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Sexual size dimorphism in parasitoid wasps

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Sexual dimorphism in body length and proportion of overlap between the ranges of body length for males and females were estimated for 361 species of parasitoid wasps from 21 families. In most species, females are generally larger than males, though the range of male and female sizes overlap. Species in the family Ichneumonidae differ significantly from species in other families in three ways: (1) ichneumonids on average are larger, (2) in most species, females are generally smaller than males, and (3) on average, proportion overlap between the ranges of body length for males and females is greater. At present, there is a paucity of life history data on parasitoid wasp species for which size dimorphism is known. Thus it is not clear why ichneumonids differ from species in other families. Possible evolutionary explanations for variation in dimorphism among parasitoid wasp species are discussed.

KEY WORDS:—sexual dimorphism – sexual selection – parasitoid wasps – Ichneumonidae

CONTENTS

INTRODUCTION

Sexual size dimorphism has been reviewed for a range of vertebrate taxa. Interspecific differences in degree of dimorphism have been related to differences in mating systems (e.g. Alexander, Hoogland, Howard, Noonan & Sherman, 1979; Stamps, 1983; Carothers, 1984) body size (Clutton-Brock, Harvey & Rudder, 1977), and habitat type (Clutton-Brock *et al.*, 1977; Berry & Shine, 1980). However, little attention has been given to sexual size dimorphism in invertebrate groups except zooplankton (Gilbert, 1983) and spiders (Jocque, 1983).

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In this paper, I quantitatively assess the degree of sexual size dimorphism in more than 360 species of parasitoid wasps from 21 families. I examine taxonomic patterns of dimorphism and discuss possible evolutionary causes of dimorphism. Parasitioid wasps are a large group within the order Hymenoptera. They consist of more than 100 000 identified species and probably numerous other as yet undiscovered ones (Hopper, 1984). A parasitoid wasp lays one or more eggs in or on a host. When the wasp eggs hatch, the emerging larvae feed on their hosts, killing the hosts by the time the wasp larvae pupate and emerge as adults. For parasitoid wasps as a group, females are reported to be larger than males (e.g. van den Assem, 1976). However, the extent to which this generalization holds across the various taxa of parasitoid wasps has not been examined.

Parasitoid wasps exhibit a variety of mating systems, and I intended to examine relationships between degree of size dimorphism and mating attributes. However, I was unable to do this as there are few species for which data are available both on mating system and on male and female size. I hope that this paper will serve as a source and stimulus for further study.

METHODS

Data on length, weight, and headwidth of adult male and female wasps were compiled from published records (specifically from *U.S. National Museum Proceedings*, 1921–1968; *Bulletin of Entomological Research*, 1960 to date; *Canadian Entomologist*, 1965 to date; *Annals of the Entomological Society of America*, 1972 to date; and *Entomologica Scandinavica*, 1973 to date; as well as from other publications). I also took measurements of length (five males, 12 females) and headwidth (289 males, 95 females) on *Hyposoter exiguae* (Ichneumonidae) from a laboratory colony. Species whose hosts are not known were included only if they belong to families or subfamilies composed primarily of parasitoid species. Species were classified taxonomically following Krombein, Hurd, Smith & Burks (1979).

Size measures are reported for males and females separately as ranges or as averages. The degree of dimorphism was estimated by dividing the midpoint size value for the female by that for the male or by dividing the average female size by the average male size. My analyses focus on ranges of lengths because this is how size is most often reported. I assume that all lengths were measured from the front of the head to the tip of the abdomen, excluding the ovipositor (as by P. DeBach, pers. comm.; C. M. Yoshimoto, pers. comm.; N. F. Johnson, pers. comm.; Samson, 1984).

The proportion of overlap between the range of length for males and females was also estimated for each species. It was calculated as the difference between the maximum size of the smaller sex and the minimum size of the larger sex, divided by the difference between the maximum size of the larger sex and the minimum size of the smaller sex. Overlap values greater than zero indicate that there is overlap between the male and the female size ranges. Values less than zero indicate no overlap, and values of zero indicate that the ranges abut.

Nonparametric statistics were used when variables were not normally distributed as determined from tests of skewness and kurtosis (Sokal & Rohlf, 1981).

RESULTS

Dimorphism

Sizes for males and for females, dimorphism, and proportion of overlap are presented in the Appendix. Length data are given in terms of the range for 361 species. The dimorphism values of these species vary from 0.64 to 1.77 (Fig. 1). In most species, females are larger than males. The mean dimorphism (female : male) is 1.12 ± 0.19 (standard deviations are used throughout).

One obvious exception to the general trend of female-biased size dimorphism is the subfamily Ichneumoninae in the family Ichneumonidae. In most species of Ichneumoninae, females are smaller than males. The average dimorphism is 0.91 ± 0.08 ($N = 81$). It should be noted that all the size data on Ichneumoninae are from Florida and neighboring states (Heinrich, 1977). Size data on species from other subfamilies of Ichneumonidae are few but are from Canada, the U.S.A. and the Virgin Islands. Although the average dimorphism of these species (1.06 ± 0.05, $N = 5$) is greater than the average dimorphism for the subfamily Ichneumoninae (Mann–Whitney $U = 19.0$, $P = 0.001$), it is still less than the average dimorphism for species outside the family Ichneumonidae (1.19 ± 0.17, $N = 275$; Mann-Whitney $U = 293.0$, $P = 0.028$).

Two other families besides Ichneumonidae which have average dimorphism values which are male-biased are Mymaridae and Scelionidae (Table 1). However, these values are based on only two and one species, respectively.

The lower (more male-biased) dimorphism of ichneumonids may somehow be related to their larger size. Within the family Ichneumonidae, the average midlength of males and females for species of Ichneumoninae (13.06 ± 4.48 mm) is larger than that for species of non-Ichneumoninae (7.07 ± 2.95 mm; Mann–Whitney $U = 36.0$, $P = 0.002$). The non-Ichneumoninae are in turn larger than species belonging to other families (2.54 ± 2.17 mm; Mann–Whitney $U = 92.0$, $P = 0.001$).

In addition to variation in dimorphism among families, subfamilies, and

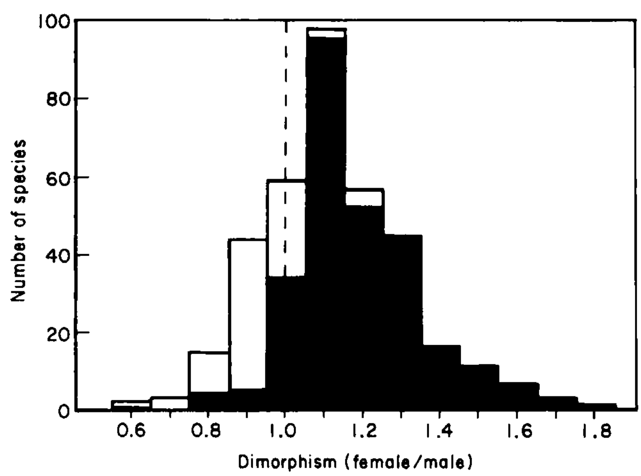

Figure 1. Histogram of sexual dimorphism in length: □ = species in the subfamily Ichneumoninae, ■ = species not in the subfamily Ichneumoninae (includes species not in the family Ichneumonidae).

Table 1. The average (S.D. in parentheses) sexual dimorphism in length for 21 families

Family	Number of species	Dimorphism (female/male)
Ichneumonidae	86	0.92 (0.09)
Mymaridae	2	0.98 (0.07)
Scelionidae	1	0.99 (0.00)
Aphidiidae	2	1.05 (0.03)
Chrysididae	1	1.11 (0.00)
Sclerogibbidae	1	1.11 (0.00)
Bethylidae	7	1.12 (0.21)
Chalcididae	21	1.12 (0.13)
Eucoilidae	11	1.13 (0.08)
Braconidae	33	1.15 (0.17)
Trichogrammatidae	2	1.16 (0.02)
Pteromalidae	53	1.18 (0.15)
Platygastridae	2	1.19 (0.25)
Encyrtidae	70	1.20 (0.17)
Diapriidae	3	1.23 (0.12)
Eulophidae	49	1.25 (0.17)
Tiphiidae	8	1.25 (0.27)
Dryinidae	3	1.28 (0.20)
Torymidae	3	1.32 (0.29)
Eurytomidae	2	1.34 (0.34)
Eupelmidae	1	1.45 (0.00)

species, there is also intraspecific variation in dimorphism (see Appendix). This intraspecific variation is associated with differences in (1) character measured (e.g. *Muscidifurax* (Pteromalidae), *Pachycrepoideus vindemiae* (Pteromalidae), *Trichogramma minutum* (Trichogrammatidae)), (2) host species (e.g. *Invreia deceptor* (Chalcididae), *Dolchomitus* sp., *Pimpla turionellae* (Ichneumonidae), *Poropoea morimotoi* (Trichogrammatidae)), (3) host size (e.g. *H. exiguae* (Ichneumonidae), *Roptrocerus xylophagorum* (Torymidae)), (4) rearing temperature (Nealis, Jones & Wellington 1984), and (5) geographic location of the wasp population (e.g. *Muscidifurax* (Pteromalidae)).

