a, 2008); sex pheromones (ALDRICH 1985, 1995; BORGES et al. 1998, 2003; BRUNI et al. 2000; SILVA et al. 2006); volatile defensive secretions from the metathoracic (adults), or dorsal abdominal (nymphs) glands of stink bugs (ALDRICH 1985, 1995; MATTIACI et al. 1993; BORGES & ALDRICH 1994); or crude whole body extracts of stink bugs (COLAZZA et al. 1999; SALERNO et al. 2006). Volatiles from nonhost stages of stink bugs, such as pheromones or defensive compounds, as well as contact chemicals (traces left by walking insects) also can be used for host location, recognition, and acceptance, thus leading to successful oviposition (BIN et al. 1993; BORGES et al. 1999, 2003; COLAZZA et al. 1999; CONTI et al. 2003). Physical stimuli such as visual and resonance cues also may be involved in successful host search (BORGES et al. 1999). LAUMANN et al. (2007) demonstrated that foraging *Telenomus podisi* ASHMEAD 1881 can orientate toward hosts by using substrate-borne vibratory signals produced during sexual communication of host stink bugs.

The most commonly used hosts by tachinid flies are phytophagous insects, primarily Lepidoptera, Coleoptera (Scarabaeidae and Chrysomelidae), Hymenoptera (Symphyta), Heteroptera, and Orthoptera. However, hosts in at least six additional insect orders, including Blattodea, Dermaptera, Diptera, Embioptera, Mantodea, and Phasmida, are attacked. The Phasiinae comprise a morphologically diverse assemblage of species that was historically united chiefly because of their parasitism of Heteroptera (CROSSKEY 1973). However, more recently the monophyly of the Phasiinae has been based primarily on a feature of the male genitalia (RICHTER 1992; TSCHORSNIG 1985). There has been a long and valuable history of applied and basic research on tachinid-host associations since the early 1900s, but only recently has ecological research on tachinids been widely integrated into modern ecological and evolutionary theory (BELSHAW 1993; HAWKINS 1994; STIREMAN et al. 2006). The apparent lability of host use among most Tachinidae may be due to a general lack of host-specific adaptations relating to host physiological defenses. Larval tachinids are well known for their formation of respiratory funnels derived from host defensive cells. Rather than evading or destroying host hemocytes as do many hymenopteran parasitoids (STRAND & PECH 1995), tachinids often coopt them to form "breathing tubes". These structures allow many tachinids to maintain direct contact with atmospheric air via their posterior spiracles through either the host's external integument or major tracheal branches (CLAUSEN 1940). The ability to capitalize on the immune response by forming respiratory funnels may allow tachinids flexibility to ecologically "explore" new hosts more easily, resulting in dynamic evolution and diversification of host associations. This hypothesis is supported by the observation that tachinids that remain free in the hemocoel without forming a respiratory funnel exhibit signifi-

cantly narrower host ranges than average for the family (BELSHAW 1994). In addition, tachinids may be relatively tolerant of toxins actively or inadvertently ingested by their hosts (GAULD et al. 1992; MALLAMPALLI et al. 1996), allowing greater evolutionary plasticity in host range. This tolerance may be due to preadaptations associated with the ancestral saprophagous habits of the Oestroidea (EGGLETON & GASTON 1992), in which larvae faced with highly toxic environments produced by bacteria and fungi accumulated adaptations to tolerate these toxins. The apparent tolerance of tachinids to host physiological defenses may be related also to the position of young larvae within the host. Many early larval stages of tachinids embed themselves in specific tissues rather than float free in the hemocoel (BELSHAW 1994), and at least one highly polyphagous species, *Compsilura concinnata*, undergoes most of its larval development in the gut (i.e., between the peritrophic membrane and gut wall) (ICHIKI & SHIMA 2003; STIREMAN et al. 2006).

Some tachinids, such as *Trichopoda pennipes*, utilize the volatile sexual pheromones of their heteropteran hosts for host location via chemotaxis (HARRIS & TODD 1980). In at least one case, *Euclytia flava*, the tachinid species appears to consist of cryptic "pheromone races" that are differentially sensitive to particular pheromone components associated with different host species (even more sensitive than the hosts themselves) (ALDRICH & ZHANG 2002). As in the hosts of Ormiini, conflicting selection pressures associated with mate and parasitoid attraction may lead to coevolutionary "arms races" in which hosts are constantly selected to produce sexual signals unattractive to tachinids but attractive to mates ("new codes") and tachinids are constantly selected for greater sensitivity to these signals ("code-breakers"). Repeated cycles of these dynamics may facilitate speciation and evolutionary diversification of both players. Dependence on host pheromones in host location is probably widespread in the Phasiinae and may have been pivotal in their evolutionary radiation on heteropteran hosts (STIREMAN et al. 2006).

