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King, B.H. 1991. No intersexual differences in host size and species usage in *Spalangia endius*
(Hymenoptera: Pteromalidae). Great Lakes Entomologist 24:17-20.

NO INTERSEXUAL DIFFERENCES IN HOST SIZE AND SPECIES USAGE IN *SPALANGIA ENDIUS* (HYMENOPTERA: PTEROMALIDAE)

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ABSTRACT

Spalangia endius were collected from fly pupae, primarily house fly and stable fly, from a poultry house in Indiana. Male and female wasps did not differ within and across host species in host size usage. Also, despite stable fly pupae being significantly smaller than house fly pupae, the proportion of male wasps emerging from the two host species was similar.

Early in the 1900's, entomologists observed that in some species of parasitoid wasps, males tended to emerge from smaller hosts than did females, resulting in a negative relationship between host size and parasitoid sex ratio (proportion males) (reviewed in Flanders 1939, 1946). Since then, a group of sex ratio models, the host quality models have been developed to explain this pattern (Charnov 1979, Charnov et al. 1981, Werren 1984). These models were designed for solitary species (species in which one offspring completes development per host). In these models, the prediction that male parasitoids should emerge from smaller hosts than females is based on the assumption that developing on a small host will be more detrimental to a female than to a male in terms of future ability to reproduce. The rationale of the assumption was that wasps will be smaller when developing on smaller hosts; and even small males may be able to mate successfully, whereas small females probably lay fewer eggs than large females (Charnov et al. 1981). There is some support for this idea in a few species of parasitoid wasps (Charnov et al. 1981; Jones 1982; van den Assem et al. 1989), but not in all species (King 1988). In those species or populations in which the assumption is valid, natural selection is expected to favor females that oviposit a greater proportion of males in small than in large hosts (Charnov et al. 1981). Female wasps can potentially control the sex of their offspring by controlling fertilization because they have haplodiploid sex determination. Under haplodiploid sex determination, males develop from unfertilized eggs and females from fertilized eggs.

Here the host quality models' prediction of a greater proportion of sons from small than from large hosts is tested using field collections of the solitary parasitoid wasp *Spalangia endius* Walker (Hymenoptera: Pteromalidae). The wasps emerged from house fly pupae (*Musca domestica* Linnaeus) and stable fly pupae (*Stomoxys calcitrans* (Linnaeus)) (Diptera: Muscidae) collected from a poultry house in northern Indiana.

MATERIALS AND METHODS

Weekly from 28 May to 12 November 1985, fly pupae were collected from an enclosed, shallow-pit, egg-layer poultry house in Delphi, Indiana (the Hilltop poultry house described in Merchant 1984; Merchant et al. 1987), using pupal traps (Hogsette and Butler 1981; Merchant et al. 1985). The pupae were held until flies emerged and died. Then pupae from which no flies emerged and which had not been depredated (Merchant 1984) were held individually in gelatin capsules for parasitoid emergence. Wasp species were identified following Boucek (1963) and Rueda and Axtell (1985) and house fly and stable fly pupae following Skidmore (1985). Voucher specimens have been deposited at the museum of the Department of Entomology at Purdue University, West Lafayette, Indiana.

Width of fly pupae was measured to the nearest 0.05 mm at a magnification of 360 X under a dissecting microscope. These widths were converted to volumes (mm^3) using the following formulas: for house flies volume = $(22.68)(\text{width}) - 37.63$ and for stable flies volume = $(11.31)(\text{width}) - 11.18$. These regression equations had been determined by measuring both width and length on seventeen stable flies and thirty-six house flies, then calculating volume with the equation for a prolate spheroid (Holdaway and Smith 1932), and finally regressing volume against width.

RESULTS

There were no significant differences among collection dates in *S. endius* sex ratio ($G = 3.82$, $df = 6$, $P > 0.50$). Pooling across all dates, *S. endius* sex ratio was 26.1% males ($n = 330$ male and female wasps).