Overlap

Proportion of overlap shows much more interspecific variation than dimorphism (coefficient of variation = 117% *vs.* 17%). It ranges from -0.64 to 1.00 (Appendix), with a mean of 0.30 ± 0.35. The sexes overlap in length in 313 of the 361 species examined. Overlap is significantly greater for ichneumonids than for non-ichneumonids (0.38 ± 0.33 *vs.* 0.27 ± 0.35; $t = 2.58$, $P = 0.01$). This difference in overlap is related to the difference in dimorphism. Overlap will approach its maximum as dimorphism approaches 1.00. The average dimorphism of non-ichneumonid species (1.19) is about twice as far from a dimorphism of 1.00 as is that of ichneumonids (0.92). Overlap and average midlength of males and females are not correlated (Spearman rank coefficient = 0.05, $P = 0.16$).

DISCUSSION

Several hypotheses have been proposed to explain the evolution of sexual size dimorphisms in vertebrates (Alexander *et al.*, 1979; Carothers, 1984). The competition avoidance hypothesis states that dimorphism is selected for as a means of reducing competition between males and females of the same species by allowing differential use of resources, e.g. food (Selander, 1966). Alternatively, sexual size dimorphism may result from differences in maternal *vs.* paternal reproductive effort or from sexual selection either through mate competition or mate choice. These latter two hypotheses can be included under a more general hypothesis that sexual size dimorphism results from differences between males and females in the effect of size on reproductive success.

Competition avoidance

In parasitoid wasps, selection for differential food usage between the sexes probably does not contribute to sexual size dimorphism. Adults feed on nectar or honeydew. There do not seem to be sex-specific differences in nectar usage. At least for *Scambus buolianae*, males and females exhibit the same relative preferences for four different kinds of flowers (Leius, 1967). In some species, females, but not males, also feed on host body fluids. This trophic difference between the sexes is probably a result of nutritional requirements of females for egg production (e.g. *Bracon hebetor, B. serinopae* (Clark, 1963), *Muscidifurax zaraptor* (Whiting, 1967), Spalangia cameroni (Gerling & Legner, 1968)), rather than a means of reducing competition for food resources. Furthermore, this could not be a universal explanation for sexual size dimorphism because not all dimorphic species exhibit host feeding, e.g. *H. exiguae* (personal observation). Also, host feeding does not explain both male-biased and female-biased dimorphisms: no species are known in which males, but not females, host feed. In some species, males do not feed at all, e.g. *Melittobia chalybii* (Buckell, 1928) and thus do not compete with females for food.

Differential effect of size on reproductive success

Differences between males and females in the effect of size on reproductive success is a more likely explanation for sexual size dimorphisms in parasitoid wasps. For parasitoid wasps, these differences may result, not only from differences in maternal and paternal reproductive effort and from sexual selection, as has been suggested for vertebrates, but also from sib-mating and from the haplodiploid genetics of parasitoid wasps. The combined effects of all four of these factors will determine a species' degree of sexual size dimorphism.

Female-biased size dimorphisms are expected in species for which size has a more positive effect on the reproductive success of females than of males. There is usually a positive relationship between female body size and egg production (e.g. Iwata, 1966; Lawrence, 1981; Narasimham, 1984). However, there are no data for parasitoid wasps on how male size affects sperm production.

Large size may also be beneficial to females in obtaining hosts. (1) In species of *Trichogramma*, large females travel faster and further than small females (Boldt, 1974). Thus, large females may be better able to find hosts. (2) In species in which females must penetrate a hard covering to parasitize their hosts, large females may be more capable of piercing the covering than smaller females (van den Assem, 1976). (3) In species which parasitize larval hosts or host eggs defended by the parents, large females may be less susceptible than small females to mortality related to host defence (e.g. biting). (4) In species in which the females fight among themselves for hosts, large females would be expected to have an advantage in fights, as in *Biosteres longicaudatus* (Lawrence, 1981). Thus, species exhibiting female–female combat would be expected to have more female-biased dimorphism values than species without female–female combat. At present, information on both size dimorphism and the occurrence of female–female combat is known for only a few species.

Sib-mating is an additional factor which may contribute to female-biased sexual size dimorphisms in parasitoid wasps. For those species for which information on mating is available, the usual pattern seems to be that mating among siblings is common but some outcrossing may still occur (Matthews, 1975; Gordh & Hawkins, 1981). When all mating is among siblings, females will be expected to produce only enough sons to fertilize their daughters (Hamilton, 1967). If a small male can produce enough sperm to fertilize all his sisters and if the cost of producing a son increases with its size, then females of sib-mating species should produce small males. In solitary species (species which produce one offspring per host, as opposed to gregarious species which produce multiple offspring per host), the cost of producing an offspring may increase with its size if a wasp's size is positively correlated with its host size (e.g. Jowyk & Smilowitz, 1978; Nealis *et al.*, 1984; Samson, 1984), and large hosts are scarce and/or parasitizing large hosts is difficult or dangerous. In gregarious species the cost of producing an offspring also may increase with the offspring's size because of larval competition. The larger the son, the more host resources he consumes, and the less resources are available for siblings developing in the same host.

Sib-mating is probably more common in gregarious species than in solitary species. For example, in some gregarious species, mating occurs within the host, and males may never even leave the host (e.g. Suzuki & Hiehata, 1985). Thus one would predict that, all else being equal, gregarious species would have more female-biased dimorphism values than solitary species.

The haplodiploid genetic system of parasitoid wasps provides another explanation for female-biased dimorphisms in gregarious species (Pickering, 1980). This genetic system results in asymmetries in relatedness among family members: a male is more closely related to his sister than she is to him, and sisters are more closely related than are brothers. Based on these asymmetries, inclusive fitness theory predicts that selection will result in females which are more selfish to their brothers than males are to their sisters. Thus, female larvae may be more aggressive than their brothers in competing for host resources which are needed to reach maximum size.

Another factor which may affect sexual size dimorphism is sexual selection through mate competition. Competition for mates seems to be limited to males in parasitoid wasps. Males will mate repeatedly throughout their lives, whereas females generally mate only once (Matthews, 1975; Gordh & DeBach, 1978) or repeatedly only for a brief period shortly after emergence (e.g. Stary, 1970).

Sexual selection will result in a female-biased size dimorphism when small size is indirectly beneficial to male reproductive success through selection for early emergence. Both sexes tend to mate at or near their emergence sites (Matthews, 1975). Males frequently emerge before females. By emerging early, a male may increase the number of virgin females with which he can potentially mate. This will be especially true for species in which males defend emergence sites and in which there is a prior ownership advantage (as in *Asolcus basilis*; Wilson, 1961). If male and female larvae grow at the same rate, then to emerge first, males must emerge smaller. This explanation for female-biased size dimorphisms differs from the other explanations I have discussed in that it suggests a benefit to small male size. Some evidence that small size and/or short development time has a positive effect on male reproductive success comes from the solitary species *H. exiguae*. In *H. exiguae*, small male size is not simply a result of mothers ovipositing sons in small hosts, and sons thus not having sufficient food to grow as large as females. Males are smaller and/or emerge earlier than females at a given size host (Jowyk & Smilowitz, 1978).

Alternatively, sexual selection through mate competition may cause a more male-biased size dimorphism. In some species, of parasitoid wasps, males fight for ownership of female emergence sites. Assuming a positive correlation between size and fighting ability, species with male–male aggression would be expected to exhibit a lower degree of size dimorphism than species without male–male aggression. Male–male combat could be the cause of the male-biased dimorphism found in most species of Ichneumoninae; however, the prevalence of male–male combat in this subfamily is not known.