### Acknowledgments

The authors are indebted to Gh. R. Radjabi (Plant Protection Institute, Tehran), P.N. Buhl (Plantvägen 1, SE-260 51 Ekeby, Sweden), N.F. Johnson (Ohio State University, USA), J.E. O'Hara and L. Masner (Agriculture and Agri-Food Canada) and B. Daniela (University of Pitești, Romania) for sending the necessary resources and valuable helps in progress of the project. The research was supported by Tehran Science & Research Branch (Islamic Azad University) and Turkish Ministry of Agriculture (Central Plant Protection Research Institute).

### Zusammenfassung

Die phytopathogene Wanzenart *Eurygaster integriceps* PUTON (Heteroptera: Scutelleridae) ist eine der größten Schädlinge auf den Weizenfeldern des Irans. Vorliegende Arbeit behandelt die parasitoiden Gegenspieler aus den Familien Scelionidae (Hymenoptera) (19 Arten) und Tachinidae (Diptera) (7 Arten).

## References

- ALDRICH J.R. (1985): Pheromone of a true bug (Hemiptera: Heteroptera): attractant for the predator, *Podisus maculiventris* and kairomonal effects, pp. 95-119. — In: ACREE T.E. & M.D. SODERLUND (eds), *Semiochemistry: Flavors and Pheromones*. Proceedings of the American Chemical Society Symposium, Washington, D.C., August 1983. W. de Gruyter, New York.
- ALDRICH J.R. (1995): Chemical communication in the true bugs and parasitoid exploitation, pp. 318-363. — In: CARDÉ R.T. & W.J. BELL (eds), *Chemical Ecology of Insects II*. Chapman and Hall, New York.
- ALDRICH J.R. & A. ZHANG (2002): Kairomone strains of *Euclytia flava* (TOWNSEND), a parasitoid of stink bugs. — *J. Chem. Ecol.* **28**: 1565-1582.
- ARIAS-PENNA T.M. (2002): Lista de los géneros y especies de la superfamilia Platygastroidea (Hymenoptera) de la Región Neotropical. — *Biota Colombiana* **3**: 215-233.
- ASGARI Sh. (1995): A study on possibility of mass rearing of sunn bug egg parasitoids on its alternative host, *Graphosoma lineatum* L. (Heteroptera: Pentatomidae). — M. Sc thesis of Entomology, College of Agriculture, Tehran University 220 pp.
- ASGARI Sh. (2002): Comparative fitness of eggs of *Graphosoma lineatum* (L.) (Pentatomidae) and *Eurygaster integriceps* Put. (Scutelleridae) to the egg parasitoid, *Trissolcus semistriatus* Nees (Scelionidae). — Ph. D thesis of Entomology, Department of Entomology, Tarbiat Modarres University 142 pp.
- AUSTIN A.D., JOHNSON N.F. & M. DOWTON (2005): Systematic, evolution and biology of scelionid and platygastriid wasps. — *Annu. Rev. Entomol.* **50**: 553-582.
- BEGON M. & M. MORTIMER (1986): *Population ecology: a unified study of animals and plants*, 2nd edition. — Blackwell Scientific Publications, Oxford.
- BELSHAW R. (1993): Tachinid flies. Diptera: Tachinidae. Handbooks for the identification of British Insects. — London: R. Entomol. Soc. London 10, Part 4a(i). 170 pp.
- BELSHAW R. (1994): Life history characteristics of Tachinidae (Diptera) and their effect on polyphagy, pp. 145-62. — In: HAWKINS B.A. & W. SHEEHAN (eds), *Parasitoid community ecology*. New York: Oxford Univ. Press. 519 pp.
- BIN F., VINSON S.B., STARND M.R., COLAZZA S. & W.A. Jr. JONES (1993): Source of an egg kairomone for *Trissolcus basalidis*, a parasitoid of *Nezara viridula*. — *Physiol. Entomol.* **18**: 7-15.
- BORGES M. & J.R. ALDRICH (1994): Estudos de semioquímicos para o manejo de Telenominae, insetos benéficos. — *Ann. Soc. Entomol. Brazil* **23**: 575-577.
- BORGES M., MEDEIROS M.A., MORI K., ZARBIN P.H.G. & J.T.B. FERIERA (1998): Field responses of stink bugs to the natural and synthetic pheromone of the Neotropical Brown Stink Bug, *Euschistus heros* (Heteroptera: Pentatomidae). — *Physiol. Entomol.* **23**: 202-207.
- BORGES M., COSTA M.L.M., SUJII E.R., CAVALCANTI M., DAS G., REDIGOLO G.F., RESCK I.S. & E.F. VILELA (1999): Semiochemical and physical stimuli involved in host recognition by *Telenomus podisi* (Hymenoptera: Scelionidae) toward *Euschistus heros* (Heteroptera: Pentatomidae). — *Physiol. Entomol.* **24**: 227-233.
- BORGES M., COLAZZA S., RAMIREZ-LUCAS P., CHAUHAN K.R., MORAES M.C.B. & J.R. ALDRICH (2003): Kairomonal effect of walking traces from *Euschistus heros* (Heteroptera: Pentatomidae) on two strains of *Telenomus podisi* (Hymenoptera: Scelionidae). — *Physiol. Entomol.* **28**: 349-355.
- CLAUSEN C.P. (1940): *Entomophagous insects*. — New York: Hafner.
- COLAZZA S., SALERNO G. & E. WAJNBERG (1999): Volatile and contact chemicals released by *Nezara viridula* (Heteroptera: Pentatomidae) have a kairomonal effect on the egg parasitoid *Trissolcus basalidis* (Hymenoptera: Scelionidae). — *Biol. Control* **16**: 310-317.

