Sex allocation in a sequence of oviposition by *Lysiphlebia mirzai* (Hymenoptera: Braconidae)

Lysiphlebia mirzai Shuja-Uddin is a solitary endoparasitoid of cereal aphids and has recently been reported as a potential biocontrol agent of millet-aphid (*Rhopalosiphum maidis* (Fitch)), corn aphid (*Melanaphis sacchari* (Zehntner)) and grain aphid (*Schizaphis graminum* (Rondani)) on several crops[1]. It reproduces by arrhenotoky, which is characterized by the parthenogenetic development of sons from haploid eggs and zygogenetic development of daughters from diploid eggs. Therefore, virgin mothers always produce only sons while inseminated mothers may produce both sons and daughters. Thus, inseminated mothers are able to adjust the proportion of haploid and diploid eggs at oviposition. Understanding the factors that could affect the fertilization of the eggs, thus influencing offspring sex ratio (p) in aphid parasitoids, becomes a pre-requisite in the development and testing sex ratio theories and models, as well as for their practical applications in biological control because it is the females that killed the aphids. The offspring sex ratio of the parasitoids not only affects the level of their population but also influences the stability of the host–parasitoid interactions[2]. Moreover, efficiency of the parasitoid mass-rearing for biocontrol may be enhanced by maximizing the number of females per unit of host material[3].

The pattern of sex allocation in a sequence of oviposition differs between gregarious and solitary parasitoids. In most solitary parasitoids, the sex allocation in a sequence is random[4]. However, since aphids are patchily distributed, their parasitoids need less searching and handling time for oviposition and they may, therefore, be considered as quasi-gregarious. Non-random sex allocation in a sequence of oviposition has been observed in the case of an aphid parasitoid *Trioxys indicus* Subba Rao and Sharma[5]. No such information exists for the other aphid parasitoids. In this paper, observations on the sequence of deposition of male and female eggs by *L. mirzai* are presented.

Fifteen females and 15 males of the same cohort emerged from hosts (*M. sacchari*) that were parasitized in third instar stage were allowed to mate separately in glass vials. They were fed with a mixture of honeydew, honey and distilled water. Each mated female was introduced into a petri dish (15 cm dia × 1.5 cm height) having 40 third instar aphid nymphs settled on a host plant leaf (trimmed leaf, 5 × 10 cm). The locus of each nymph was visually marked and copied on a paper. After introduction, the female begins to oviposit and the sequence of oviposition into marked hosts (locus is marked not the host) was observed and recorded. When more than 25 hosts were parasitized, the leaf along with the hosts was withdrawn. The exposed and marked aphid nymphs were reared singly on a small trimmed twig of host plant kept in glass containers (500 cc) which were marked for sequence until the emergence of adult parasitoids whereupon they were sexed and recorded. The experiment was carried out at 22°C ± 2 and 70–80% RH.