Another aspect of sexual size dimorphism, besides interspecific variation, which deserves attention is intraspecific variation. Variation in the extent of dimorphism in different characters may result from how selection pressures influence different body parts. For example, selection for increased egg production may result in greater dimorphism in abdominal size than in headwidth. Geographic variation in dimorphism may result from different environmental pressures. For example, geographic variation in host distribution may result in interpopulation variation in the occurrence of female–female combat. When hosts are abundant, it may not be worthwhile for females to defend them. Populations with female–female combat are expected to have greater female bias in size dimorphism than populations without female–female combat. For the two species in which dimorphism is known to change with host size (see Results), dimorphism is greater in larger hosts. Perhaps food limitation constrains dimorphism in small hosts by preventing the larger sex from reaching its maximum size. This explanation for intraspecific variation in sexual size dimorphism may also help to explain some of the interspecific differences in sexual size dimorphism. Do species which parasitize smaller hosts exhibit less dimorphism than those parasitizing larger hosts?

FUTURE STUDY

I have discussed some factors which potentially may contribute to sexual size dimorphism in parasitoid wasps. As more data becomes available, a better understanding of the forces acting on the size of males relative to females may be obtained by applying an inter- and an intraspecific approach. The interspecific approach involves comparing the behaviour, physiology and ecology of closely related species which exhibit differences in degree and/or direction of size dimorphism, e.g. *Pteromalinae* species (van den Assem, 1976). As discussed previously, do species with male–male aggression exhibit more male-biased size dimorphisms than species without male–male aggression? Do species with female–female aggression exhibit more female-biased size dimorphism than species without female–female aggression? How do species of Ichneumoninae, which tend to have male-biased dimorphisms, differ from other species of parasitoid wasps? The intraspecific approach involves examining, for individual species, the effect of size on reproductive success of males relative to females. To date this has been done for only one species (*Heterospilis prosopidis*; Charnov, Los-den Hartogh, Jones & Assem, 1981; Jones, 1982). Size had a greater effect on the reproductive success of females than of males. Thus one would predict a female-biased size dimorphism. Indeed females generally are larger than males (W. T. Jones, pers. comm.).

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APPENDIX

Sexual size dimorphism and proportion of overlap of size ranges (see text for definitions)

Wasp	Measure*	Dimorphism (female/male)	Size range or average: male	Size range or average: female	Overlap
APHIDIIDAE					
Binodoxys nearctaphidis (Mackauer, 1965)	Length	1.03	1.8–2.0	1.8–2.1	0.67
Praon callaphis (Mackauer *et al.* 1982)	Length	1.06	1.3–1.8	1.3–2.0	0.71
BETHYLIDAE					
Anisepyris aeneus (= *Rhabdepyris bridwelli*) (Evans, 1959a)	Length	1.14	4–5	5.0–5.3	0.00
A. columbianus	Length	1.25	3–5	4–6	0.33
A. occidentalis	Length	1.20	3.5–5.0	4.0–6.2	0.37
A. subviolaceus	Length	1.19	3.3–4.8	4.0–5.6	0.35
A. williamsi (Evans, 1959b)	Length	1.19	3–5	4–5.5	0.40

*Length and headwidth in millimetres. Weight in milligrams.

Appendix (*cont.*)

Wasp	Measure*	Dimorphism† (female/male)	Size range or average: male	female	Overlap
Dissomphalus xanthopus					
(Evans, 1954)	Length	0.64	1.7–3.3	1.2–2.0	0.14
Goniozus aethiops					
(Gordh & Evans, 1976)	Length	1.23	2.0–2.4	2.4–3.0	0.00
BRACONIDAE					
Acrophasmus ferrugineus	Length	1.46	2.4–5.5	4.5–7	0.22
A. immigrans					
(= *A. lycti*)					
(Marsh, 1968a)	Length	1.30	2–3	2.5–4	0.25
Agathirsia gibbosa	Length:				
(= *Agathis gibbosa*)	range	0.96	3.4–4.5	3.1–4.5	0.79
(Odebiyi & Oatman, 1972)	average	0.97	3.9	3.8	
Alysia cariosa					
(Marsh, 1968b)	Length	0.79	5.5–9	4–7.5	0.40
Apanteles absonus	Length	1.06	2.3–2.8	2.5–2.9	0.50
A. fumiferanae	Length	0.96	2.0–2.9	2.0–2.7	0.78
A. milleri	Length	1.07	2.7–2.8	2.8–3.1	0.00
A. morrisi	Length	1.08	2.5–2.8	2.8–2.9	0.00
A. petrovae					
(Mason, 1974)	Length	1.29	2.2–2.3	2.8–3.0	−0.63
A. dignus	Length				
(Cardona & Oatman, 1971)	average	1.04	2.14	2.23	
A. glomeratus		>			
A. rubecula					
(Nealis *et al.*, 1984)		>			
Asobara citri		=			
A. tabida					
(Bouletreau					
& David, 1981)		=			
Biosteres longicaudatus					
(Lawrence *et al.*, 1976)	Length	1.42	2.5–2.8	3.5–4.0	−0.47
Bracon caulicola					
(= *Microbracon caulicola*)					
(Gahan, 1922)		>			
B. compressitarsis					
(Wharton, 1983)	Length	1.42	2.0–2.8	3.0–3.8	−0.11
B. hebetor					
(Benson, 1973)	Headwidth	>			
B. rhyacioniae	Length:				
(Goyer & Schenk, 1970)	average	1.53	3.0	4.6	
Calaphidius elegans					
(Gardenfors, 1983)	Length	1.08	1.6–2.2	1.7–2.4	0.63
Cantharoctonus canadensis					
(Mason, 1968b)	Length	1.00	2.2–3.0	2.4–2.8	0.50
Coeloides crocator	Length	1.29	3.5–6.0	3.8–8.5	0.44
C. rossicus betulae	Length	1.17	4.5–7.0	4.5–9	0.56
C. scolytivorus	Length	1.00	2.5–3.5	2.5–3.5	1.00
C. sympitys	Length	1.14	3.0–7.5	3.3–8.7	0.74
C. tsugatorus					
(Mason, 1978)	Length	0.99	3.5–8.5	3.4–8.5	0.98
Colastes polypori					
(Mason, 1968b)	Length	1.06	1.7–3.5	2.0–3.5	0.83
Diospilus fomitis					
(Mason, 1968b)	Length	1.11	2.8–3.5	3.0–4.0	0.42
Glyptocolastes caryae					
(Marsh, 1968a)	Length	1.31	2.5–4.0	2.5–6	0.43

*Length and headwidth in millimetres. Weight in milligrams.
† = denotes female size = male size; > denotes female size > male size; < denotes female size < male size.

Appendix (*cont.*)

Wasp	Measure*	Dimorphism† (female/male)	Size range or average male	Size range or average female	Overlap
Heterospilus annulatus					
(Marsh, 1982)	Length	1.20	2–3	2.5–3.5	0.33
Hormius tsugae					
(Mason, 1968b)	Length	1.03	1.7–2.2	1.5–2.5	0.50
Illidops terrestris					
(Wharton, 1983)	Length	1.12	1.8–2.4	2.2–2.5	0.29
Leluthia floridensis	Length	1.29	3–4	4–5	0.00
L. mexicana					
(Marsh, 1967)	Length	1.29	2.5–4.5	3–6	0.43
Macrocentrus ancylivorus					
(Finney *et al.*, 1947)		>			
Meteorus betulini					
(Mason, 1968b)	Length	1.00	3.5–4.5	3.5–4.5	1.00
Myosoma durango	Length	1.55	4.5–5.5	7.0–8.5	−0.38
M. eumystax					
(Mason, 1978)	Length	1.24	4.5–7.5	6.0–8.9	0.34
Opius bellus					
(Gahan, 1930)	Length	1.07	3.5–4	3.5–4.5	0.50
Perilitus areolaris					
(Gerdin & Hedqvist, 1984)	Length	1.05	2.8–3.5	2.9–3.7	0.67
Rhacontus					
(Marsh, 1976)		>			
Rogas hyphantriae					
(Gahan, 1922)		=			
Stenocorse bruchivora					
(Marsh, 1968a)	Length	1.07	2.5–4.5	3–4.5	0.75
Zele daurica					
(Watanabe, 1969)	Length	1.13	7–8	8–9	0.00
CHALCIDIDAE					
Brachymeria intermedia					
(Minot & Leonard, 1976)	Weight	>			
Ceratosmicra debilis	Length	1.00	4–4.5	4–4.5	1.00
C. meteori					
(Burks, 1940)	Length	1.27	3.5–4	4.5–5	−0.33
Chalcis barbara					
(Burks, 1940)	Length	1.04	5–7	5–7.5	0.80
C. barbara	Length	1.08	5.0–7.0	5.0–8.0	0.67
C. divisa	Length	1.03	6.5–8.0	7.0–8.0	0.67
C. neptis					
(Burks, 1977)	Length	0.96	5.5–6.0	5.0–6.0	0.50
C. canadensis	Length	1.11	4.5–5	5–5.5	0.00
C. flebilis	Length	1.11	4–5.5	4.5–6	0.50
C. microgaster					
(Burks, 1940)	Length	1.13	3.5–4.5	4–5	0.33
Invreia deceptor					
(Grissel & Schauff, 1981)					
from host:					
Elasmopalpus lignosellus	Length	1.10	2.3–3.8	2.9–3.8	0.60
Stegasta bosqueella	Length	0.86	2.3–2.7	2.0–2.3	0.00
combined	Length	0.95	2.3–3.8	2.0–3.8	0.83
Metadontia amoena					
(Burks, 1940)	Length	1.29	4.5–6	6–7.5	0.00
Spilochalcis arcana	Length	0.95	4.5–5	4–5	0.50
S. dorsata	Length	1.16	4.5–5	5–6	0.00
S. hirtifemora	Length	1.27	2.5–3	3–4	0.00
S. igneoides	Length	1.24	4.5–6	4.5–8.5	0.38