- COLAZZA S., FUCARINO A., PERI E., SALERNO G., CONTI E. & F. BIN (2004): Insect oviposition induces volatile emission in herbaceous plants that attracts egg parasitoids. — J. Exp. Biol. **207**: 47-53.
- CONTI E., SALERNO G., BIN F., WILLIAMS H.J. & S.B. VINSON (2003): Chemical cues from *Murgantva histrionica* eliciting host location and recognition in the egg parasitoid *Trissolcus brochymenae*. — J. Chem Ecol. **29**: 115-130.
- CROSSKEY R.W. (1973): A conspectus of the Tachinidae (Diptera) of Australia, including keys to the supraspecific taxa and taxonomic and host catalogues. — Bull. Br. Mus. Natl. Hist. Entomol. Suppl. **21**, 221 pp.
- DUTTON A., MATTIACCI L. & S. DORN (2000): Learning used as a strategy for host stage location in an endophytic host-parasitoid system. — Entomol. Exp. Appl. **94**: 123-132.
- EGGLETON P. & K.J. GASTON (1992): Tachinid host ranges: a reappraisal (Diptera: Tachinidae). — Entomol. Gaz. **43**: 139-43.
- ENGLISH-LOEB G.M., KARBAN R. & A.K. BRODY (1990): Arctiid larvae survive attack by a tachinid parasitoid and produce viable offspring. — Ecol. Entomol. **15**: 361-62.
- FATOUROS N.E., DICKE M., MUMM R., MEINERS T. & M. HILKER (2008): Foraging behavior of egg parasitoids exploiting chemical information. — Behav. Ecol. **19**: 677-689.
- GAULD I.D., GASTON K.J. & D.H. JANZEN (1992): Plant allelochemicals, tritrophic interactions and the anomalous diversity of tropical parasitoids: the 'nasty' host hypothesis. — Oikos **65**: 353-57.
- GODFRAY H.C.J. (1994): Parasitoids, behavioral and evolutionary ecology. Princeton University Press, 473 pp.
- GREATHEAD D. (1986): Parasitoids in classical biological control, pp. 289-318. — In: WAAGE J.K. & D. GREATHEAD (eds), Insect parasitoids. Proceedings of 13th Symposium of the Royal Entomological Society of London. London: Academic.
- GRENIER S. (1988): Applied biological control with tachinid flies (Diptera, Tachinidae): A review. — Anz. Schädling. Pfl. Umw. **51**: 49-56.
- HARRIS V.E. & J.W. TODD (1980): Malemediated aggregation of male, female, and 5<sup>th</sup> instar southern green stink bugs and concomittant attraction of a tachinid parasite, *Trichopoda pennipes*. — Entomol. Exp. Appl. **27**: 117-26.
- HAWKINS B.A. (1994): Pattern and Process in Host-Parasitoid Interactions. — Cambridge, UK: Cambridge University Press. 190 pp.
- ICHIKI R. & H. SHIMA (2003): Immature life of *Compsilura concinnata* (MEIGEN) (Diptera: Tachinidae). — Ann. Entomol. Soc. Am. **96**: 161-67.
- IRANIPOUR Sh. (1996): A study on population fluctuation of the egg parasitoids of *Eurygaster integriceps* PUT. (Heteroptera: Scutelleridae) in Karadj, Kamalabad and Fashand. — M. Sc thesis of Entomology, Tehran University, 187 pp.
- IRWIN M.E., SCHLINGER E.I. & F.C. THOMPSON (2003): Diptera, true flies, pp. 692-702. — In: GOODMAN S.M. & J.P. BENSTEAD (ed.), The Natural History of Madagascar. Chicago/London: University Chicago Press. 1728 pp.
- KARIMI H. (1992): Wheat. — Iran University Press. 599 pp. (In Persian).
- KIVAN M. & N. KILIC (2002): Host preference: parasitism, emergence and development of *Trissolcus semistriatus* (Hym., Scelionidae) in various host eggs. — J. Appl. Entomol. **126**: 395-399.
- KIVAN M. & N. KILIC (2004): Parasitism and development of *Trissolcus simoni* in eggs of different host species. — Phytoparasitica **32**: 57-60.
- LAUMANN R.A., MORAES M.C.B., COKL A. & M. BORGES (2007): Eavesdropping on the sexual vibratory communication of stink bugs (Hemiptera: Pentatomidae) by the egg parasitoid *Telenomus podisi*. — Anim. Behav. **73**: 637-649.

