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Strange loves: a remarkable case of aberrant copulation in beetles (Coleoptera: Meloidae, Chrysomelidae)

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Abstract
A case of copulation between two mimic and repellent beetle species (a male of *Timarcha fracassii*, and a female of *Meloe autumnalis*), belonging to distinct families (Chrysomelidae, Meloidae), is recorded.

Key words: interfamiliar mating, sexual behaviour, costs of mimicry.

Introduction

Species are genetically closed systems because the gene exchange between them is impeded or prevented by pre- and post-mating reproductive isolating mechanisms, which reduce gene flow between related species (Dobzhansky 1937; Mayr 1963). However, recognition of species identity is the precondition of any successful sexual interaction ending with copulation. In most insect species, pheromones play a primary role in species recognition, sexual attraction and reproductive isolation, but they are often supplemented, or even replaced, by tactile, acoustical and visual signals.

In the mimetic chains, visual mating stimuli can happen to be similar enough to induce confusion in the courtship behaviour of the different species: this practice could reflect a reduction in fitness usually involving a waste of energy or time but, in general, not a waste of gametes (Estrada & Jiggins 2008). This is true especially for those species that share the same courtship behaviour.

Members of Meloidae family, commonly known as blister beetles for their capability of synthesizing cantharidin, a highly toxic substance mostly used as a deterrent against predators (Bologna 1991), represent a good mimetic model for other insects. Some species of the genera *Trichodes* Herbst, 1792 (Coleoptera: Cleridae), *Cercopis* Fabricius, 1775 (Homoptera, Cercopidae) and *Zygaena* Fabricius, 1775 (Lepidoptera, Zygaenidae) are similar to those of the blister beetle genus *Mylabris* Fabricius, 1775, and related genera of the tribe Mylabrini for the general morphology, size and aposematic pattern (Bologna 1991; Bologna et al. 2010). In the family Chrysomelidae, the genera *Timarcha* Latreille, 1829 and *Galeruca* Geoffroy, 1762 are very similar to the genus *Meloe* Linnaeus, 1758 due to their black or black-blue coloration, a great and distinctly convex abdomen associated with apterism and in some cases brachyelytry, and to a general slow walking behaviour on the ground. Furthermore, they show common defensive behaviours: the thanatosis and autohaemorrage of toxic hemolymph containing respectively cantharidin in *Meloe* (Bologna 1991; Bologna et al. 2010) and anthrachinones and anthrones in *Timarcha* and *Galeruca* (Jolivet & Petitpierre 1981; Petitpierre 1991; Jolivet et al. 1994). This mimicry could definitely explain the association of *Meloe* with Chrysomelidae of these and other genera (such as *Arima* Chapuis, 1872) repeatedly observed in distinct Mediterranean areas (Morocco, Spain, Italy, Turkey: Bologna unpublished), and it is evident enough to embarrass specialists of Meloidae such as the authors of this paper.

Is it possible that such similarity could induce mating confusion between the two co-mimetic species? For the first time we report an aberrant case of mating between a chrysomelid male of *Timarcha fracassii* Meier, 1900 and a blister beetle female of *Meloe (Treiodus) autumnalis* Olivier, 1792.

Results

During a field survey in Central Apennines (Italy), aimed at collecting individuals of the blister beetles genus *Meloe* for phylogenetic and chemical studies, we found in the same small pasture (Ovindoli, Abruzzi, Central Italy, L'Aquila Province, SW slope of Magnola Mt., Mon-

A **B**

Fig. 1 – Mating behaviour between *Timarcha fracassii* male (Coleoptera, Chrysomelidae) and *Meloe autumnalis* female (Coleoptera, Meloidae) observed in the Abruzzi region (Central Italy). **A**, dorsal view; **B**, right lateral view.

te Freddo, 1600 m a.s.l., October 2016), ten specimens of *Meloe (Eurymeloe) apenninicus* Bologna, 1988, and *M. autumnalis,* together with several individuals of two leaf beetle species [*T. fracassii*; *Galeruca tanaceti* (Linnaeus, 1758)].

In this interspecific syntopic assemblage, we found a male of *T. fracassii* and a large female of *M. autumnalis* in a posterior sexual behaviour (Fig. 1), which is typical of both genera (Pinto & Selender 1970; Bologna & Marangoni 1985; Bologna 1991; Thomas et al. 1999). From the moment that we found the beetles, the sexual act lasted several minutes, but the beetles were somewhat disturbed by our presence and pictures. We clearly observed that the male *T. fracassii* genitalia were inserted in the female *M. autumnalis* abdominal opening, so we can state that a pseudocopulation occurred. We also noticed the presence of several females of *T. fracassii* in the pastures less than 10 m from the copulating co-specific male.

Discussion

In our knowledge a similar situation of sexual behaviour involving different insect families, has never been observed before. On the contrary, events of interspecific sexual behaviour have been described in literature, also in Meloidae, including the genus *Meloe* (Pinto & Selander 1970; Bologna & Marangoni 1985) and the genus *Epicauta* Dejan, 1834 (Selander & Mathieu 1969; Adams & Selander 1979). It was demonstrated that males of two comimetic butterfly's species, *Heliconius erato* (Linnaeus, 1758) and *Heliconius melpomene* (Linnaeus, 1758), which use the colour wings pattern for the mate recognition, approach and court co-mimic females. However, the male of *H. erato* could distinguish co-mimics avoiding a real copula (Estrada & Jiggins 2008) and consequently a waste of gametes. In fact, it seems that despite the strong similarity, mimetic species have evolved other recognition mechanisms at a closer range to recognize their own model species. On the contrary the male of *T. fracassii*, was unable to recognize its co-mimic, *M. autumnalis,* as a different species. We can hypothesize that in these species the visual cue must be the major signal for species recognition. For animals with such a simple recognition system, as it seems for *T. fracassii,* the risk of mating confusion is higher than for those who use a mixture of different signals, with an inevitable raise in the costs of mimicry. The combined use of many cues can give several additional information about the potential partner in order to avoid any misunderstanding.

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