*Length and headwidth in millimetres. Weight in milligrams.
† = denotes female size = male size; > denotes female size > male size; < denotes female size < male size.

Appendix (*cont.*)

Wasp	Measure*	Dimorphism† (female/male)	Size range or average male	female	Overlap
S. juxta	Length	1.12	4–4.5	4.5–5	0.00
S. mariae	Length	1.32	4–7	4.5–10	0.42
S. nigricornis	Length	1.07	5.5–8.5	6–9	0.71
S. phais	Length	1.28	4–5	5–6.5	0.00
S. phoenica	Length	1.29	5–5.5	6.5–7	−0.50
S. subobsoleta	Length	0.85	4.5–5.5	4–4.5	0.00
S. transitiva (Burks, 1940)	Length	1.10	4–6.5	5–6.5	0.60
CHRYSIDIDAE					
Muesebeckidium occidentale (Krombein, 1969)	Length	1.11	4–5	4.5–5.5	0.33
DIAPRIIDAE					
Trichopria fumipennis	Length	1.18	2.4–2.6	2.8–3.1	−0.29
T. stratiomyiae (Huggert, 1982)	Length	1.14	1.6–2.0	2.0–2.1	0.00
T. popei (= *Phaenopria popei*) (Knutson & Berg, 1963)	Length	1.37	0.84–1.20	1.20–1.59	0.00
Trichopria sp. (Bouletreau & David, 1981)	Length	=			
DRYINIDAE					
Neogonatopus agropyrus	Length	1.11	2–2.25	2–3	0.50
N. ombrodes (Freytag, 1977)	Length	1.22	2–2.5	2.5–3	0.00
Pachygonatopus minimus (Barrett *et al.*, 1965)	Length	1.50	1.8–2.0	2.7–3.0	−0.58
ENCYRTIDAE					
Adektitopus gordhi (Noyes & Hayat, 1984)	Length	1.47	0.87–1.03	1.24–1.56	−0.30
Aleurodiphilus americanus (DeBach & Rose, 1981)	Length	1.16	0.65–0.81	0.74–0.96	0.23
Aphytis acrenulatus	Length	1.56	0.62–0.74	0.86–1.25	−0.19
A. africanus	Length	1.16	0.49–0.80	0.61–0.89	0.48
A. capensis	Length	1.27	0.80–1.19	1.22–1.30	−0.06
A. capillatus	Length	1.01	0.64–0.97	0.60–1.03	0.77
A. cercinus	Length	1.09	0.79–1.19	0.93–1.22	0.60
A. chilensis	Length	1.07	0.54–0.93	0.50–1.08	0.67
A. chrysomphali	Length	1.08	0.56–0.86	0.55–0.99	0.68
A. cochereaui	Length	1.34	0.59–1.08	0.89–1.35	0.25
A. coheni	Length	1.26	0.66–0.90	0.86–1.11	0.09
A. columbi	Length	1.21	0.86–0.95	0.96–1.23	−0.03
A. confusus	Length	1.26	0.75–0.85	0.94–1.07	−0.28
A. costalimai	Length	1.29	0.68–0.86	0.81–1.18	0.10
A. cylindratus	Length	1.40	0.66–0.85	0.76–1.36	0.13
A. debachi		>			
A. diaspidis	Length	1.09	0.61–1.11	0.61–1.26	0.77
A. equatorialis	Length	1.12	0.60–0.74	0.70–0.80	0.20
A. fabresi	Length	1.27	0.59–0.92	0.85–1.07	0.15
A. fisheri	Length	1.31	0.61–0.86	0.68–1.24	0.29
A. funicularis	Length	1.17	0.61–0.93	0.71–1.09	0.46
A. gordoni	Length	1.12	0.55–0.77	0.65–0.83	0.43
A. griseus	Length	1.05	0.72–1.03	0.67–1.17	0.62
A. hispanicus	Length	1.05	0.62–1.02	0.73–1.00	0.67
A. holoxanthus	Length	1.29	0.71–0.92	0.92–1.18	0.00
A. ignotus	Length	1.46	0.62–1.22	1.23–1.45	−0.01

*Length and headwidth in millimetres. Weight in milligrams.
† = denotes female size = male size; > denotes female size > male size; < denotes female size < male size.

Appendix (*cont.*)

Wasp	Measure*	Dimorphism† (female/male)	Size range or average: male	female	Overlap
A. immaculatus	Length	1.06	0.73–1.04	0.84–1.03	0.61
A. japonicus	Length	1.10	0.64–0.83	0.73–0.89	0.40
A. lepidosaphes	Length	1.26	0.70–0.93	0.90–1.15	0.07
A. lingnanensis	Length	1.08	0.69–0.96	0.73–1.05	0.64
A. longicaudus	Length	1.77	0.77–0.96	1.45–1.61	−0.58
A. luteus	Length	1.10	0.91–1.25	0.87–1.50	0.54
A. maculatipennis	Length	1.43	0.57–0.72	0.88–0.96	−0.41
A. margaretae	Length	1.14	0.69–0.97	0.78–1.11	0.45
A. mazalae	Length	1.12	0.65–0.79	0.79–0.82	0.00
A. melanostictus	Length	1.10	0.55–1.10	0.67–1.14	0.73
A. melinus	Length	1.17	0.73–1.01	0.83–1.21	0.38
A. merceti	Length	1.41	0.76–1.16	1.02–1.68	0.15
A. mimosae	Length	1.06	0.74–0.83	0.81–0.85	0.18
A. mytilaspidis	Length	0.83	1.14–1.27	0.75–1.26	0.23
A. notialis	Length	1.29	0.66–0.91	0.81–1.22	0.18
A. obscurus	Length	1.06	0.73–1.03	0.76–1.11	0.71
A. opuntiae	Length	1.04	0.84–0.98	0.70–1.20	0.28
A. philippinensis	Length	1.28	0.76–0.90	0.94–1.18	−0.10
A. pilosus	Length	1.06	0.73–0.80	0.65–0.97	0.22
A. pinnaspidis	Length	1.22	0.54–0.80	0.63–1.00	0.37
A. proclia	Length	1.07	0.82–1.06	0.82–1.20	0.63
A. roseni	Length	1.51	0.68–1.16	1.18–1.59	−0.02
A. salvadorensis	Length	1.26	0.75–0.92	0.98–1.12	−0.16
A. sensorius	Length	1.15	0.43–0.67	0.52–0.74	0.48
A. setosus	Length	1.18	0.58–0.73	0.62–0.92	0.32
A. taylori	Length	1.30	0.62–0.84	0.75–1.15	0.17
A. theae	Length	0.98	0.55–0.78	0.53–0.77	0.88
A. tucumani	Length	1.11	0.85–1.03	0.95–1.14	0.28
A. ulianovi	Length	1.19	0.41–0.87	0.50–1.02	0.61
A. yasumatsui (Rosen & De Bach, 1979)	Length	1.21	0.62–1.02	0.81–1.18	0.38
Chrysoplatycerus ferrisi (Timberlake, 1922)	Length	1.67	0.84–1.18	1.51–1.87	−0.32
Copidosoma innocuellae (Barron, 1970)	Length	1.16	1.0–1.5	1.3–1.6	0.33
Cremesina aquilonaris (Noyes & Hayat, 1984)	Length	1.52	0.67–1.05	1.02–1.59	0.03
Encarsia acaudaleyrodis (Hayat, 1976)	Length	1.13	0.45–0.52	0.47–0.63	0.28
E. pergandiella	Length:				
(Girault, 1908)	range	1.21	0.500–0.580	0.620–0.690	−0.21
	average	1.20	0.546	0.6545	
(Gerling, 1966a)	range	1.08	0.370–0.700	0.485–0.667	0.55
	average	1.03	0.529	0.544	
Eretmocerus californicus	Length:				
(Gerling, 1966b)	range	1.09	0.565–0.825	0.720–0.795	0.29
	average	1.09	0.704	0.767	
E. rajasthanicus (Hayat, 1976)	Length	1.00	0.5–0.62	0.51–0.61	0.83
Hengata spinosa (Noyes & Hayat, 1984)	Length	1.01	0.71–0.94	0.71–0.95	0.96
Hexacladia hilaris (Burks, 1972)	Length	1.10	2.25–2.75	2.5–3.0	0.33
Kataka mudigerensis (Noyes & Hayat, 1984)	Length	1.22	0.89–0.92	0.98–1.22	−0.18
Parapyrus manihoti (Noyes, 1984)	Length	1.13	0.52–0.97	0.57–1.11	0.68