- LAUMANN R.A., MORAES M.C.B., PAREJA M., ALARCAO G.C., BOTELHO A.C., MAIA A.N.H., LEONARDECZ NETO E. & M. BORGES (2008): Comparative biology and functional response of *Trissolcus* spp. (Hymenoptera: Scelionidae) and implications for stink-bugs (Hemiptera: Pentatomidae) biological control. — *Biol. Control* **44**: 32-41.
- LEWIS W.J. & J. MARTIN (1990): Semiochemicals for use with parasitoids: status and future. — *J. Chem. Ecol.* **16**: 3067-3089.
- LEWIS W.J. & J.H. TUMLINSON (1988): Host detection by chemically mediated associative learning in a parasitic wasp. — *Nature* **331**: 257-259.
- LEWIS W.J. & W.R. MARTIN (2000): Semiochemicals for use with parasitoids: status and future. — *J. Chem. Ecol.* **16**: 306-309.
- LODOS N. (1982): Turkish Entomology Volume II (Genel, Uygulamalı ve Faunistik). — Ege University. Ziraat Fakültesi Yayınları, No: 429, İzmir. 580 pp. (In Turkish).
- MACKAUER M., EHLE L.E. & J. ROLAND (1990): Critical issues in biological control. — Intercept Ltd, Andover.
- MALLAMPALLI N., BARBOSA P. & K. WEINGES (1996): Effects of condensed tannins and catalpol on growth and development of *Compsilura concinnata* (Diptera: Tachinidae) reared in gypsy moth (Lepidoptera: Lymantriidae). — *J. Entomol. Science* **31**: 289-300.
- MASNER L. (1993): Superfamily Platygastroidea, pp. 558-565. — In: GOULET H. & J.T. HUBER (eds), Hymenoptera of the World: An identification guide to families. Agriculture Canada, Ottawa.
- MATTIACI L., VINSON S.B., WILLIAMS H.J., ALDRICH J. R. & F. BIN (1993): A long range attractant kairomone for egg parasitoid *Trissolcus basalis*, isolated from defensive secretion of its host, *Nezara viridula*. — *J. Chem. Ecol.* **19**: 1167-1181.
- MCAUSLANE J.H., VINSON S.B. & H.J. WILLIAMS (1991): Influence of adult experience on host microhabitat location by the generalist parasitoid *Campoletis sonorensis* (Hymenoptera: Ichneumonidae). — *J. Insect Behav.* **4**: 101-103.
- MEHRAVAR M. (2000): Faunistic study of parasitoid wasps of sunn bug egg in Isfahan region. — M. Sc thesis of Entomology, Department of Entomology, Islamic Azad University, Science and Research Branch, 83 pp.
- MODARRES AWAL M. (1997): Scelionidae, pp. 279-280. — In: MODARRES AWAL M. (ed.), List of agricultural pests and their natural enemies in Iran. Ferdowsi University Press.
- MORAES M.C.B., LAUMANN R.A., SUJII E.R., PIRES C. & M. BORGES (2005): Induced volatiles in soybean and pigeon pea plants artificially infested with the neotropical stink bug, *Euschistus heros*, and their effect on the egg parasitoid, *Telenomus podisi*. — *Entomol. Exp. Appl.* **115**: 227-237.
- MORAES M.C.B., PAREJA M.F., LAUMANN R.A., HOFFMANNCAMPO C.B. & M. BORGES (2008): Response of the parasitoid *Telenomus podisi* to induced volatiles from soybean damaged by stink bug herbivory and oviposition. — *J. Plant Int.* **3**: 1742-1756.
- PACHECO D.J.P. & B.S. CORREA-FERREIRA (2000): Parasitismo de *Telenomus podisi* ASHMEAD (Hymenoptera: Scelionidae) em populações de percevejos pragas da soja. — *Ann. Soc. Entomol. Brasil* **29**: 295-302.
- PENNACCHIO F. & M.R. STRAND (2006): Evolution of developmental strategies in parasitic Hymenoptera. — *Annual Review of Entomology* **51**: 233-258.
- PERI E., SOLE M.A., WAINBERG E. & S. COLAZZA (2006): Effect of host kairomones and oviposition experience on the arrestment behavior of an egg parasitoid. — *The Journal of Experimental Biology* **209**: 3629-3635.
- PETITT F.L., TURLINGS T.C.J. & S.P. WOLF (1992): Adult experience modifies attraction of the leafminer parasitoid *Opius dissitus* (Hymenoptera: Braconidae) to volatile semiochemicals. — *J. Insect Behav.* **5**: 623-634.
- POWELL W.A. & J.A. PICKETT (2003): Manipulation of parasitoids for aphid pest management: progress and prospects. *Pest Management Science* **59**: 149-155.