There was no significant difference in the size of hosts from which male and female *S. endius* emerged. This was true regardless of whether one looked 1) within host species, 2) at all host species combined, or 3) between different host species. Looking at house fly hosts, among the five dates with sample sizes of greater than ten, a two-way analysis of variance on host size showed no significant effect of wasp sex ($F = 0.34$, $P = 0.56$) and no significant interaction between wasp sex and date ($F = 2.26$, $P = 0.06$). Because the interaction approached significance, I also did individual t-tests for each date, but these also revealed no significant difference in the size of hosts from which male and female wasps emerged (Table 1). Looking at stable fly hosts, combining all dates, there was no significant difference in host size between male and female wasps, though sample sizes are small (males: $X + SD 14.54 + 0.73$, $n = 4$; females $14.50 + 0.97$, $n = 7$; $t = 0.07$, $P = 0.94$). Combining host species, among the five dates with sample sizes of greater than ten, a two-way analysis of variance on host size showed no significant effect of wasp sex ($F = 0.51$, $P = 0.48$) and no significant interaction between sex and date ($F = 1.57$, $P = 0.18$). Looking between host species, though stable fly pupae are on average smaller than house fly pupae (Skidmore 1985; King in press-a), the sex ratio of *S. endius* on stable flies (36% males, $n = 11$ wasps) was not significantly greater than on house flies (25% males, $n = 264$ wasps) ($G = 0.67$, $P > 0.30$).

DISCUSSION

The absence of host size differences between the sexes for *S. endius* in this study is consistent with results of laboratory experiments by Donaldson and Walter (1984). Their

experiments indicated that *S. endius* females do not manipulate the sex of their offspring in response to the size of house fly hosts. The lack of any significant relationship between host size and parasitoid sex ratio for *S. endius* contrasts both with the pattern observed in most other species of parasitoid wasps that have been examined and with the prediction of the host quality models. In most, though not all, species of parasitoid wasps that have been examined, females emerge from larger hosts than do males (about 44 of 65 parasitoid wasp species (reviewed in King 1987, 1989, in press-b)).

Results with other species of *Spalangia* besides *S. endius* have been mixed. These other species of *Spalangia* are also parasitoids of fly pupae. Legner (1969) found the predicted negative relationship between host size and offspring sex ratio for *S. nigra*, but not for *S. cameroni* or *S. drosophilae* (statistical analyses of his results in Table 7 of King 1987). King's (1988) laboratory results support the prediction for *S. cameroni* parasitizing house flies. However, field results with *S. cameroni* are more complicated: the prediction is supported on a within host species basis for two of three dates--two dates on which *S. cameroni* emerged only from house fly pupae--but not on the date when stable fly pupae were also parasitized by *S. cameroni* (King in press-a). And looking just at stable fly pupae, *S. cameroni* males actually emerged from significantly larger hosts than did females, opposite the prediction. As was the case with *S. endius*, *S. cameroni* sex ratio did not differ between small and large host species (i.e., stable fly and house fly pupae) (King in press-a).

Because the members of the genus *Spalangia* exhibit such a variety of relationships between sex ratio and host size, it is a promising group for a comparative study. A comparison of behavioral, ecological, and life history factors among the species may help to explain the interspecific differences in sex ratio patterns. One possibility is that the species that do not support the host quality models' prediction may not meet the models' assumption of a more positive effect of host size on female than male reproduction. For example, competition among males for mates may increase the importance of large male body size in some species. In general, among parasitoid wasps, the importance of size on male reproductive success has been little-studied (Charnov et al. 1981; Jones 1982; King 1988; van den Assem et al. 1989), especially relative to the attention given females (e.g., Charnov et al. 1981; Jones 1982; King 1988; van den Assem et al. 1989; fourteen references in Table 6 of King 1987).

ACKNOWLEDGMENTS

I thank R. Flanders for introducing me to parasitoid wasps, the Brubakers of Hilltop Egg Farm for the use of their poultry house, M. Merchant for helpful tips on identification, R. Howard for valuable discussions in the planning, analyzing, and writing of this research, and R. King for comments on the manuscript. This research was aided by a National Science Foundation Graduate Fellowship and by Grants-in-Aid of Research from Sigma Xi, The Scientific Research Society.

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Table 1.--X + SD (n) size (mm³) of house fly pupae from which male and female *Spalangia endius* emerged for five collection dates.

Fly pupae size			
Date	Male wasps	Female wasps	Test Comparison*
Sep 03	26.24 + 3.09 (38)	25.86 + 3.02 (110)	t = 0.66, P = 0.51
Sep 10	28.15 + 2.27 (3)	25.16 + 2.94 (14)	t = 1.65, P = 0.12
Oct 01	16.57 + 5.04 (14)	18.51 + 5.16 (30)	t = 1.17, P = 0.12
Oct 08	19.31 + 7.19 (5)	23.94 + 6.27 (14)	t = 1.37, P = 0.09
Oct 15	27.02 + 3.21 (2)	25.81 + 4.72 (15)	t = 0.35, P = 0.73

* t-tests of whether females emerged from larger hosts than did males; two-tailed P values given when means were in direction opposite to that predicted