*Length and headwidth in millimetres. Weight in milligrams.
† = denotes female size = male size; > denotes female size > male size; < denotes female size < male size.

Appendix (*cont.*)

Wasp	Measure*	Dimorphism† (female/male)	Size range or average: male	female	Overlap
Protaphelinus nikolskajae (Mackauer, 1972)	Length	1.09	1.03–1.14	0.87–1.50	0.17
Stemmatosteres kuchari (Yoshimoto, 1972)	Length	1.07	0.65–0.70	0.65–0.8	0.33
Tongyus nesus (Noyes & Hayat, 1984)	Length	1.27	0.96–1.30	1.11–1.75	0.24
Zeteticontus utilis (Noyes, 1982)	Length	1.15	1.39–2.08	1.58–2.40	0.50
EUCOILIDAE					
Ganaspidium pusillae (Weld, 1955)	Length: range	0.98	0.95–1.05	0.8–1.15	0.29
	average	1.02	0.98	1.0	
Leptopilina boulardi	Length	1.15	1.0–1.6	1.2–1.8	0.50
L. clavipes	Length	1.07	1.2–1.5	1.2–1.7	0.60
L. fimbriata	Length	1.04	1.2–1.4	1.2–1.5	0.67
L. heterotoma	Length	1.16	1.3–1.8	1.5–2.1	0.37
L. longipes	Length	1.22	1.1–1.6	1.5–1.8	0.14
L. victoriae (Nordlander, 1980)	Length	1.13	1.4–1.6	1.5–1.9	0.20
Rhoptromeris heptoma	Length: range	1.24	1.0–1.5	1.2–1.9	0.33
	average	1.15	1.3	1.5	
R. nigriventris	range	1.16	1.1–1.4	1.3–1.6	0.20
	average		1.2	1.4	
R. villosa (Nordlander, 1978)	Length	1.12	1.0–1.4	1.3–1.4	0.25
Zamischus elongatus (Yoshimoto, 1971)	Length	1.10	5.0–5.5	5.5–6.0	0.00
EULOPHIDAE					
Astichus notus (Yoshimoto, 1970a)	Length	1.27	1.1–1.5	1.5–1.8	0.00
Chrysocharis caribea (Boucek, 1977b)	Length	1.20	0.9–1.4	1.3–1.45	0.18
Colpixys gigas (Boucek, 1972)	Length	1.73	3.5–3.9	6–6.8	−0.62
Dicladocerus nearcticus	Length	1.45	1.8–2.0	2.5–3.0	−0.42
D. pacificus	Length	1.42	1.2–1.4	1.5–2.2	−0.10
D. westwoodi (Yoshimoto, 1976b)	Length	1.26	2.0–2.2	2.5–2.8	−0.37
Dicladocerus (= *Diglyphus*) (Gordh & Hendrickson, 1979)		>			
Edovum puttleri (Grissell, 1981)	Length	1.07	1.2–1.5	1.3–1.6	0.50
Elachertus lasiodermae (Hedqvist, 1977a)	Length	1.29	1.3–1.8	1.8–2.2	0.00
Encarsia versicolor (Girault, 1908)	Length: range	1.21	0.500–0.580	0.620–0.690	−0.21
	average	1.20	0.546	0.6545	
Horismenus bruchophagus	Length	1.20	1.2–1.8	1.6–2.0	0.25
H. carolinensis	Length	1.14	1.5–2.0	1.8–2.2	0.29
H. latrodecti (Burks, 1971)	Length	1.65	0.7–1.3	1.5–1.8	−0.18
Mestocharis nearctica (Yoshimoto, 1976a)	Length	1.20	1.5–2.0	2.0–2.2	0.00

*Length and headwidth in millimetres. Weight in milligrams.
† = denotes female size = male size; > denotes female size > male size; < denotes female size < male size.

Appendix (*cont.*)

Wasp	Measure*	Dimorphism† (female/male)	Size range or average male	Size range or average female	Overlap
Myrmokata diparoides (Boucek, 1972)	Length	1.06	1.5–1.8	1.6–1.9	0.50
Pediobius balyanae	Length	1.35	0.8–0.9	1.1–1.2	−0.50
P. derroni	Length	1.15	1.3–1.4	1.5–1.6	−0.33
P. madas	Length	1.28	1.1–1.8	1.6–2.1	0.20
P. multisetis (Boucek, 1976)	Length	1.53	1.05–1.3	1.5–2.1	−0.19
P. lonchaeae	Length	1.12	1.0–1.6	1.1–1.8	0.63
P. testaceipes (Burks, 1966)	Length	1.30	0.9–1.1	1.2–1.4	−0.20
Pnigalio ternatus (Askew, 1984)	Length	1.40	2.0–2.5	2.8–3.5	−0.20
Syntomosphyrum blattae	Length	1.05	1.0–1.2	0.8–1.5	0.29
S. esurus (Burks, 1952)	Length	1.27	1.0–1.2	1.2–1.6	0.00
Tachinobia repanda (Boucek, 1977a)	Length	0.86	1.15–1.30	0.7–1.4	0.21
Tetrastichus ainsliei	Length	1.17	1.1–1.2	1.2–1.5	0.00
T. baldufi	Length	1.09	1.0–1.2	1.0–1.4	0.50
T. cormus	Length	1.32	1.5–1.9	2.0–2.5	−0.10
T. crino (= *T. oecanthivorus*)	Length	1.08	1.2–1.3	1.3–1.4	0.00
T. gigas	Length	1.40	2.0–3.0	3.0–4.0	0.00
T. hagenowii	Length	1.03	1.2–1.9	1.2–2.0	0.87
T. hibus	Length	1.18	1.4–2.0	1.8–2.2	0.25
T. malacosomae	Length	1.37	0.8–1.1	1.1–1.5	0.00
T. marylandensis	Length	1.24	0.8–1.5	1.0–1.85	0.48
T. melanis	Length	1.19	1.3–1.4	1.3–1.9	0.17
T. minutus	Length	1.29	0.8–1.3	0.9–1.8	0.40
T. pandora	Length	1.03	1.1–1.8	1.4–1.6	0.29
T. pattersonae	Length	1.08	1.8–2.0	1.9–2.2	0.25
T. racemariae	Length	1.14	1.5–2.0	1.8–2.2	0.29
T. rapo	Length	1.23	1.1–1.5	1.4–1.8	0.14
T. sobrius	Length	1.56	1.0–1.25	1.5–2.0	−0.25
T. spilopteris	Length	1.23	1.1–1.5	1.0–2.2	0.33
T. strobilus	Length	1.09	1.5–1.9	1.5–2.2	0.57
T. tesserus	Length	1.12	1.6–1.7	1.6–2.1	0.20
T. tineivorus (= *T. carpatus*)	Length	1.29	0.8–1.3	1.1–1.6	0.25
T. triozae	Length	1.25	0.7–0.9	0.95–1.05	−0.14
T. turionum	Length	1.29	1.0–1.4	1.1–2.0	0.30
T. verrucarii (Burks, 1943)	Length	1.21	1.0–1.4	1.3–1.6	0.17
T. inferens (Yoshimoto, 1970b)	Length	1.52	1.4–1.7	1.7–3.0	0.00
Wichmannia pictipennis (Boucek, 1972)	Length	1.21	0.8–1.1	1.0–1.3	0.20
EUPELMIDAE					
Anastatus umae (Boucek, 1979)	Length	1.45	2.7–3.1	3.4–5.0	−0.13
EURYTOMIDAE					
Buresium naso	Length	1.58	1.45–3.1	3.0–4.2	0.04
B. tenue (Boucek, 1983)	Length	1.10	1.7–2.5	2.0–2.6	0.56

*Length and headwidth in millimetres. Weight in milligrams.
† = denotes female size = male size; > denotes female size > male size; < denotes female size < male size.