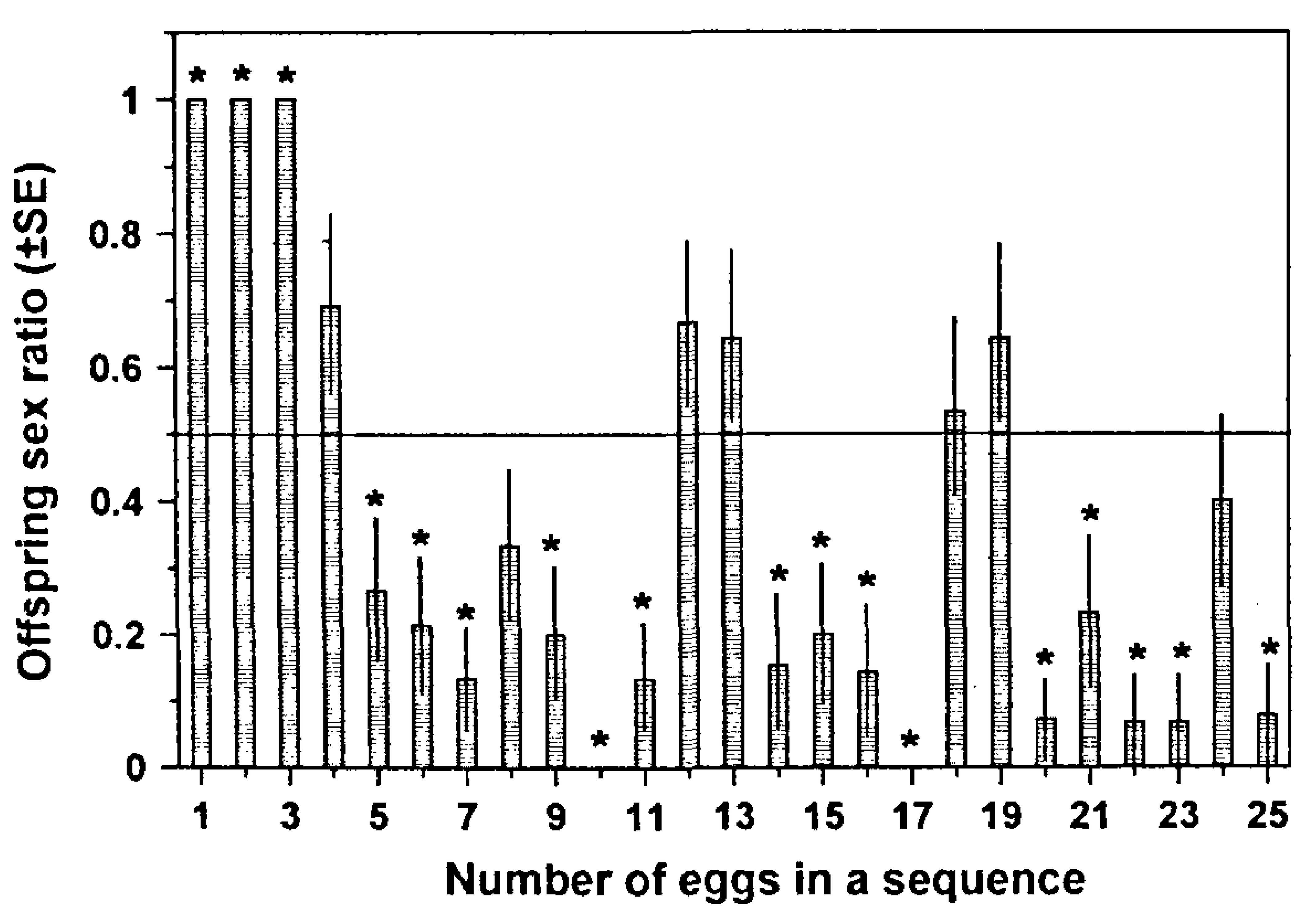

Figure 1. Mean offspring sex ratio of 25 eggs laid in a sequence by 15 female *Lysiphlebia mirzai* into the host aphid *Melanaphis sacchari*. *Mean values significantly differ ($P < 0.05$, *t*-test) from the expected sex ratio, $p = 0.5$.

The first 3–4 eggs deposited by females are almost always haploid (Figure 1), implying that newly-mated female *L. mirzai* are *functionally virgin*[6]. The 5th to 11th eggs in a sequence produced predominantly female progeny (67–100%) while the 12th and 13th eggs yield 64–67% male progeny followed by again 80–100% female progeny by the 14th to 17th eggs. The probability of male eggs increased again in 18th and 19th eggs (53–64%). Twentieth to 25th eggs yield mostly female offspring (60–100%). The mean offspring sex ratio of the 5th–11th, 14th–17th and 20th–25th eggs in a sequence are female biased and differ significantly from $p = 0.5$ (equal proportion of sexes, Figure 1). The observations demonstrated that the oviposition bout where male eggs are laid is shorter (only 1–2 eggs in a sequence) than where female eggs are laid (1–9 eggs in a sequence). The results, thus, evince a clear tendency towards a non-random sequence of male and female eggs. Laying of a few male eggs early in the bout may ensure the availability of necessary males in the population that can inseminate the female progeny to be produced from the remaining hosts and extra males added at regular intervals according to the insemination capacity of the male, increases the fitness of the females[7,8].