- QUICKE D.L.J. (1997): Parasitic wasps. — Chapman and Hall, London.
- RADJABI Gh. (2000): Ecology of cereals' sunn pest in Iran. — Agricultural Research, Education and Extension Organization, 343 pp. (In Persian).
- RICHTER V.A. (1992): A new tribe, new and little known species of the tachinid flies (Diptera, Tachinidae) of the fauna of the USSR. — Entomol. Rev. **70**: 133-50.
- SALERNO G., CONTI E., PERI E., COLAZZA S. & F. BIN (2006): Kairomone involvement in host specificity of the egg parasitoid *Trissolcus basalis* (Hymenoptera: Scelionidae). — European J. Entomol. **103**: 311-318.
- SAMIN N., KOÇAK E., SHOJAI M. & M. HAVASKARY (2010): An annotated list of the Platygastroidea (Hymenoptera) from the Arasbaran biosphere reserve and vicinity, northwestern Iran. — Far Eastern Entomologist **210**: 1-8.
- SHAW M.R. (2006): Habitat considerations for parasitic wasps (Hymenoptera). — Journal of Insect Conservation **10**: 117-127.
- SILVA C.C., MORAES M.C.B., LAUMANN R.A. & M. BORGES (2006): Sensory response of the egg parasitoid, *Telenomus podisi* to stimuli from the bug, *Euschistus heros*. — Pesq. Agropec. Bras. **41**: 1093-1098.
- STEIDLES J.L.M. & J.J.A. VAN LOON (2002): Chemoecology of parasitoid and predator oviposition behaviour, pp. 291-317. — In: HILKER M. & T. MEINERS (eds), Chemoecology of insect eggs and egg deposition. Blackwell Publishing, Oxford and Berlin.
- STIREMAN J.O., O'HARA J.E. & D.M. WOOD (2006): Tachinidae: evolution, behavior and ecology. — Annual Review of Entomology **51**: 525-55.
- STRAND M.R. & L.L. PECH (1995): Immunological basis for compatibility in parasitoid-host relationships. — Annu. Rev. Entomol. **40**: 31-56.
- SUJII E.R., COSTA M.L.M., PIRES C.S., COLAZZA S. & M. BORGES (2002): Inter and intra-guild interactions in egg parasitoid species of the soybean stink bug complex. — Pesq. Agropec. Bras. **37**: 1541-1549.
- TSCHORSNIG H.-P. (1985): Taxonomie forstlich wichtiger Parasiten: Untersuchungen zur Struktur des männlichen Postabdomens der Raupenfliegen (Diptera, Tachinidae). — Stuttg. Beitr. Naturkunde Ser. A **383**: 1-137.
- TURLINGS T.C.J., WÄCKERS F.L., VET L.E.M., LEWIS W.J. & J.H. TUMLINSON (1993): Learning of host-finding cues by hymenopterous parasitoids, pp. 51-78. — In: PAPA J.D.R. & A.C. LEWIS (ed.), Insect Learning: Ecological and Evolutionary Perspectives. New York: Chapman & Hall.
- VAN LENTEREN J.C. (2003): Quality control and production of biological control agents: theory and testing procedures. — CABI Publishing, Wallingford.
- VET L.E.M. & A.W. GROENEWOLD (1990): Semiochemicals and learning in parasitoids. — J. Chem. Ecol. **16**: 3119-3135.
- VET L.E.M., WÄCKERS F.L. & M. DICKE (1991): How to hunt for hiding hosts: the reliability-detectability problem in foraging parasitoids. — Neth. J. Zool. **41**: 202-213.
- VET L.E.M. & M. DICKE (1992): Ecology of infochemical use by natural enemies in a tri-trophic context. — Annu. Rev. Entomol. **47**: 141-172.
- VET L.E.M., LEWIS W.J. & R.T. CARDE (1995): Parasitoid foraging and learning, pp. 65-101. — In: CARDÉ R.T. & W.J. BELL (eds), Chemical Ecology of Insects II. Chapman and Hall, New York.
- VINSON S.B. (1985): The behaviour of parasitoids, pp. 417-469. — In: KERKUT G.A. & L.I. GILBERT (eds), Comprehensive Insect Physiology, Biochemistry and Pharmacology. Pergamon Press, New York.
- VINSON S.B. (1998): The general host selection behaviour of parasitoid Hymenoptera and a comparison of initial strategies utilized by larvaphagous and oophagous species. — Biol. Control **11**: 79-96.