Appendix (*cont.*)

Wasp	Measure*	Dimorphism† (female/male)	Size range or average male	Size range or average female	Overlap
ICHNEUMONIDAE					
Anomaloniae (subfamily):					
Agrypon caribbaeum					
(Bland, 1984)	Length	1.02	11.0–12.9	11.0–13.4	0.79
Campopleginae (subfamily):					
Hyposoter exiguae	Length:				
(Hurlbutt, unpubl.)	range	1.08	4.3–7.5	5.6–7.1	0.47
	average S.D.	1.04	6.14 1.17	6.38 0.52	
	Headwidth:				
	range	1.00	0.85–1.55	0.95–1.45	0.71
	average S.D.	1.06	1.18 0.12	1.24 0.11	
(Jowyk & Smilowitz, 1978)	Weight:				
on 2nd instar host	average S.D.	1.07	4.81 0.23	5.17 0.34	
on 4th instar host	average S.D.	1.11	6.25 0.46	6.91 0.49	
Cryptinae (subfamily):					
Anurotropus minutus					
(Cushman, 1924)		>			
Cryptus leechi					
(Mason, 1968a)	Length	1.08	4.5–7.5	5–8	0.71
Diapetimorpha alabama					
(Cushman, 1929)		>			
Mastrus laplantei					
(Mason, 1968a)	Length	1.00	3.5–5	3.5–5	1.00
Messatoporus discoidalis					
(Cushman, 1929)		>			
Ichneumoninae (subfamily):					
Apaeleticus americanus	Length	1.00	7.5–8.5	7.5–8.5	1.00
Barichneumon carolinensis	Length	0.79	6–8	5–6	0.00
B. flaviscuta	Length	0.88	7–9	6–8	0.33
B. libens	Length	0.92	6–7	5–7	0.50
B. neosorex	Length	0.94	7–9	7–8	0.50
B. peramoenus calliandros	Length	0.88	7–10	7–8	0.33
B. peramoenus peramoenus	Length	0.79	9–10	7–8	−0.33
Carinodes havanensis	Length	1.08	12–14	13–15	0.33
Chasmias scelestus	Length	0.86	16–19	13–17	0.17
Chratichneumon					
C. anisotae	Length	0.82	15–18	12–15	0.00
C. annulatipes annulatipes	Length	0.64	9–13	5–9	0.00
C. facetus facetus	Length	0.89	8–10	7–9	0.33
C. flavipectus flavipectus	Length	0.80	6–9	4–8	0.40
C. floridensis	Length	0.89	6–12	5–11	0.71
C. georgius	Length	0.94	15–17	14–16	0.33
C. horani	Length	0.90	9–11	8–10	0.33
C. insulae	Length	0.82	10–12	8–10	0.00
C. louisianae	Length	0.87	11–12	9–11	0.00
C. paraparatus	Length	0.87	9–14	8–12	0.50
C. paratus paratus	Length	0.68	9–13	5–10	0.13
C. proximus	Length	0.90	14–16	13–14	0.00
C. pseudanisotae	Length	0.97	12–17	13–15	0.40
C. ritus	Length	0.96	11–14	10–14	0.75
C. scitulus	Length	0.94	6–10	7–8	0.25
C. subfilatus	Length	1.00	11–15	11–15	1.00
C. sublatus	Length	0.77	14–17	9–15	0.13
C. unifasciatorius					
unifasciatorius	Length	0.91	14–18	12–17	0.50
C. variegatus variegatus	Length	0.83	16–19	14–15	−0.20
C. vescus	Length	0.73	9–13	7–9	0.00

*Length and headwidth in millimetres. Weight in milligrams.
† = denotes female size = male size; > denotes female size > male size; < denotes female size < male size.

Appendix (*cont.*)

Wasp	Measure*	Dimorphism†	Size range or average		Overlap
		(female/male)	male	female	
C. vinnulus	Length	1.04	9–14	9–15	0.83
C. w-album w-album	Length	0.89	12–15	11–13	0.25
Diphyus comes	Length	0.80	16–19	13–15	−0.17
Eutanyacra pycnopus	Length	1.00	12–13	12–13	1.00
E. succincta	Length	0.90	14–16	13–14	0.00
Gnamptopelta obsidianator					
G. o. austrina	Length	0.98	21–26	21–25	0.80
G. o. obsidianator	Length	0.90	25–27	21–26	0.17
Hemihoplis teres	Length	0.95	9–12	9–11	0.67
Homotherus townesi	Length	0.88	8–9	7–8	0.00
Ichneumon (= *Coelichneumon*)					
I. azotus	Length	0.97	14–18	15–16	0.25
I. eximius	Length	0.94	15–18	14–17	0.50
I. jejunus	Length	1.04	11–16	13–15	0.40
I. maurus	Length	1.03	18–22	19–22	0.75
I. navus albidior	Length	0.95	8–13	8–12	0.80
I. navus navus	Length	0.95	8–13	8–12	0.80
I. pulcher	Length	1.03	16–18	17–18	0.50
I. punctifer	Length	0.97	14–18	14–17	0.75
I. sassacus	Length	0.94	15–17	13–17	0.50
I. viola	Length	0.92	16–21	16–18	0.40
Limonethe maurator	Length	0.93	12–18	12–16	0.67
Linycus					
L. exhortator thoracicus	Length	1.00	7–8	7–8	1.00
Melanichneumon					
M. disparilis disparilis	Length	0.90	9–11	8–10	0.33
M. heiligbrodtii	Length	0.96	10–14	10–13	0.75
M. leviculus	Length	0.86	10–11	8–10	0.00
Orgichneumon					
O. calcatorius albidior	Length	0.91	16–19	14–18	0.40
O. calcatorius calcatorius	Length	0.97	13–16	11–17	0.50
Phaeogenes trianguliferens	Length	1.00	7–8	7–8	1.00
Platylabus clarus	Length	0.93	14–16	13–15	0.33
P. hyperetis	Length	0.93	10.5–11	9.5–10.5	0.00
Probolus detritus	Length	0.90	14–16	12–15	0.25
Protichneumon ambiguus	Length	1.00	20–25	20–25	1.00
P. grandis grandis	Length	0.94	26–28	24–27	0.25
P. radtkeorum	Length	0.94	25–29	25–26	0.25
Protopelmus atrocaeruleus	Length	1.09	20–24	22–26	0.33
Pterocormus (= *Ichneumon*)					
P. ambulatorius	Length	0.74	14–17	10–13	−0.14
P. devinctor	Length	0.95	20–21	19–20	0.00
P. fuscifrons fuscifrons	Length	1.00	12–15	13–14	0.33
P. lewisii	Length	0.94	17–18	14–19	0.20
P. mendax	Length	0.96	11–13	10–13	0.67
P. versabilis	Length	0.85	12–14	10–12	0.00
P. weemsi	Length	0.89	13–15	11–14	0.25
P. weemsi					
(= *I. tritus*)	Length	0.81	13–14	10–12	−0.25
Rictichneumon belfragei	Length	0.86	13–15	10–14	0.20
Rubicundiella annulicornis	Length	0.88	7–10	6–9	0.50
R. mucronata	Length	0.81	10–11	7–10	0.00
R. perturbatrix	Length	0.82	7–10	6–8	0.25
Setanta compta compta	Length	0.93	13–15	12–14	0.33
Spilichneumon					
S. provancheri provancheri	Length	0.93	14–15	13–14	0.00
Tricholabus adventicus	Length	0.96	12–14	11–14	0.67

*Length and headwidth in millimetres. Weight in milligrams.