The sequence of sex allocation in parasitoids is known to be non-random for most of the gregarious and quasi-gregarious parasitoids and random for solitary ones[4]. However, the greater probability of fertilization of alternate eggs by a solitary parasitoid *T. indicus* demonstrates a non-random sex allocation in a sequence[5]. This is the only available information for aphid parasitoids. Predominance of female progeny observed in host-patches of variable size collected from field population[7,8], suggests that the female allocates only as many haploid eggs in the host-patch as are sufficient enough for the brood. This kind of adaptive sex allocation in aphid parasitoids differs significantly with random sex allocation as observed in solitary parasitoids where mean sex ratio is more important[4].

Since several factors influence the fertilization of eggs[9], the sequence of deposition of haploid–diploid eggs has certain limitations. Therefore, the sequence alone is of little adaptive significance for the females.

1. Tripathi, R. N. and Singh, R., *Biol. Agric. Hortic.*, 1995, **12**, 283–294.
2. Waage, J. K. and Ng, S. M., *J. Anim. Ecol.*, 1984, **53**, 401–416.
3. Srivastava, M. and Singh, R., *Biol. Agric. Hortic.*, 1995, **12**, 15–28.
4. Hardy, I. C. W., *Oikos*, 1992, **65**, 143–158.
5. Pandey, R. K., Singh, R., Kumar, A., Tripathi, C. P. M. and Sinha, T. B., *Entomon*, 1983, **8**, 183–185.
6. Mackauer, M., *Ann. Entomol. Soc. Am.*, 1976, **69**, 453–456.
7. Singh, R. and Sinha, T. B., *Entomon*, 1980, **5**, 269–276.
8. Mishra, S. and Singh, R., *J. Appl. Entomol.*, 1991, **111**, 72–77.
9. Srivastava, M. and Singh, R., *J. Appl. Entomol.*, 1995, **119**, 73–77.

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Didwana–Rajod meteorite: An unusual chondrite

A stony meteorite fell on 12 August 1991 at 10.00 PM at a site near Didwana in Nagaur District, Rajasthan, India (Figure 1). It fell in the open field of village Soanlias P.O. Rajod, and was picked up by Sohan Ram, an undergraduate student residing in the village.

The stone is fully crusted and free of fractures. It contains typical thumb marks of a meteorite (Figure 2). The fusion crust is moderately thick. A face of the stone was polished to show internal structures (Figure 3). On megascopic examination, the polished surface shows poorly-developed banded structure, dark brown chondrules and a few creamy white specs. The polished surface deteriorates rapidly by rusting of metallic grains. This is the first report on this meteorite fall and this meteorite is named the 'Didwana–Rajod meteorite'.

Thin sections covering nearly 10 cm^2 area were studied under the microscope. The rock under thin section consists of a variety of chondrules set in a fragmental matrix predominantly consisting of enstatite and metallic phases. The chondrules are distinct in shape (sometimes ideally spherical) and some of them are moderately degraded. Chondrules are generally 0.1 to 1 mm in size, except one which is 5 mm in size (Figure 2) observed on the broken surface of the meteorite. The type of chondrules encountered in Didwana–Rajod meteorite is described below:

Very cloudy glassy-looking chondrules exhibit one of the best spheroidal geometries. Although they look glassy and are very uniform under plane polarized light, they show an exocentric chondrule-like extinction pattern. These chondrules have a metallic phase which is sometimes seggregated (Figure 4) and at times totally diffused in the body of the chondrule. In the cryptic crystalli-