- WAJNBERG E. & S.A. HASSAN (1994): Biological control with egg parasitoids. — CABI Publishing, Wallingford.
- WAJNBERG E., SCOTT J.K. & P.C. QUIMBY (2001): Evaluating indirect ecological effects of biological control. — CABI International, Wallingford.
- WAJNBERG E., BERNSTEIN C. & J.J.M. VAN ALPHEN (2008): Behavioral ecology of insect parasitoids – from theoretical approach to field application. — Blackwell Publishing, Oxford.
- WILLIAMSON S. (1998): Understanding natural enemies; a review of training and information in the practical use of biological control. — *Biocontrol News and Information* **19**: 117-126.

Author's addresses:

Najmeh SAMIN  
Department of Entomology, Islamic Azad University  
Science & Research Branch, Tehran, Iran  
E-mail: [n\\_samin63@yahoo.com](mailto:n_samin63@yahoo.com)

Mahmood SHOJAI  
Department of Entomology, Islamic Azad University  
Science & Research Branch, Tehran, Iran

Shahreyar ASGARI  
Plant Pests and Diseases Research Institute  
Varamin, Tehran, Iran

Hassan GHAHARI  
Department of Entomology, Islamic Azad University  
Science & Research Branch, Tehran, Iran  
E-mail: [hghahari@yahoo.com](mailto:hghahari@yahoo.com)

Erhan KOCAK  
Ministry of Agriculture, Central Plant Protection Research Institute  
Ankara, Turkey  
E-mail: [erhan\\_kocak@hotmail.com](mailto:erhan_kocak@hotmail.com)

# ZOBODAT - [www.zobodat.at](http://www.zobodat.at)

Zoologisch-Botanische Datenbank/Zoological-Botanical Database

Digitale Literatur/Digital Literature

Zeitschrift/Journal: [Linzer biologische Beiträge](#)

Jahr/Year: 2010

Band/Volume: [0042\\_2](#)

Autor(en)/Author(s): Samin Najmeh, Shojai Mahmood, Asgari Shahreyar, Ghahari Hassan, Kocak Erhan

Artikel/Article: [Sunn pest \(\*Eurygaster integriceps\* PUTON, Hemiptera: Scutelleridae\) and its scelionid \(Hymenoptera: Scelionidae\) and tachinid \(Diptera: Tachinidae\) parasitoids in Iran 1421-1435](#)