† = denotes female size = male size; > denotes female size > male size; < denotes female size < male size.

Appendix (*cont.*)

Wasp	Measure*	Dimorphism† (female/male)	Size range or average male	female	Overlap
T. mitchelli	Length	1.00	12–13	12–13	1.00
Tricyphus apicalis	Length	0.90	20–21	17–20	0.00
T. floridanus	Length	0.95	20–21	19–20	0.00
Trogomorpha trogiformis	Length	0.93	13–16	12–15	0.50
Virgichneumon					
V. albomarginatus	Length	0.89	13–15	12–13	0.00
V. subcyaneus subcyaneus	Length	0.86	12–16	10–14	0.33
Vulgichneumon brevicinctor	Length	0.96	9–14	10–12	0.40
V. terminalis terminalis (Heinrich, 1977)	Length	0.83	7–11	7–8	0.25
Mesosteninae (subfamily):					
Lagarosoma assitum (Gupta & Gupta, 1984)		>			
Pimplinae (subfamily):					
Dolichomitus sp. (Kishi, 1970) on host species (lightest to heaviest):					
Shirahoshizo sp.	Pupal weight	1.33	10–50	30–50	0.50
Niphades variegatus	Pupal weight	1.67	10–50	20–80	0.43
Gregopimpla himalayensis (Shiga & Nakanishi, 1968)	Weight	2.00	1–4	2–8	0.29
Itoplectis cristatae (Nozato, 1969)	Pupal length	1.27	3.79–7.33	5.47–8.67	0.38
Pimpla turionellae (Arthur & Wylie, 1959) on host species (lightest to heaviest)					
Rhyacionia buoliana	Average weight	1.33	12	16	
Pyrausta nubilalis	Average weight	1.61	18	29	
Galleria mellonella	Average weight	1.36	22	30	
Pieris rapae	Average weight	1.29	21	27	
Trichoplusia ni	Average weight	1.79	24	43	
Algais milberti	Average weight	1.29	31	40	
Malacosoma americanum	Average weight	1.52	29	44	
Danaus plexippus	Average weight	2.11	36	76	
Combined	Average weight	1.58	24	38	
Rhyssa persuasoria (Spradbery & Ratowsky, 1974)		>			
Tryphoninae (subfamily):					
Phytodietus rutilus (Krebs, 1969)	Length	1.11	5.9–6.7	6.7–7.3	0.00
MYMARIDAE					
Anneckia oophaga (Subba Rao, 1968)	Length	1.04	1.3–1.5	1.2–1.7	0.40
Polynema ema	Length:				
(Schauff	range	0.93	0.60–0.75	0.60–0.66	0.40
& Grissell, 1982)	average	0.97	0.66	0.64	
PLATYGASTRIDAE					
Platygaster gracilipes (Huggert, 1975)	Length	1.36	1.0–1.2	1.1–1.9	0.11
P. tubulosa (Huggert, 1980)	Length	1.02	1.1–1.3	0.74–1.70	0.21

*Length and headwidth in millimetres. Weight in milligrams.
† = denotes female size = male size; > denotes female size > male size; < denotes female size < male size.

Appendix (*cont.*)

Wasp	Measure*	Dimorphism† (female/male)	Size range or average: male	female	Overlap
PTEROMALIDAE					
Arthrolytus muesebecki					
(Burks, 1969b)	Length	1.31	3.0–3.5	3.5–5.0	0.00
A. oezbeki					
(Doganlar, 1978)	Length	1.47	1.13–2.81	2.29–3.52	0.22
Echthrodape africana					
(Burks, 1969a)	Length	0.94	3.5–4.5	3.5–4.0	0.50
Euperilampus krombeini					
(Burks, 1969a)	Length	1.16	4.0–5.5	5.0–6.0	0.25
Habrocytus actinopterae					
(Hedqvist, 1977b)	Length	1.06	1.5–2.0	1.5–2.2	0.71
Halticoptera rosae					
(Burks, 1955a)	Length	1.15	3.0–3.5	3.5–4.0	0.00
Herbertia indica	Length	1.08	1.1–1.4	1.2–1.5	0.50
H. wallacei					
(Burks, 1959)	Length	1.33	1.0–1.25	1.25–1.75	0.00
Lariophagus distinguendus					
(van den Assem, 1971)	Length	1.21	0.67–2.3	1.1–2.5	0.66
Macromesus javensis					
(Hedqvist, 1968)	Length	1.10	1.9–2.2	2.0–2.5	0.33
Mesopolobus finlaysoni					
(Doganlar, 1979)	Length	1.31	1.61–1.80	2.06–2.42	−0.32
Monacon platypodis					
(Boucek, 1980)	Length	0.97	2.8–3.2	2.8–3.0	0.50
Muesebeckisia mandibularis					
(Hedqvist, 1969)	Length	1.21	3.2–4.0	4.2–4.5	−0.15
Muscidifurax raptor					
(Legner, 1976)	Average weight	1.44	0.09	0.13	
(Kogan & Legner, 1970)	Headwidth	1.11	0.61	0.68	
	Length:				
(Rueda & Axtell, 1985)	range	1.13	1.70–2.20	1.90–2.50	0.38
	average	1.15	1.83	2.10	
(Kogan & Legner, 1970)	average	1.35	1.73	2.33	
(Legner, 1969)					
from Chile	Weight	1.76	0.62	1.09	
from South Africa	Weight	1.27	0.94	1.19	
from Israel	Weight	1.32	0.99	1.31	
from Orlando, Florida	Weight	1.57	0.86	1.35	
from s.w. U.S.					
(small form)	Weight	1.48	0.92	1.36	
from Costa Rica	Weight	1.51	0.90	1.36	
from Puerto Rico	Weight	2.45	0.60	1.47	
from Uruguay	Weight	1.81	0.85	1.54	
from Mexico	Weight	1.73	1.20	2.07	
from s.w. U.S.					
(giant form)	Weight	1.32	1.80	2.38	
M. raptorellus					
(Kogan & Legner, 1970)					
from Chile	Length	1.16	1.82	2.11	
	Headwidth	1.03	0.60	0.62	
from Uruguay	Length	1.24	1.85	2.29	
	Headwidth	1.08	0.62	0.67	
M. raptoroides					
(Kogan & Legner, 1970)					
from Costa Rica	Length	1.30	1.78	2.31	
	Headwidth	1.06	0.63	0.67	

*Length and headwidth in millimetres. Weight in milligrams.
† = denotes female size = male size; > denotes female size > male size; < denotes female size < male size.

Appendix (*cont.*)