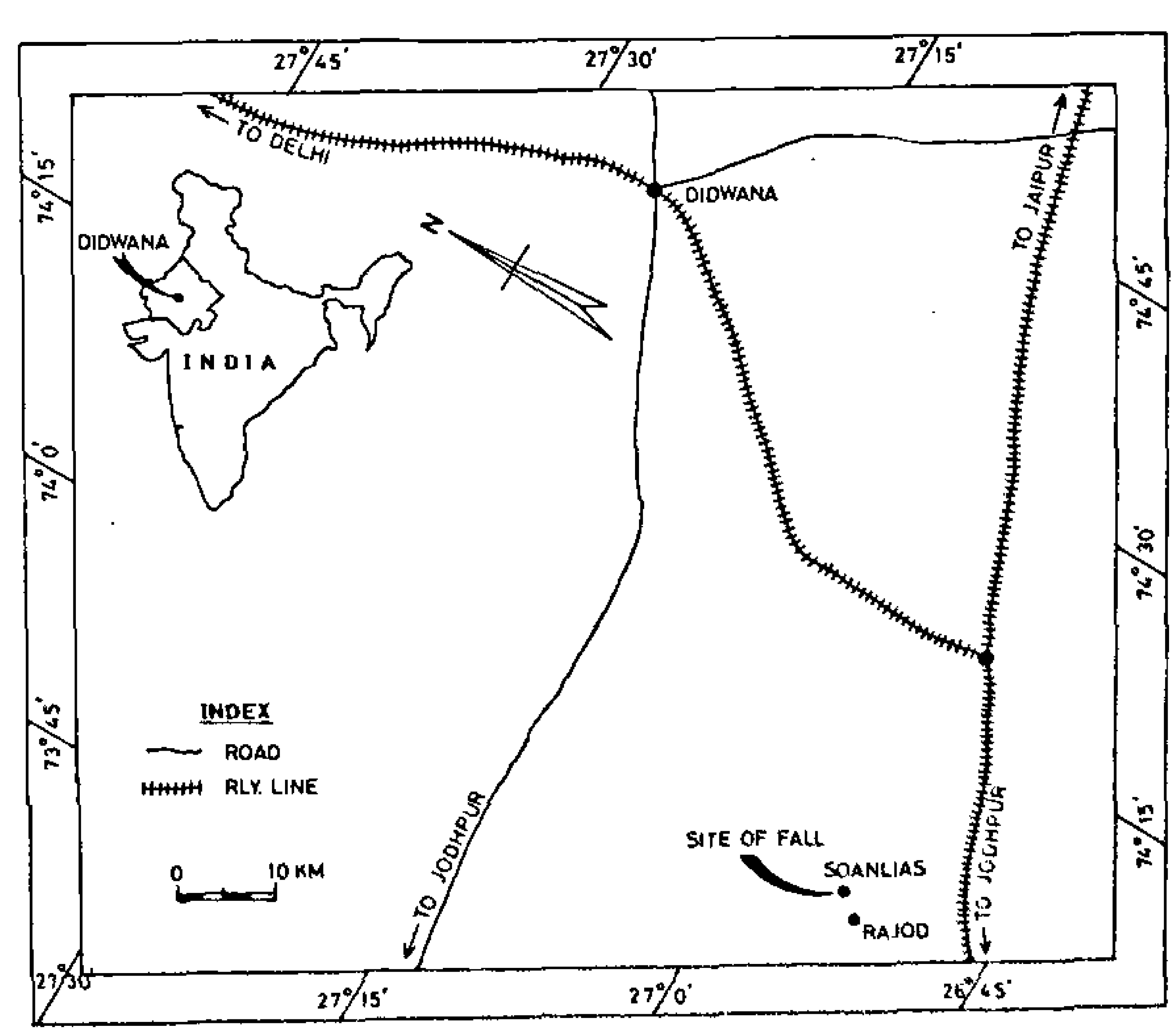

Figure 1. Location map of fall site.