Wasp	Measure*	Dimorphism† (female/male)	Size range or average: male	female	Overlap
from Mexico	Length	1.21	1.98	2.39	
	Headwidth	1.06	0.66	0.70	
M. zaraptor					
(Legner, 1976)	Average weight	1.43	0.14	0.20	
(Kogan & Legner, 1970)	Headwidth	1.06	0.71	0.75	
	Length	1.30	2.18	2.84	
(Rueda & Axtell, 1985)	Length:				
	range	1.26	1.80–2.20	1.95–3.10	0.19
	average	1.41	2.03	2.87	
Nasonia vitripennis	Length:				
(Rueda & Axtell, 1985)	range	1.20	1.00–1.50	1.10–1.90	0.44
	average	1.50	1.15	1.73	
Obtusiclava oryzae					
(Subba Rao, 1973)	Length	1.35	1.75–2.5	2.5–3.25	0.00
Pachycrepoideus vindemiae					
(van Alphen &	Weight	1.35	0.025–0.075	0.028–1.075	0.58
Thunissen, 1983)	Headwidth	1.02	0.002–0.246	0.002–0.240	0.98
(Rueda & Axtell, 1985)	Length:				
	range	1.19	1.10–2.00	1.50–2.20	0.45
	average	1.08	1.81	1.96	
Perilampus anomocerus	Length	1.06	1.75–2.25	1.75–2.5	0.67
P. canadensis	Length	1.25	2.5–3.5	3–4.5	0.25
P. carinifrons	Length	1.18	2–2.25	1.75–3.25	0.17
P. carolinensis	Length	1.33	3.5–4	4.5–5.5	−0.25
P. chrysopae	Length	1.13	1.5–2.5	1.5–3	0.67
P. crawfordi	Length	1.00	2.5–3	2.5–3	1.00
P. fulvicornis	Length	1.11	1.5–3	1.5–3.5	0.75
P. granulosus	Length	1.06	1.75–2.5	1.75–2.75	0.75
P. hyalinus	Length	1.25	2–4	2–5.5	0.57
P. muesebecki	Length	1.21	1.5–2	1.5–2.75	0.40
P. ocellatus	Length	1.04	2.75–3.25	3–3.25	0.50
P. platygaster	Length	1.14	2.25–3	2.5–3.5	0.40
P. robertsoni	Length	1.10	2.25–2.75	2.5–3	0.33
P. rohweri	Length	0.91	2.5–3	2–3	0.50
P. similis	Length	1.22	1.75–2.75	1.75–3.75	0.50
P. stygicus	Length	1.07	1.75–2	1.75–2.25	0.50
P. subcarinatus	Length	1.04	2.5–3.5	2.5–3.75	0.80
P. tristis					
(= *P. capitatus*)					
(Smulyan, 1936)	Length	1.11	1.75–2.75	2–3	0.60
P. philembia					
(Burks, 1969a)	Length	1.13	1.75–2.0	1.75–2.50	0.33
Pteromalus osmiae	Length	1.42	2.0–3.0	3.0–4.1	0.00
P. sylveni					
(Hedqvist, 1979)	Length	1.28	2.0–2.3	2.0–3.5	0.20
P. puparum					
(Bouletreau & David, 1981)		>			
(Nealis *et al.*, 1984)		>			
Spalangia cameroni	Length:				
(Boucek, 1963)	range	1.07	2.4–3	2.5–3.3	0.56
(Rueda & Axtell, 1985)	range	1.13	1.80–2.60	2.10–2.85	0.48
	average	1.13	2.29	2.59	
S. drosophilae	Length:				
(Boucek, 1963)	range	1.07	1.3–1.6	1.4–1.7	0.50
(Rueda & Axtell, 1985)	range	1.22	0.80–1.25	0.90–1.60	0.44
	average	1.24	1.05	1.30	

*Length and headwidth in millimetres. Weight in milligrams.
† = denotes female size = male size; > denotes female size > male size; < denotes female size < male size.

Appendix (*cont.*)

Wasp	Measure*	Dimorphism† (female/male)	Size range or average: male	female	Overlap
S. endius					
(Legner, 1976)	Average weight	1.58	0.12	0.19	
	Length:				
(Boucek, 1963)	range	1.11	1.9–2.6	2–3	0.55
(Rueda & Axtell, 1985)	range	1.21	1.60–2.30	1.80–2.90	0.38
	average	1.25	2.06	2.57	
S. erythromera	Length	1.07	1.9–2.7	1.7–3.2	0.53
S. fuscipes	Length	1.13	1.3–1.8	1.5–2	0.43
S. nigra	Length:				
(Boucek, 1963)	range	1.21	2.5–3.7	3–4.5	0.35
(Rueda & Axtell, 1985)	range	1.09	2.00–2.70	2.20–2.90	0.55
	average	1.10	2.36	2.59	
S. nigripes	Length	1.21	2–3.1	2.5–3.7	0.35
S. nigroaenea	Length:				
(Boucek, 1963)	range	1.12	2.5–3.5	2.9–3.8	0.46
(Rueda & Axtell, 1985)	range	1.08	2.10–2.80	2.20–3.10	0.60
	average	1.07	2.48	2.66	
S. subpunctata					
(Boucek, 1963)	Length	1.02	2.1–2.7	1.8–3.1	0.46
Theocolaxia bifasciata					
(Hedqvist, 1969)	Length	1.05	3.0–3.2	3.1–3.4	0.25
Urolepis rufipes	Length:				
(Rueda & Axtell, 1985)	range	1.56	1.25–2.08	2.18–3.02	0.00
	average	1.56	1.75	2.73	
Zatropis capitis	Length	1.07	1.2–1.8	1.2–2.0	0.75
Z. chalcis	Length	1.23	1.2–1.8	1.5–2.2	0.30
Z. rosaecolis					
(Burks, 1955b)	Length	1.71	1.5–2.0	2.0–4.0	0.00
SCELIONIDAE					
Telenomus fariai					
(Bosque & Rabinovich, 1979)	Length	>			
T. phymatae					
(Masner & Johnson, 1979)	Length	0.99	1.21–1.31	1.09–1.40	0.32
T. solitus	Length:				
(Johnson, 1983)	average S.D.	1.04	1.26 0.07	1.31 0.06	
SCLEROGIBBIDAE					
Sclerogibba citipes					
(Krombein, 1979)	Length	1.11	3.0–3.5	3.2–4.0	0.30
TIPHIIDAE					
Mizininae (subfamily):					
Hylomesa longiceps					
(Krombein, 1968)	Length	1.31	12–17	15–23	0.18
Thynninae (subfamily):					
Eirone salteri					
(Brown, 1984)	Length	0.77	14–16	11–12	−0.40
Tiphiinae (subfamily):					
Krombeinia evansi					
(Allen, 1969)	Length	1.10	6.6–11.2	8.4–11.2	0.61
Paratiphia					
P. aequalis aequalis	Length	1.18	6.5–10	9–10.5	0.25
P. nevadensis					
(= *P. intermedia*)					
(Allen, 1962)	Length	1.13	7–9	7–11	0.50
Tiphia grenada					
(Allen, 1970)	Length	1.53	6.0–7.4	9.5–11.0	−0.42

*Length and headwidth in millimetres. Weight in milligrams.
† = denotes female size = male size; >denotes female size >male size; <denotes female size <male size.

Appendix (*cont.*)

Wasp	Measure*	Dimorphism†	Size range or average		
		(female/male)	male	female	Overlap
T. hispaniolae					
(Allen & Krombein, 1961)	Length	1.65	7–10	12–16	−0.22
T. irfla					
(Allen, 1961)	Length	1.32	9–10	12–13	−0.50
Methochinae (subfamily):					
(Borror *et al.*, 1976)		<			
Myrmosinae (subfamily):					
(Borror *et al.*, 1976)		<			
TORYMIDAE					
Liondontomerus nitens					
(Boucek, 1982)	Length	1.61	1.5–2.1	2.0–3.8	0.04
Microdontomerus crassipes					
(Boucek, 1982)	Length	1.33	2.0–2.6	2.5–3.6	0.06
Monodontomerus mexicanus					
(Gahan, 1941)	Length	>			
Roptrocerus xylophagorum					
(Samson, 1984)					
on 2nd instar host	Length	1.23	2.19±0.05	2.70±0.09	
on 3rd instar host	Length	1.27	2.63±0.04	3.35±0.04	
Torymus canariensis					
(Hedqvist, 1977a)	Length	1.03	1.2–1.7	1.2–1.8	0.83
TRICHOGRAMMATIDAE					
Poropoea morimotoi	Length	1.14	0.80–1.19	0.91–1.36	0.50
on host					
(smallest to largest):					
Paracentrocorynus					
nigricollis	Length	1.15	0.80–0.86	0.91–1.00	
Phialodes rufipennis	Length	1.21	1.00–1.19	1.29–1.36	
combined	Length	1.14	0.80–1.19	0.91–1.36	
P. reticulata					
(Hirose, 1963)	Length	1.17	0.93–1.00	1.07–1.19	−0.27
Trichogramma minutum					
(Southard *et al.*, 1982)	average S.D.				
wild population:					
on *Choristoneura*	Length	0.77	2.16 0.47	1.67 0.27	
fumiferana (host)	Headwidth	0.85	4.63 0.90	3.95 0.47	
lab populations:					
12 generations on	Length	0.90	2.09 0.37	1.88 0.25	
C. fumiferana	Headwidth	0.96	4.51 0.75	4.35 0.65	
52 generations on					
Sitotroga cerealella	Length	0.92	2.64 0.25	2.42 0.25	
(host)	Headwidth	1.01	5.33 0.23	5.40 0.48	
on *C. fumiferana*,					
after 60 generations	Length	0.88	2.41 0.38	2.14 0.23	
on *S. cerealella*	Headwidth	0.93	4.89 0.53	4.54 0.46	
on *S. cerealella*,					
after 12 generations	Length	0.97	2.43 0.33	2.35 0.23	
on *C. fumiferana*	Headwidth	1.07	5.15 0.47	5.52 0.34	

*Length and headwidth in millimetres. Weight in milligrams.

† = denotes female size = male size; > denotes female size > male size; < denotes female size < male size.

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